SOOTBLOWER SAFETY AND UPGRADE GUIDELINE

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ABSTRACT - Sootblower Safety & Upgrade Guideline
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Sootblowers can pose a significant threat of injury and costly damage to surrounding equipment if they are not adequately maintained or if critical issues are not being addressed early. All accidents are preventable but the challenge is to do it in a systematic and cost-effective way. This challenge is especially real for pulp mills with aging equipment and lack of capacity of trained maintenance personnel. This condition often force the pulp mills to run their sootblower-to-failure. This maintenance practice is typically unsafe and counter to recommended operating procedure but unfortunately, is not uncommon.

There are three key factors to ensure sootblower fitness to operate. They are (1) Sootblower Design, (2) Maintenance Practice, and (3) Recovery Boiler Operation. This paper discusses these three key contributing factors, sootblower walkdown best practices, and offers recommendation on how to better deal with sootblower maintenance practices.

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Sootblower Safety & Upgrade Guideline

Danny S. Tandra

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CLYDE BERGEMANN

Introduction

- Sootblowers play an important role to control fireside deposit accumulation in recovery boilers and to prevent unscheduled shutdown due to heavy fouling / plugging

Introduction

- Especially in Canada & USA, many sootblowers are operated well beyond their normal service life.

Sootblower	Canada	USA	Brazil	Finland	Sweden + Norway
Average Age	41	41	18	28	34
Oldest	71	66	41	59	60

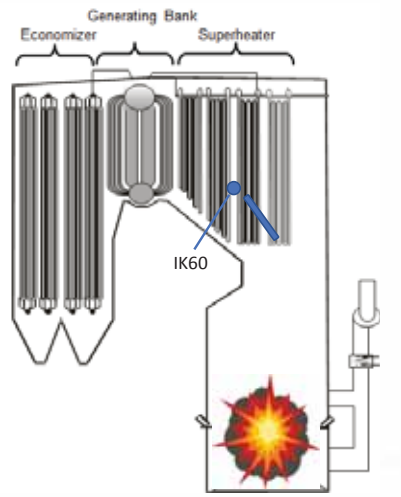
- Although it is possible to extend the sootblower's service life, the recovery boiler operators need to follow the sootblower's maintenance best practices to ensure safety, reliability, and at the same time, control the maintenance cost *(which has to be much lower than the cost of purchasing a new sootblower)*

Introduction

- Unprecedented challenges that a pulp mill has to face in dealing with their sootblowers
  - ➔Aging sootblower equipment
  - ➔Retiring experience personnel
  - ➔Lack of hands on training, and trained maintenance team
  - ➔Competing budget & resources
- There are many sootblower's components that require our attention, especially when the component is installed on an old sootblower.
- But in this presentation, we are going to focus on the lance tube

Lance Tube

- Lance tube has been a hot topic discussion lately especially after 2017 incident in Canada where a lance tube failed, fell into the furnace, punctured the floor, and caused a smelt-water explosion.

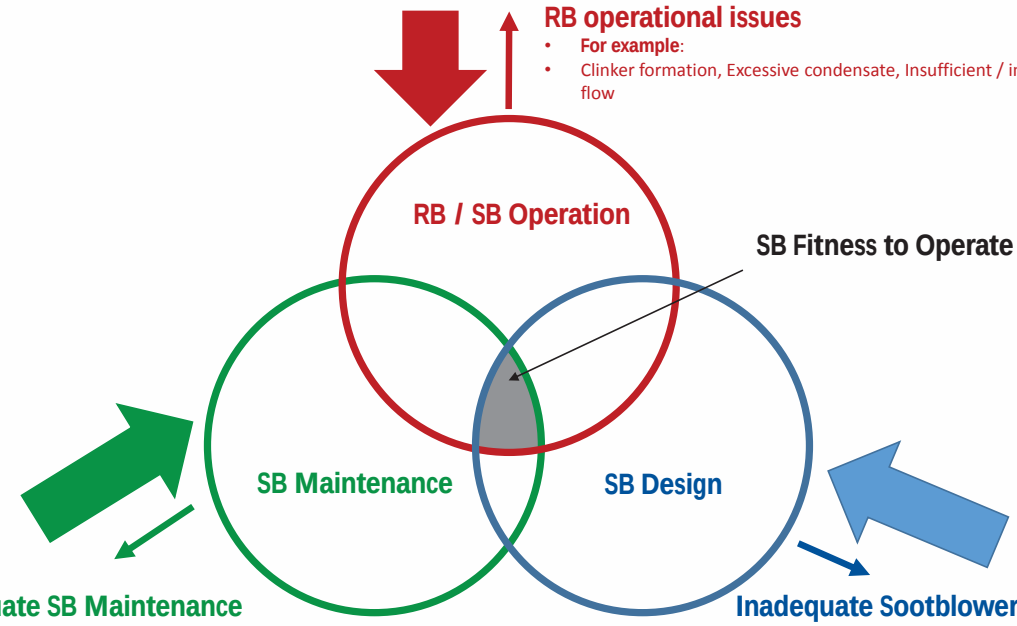


Recent Lance Tube Failure Incidents

- 5 incidents reported in 2017
  - ➔Brazil, Poland, Canada, Finland, Austria
- 3 incidents reported in 2018
  - ➔Thailand, USA, Brazil
- Occurred in multiple countries, different SB manufacturers, Boiler OEMs, and Pulp mills

Incident in a Brazilian Pulp Mill

Responsibility Circles

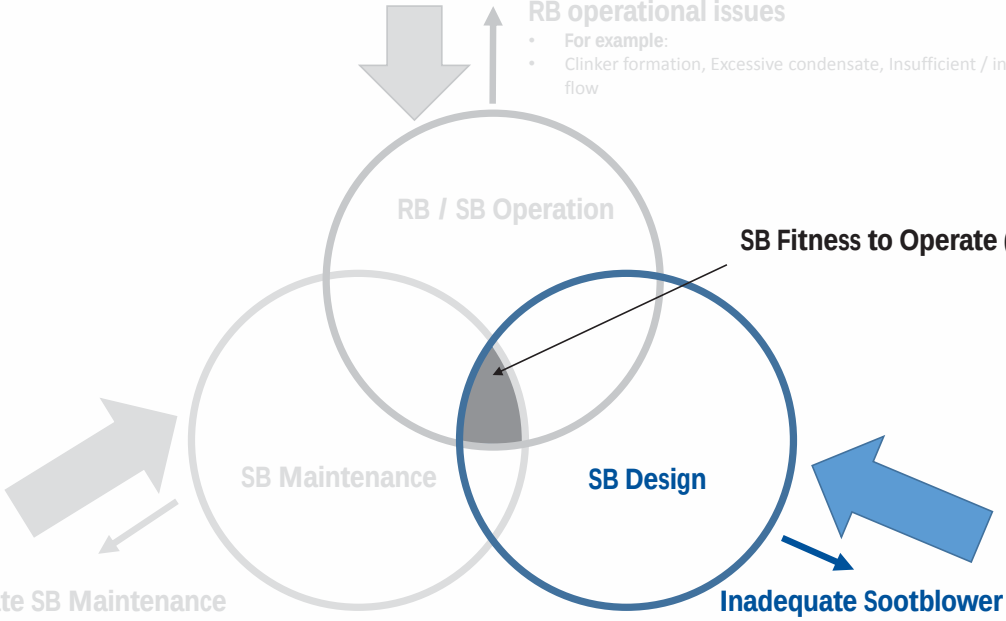


RB operational issues
- **For example**:
- Clinker formation, Excessive condensate, Insufficient / inconsistent steam flow

Inadequate SB Maintenance
- **For example**:
- Abnormal stresses due to sootblower misalignment
- Allowing corrosive gas to enter SB
- Failure to replace critical SB components in timely manner

Inadequate Sootblower Design
- **For example**:
- Material selection and manufacturing process
- Insufficient Safety Factor
- Lack of design features to prevent frequently known failure Torque limiting sprocket, Internal indexing

First, Let's look into the 1st circle (SB Design)



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Lance Tube Material

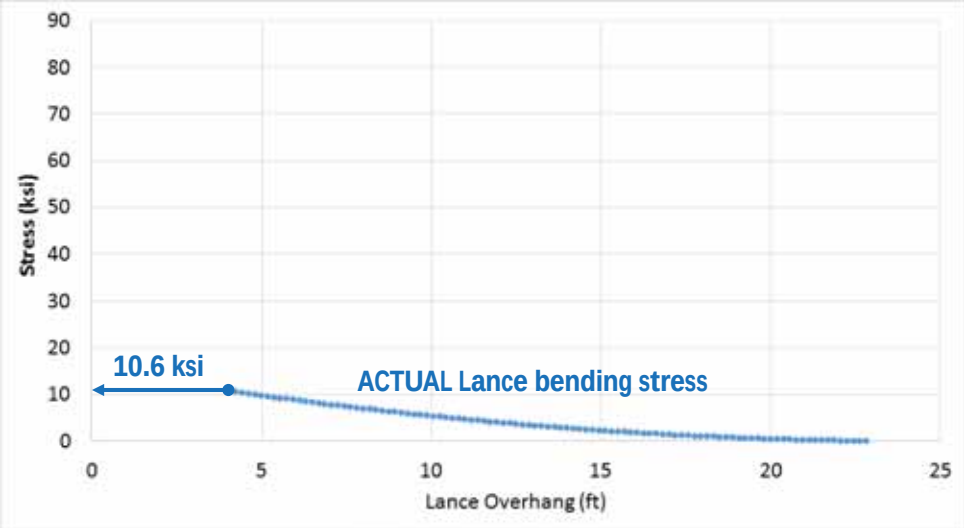
- What design code we need to use for Lance Tube material?
- In USA, the companion Guide to the ASME Code Volume 1, page 444 – 446 produces Figure 100.1.2 (B) which indicates that sootblowers is **NOT** under the jurisdiction of BPVC (Boiler & Pressure Vessel Code).
- Rather, it is under B31.1 power pressure piping code.
- But B31.1 is **NOT** written for sootblower application:
  - ➔Unlike stationary power piping, Lance tube experiences much higher stress loading (i.e., it is rotating while being inserted into a boiler. It has to hold its own weight like a cantilever)
  - ➔Lance is not a pressure vessel because there are at least two nozzles to relieve steam pressure

Lance Tube Material

- Lance has to be designed with **higher** standard than B31.1
- But it doesn't have to be more expensive.
- First off, it is proposed to completely eliminate the use of Stainless Steel lance tube.
  - ➔It is still widely used in EU and some in North America
  - ➔It does **NOT** meet B31.1 and it is **EXPENSIVE**.

Lance Material Selection (Must Exceed ASME B31.1)

- Allowable Stress ≤ Yield Strength / 3.5
- 3.5 here is the safety factor
- NOTE: Smaller allowable stress means that the design criterion is more conservative



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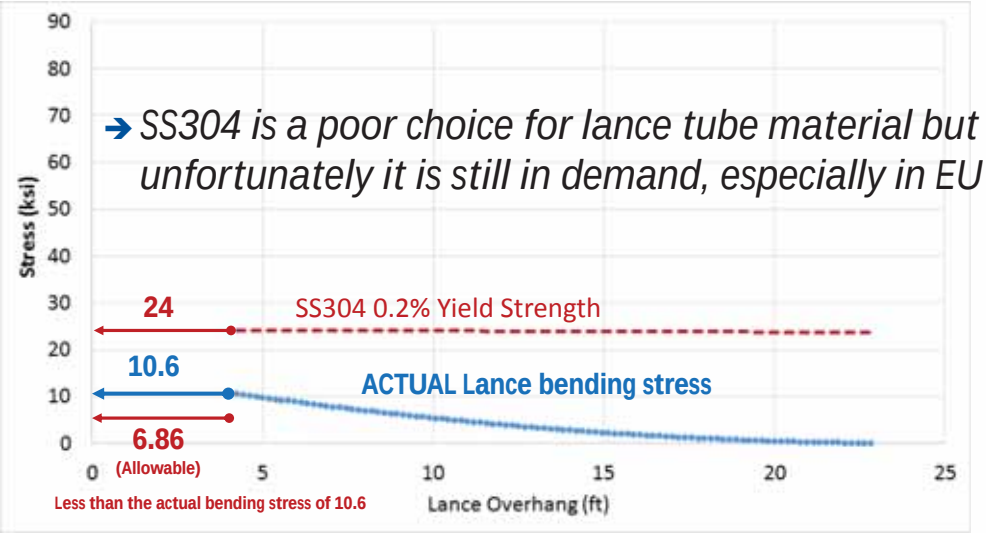

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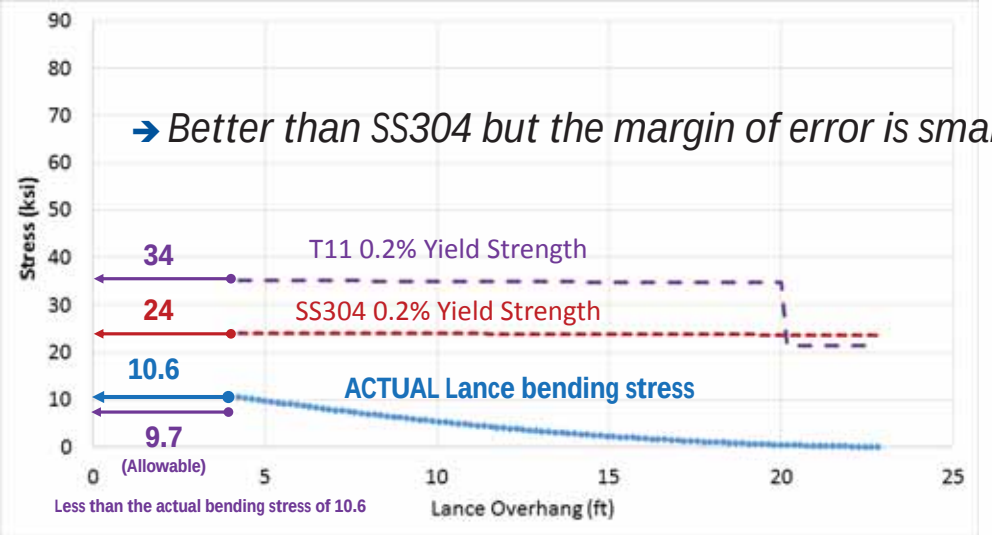

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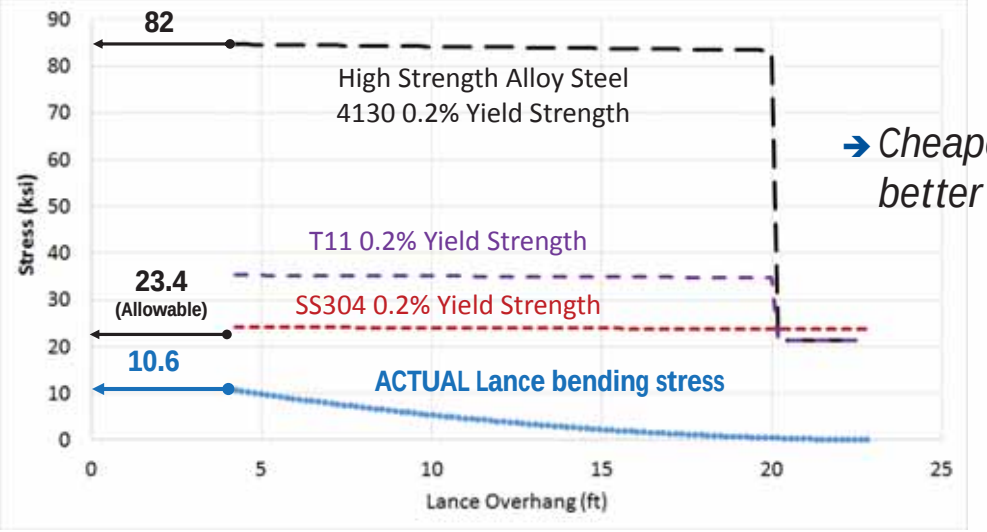


As for the recommended welding design

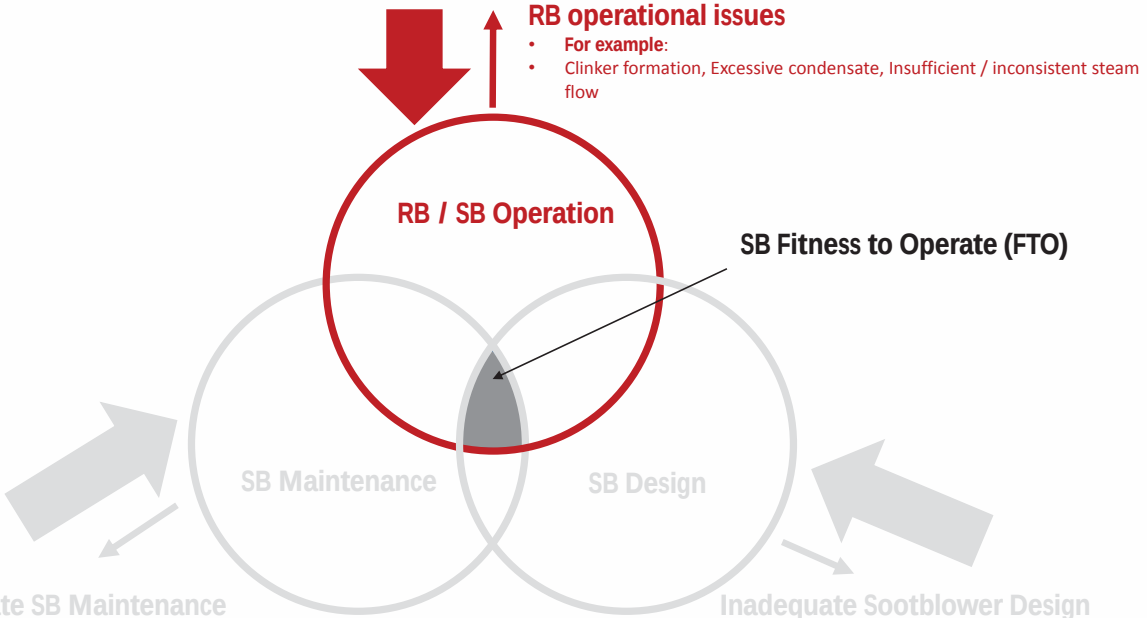
Design should follow ASME Section IX and B31.1 or its equivalent.

- Welding according to ASME Section IX
- 100% Non Destructive Test (NDT) Before Shipping – typically using X-Ray or Phased Array to inspect the quality of the weld joints
- No feed tube splicing – Means that there should NOT be any weld joint in the middle of feed tube.

ELIMATED SPLICING

- Preheat & Post Weld Heat Treatment (PWHT) according to ASME B31.1

Next, Let's look into the 2nd circle (RB/SB Operation)



Inadequate SB Maintenance

- For example:
- Abnormal stresses due to sootblower misalignment
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Inadequate Sootblower Design

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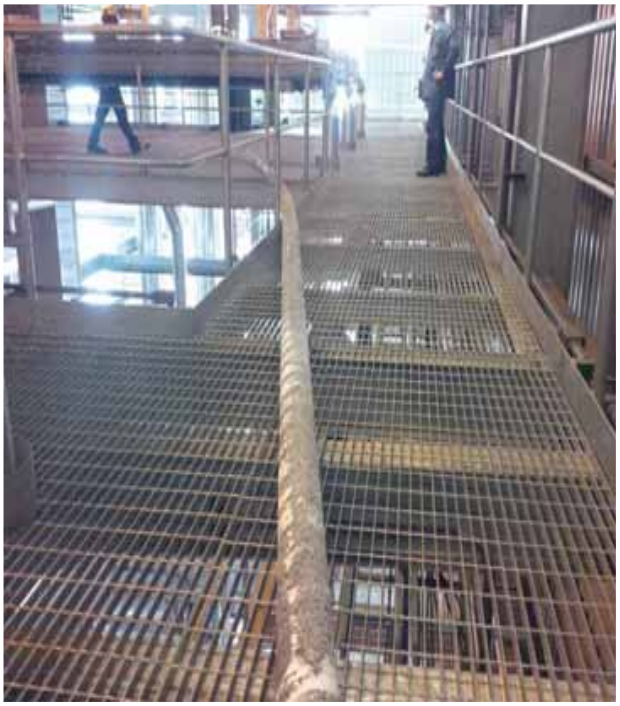
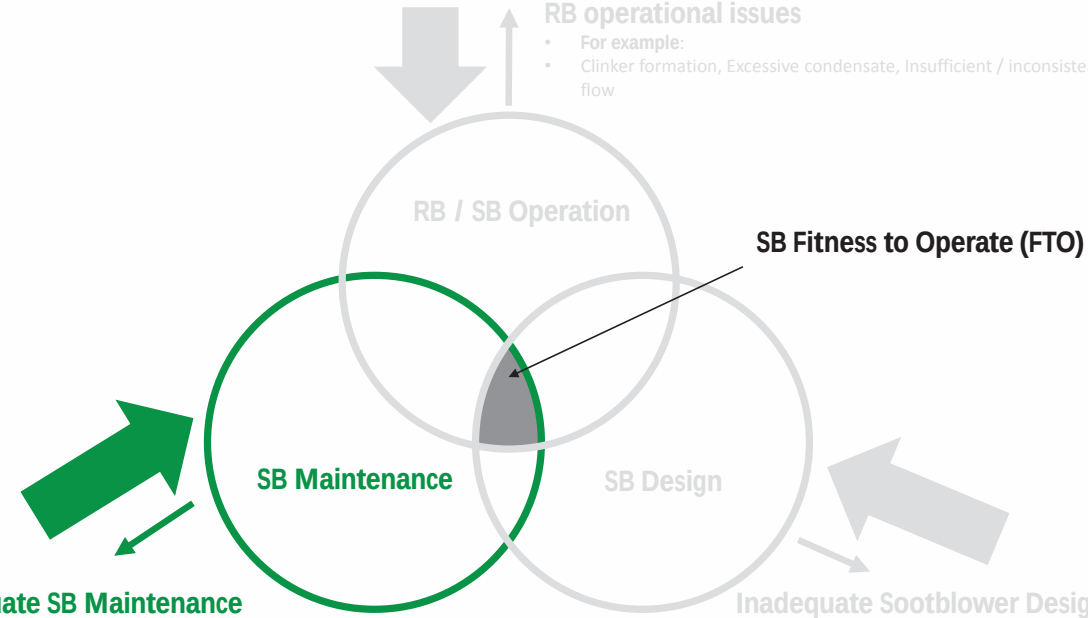
Next, Let's look into the 2nd circle (RB/SB Operation)

- Most common causes of lance tube failure from the RB / SB operational factor are
  1. Large deposit (Clinker) fall into lance tube
  2. Insufficient cooling flow, causing the lance to overheat and bend
- Sootblower motor amperage and walkdown are the two most common ways to detect lance bending.
- Early identification of the lance issue is crucial to ensure safe operation of the SB and prevent costly repair.

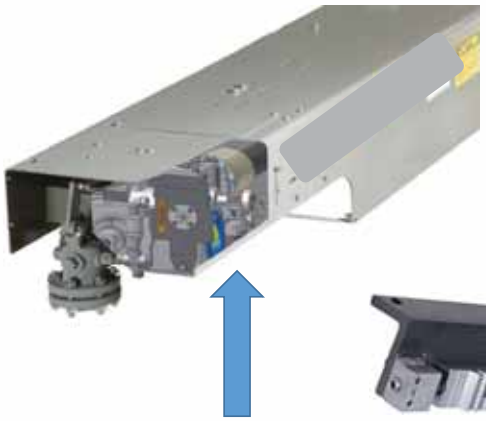


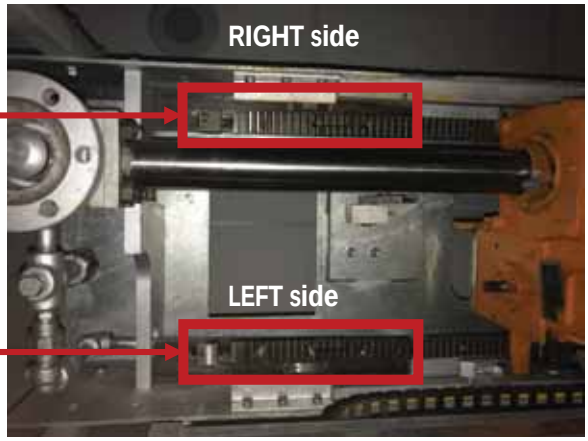
Next, the 3rd circle (Inadequate SB Maintenance)



Next, the 3rd circle (Inadequate SB Maintenance)

- Most common issue with SB Maintenance that may cause lance failure is SB misalignment due to failure in the IK type Indexing Mechanism.

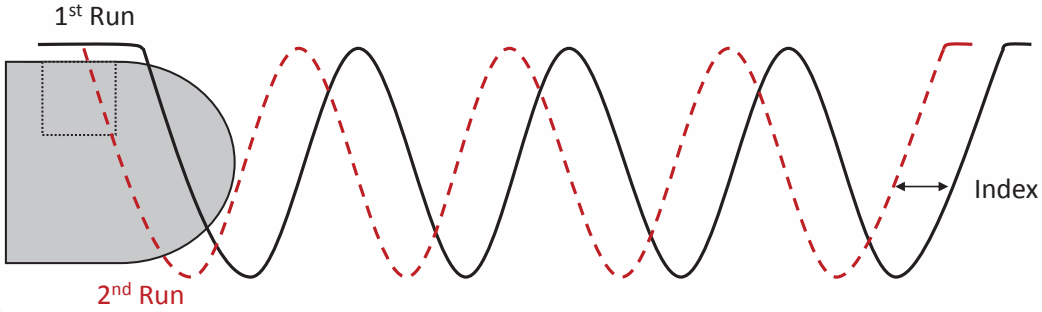




If we look the IK sootblower from below, we can see indexing mechanisms installed on the LEFT and RIGHT side of the Gear Rack

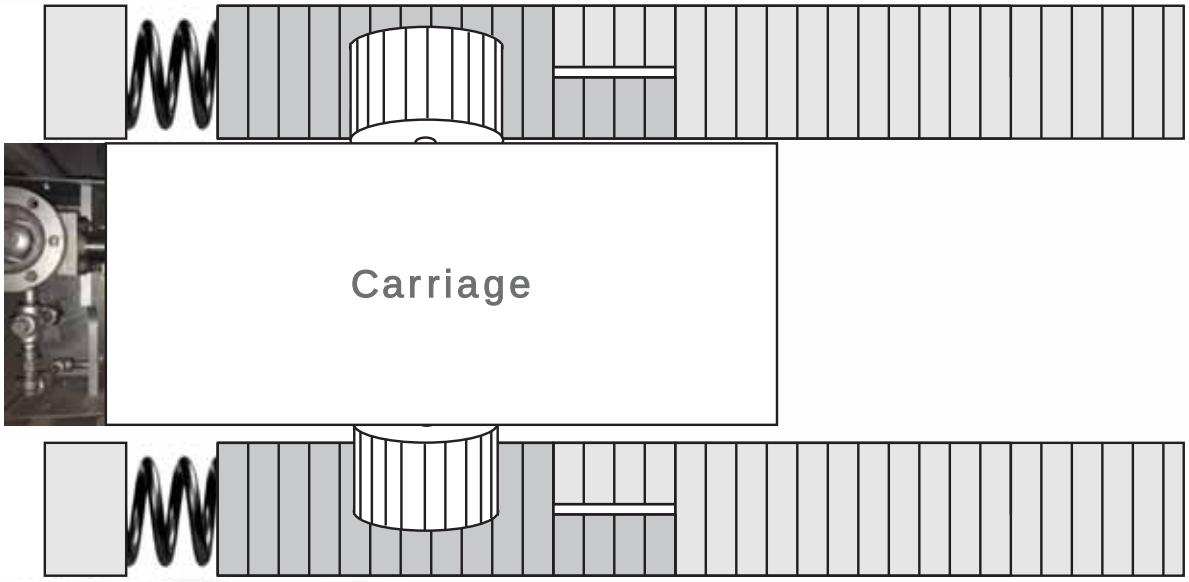
IK Indexing Mechanism

- The purpose of the indexing mechanism is to slightly change the helical path of the sootblower.
- The 1st run and 2nd run of the sootblower will be slightly different.



Indexing Mechanism

- The spring of BOTH Right and Left sides of the indexing mechanism have to compress at the same time to change the helical path



Indexing Mechanism

- If one of the indexing mechanism stuck (as seen in the video below) while the other function properly, the sootblower carriage can misaligned causing abnormal stress to the lance tube and uneven wear on the gear rack

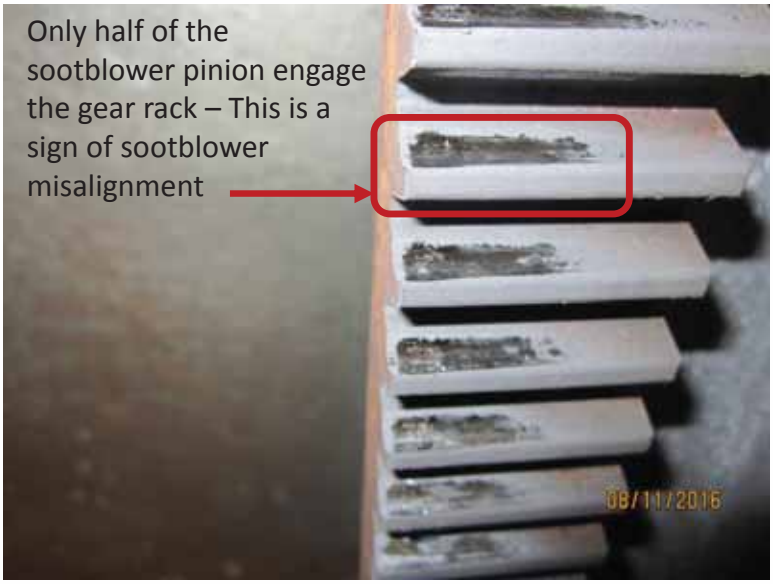
Progressive Helix Failure
Stuck on the left side

Gear Rack
Right side wear much more than Left side

Left Side

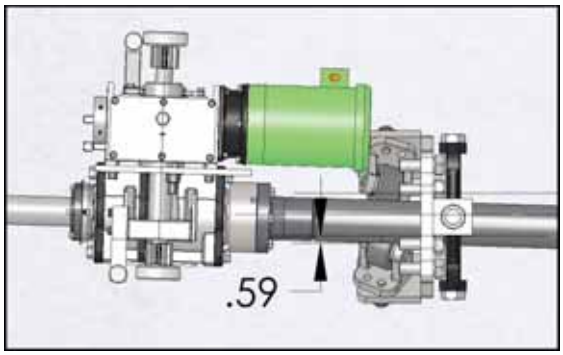
Right Side

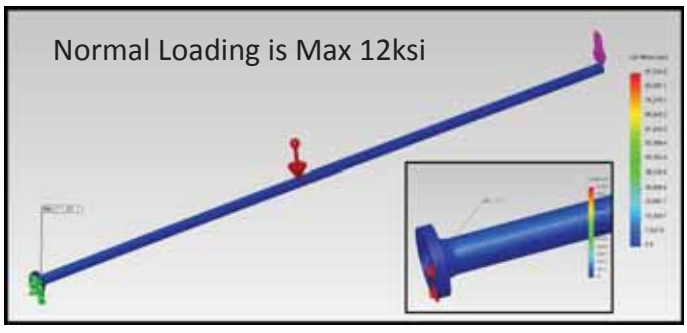
Sign of Sootblower Misalignment

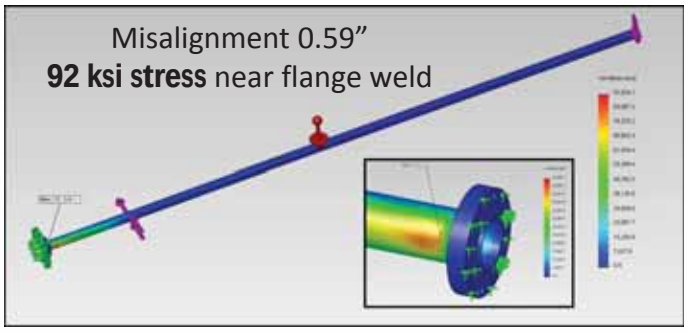


Indexing Mechanism Failure

- May result in misalignment, causing the lance to experience abnormal loading







Lance tube loading under misalignment condition

- The MAXIMUM Normal lance tube loading with NO Misalignment is about 12 ksi.
- As seen in the previous slide, using Finite Element Simulation, it can be seen that the lance experiences 92 ksi stress (about 8 times more than the maximum normal stress of 12 ksi) when the sootblower is misaligned.
- Although the lance may not fail right away under this condition, fatigue / cyclic stress to the lance will eventually cause the lance to fail.

Summary

- To ensure that the sootblower is fit to operate, three factors need to be considered (1) SB Design, (2) RB/SB Operation, and (3) SB Maintenance
- **SB Design**
  - ➔Allowable Stress ≤ Yield Strength / 3.5 should be used when selecting lance material. With this criterion, it is recommended not to use SS304 anymore as this is costly and more prone to lance failure.
  - ➔Welding quality should meet ASME B31.1 or its equivalent
- **RB/SB Operation**
  - ➔Clinker fall and insufficient cooling flow are the two most common causes of lance tube failure from RB/SB operation.
  - ➔Motor amperage and walkdown can be used to early detect this problem and prevent costly repair.

Summary

- **SB Maintenance**
  - ➔Sootblower misalignment is the most common factor that cause lance tube failure.
  - ➔When the sootblower is misaligned, the lance can experience fatigue stress 8 times higher than normal lance loading.
  - ➔It is important that the sootblower maintenance team understand how to detect misalignment and fix the issue early.