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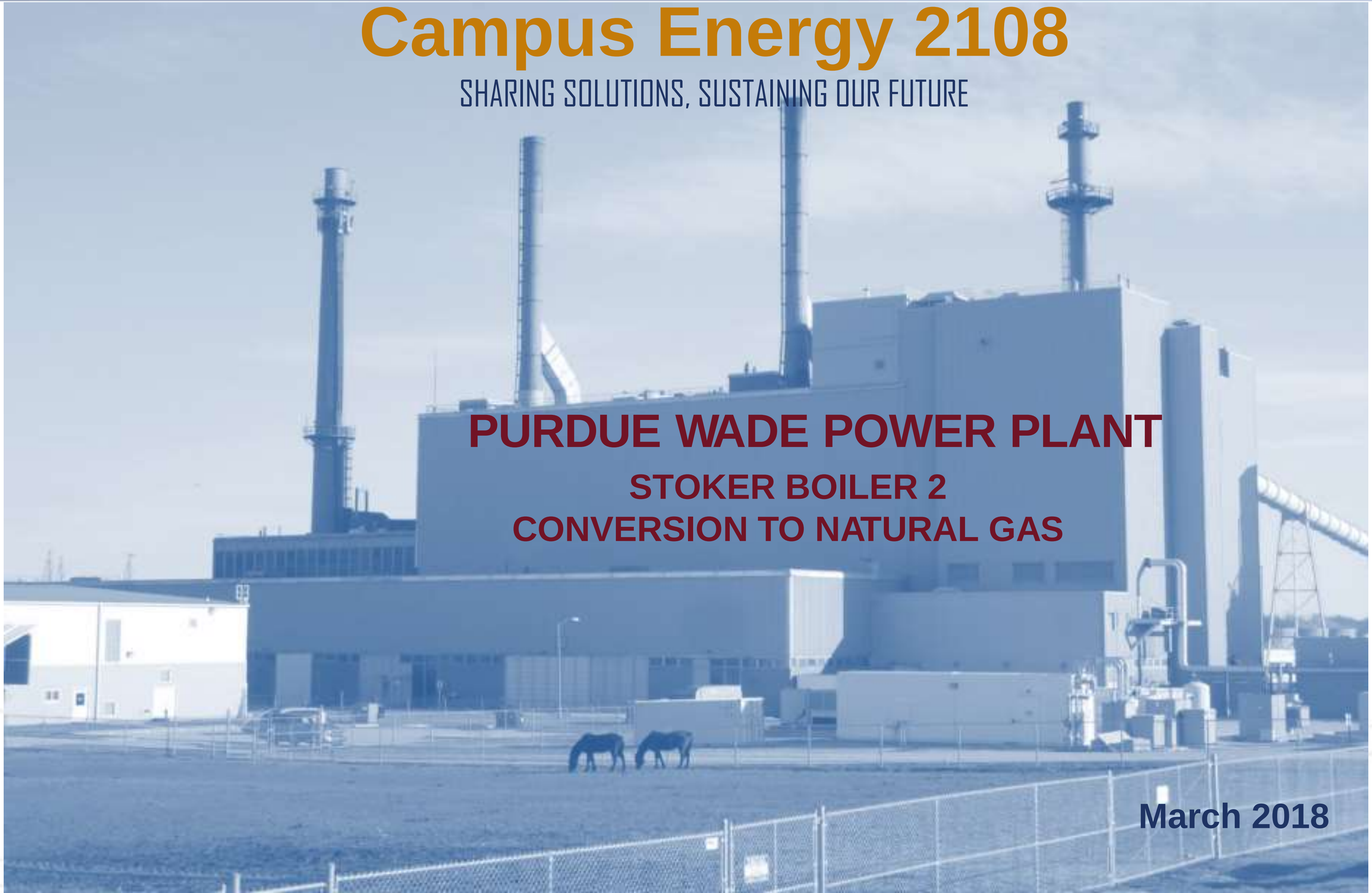
Campus Energy 2108

SHARING SOLUTIONS, SUSTAINING OUR FUTURE



PURDUE WADE POWER PLANT

STOKER BOILER 2
CONVERSION TO NATURAL GAS

March 2018

BOILER #2 BACKGROUND

- Wickes (CE) coal fired stoker boiler rated at 215 KPPH, 650 psig @ 825 F installed in 1967.
  Detroit Stoker Rotograte with hydraulic drive.
- Efficiency – Combustion air preheater, feed water heater, Ljungstrom air preheater and economizer.
- Emissions - original mechanical (cyclone) dust collectors and electrostatic precipitator.
- 1998 - Gas co-fire burners added for safer startups and reduced smoking (gas burners rated up to 25% load).
- 2005 - Baghouse, spray cooler and ID fan added for BMACT. ID fan upsized from 500 HP to 1000 HP due to increased pressure drop across BH
- 2014 - Boiler conversion to 100% gas operating with over-sized ID fan through the baghouse. ID fan was replaced Fall 2017

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BOILER “HEALTH” CONDITION ASSESSMENT

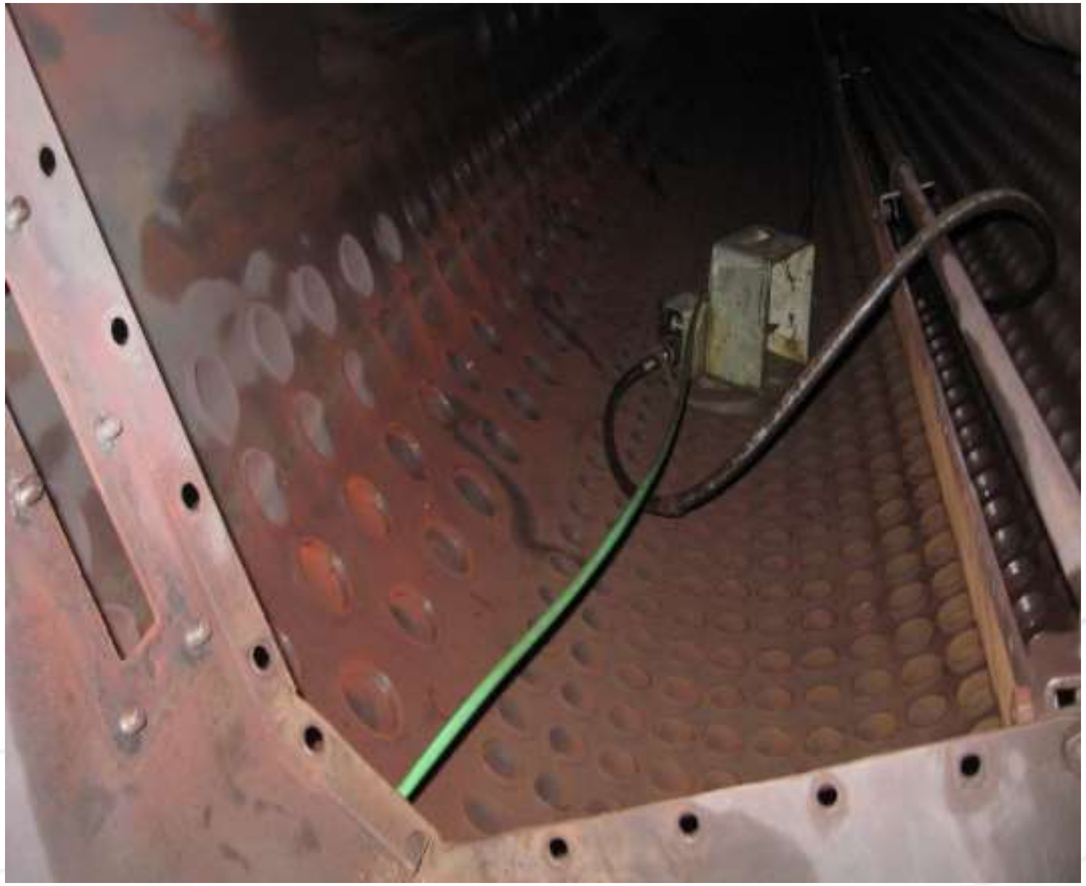
NDE METHODS;

- Visual Inspection
- UT (ultrasonic thickness)
- WFMT (wet fluorescent mag particle)
- LPA (linear phased array)
- APA (Annular phased array)
- OTM (oxide thickness measure)
- HRD (hardness testing)
- REPS (metallurgical replication)

SUPERHEATER TUBES

TUBE CLEANING WITH WATER PRESSURE WASHER

• No chemicals used in cleaning process (lower risk)
• Low cost (under $10K vs. over $100K for chemical cleaning)
• No neutralization required. Simple waste disposal.

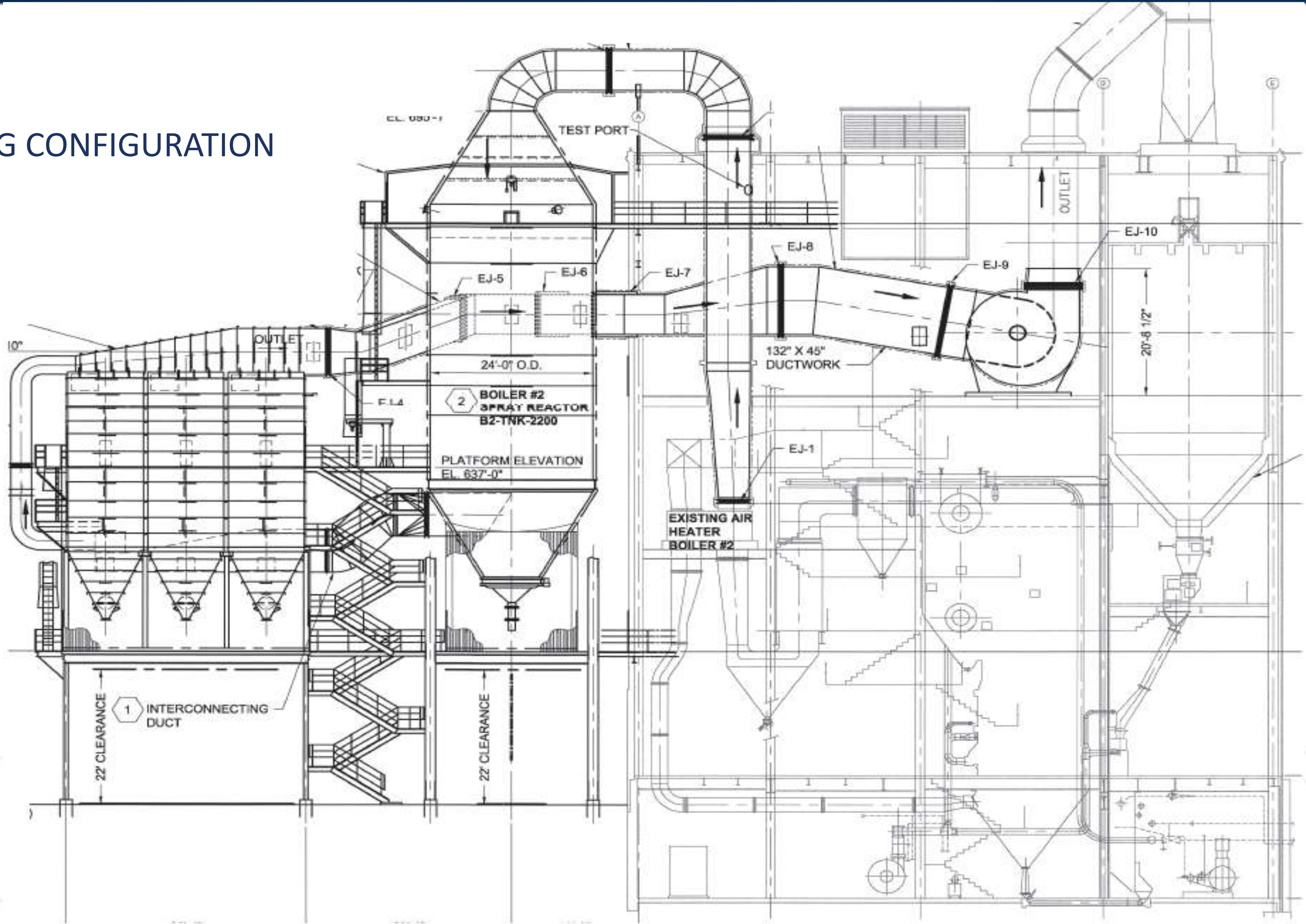


OBJECTIVES – RILEY POWER GAS CONVERSION STUDY

- Create a thermal model to predict boiler performance firing NG.
- Determine if boiler can achieve design operating conditions firing NG.
- Provide optimum location, number and size of gas burners.
- Establish the required pressure part modifications to fire NG.

- The model accurately predicted performance for loads between 50 – 100%
- This verified that the boiler could achieve the original design operating performance.
- The optimum arrangement was determined to be, four (4) low NOx burners, 72 MMBtu/hr each, mounted on front wall. More burners allowed reduce flame length protecting the rear wall, improve turndown and provide even heat distribution across the width of the furnace.
- It established that the primary superheater (PSH) tubes would overheat. We shortened the PSH tubes to reduce surface area to keep SA-192 tubes below 850 F limit. Plus the bottom returns were upgrading to chrome-moly.

STARTING CONFIGURATION



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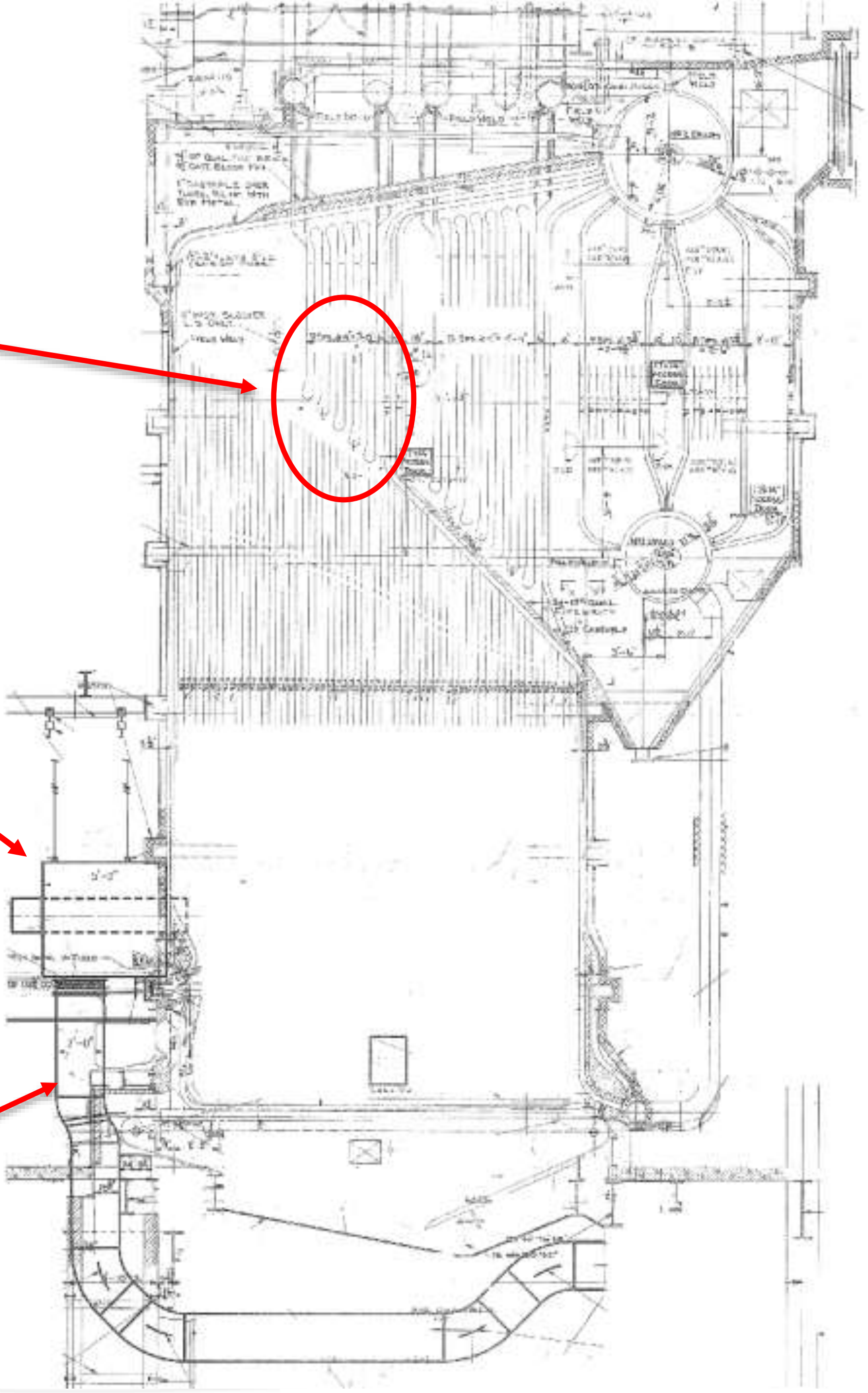
BOILER & DUCTWORK

Superheater Tubes

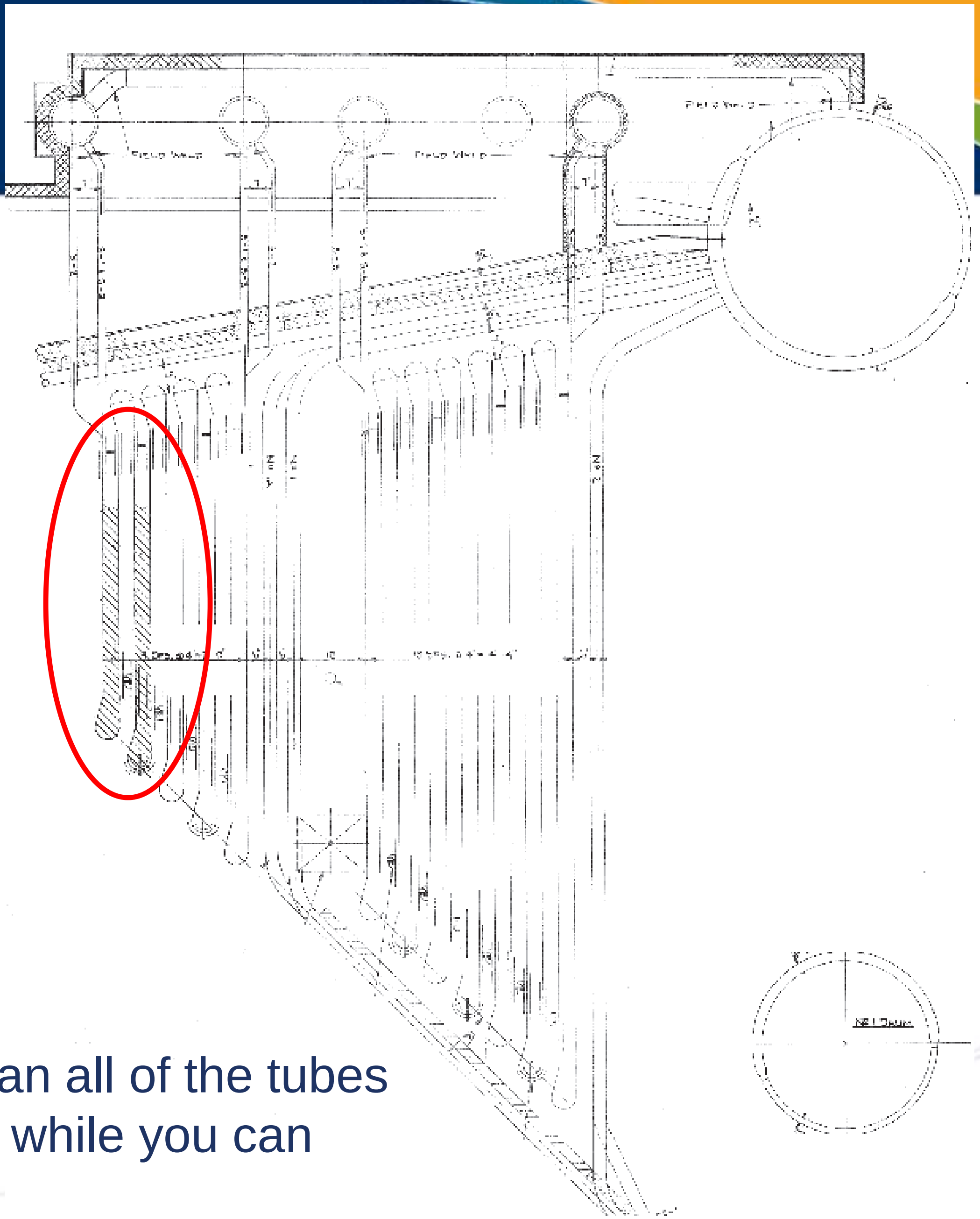
New NG Burners

Combustion air duct

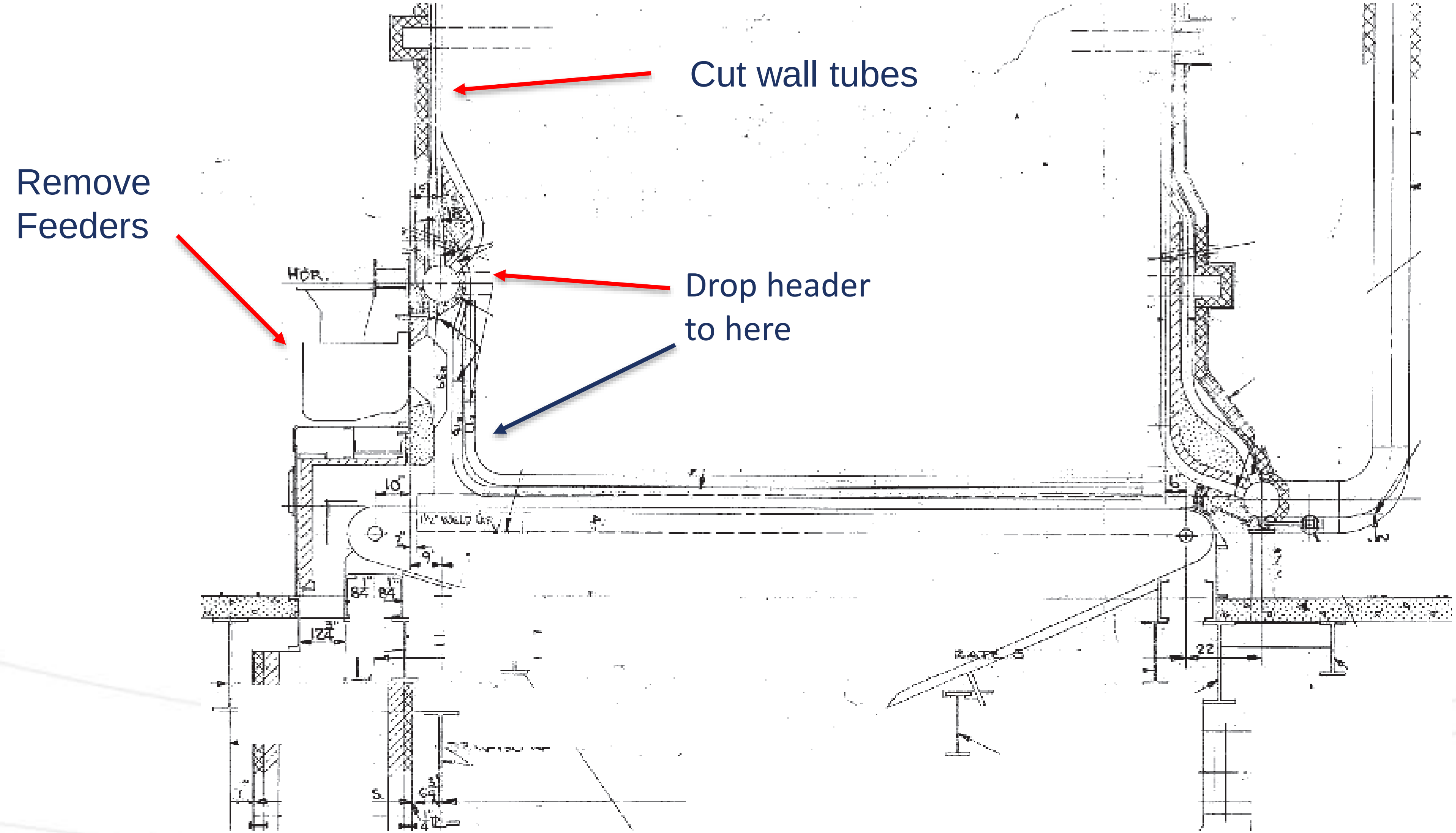


Remove Asbestos

SUPERHEATER TUBE MODIFICATIONS



Clean all of the tubes while you can


Cut wall tubes
Remove
Feeders
Drop header
to here
HDR.
10"
RATE

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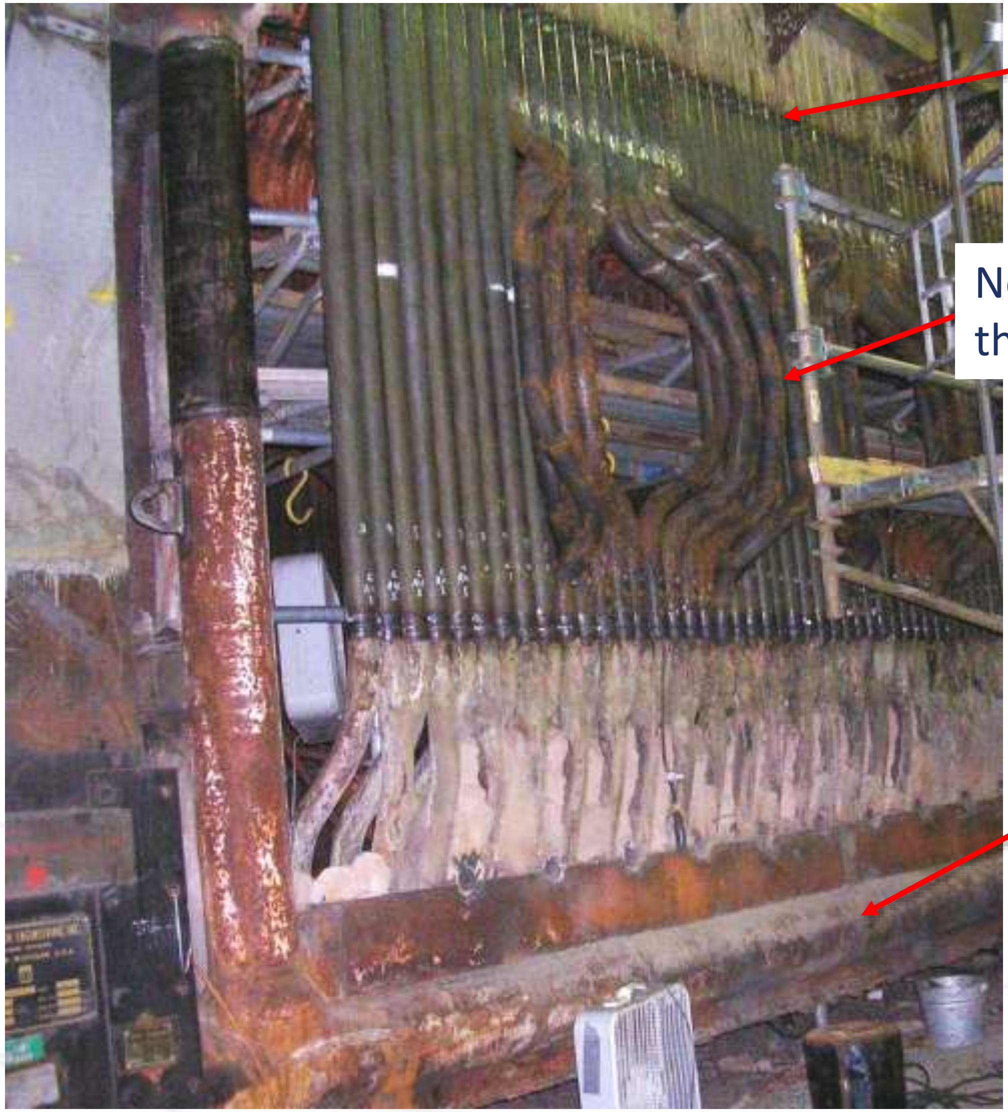
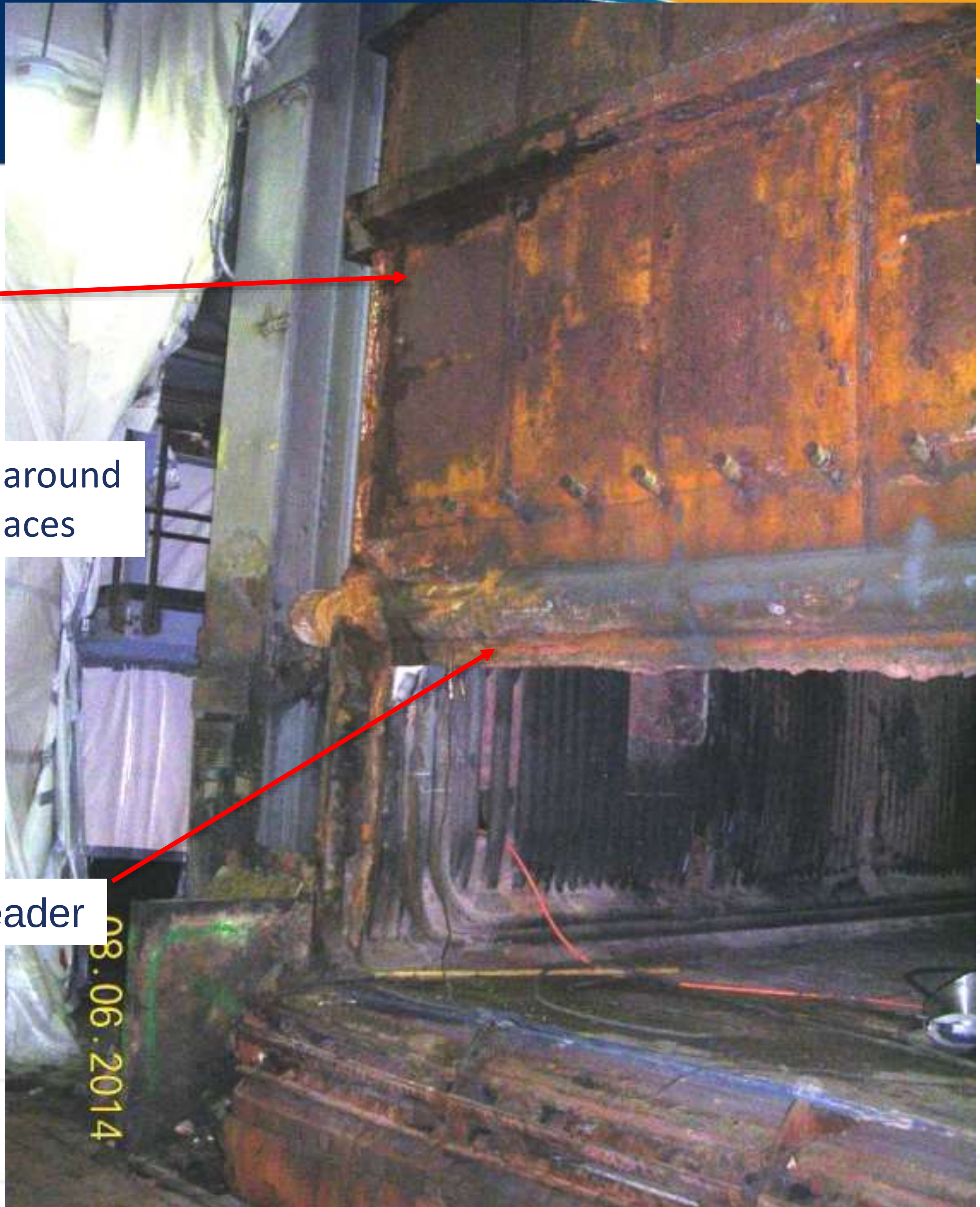


Cut casing and tubes

New wall tubes around the burners 4 places

Drop Header



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Extended down comer both sides

Add Buck stays

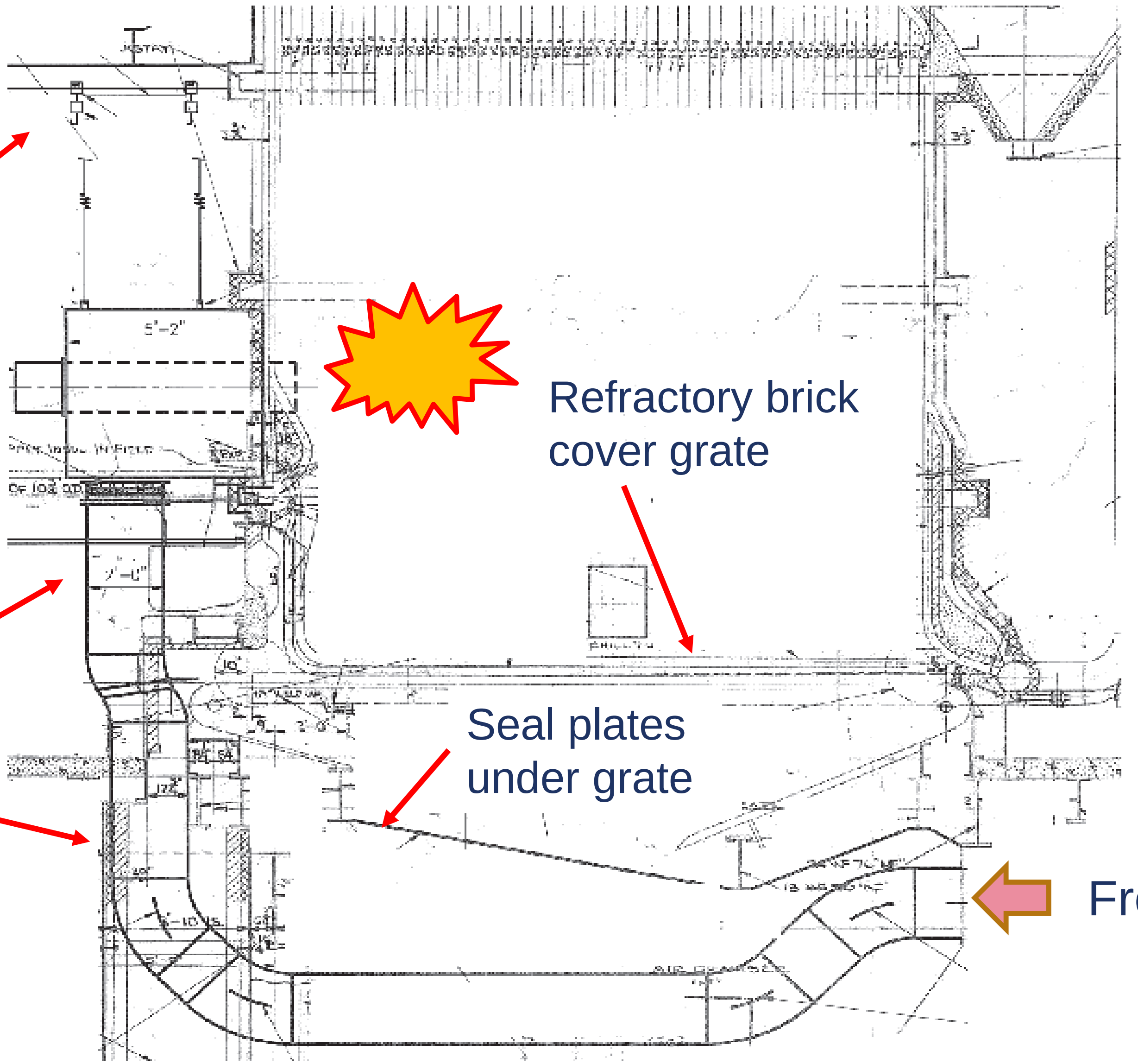
Relocated header

COMBUSTION AIR DUCT AND BURNER CONFIGURATION

Spring supports

4 new Burners

Route combustion air duct to Burners



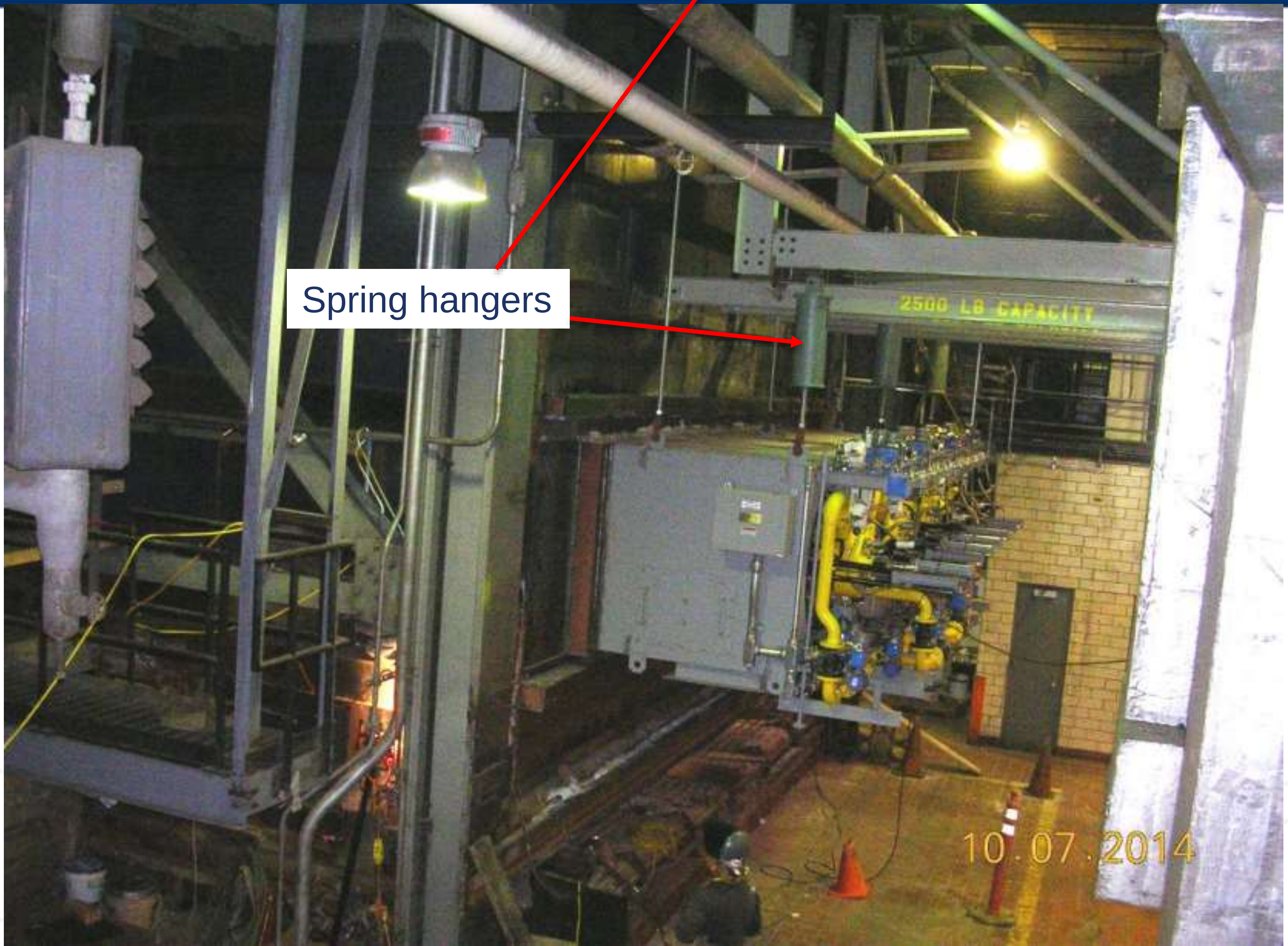
Refractory brick cover grate

Seal plates under grate

From FD Fan

Burners and Wind Box

Pre-piped and Wired


Spring hangers
2500 LB CAPACITY
10.07.2014

Final installation

Natural Gas Train

READY TO FIRE

Inside boiler fire box

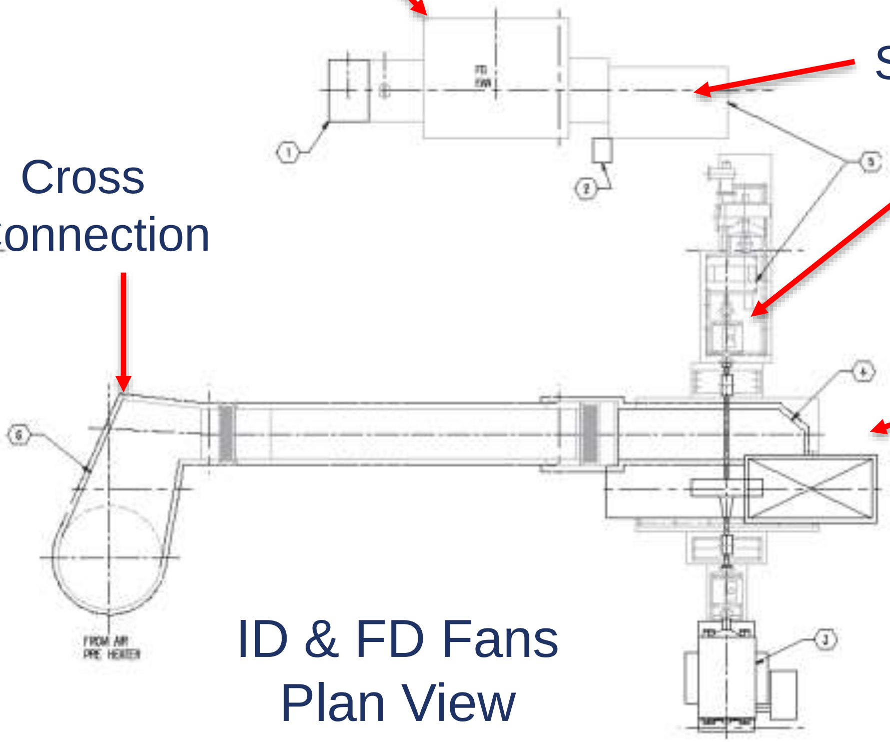
FINAL CONFIGURATION OF DUCTWORK AND ID FAN

FD Fan

Steam Drives

Cross Connection

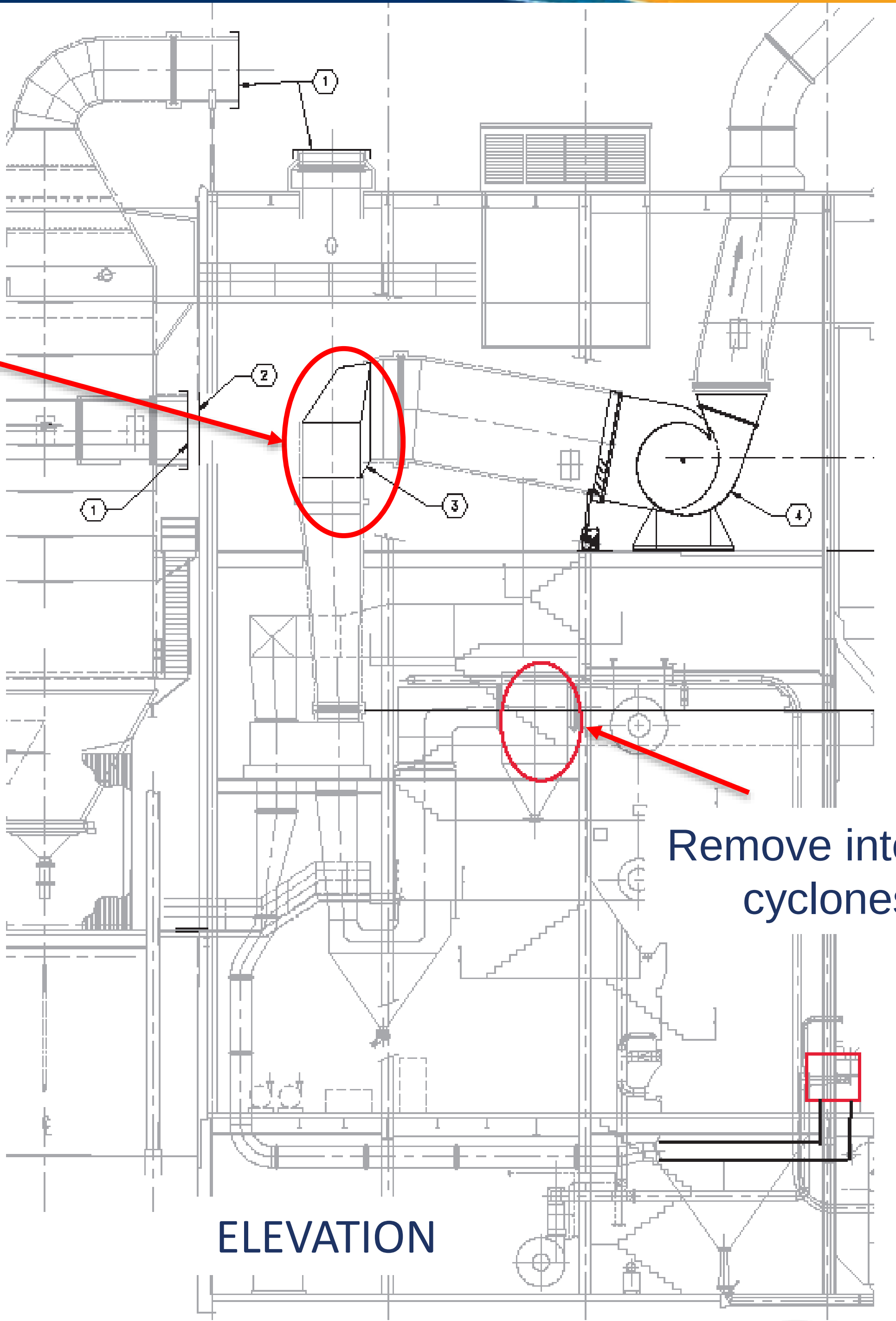
ID Fan



ID & FD Fans Plan View

Duct cross connection

Remove internal cyclones



ELEVATION

Duct cross connection

OOPS !

BOILER PERFORMANCE

- Engineering study predicted an oversized ID Fan.
- Initial operation required running the ID Fan at a slower speed and control with the inlet damper choked down. This required abandoning the motor and run on the steam turbine drive that could be slowed.
- The FD Fan was not substantially affected.
- Conducted a field flow test with the boiler near full load which confirmed the engineering study.
- Results of the field test combined with the engineering study enabled confidence in sizing the new ID Fan.

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FAN MODIFICATIONS

- ♦ FD Fan performance basically unchanged, but
  - Added VFD control which required a new motor
  - Changed out the pneumatic damper actuator for an electric actuator

- ♦ ID Fan became dramatically smaller
  - Clarage designed a fan housing to exactly match the existing ductwork, steam drive shaft, and anchorage
  - The motor went from 1000 hp @ 2300v to 250 hp @ 480v

- ♦ Both fans are now VFD controlled with damper control for start up and back up

CONCLUSIONS

- Converting from coal to natural gas can be challenging.
- Retrofit work always takes additional effort.
- Getting the details defined properly is key to success.
- Having an experienced contractor is essential.