Furnace Erosion Presentation

ChevronTexaco
Pascagoula Refinery

- Furnace Process Design
- Furnace Cleaning Methods
- Furnace Erosion and Lessons Learned
- Furnace Outlet Thermowell Location and Lessons Learned

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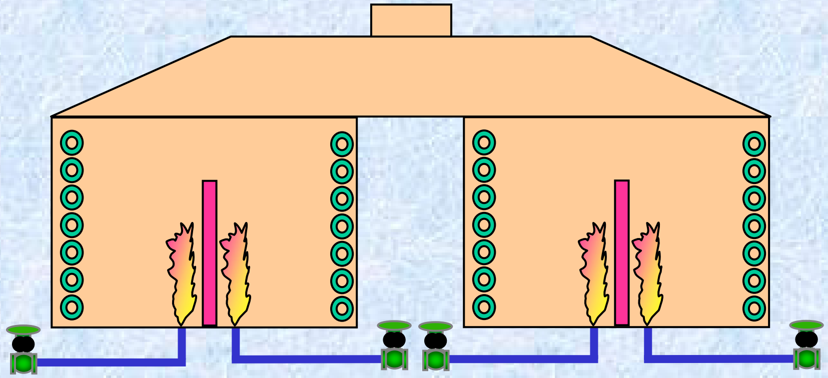
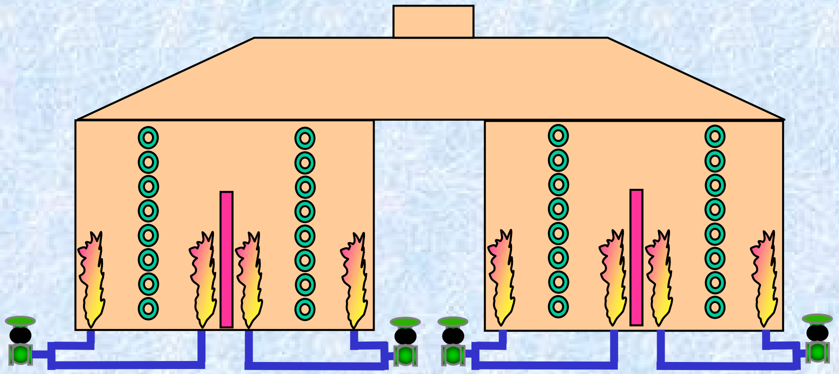
Types Of Coker Furnaces

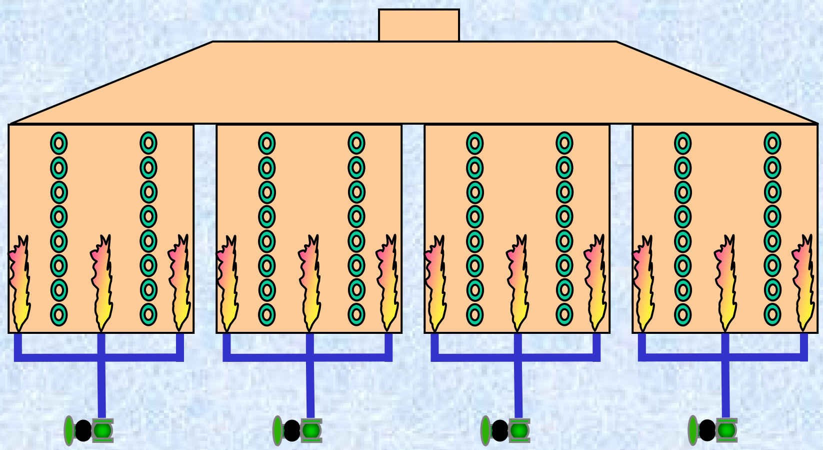
- Single Fired



- Doubled Fired



- Triple Fired

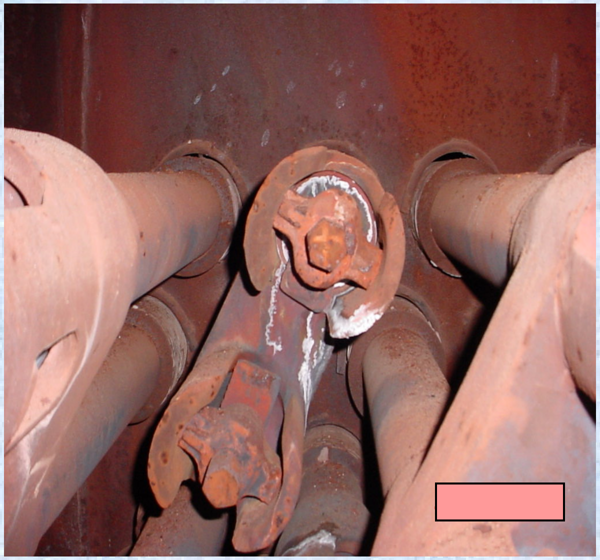


Common Factors For All Furnace Designs:

- Typical Outlet Temperatures 850-950 F.
- Large Fuel Gas Consumers
- Coke Fouling Impacts Performance and Efficiency
- Coke Fouling Requires Periodic Cleaning
- Today's Market Conditions Require Cokers To Feed Heavier, High Metal, High Sulfur Feeds To Be Profitable
- Erosion affects Safety, Reliability, and Profitability

Furnace Designs

- **Mule Ears**
  - A) Reliable Design- Erosion Resistant
  - B) Cause High DP Across Furnace
  - C) Subject To Leaking
  - D) Easy To Access Furnace Tubes



- **U-Bends**
  - A) Less Erosion Resistant
  - B) Lower DP Across Furnace
  - C) Do Not Leak
  - D) Cannot Access Furnace Tubes

Current Methods To Remove Coke

- **On-Line Cleaning:**
  - » **A) Spalling With Condensate Injection**
  - » **B) Spalling With Steam Injection**

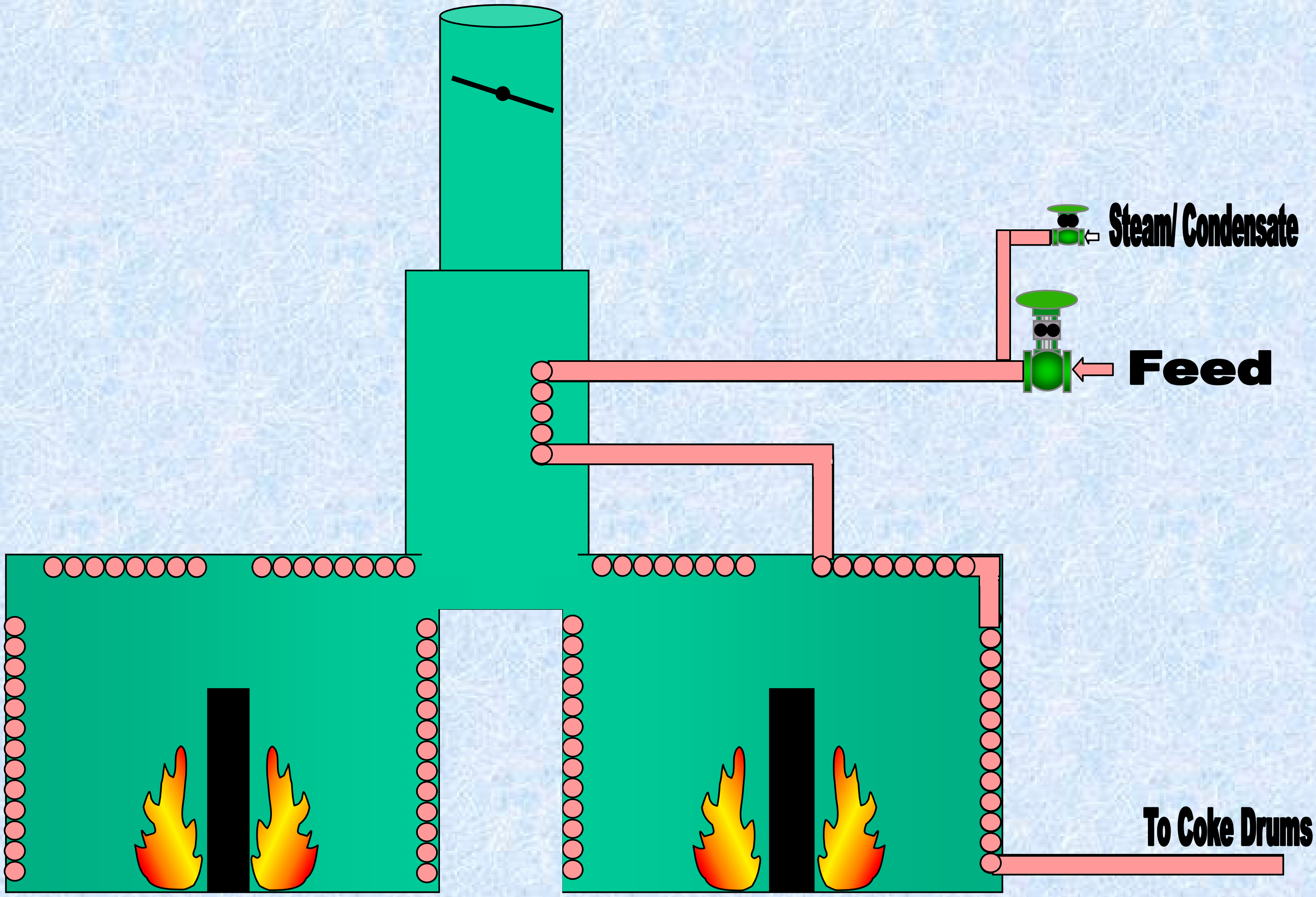
  - » **Advantage- Minimum Feed Interruption**
  - » **Advantage- Increases Time Between Decokes**
  - » **Disadvantage- Increased Erosion**

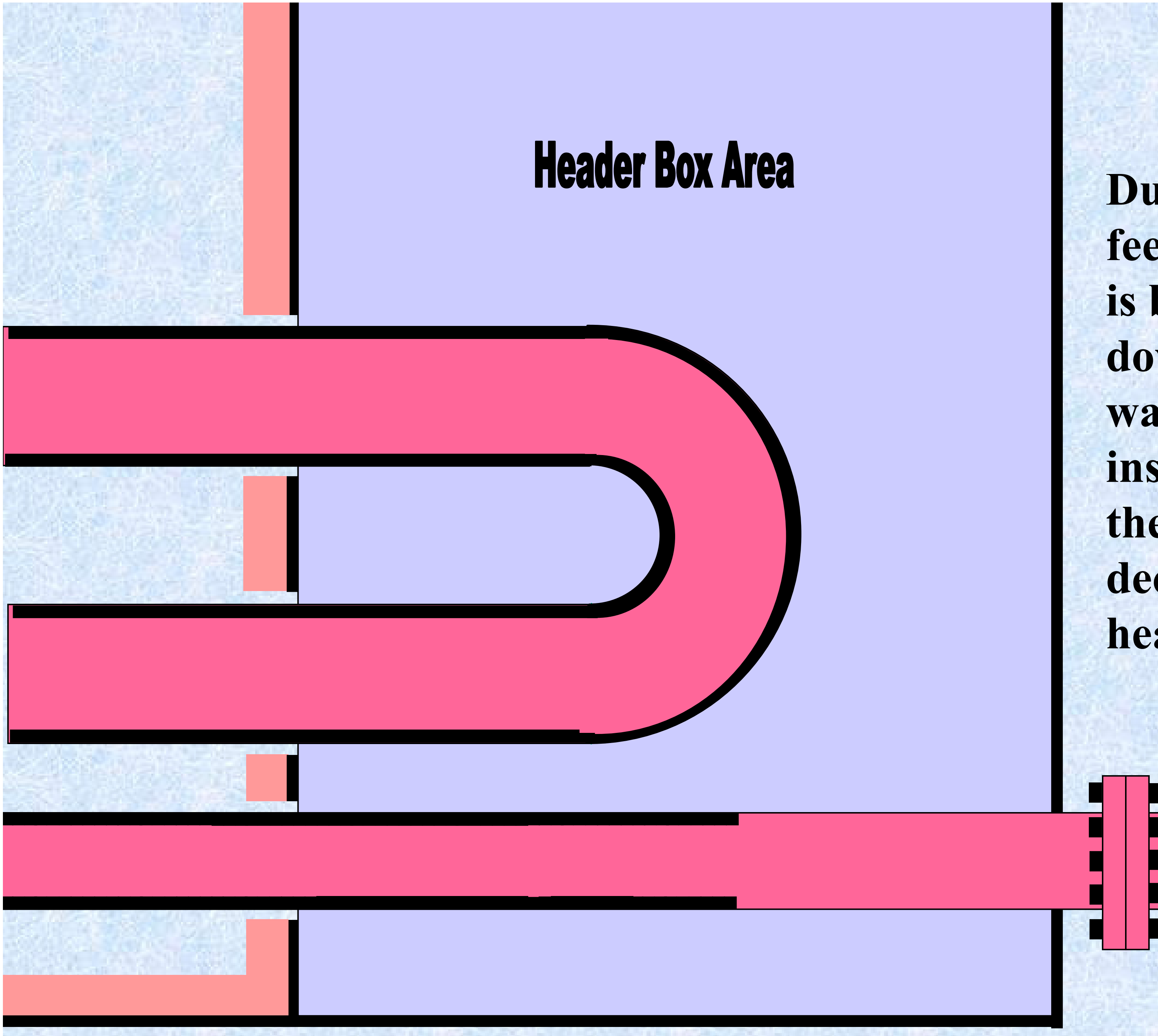
Current Methods To Remove Coke

- **Off- Line Cleaning**
  - » A) Steam/ Air Decoke
  - » B) Pigging
  - » C) Steel Shot Circulation

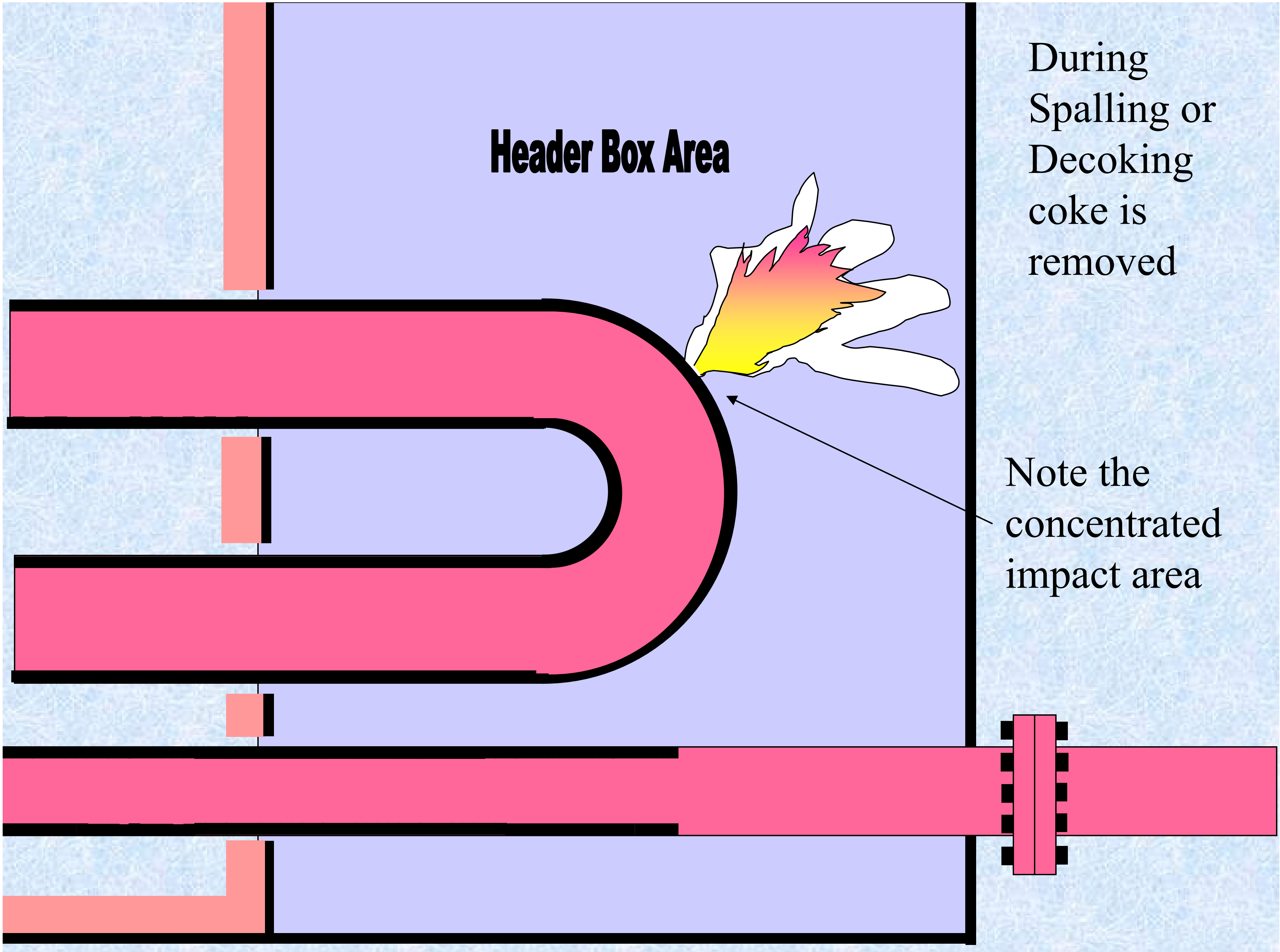
  - » Advantage- Less Erosion
  - » Disadvantage- Usually Requires Outside Contractors
  - » Disadvantage- Loss of Feed Throughput During Procedure

Typical Single-Fired Coker Furnace

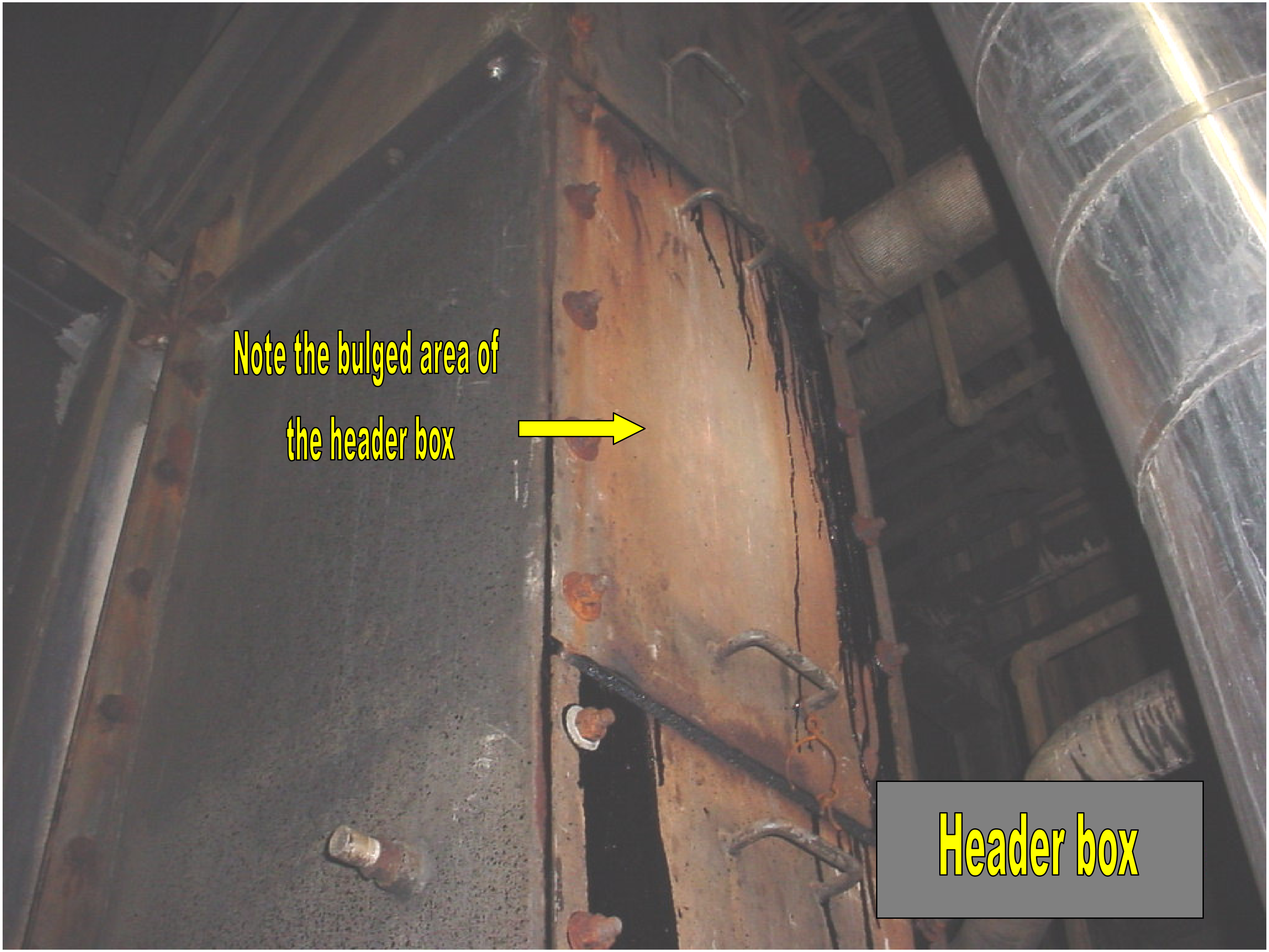


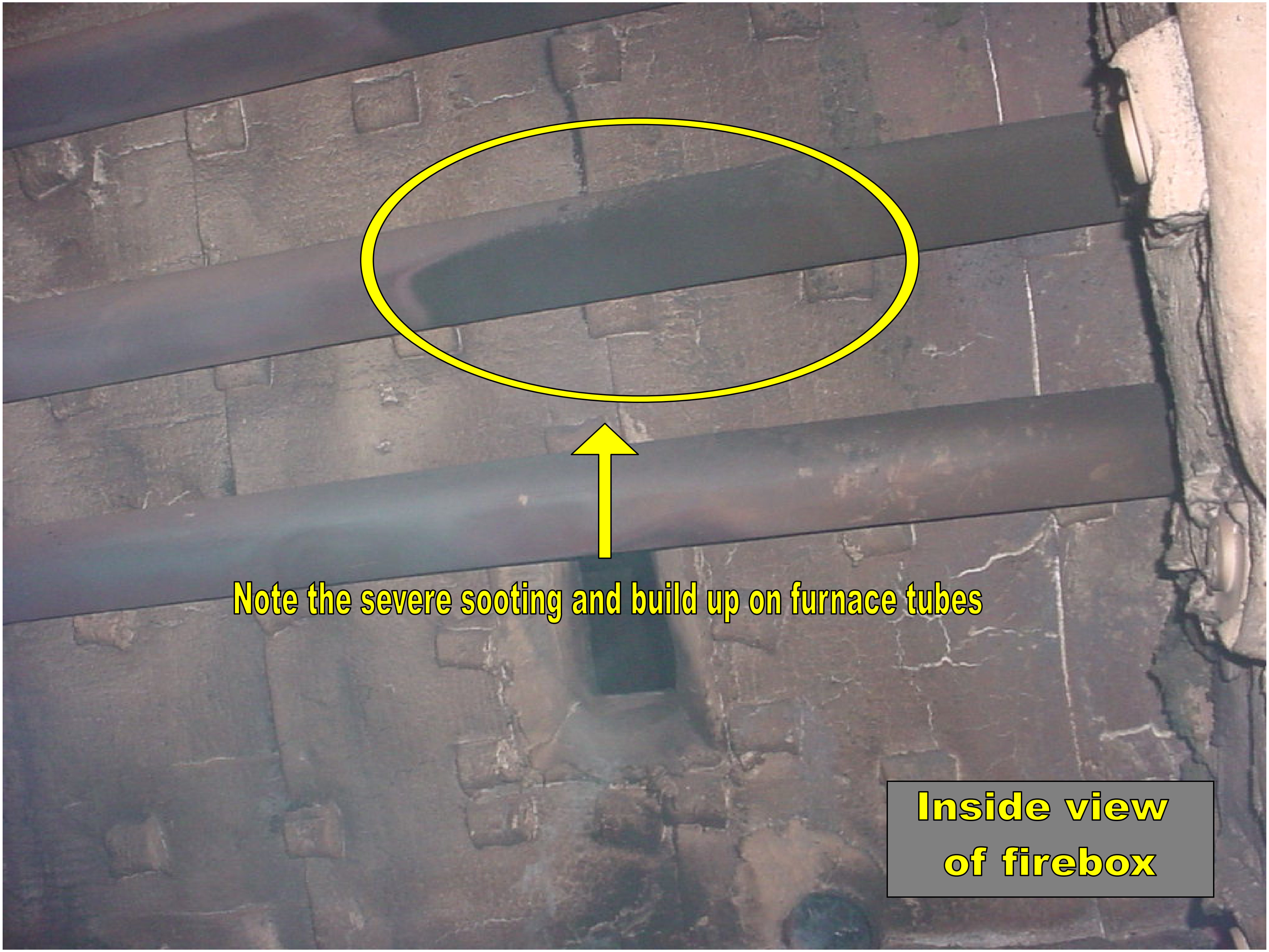


During feeding, coke is being laid down on tube walls which insulates them, decreasing heat transfer


Header Box Area
During Spalling or Decoking coke is removed
Note the concentrated impact area


Erosion Failure Area
STANLEY
1
2
3
4

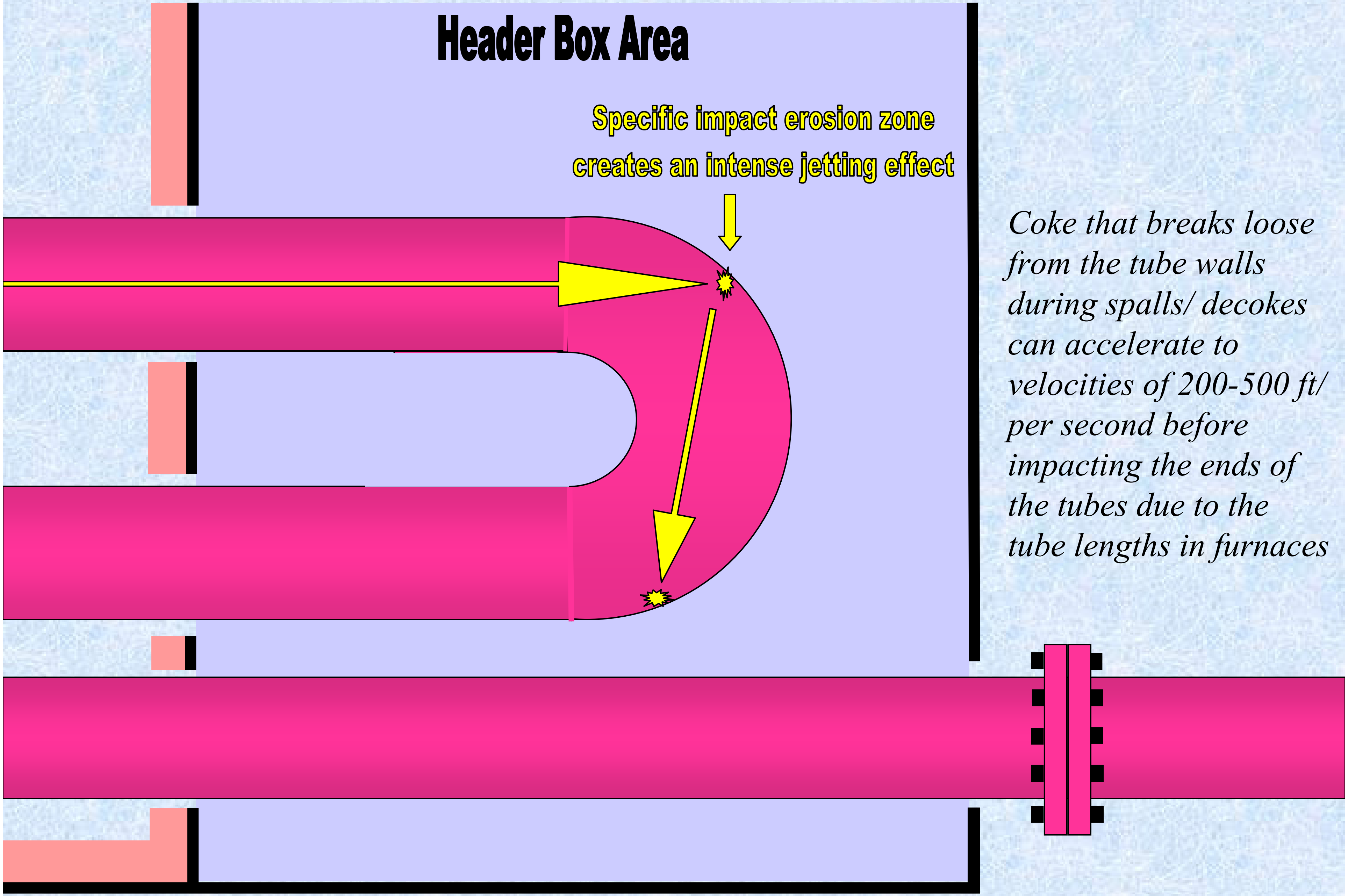

Note the bulged area of
the header box
Header box


Note the severe sooting and build up on furnace tubes
Inside view
of firebox

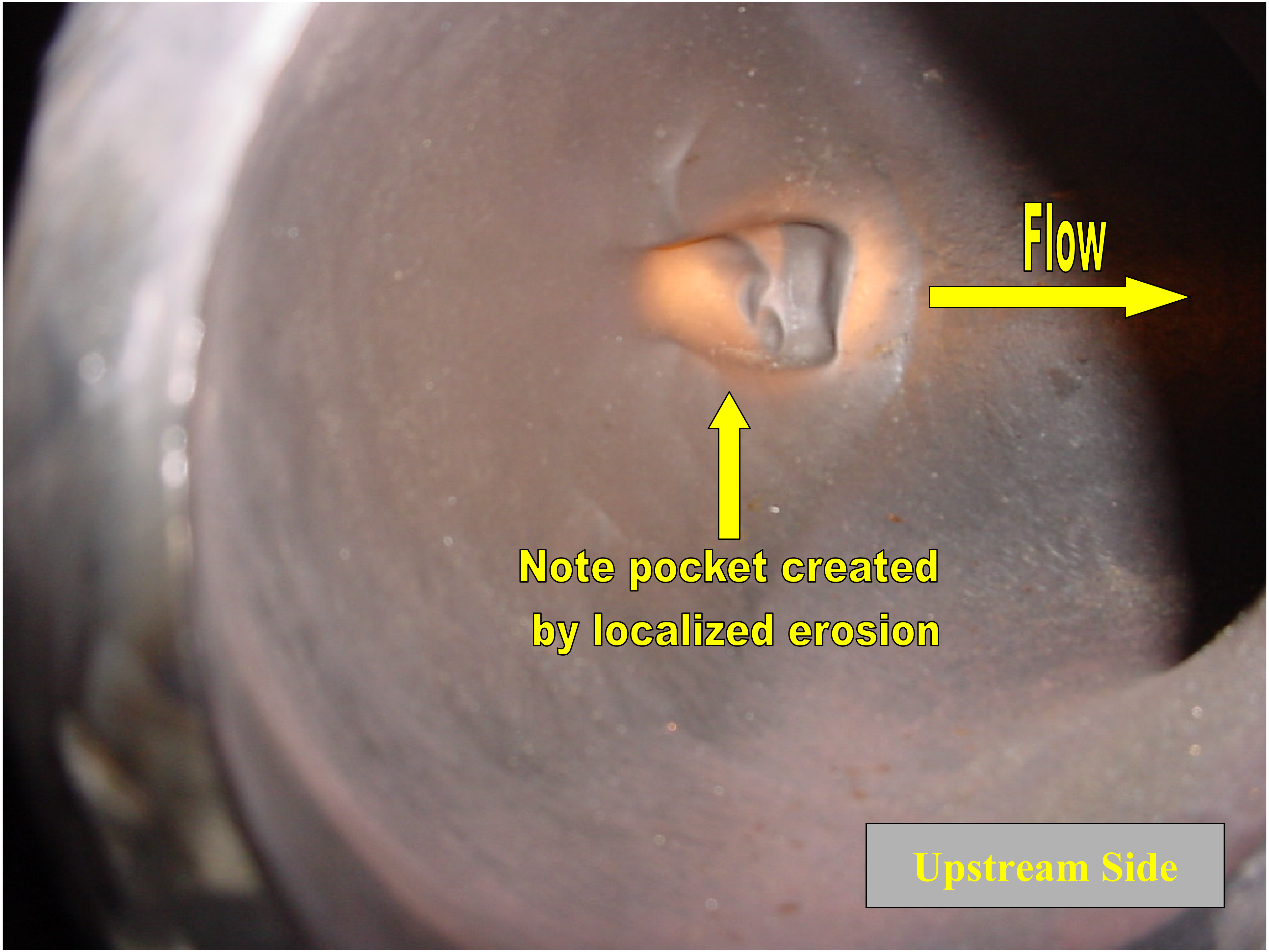

Temporary repair
to U-bend

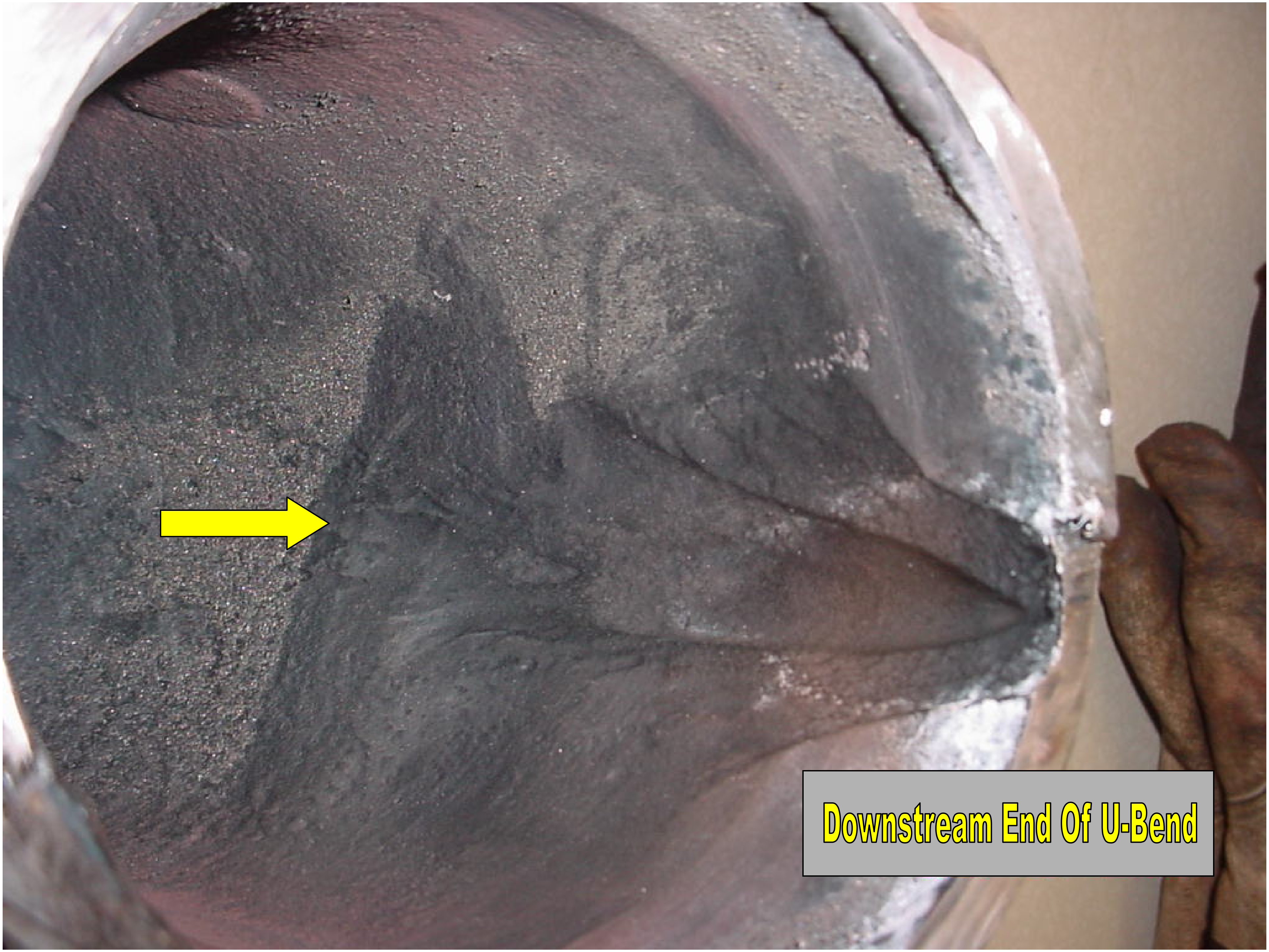
Inside view of failed U-bend

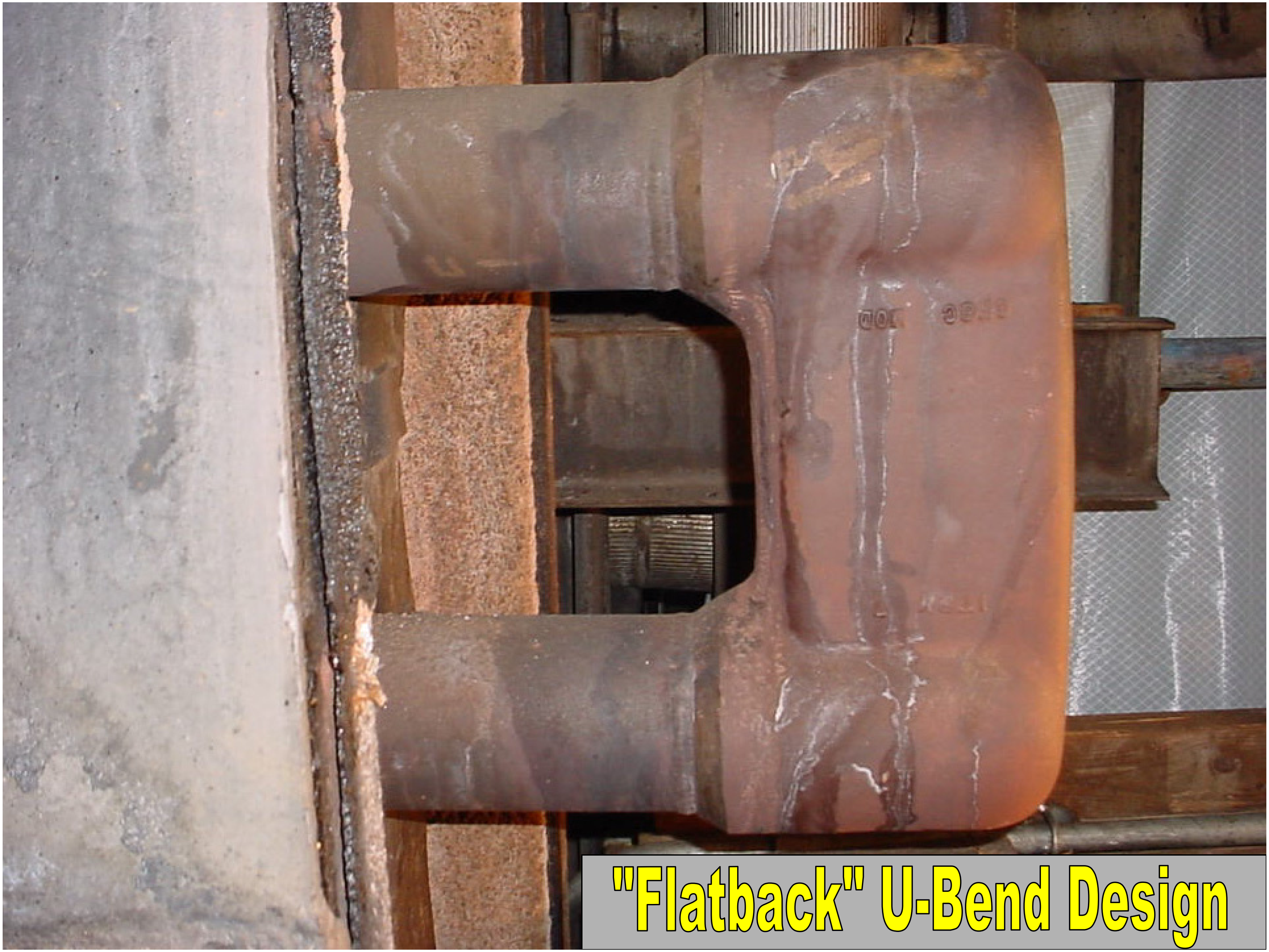
New Lesson Learned



Coke that breaks loose from the tube walls during spalls/ decokes can accelerate to velocities of 200-500 ft/ per second before impacting the ends of the tubes due to the tube lengths in furnaces

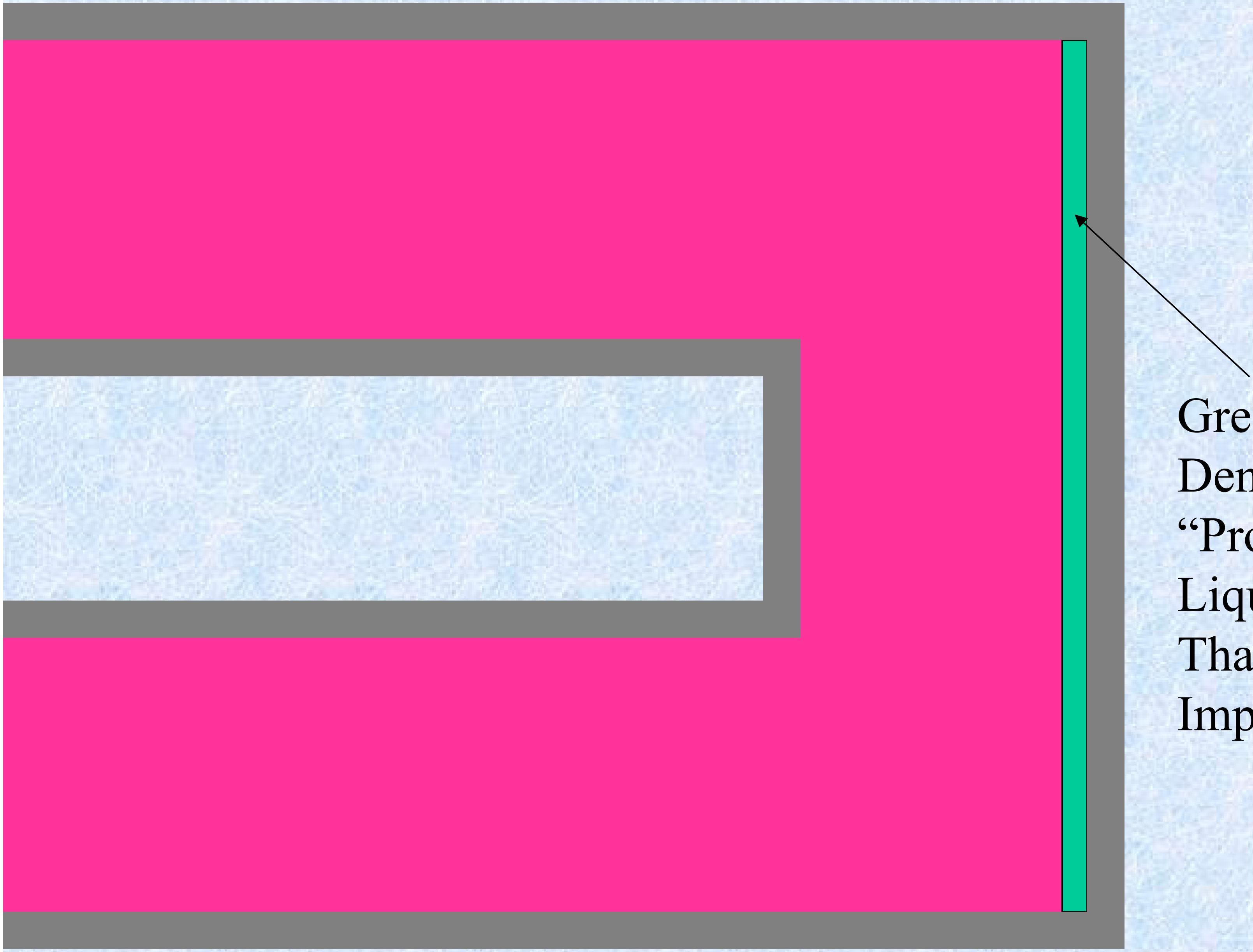

Flow
Note pocket created
by localized erosion
Upstream Side


Downstream End Of U-Bend

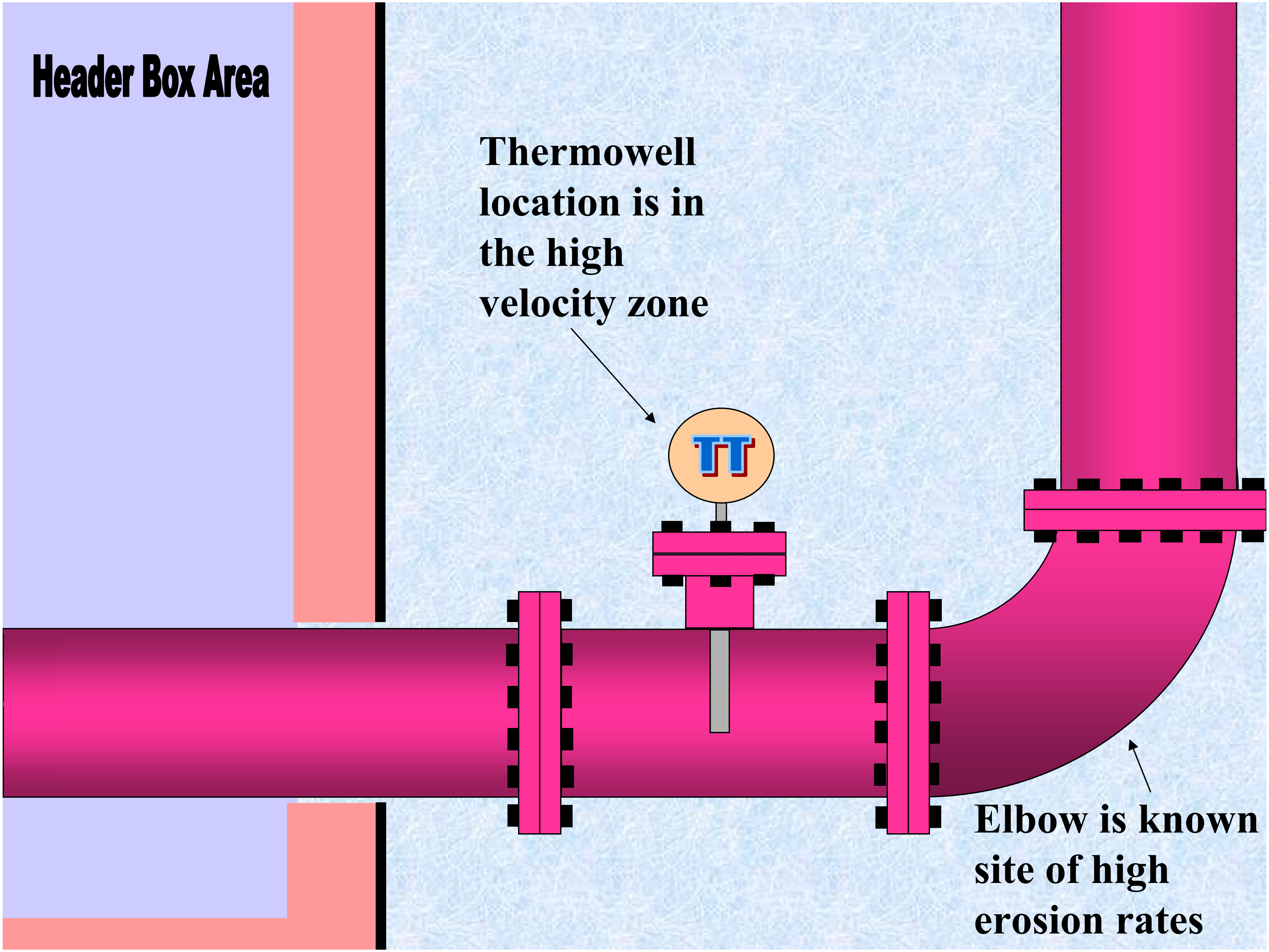


"Flatback" U-Bend Design

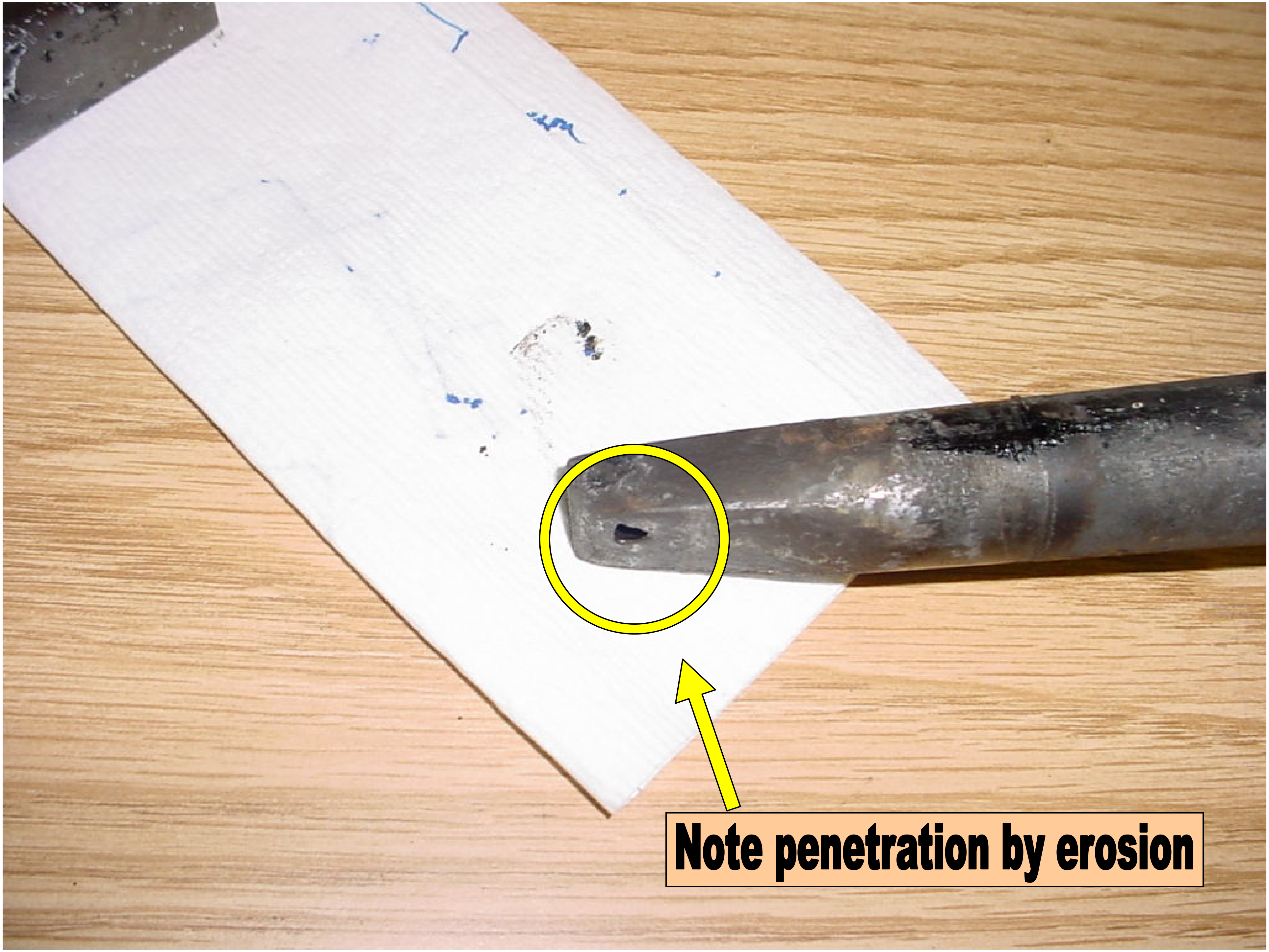
Theory Behind "Flatback" Design



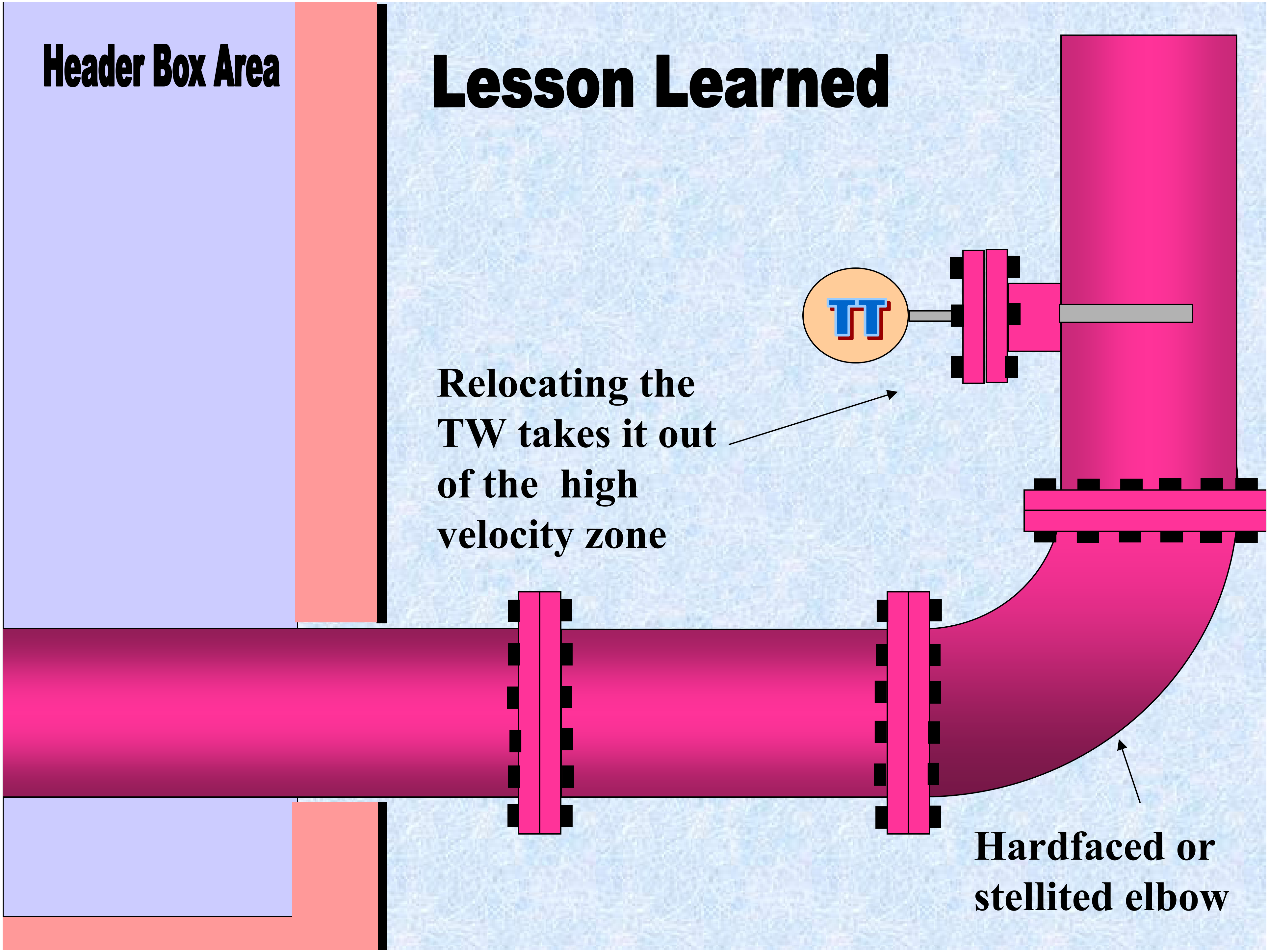
Green Area Denotes "Protective" Liquid Layer That Absorbs Impacts


Header Box Area
Thermowell location is in the high velocity zone
TT
Elbow is known site of high erosion rates


Erosion has penetrated thermowell
[redacted]

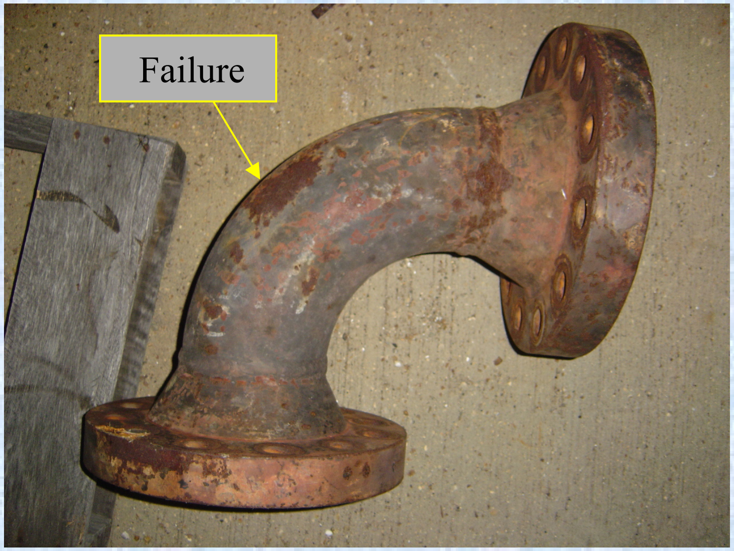

Note penetration by erosion

Lesson Learned

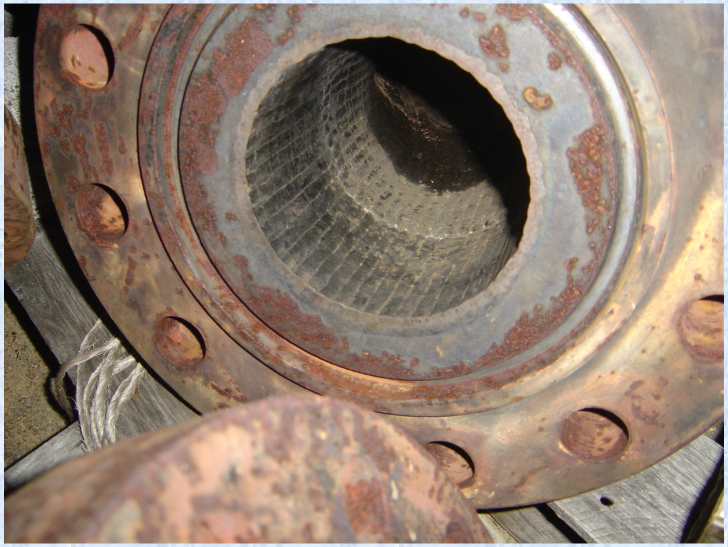


Furnace Outlet Elbows

Typical Outlet Elbow



Stellite Hardfaced Interior



Summary

- **Furnace Tube Lifespan:**
  - **A) Erosion Monitoring**
  - **B) Creep/ End Of Life Analysis**
- **U-Bend Design**
  - **A) Type U-Bends**
  - **B) Erosion Monitoring**
- **Outlet Thermowell Location**
  - **A) Hardfacing**
  - **B) Relocate to Low Velocity Area**
  - **C) Erosion Monitoring/ Inspection**
- **Outlet Piping/ Elbows**
  - **A) Hardfacing**
  - **B) Metallurgy Research/ Review**
  - **C) Erosion Monitoring/ Inspection**

Conclusions

- In normal furnace operation there is always a certain amount of erosion taking place.
- Spalling/ Decoking Procedures accelerate the erosion processes in the furnace due to the coke on the tube walls being stripped from the tube walls and those coke particles impacting areas downstream.
- Modifying your Spalling or Decoking procedures to reduce velocities can help to slow erosion process.
- Opportunity inspections with non-destructive monitoring techniques such as UT and X-ray can determine erosion rate if baseline thicknesses were taken at beginning of service life.
- Improving furnace design can help control and minimize the erosion rates.