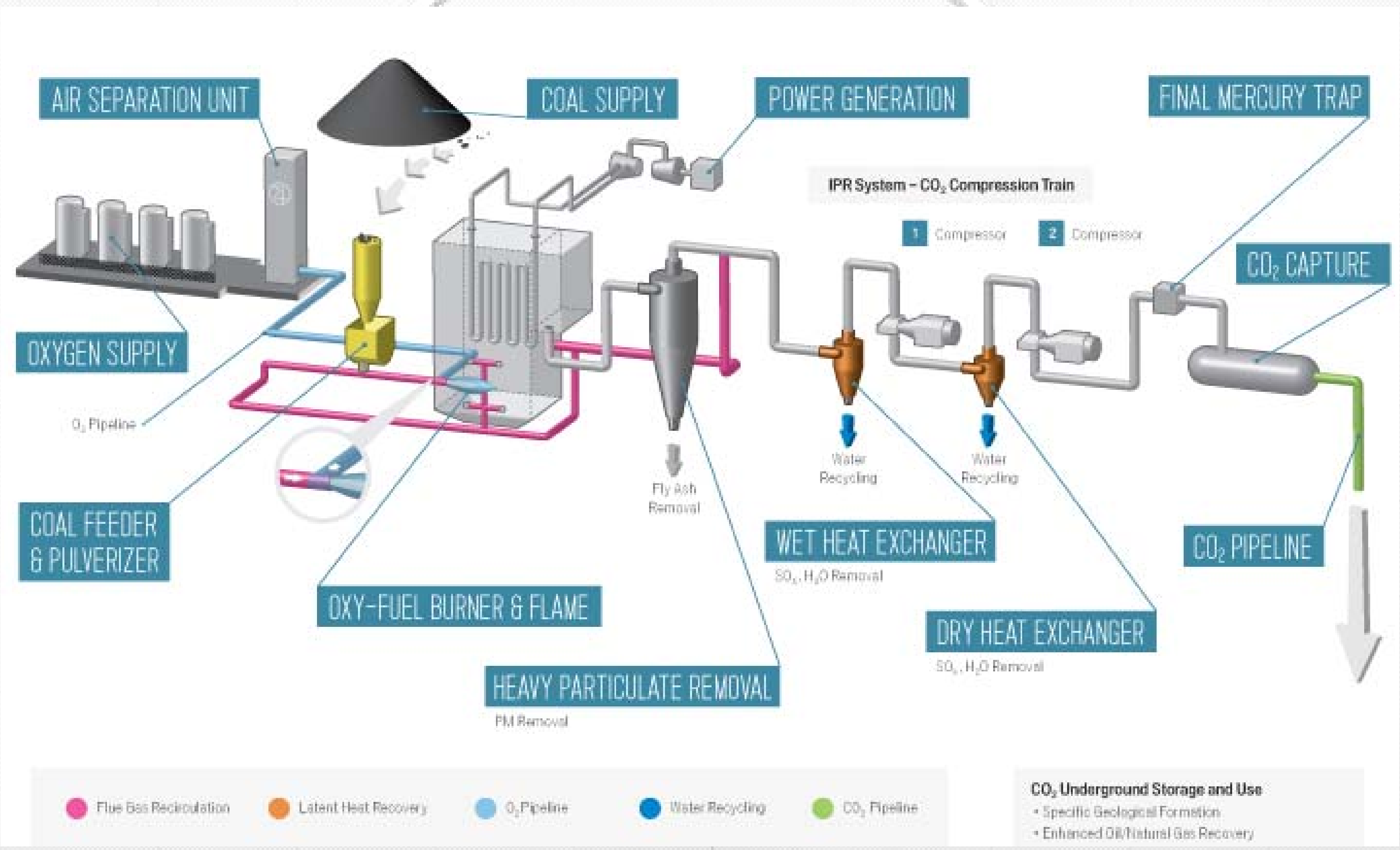

AIR SEPARATION UNIT
COAL SUPPLY
POWER GENERATION
FINAL MERCURY TRAP
IPR System – CO_2 Compression Train
1 Compressor
2 Compressor
CO_2 CAPTURE
OXYGEN SUPPLY
O_2 Pipeline
Fly Ash Removal
Water Recycling
Water Recycling
COAL FEEDER & PULVERIZER
WET HEAT EXCHANGER
SO_x, H_2O Removal
CO_2 PIPELINE
OXY-FUEL BURNER & FLAME
DRY HEAT EXCHANGER
SO_x, H_2O Removal
HEAVY PARTICULATE REMOVAL
PM Removal
Flue Gas Recirculation
Latent Heat Recovery
O_2 Pipeline
Water Recycling
CO_2 Pipeline
CO_2 Underground Storage and Use
• Specific Geological Formation
• Enhanced Oil/Natural Gas Recovery

JUPITER OXYGEN
HIGH FLAME TEMPERATURE
OXYFUEL COMBUSTION

Jupiter Oxygen has developed and patented a high flame temperature oxyfuel combustion process for heat transfer

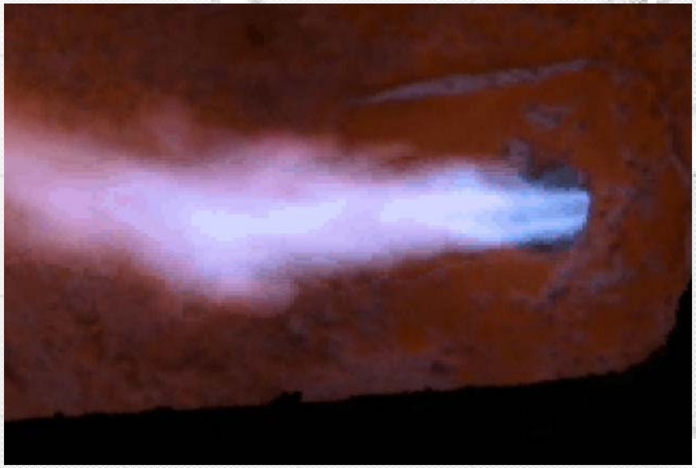
JUPITER OXYGEN ENERGY TECHNOLOGY

- Development
- Patents and Licensing
- Consulting Service

Fossil Fuel: coal, natural gas,
oil, and biomass

JUPITER OXYGEN ENERGY TECHNOLOGY

JUPITER'S FIRST APPLICATION INDUSTRIAL FURNACES



- Jupiter's process has been used in large industrial melting furnaces since 1997
- 70% fuel usage decrease per pound of aluminum melted [natural gas; oil]
- Ultra-low NOx emissions at combustion

AIR COMBUSTION - UNWANTED NITROGEN

- Air: 79% nitrogen and 21% oxygen
- Keeps flame temperature range about 3000 degrees F
  - Limiting radiant heat transfer
- Gas volume reduces residence time
  - Lower residence time = less heat transfer
- NO_X created – Emissions issue
- Carbon capture/EOR:
  - Nitrogen must be separated from CO2

OXYFUEL COMBUSTION ELIMINATES NITROGEN FROM AIR

- Oxyfuel combustion uses oxygen instead of air
- Ultra-low NOx at combustion
  Save emission control cost
- No need to separate nitrogen from CO2 for carbon capture/EOR

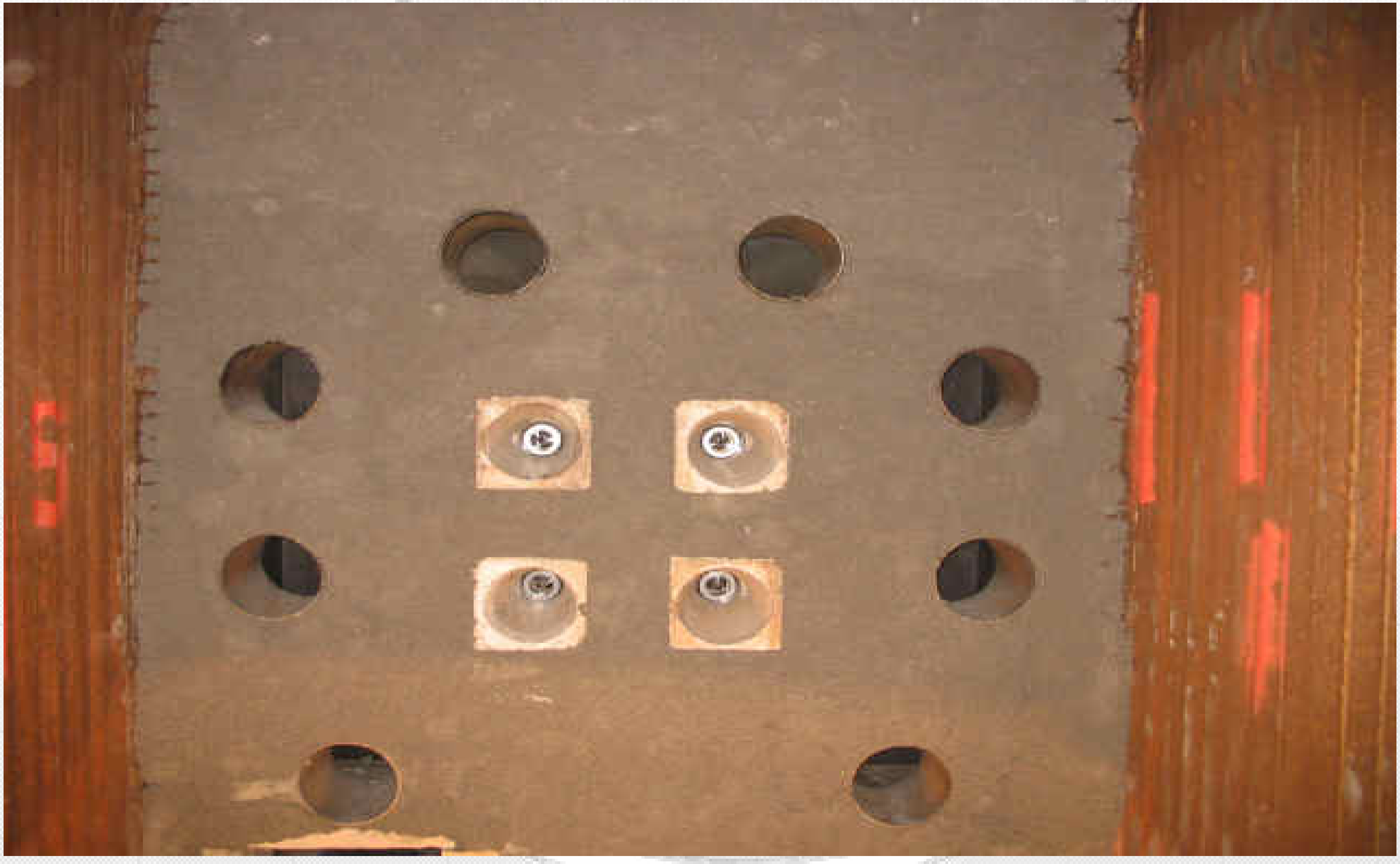
JUPITER OXYFUEL
CRITICAL FLAME TEMPERATURE DIFFERENCE

- Jupiter's process
  - High flame temperature
- Other oxyfuel processes
  - Lower flame temperature = air firing
- Why is the temperature significant?

FLAME TEMPERATURE DIFFERENCES MATTER

- Flame temperature can be lowered
- Others: Lower flame temperature
  - For control
- Jupiter: Higher flame temperature
  - Controlled
  - Process temperatures = air firing
  - Material temperatures = air firing
  - With greater radiant heat transfer

MAINTAINING HIGH TEMPERATURE FLAME WHILE RECIRCULATING FLUE GAS



GREATER RADIANT HEAT TRANSFER ADVANTAGES

- Radiant heat
  - Transfer energy faster than convective
- Oxygen firing means 3-4 x higher CO_2/water vapor concentrations
  - Than normal air firing
  - CO_2/water vapor reduce radiant energy transfer
  - Compared to air
- Much higher flame temperature
  - More than overcomes higher CO_2/water vapor concentrations
  - Means better net heat transfer
  - Key: Maintain tube design temperatures
  - More even heat distribution – no hot spots

TEMPERATURE EFFECT

- Convective heat transfer – T to the 1st

- Radiant heat transfer is T to the 4th
  - Temperature changes to the 4^{th} power
  - Temperature changes have far greater effect
  - Faster heat transfer

- Completed natural gas testing
  - Air firing 3400F
  - Jupiter oxyfuel 5400F

JUPITER OXYFUEL HEAT FLUX EFFECTS

- 600 MW Model Boiler
- 15-50 ft. distances in radiant zone
  From flame to tubes
- Increased heat flux btu/hr/sq.ft. at tubes
  Jupiter oxyfuel per btu/fuel input compared to either:
    Air firing
    Lower temperature oxyfuel
- In order to maintain tube temperature design levels
  Less fuel is required

BALANCING HEAT TRANSER

- Jupiter’s process can have lower gas volumes
  - Means more residence time
  - For better heat transfer
- New design boilers – design in balanced heat transfer
- Retrofits - use recirculated flue gas as needed
  - Balance heat transfer
  - Coal ash movement
  - Recirculate away from flame
    - Keep high flame temperature
- Lowered flame temperature oxyfuel – recirculate close to flame
  - Large volumes of CO_2 with high water vapor content
  - Questions about flame stability

JUPITER'S PROCESS SAVES FUEL

- Industrial furnaces – up to 70% fuel savings
- Current Boiler testing – natural gas

  Jupiter oxyfuel without recirculation:

  - 7.62% fuel savings vs. air [Air firing efficiency 88.40%]
  - Prior testing 14.30% vs. air [Air firing efficiency 75.85%]

  Jupiter oxyfuel with recirculation: 4.47% fuel savings vs. air
- Coal testing in progress

  More particle – better radiant heat transfer
- Lower temperature oxyfuel firing testing

  Jupiter results indicate little or no fuel savings [unless overheat tubes]

Environmental Technology Verification Certificate

Environmental Technology Verification Program

........enhancing the credibility of environmental technologies

CANADA VERIFIED VÉRIFIÉ

Jupiter Oxy-Fuel Combustion

"In a utility boiler using Jupiter Oxygen's Oxy-Fuel technology operated accordant to vendor's specifications with combustion at stoichiometry (+/-) 5% and using natural gas as the fuel source:

1. NOx produced by the boiler was reduced from 0.095 (+/-0.011) lb/MMBtu[1] under conventional operation, to 0.051 (+/- 0.010) lb/MMBtu under Oxy-Fuel operation, with an average NO_x reduction of at least 37%;
2. Combustion efficiency was increased by at least 12% based on products of combustion, with a corresponding reduction in fossil fuel usage; and,
3. Concentration of CO_2 gas of 9.1% (+/- 0.15) under conventional operation increased to 92.3% (+/- 2.3) under Oxy-Fuel operation, to ease gas capture and sequestration."

[1] All figures significant at 95% level of confidence.

License Number: ETV 2004-41
Issued to: Greenhouse Gas Separation Systems Inc.

Verified* Performance
March 2004

Dr. Ed Mallett
President and CEO
ETV Canada Inc.

Canada

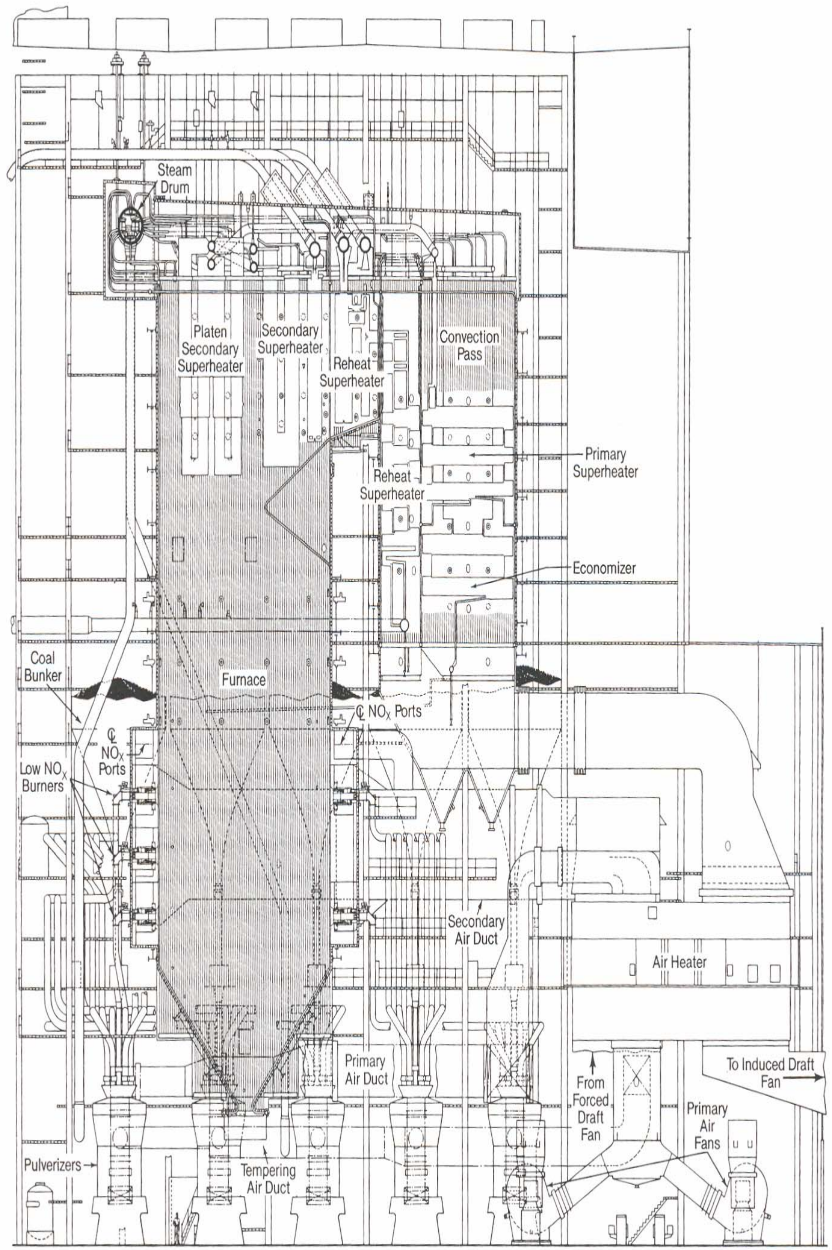
*Refer to Technology Fact Sheet for additional information on the verification of this performance claim.

For retrofit

Not a rebuild

New plant design

May be different



JUPITER OXYGEN TEST BOILER RETROFITS

Coal and natural gas

2002 - 1.5 MWth Boiler (1973)

successfully operated
saturated steam

2008 – 15.0 MWth Boiler (1985)

successfully operated
superheated steam

LOWER CAPITAL AND OPERATING COSTS

- Fuel savings with Jupiter's process
  - Lower fuel costs
  - Less fuel = less oxygen needed
  - Less fuel = less carbon dioxide created
- Lower Excess Oxygen – Stoichiometry
  - Precise oxygen control
  - Less oxygen needed
- Purer carbon dioxide at the boiler exit
  - Lowers carbon capture costs

OXYFUEL BETTER FOR CARBON CAPTURE

- Avoid CO_2/nitrogen separation cost
  Unlike air firing

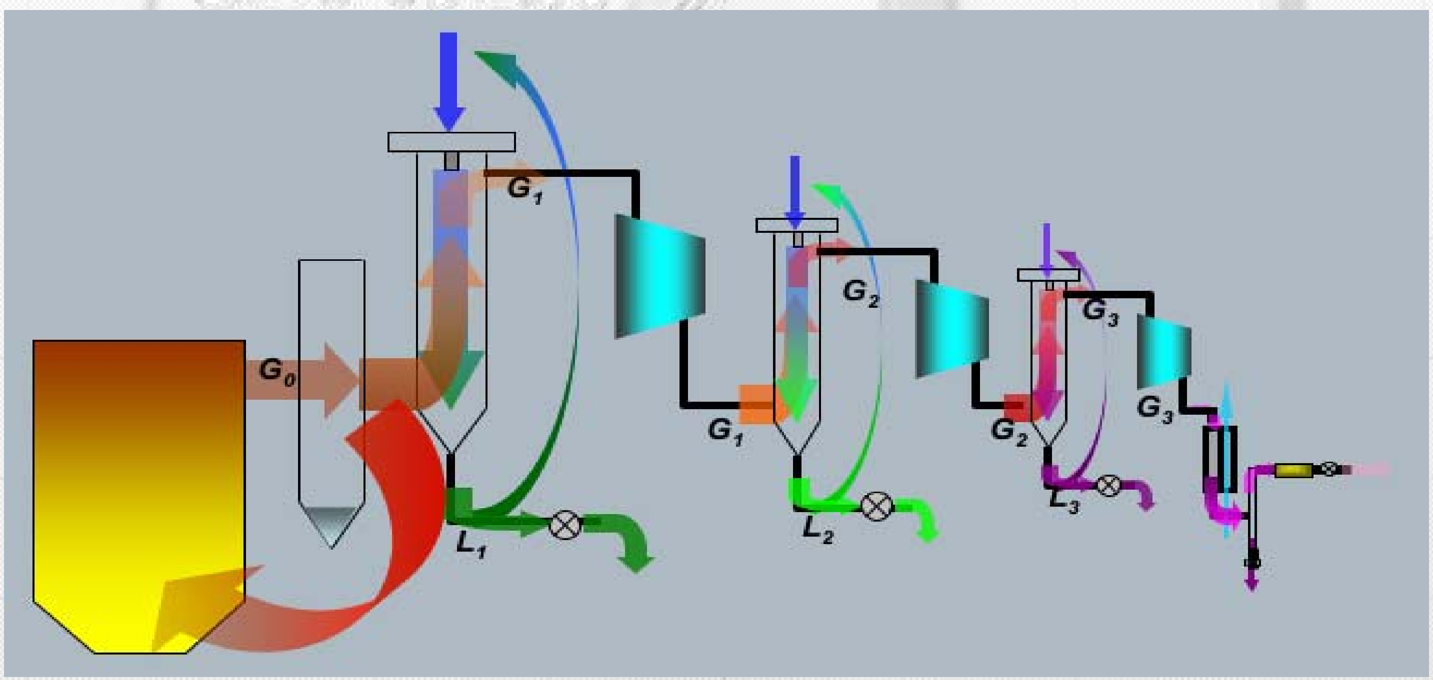
- Jupiter-IPR technology combination

INTERGRATED POLLUTANT REMOVAL

- DOE-NETL Carbon Capture System
- Compresses and changes
    - Flue gas temperature
    - Pressure
- Heat exchangers remove water and S0x
- Filters remove Hg and particulate
- Transport ready carbon capture
- Jupiter's technology enables combined Jupiter-IPR systems to be:
    - Economical
    - Efficient

INTEGRATED POLLUTANT REMOVAL

- No need for NO_X control technology
- 95-100% Capture of CO_2
- 60-90% mercury capture (mercury in coal range factor)
- 99+% sulfur removal
- 99+% removal all particulates, with 80+% removal of the small particles (PM 2.5)



ADDITIONAL SAVINGS

- Heat Recovery – Compressors

  Oxygen plant and IPR

  = 8-9% fuel savings

- Water Recovery – IPR

  Exceeds boiler feed water requirements

FEASIBILITY STUDIES

- 2007 Feasibility Study 850 MWe Coal Fired Supercritical
- 2007 Feasibility Study 120 MWe Natural Gas Fired
- 2007 Capital costs with carbon capture

  Jupiter Oxygen costs less than:

  Post-combustion capture air firing
  IGCC

JUPITER OXYFUEL HAS FAVORABLE ECONOMICS

COST OF ELECTRICITY [COE] – NEW PLANTS

- COE: $0.068/kw [fully amortized costs]
- CO2 capture costs: $9/ton [excludes transport/sequestration]
- In order to use these figures for comparison purposes, air-firing post-combustion International Enegy Agency [IEA] based comparables are:
- COE: $0.072/kw [fully amortized costs]
- CO2 capture costs: $28/ton [excludes transport/sequestration]
- Because IGCC cost projections shifting and increasing, no currently available reliable comparables for IGCC

JUPITER'S TECHNOLOGY CAN RETROFIT COAL/GAS POWER PLANTS

- Retrofit costs projected at 35% of building a new plant

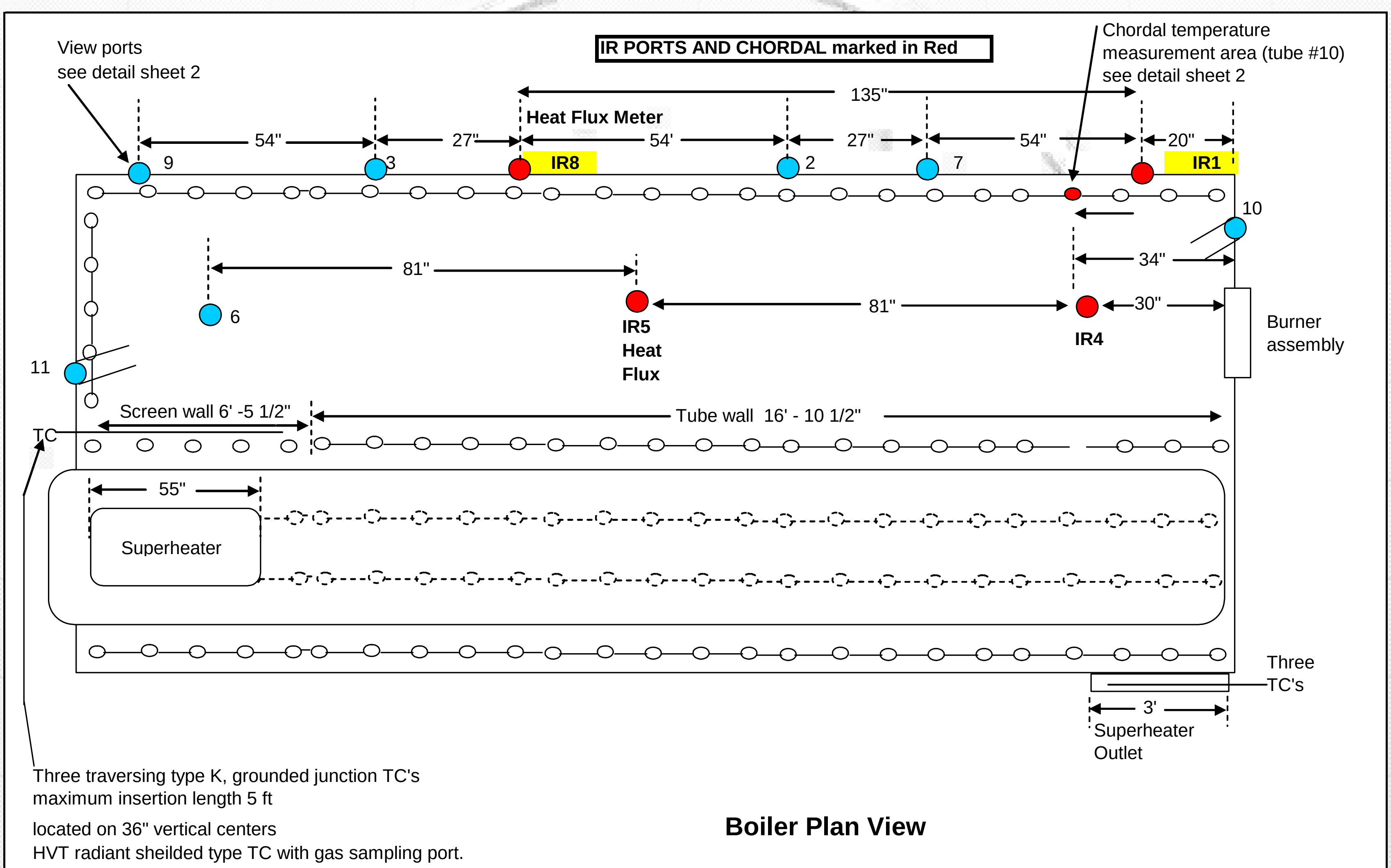
OPERATING COSTS PROJECTED GENERALLY THE SAME AS AIR FIRED POWER PLANT WITHOUT CARBON CAPTURE

15 MWth JUPITER TEST FACILITY

- Oxyfuel burner test system
- Integrated Pollutant Removal
- Flue gas recirculation
- Chamber for the continuous operation of 15 MWth oxygen burner
- 105 TPD cryogenic plant
- Coal pulverizer with recirculation system
- Automated data acquisition system

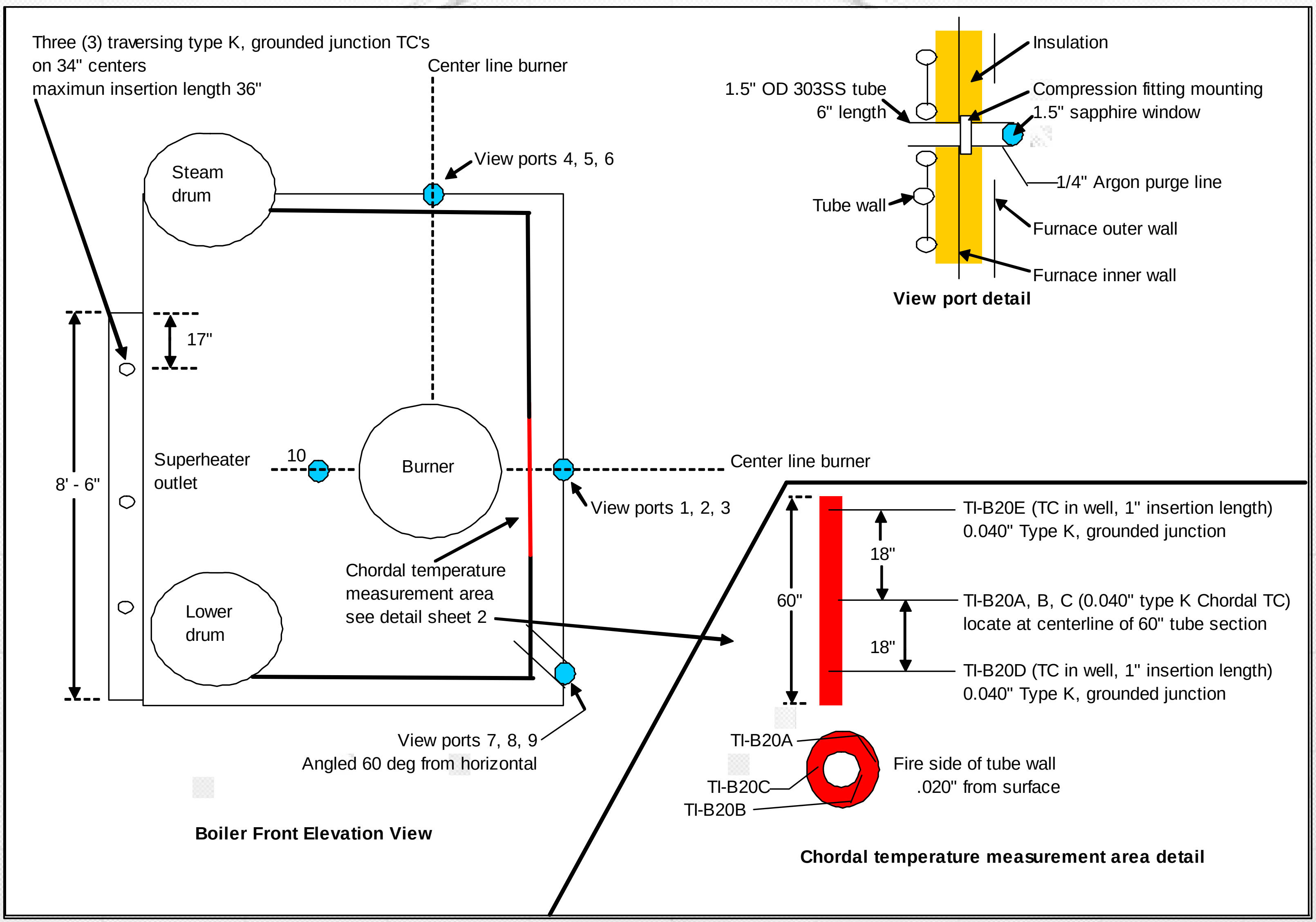
15 MWth Test Facility

15 MWth BOILER PLAN VIEW IR-UV



Boiler Plan View

15 MWth BOILER FRONT VIEW



THE PATH TO CARBON CAPTURE

Jupiter Oxygen high flame temperature heat transfer using oxyfuel combustion:

The best approach to carbon capture

For both retrofits and new build power plants.