Improving Emissions Measurement & Mitigation as a Utility

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Energy Nexus | Annual Technical Conference

Fuelling the Future

Why are we doing this?

Federal and Provincial statutes and regulations

Carbon Pricing & economic incentives

Environment, Social, & Governance targets

Safe, reliable, and cost-effective transportation of natural gas.

Revisit the problem from the ground up

Get a fresh set of eyes on the problem

Validate existing assumptions

Flue stack emissions/slip

Fuel usage

Thermal Efficiency

- Exhaust emissions/slip
- Fuel usage
- Operating Efficiency

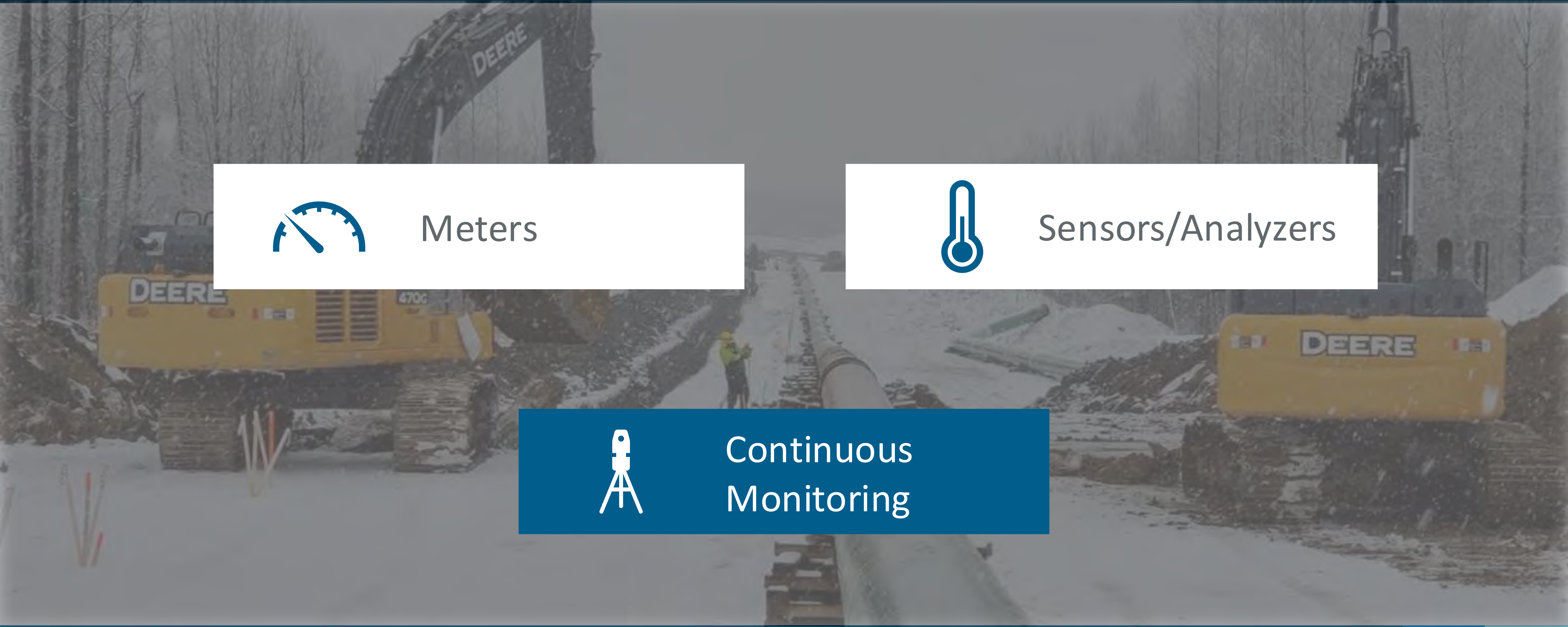
Pneumatic Actuation

Supply Fuel/Gas

Fugitive emissions

CGA Energy Nexus & Annual Technical Conference 2024

Fuelling the Future



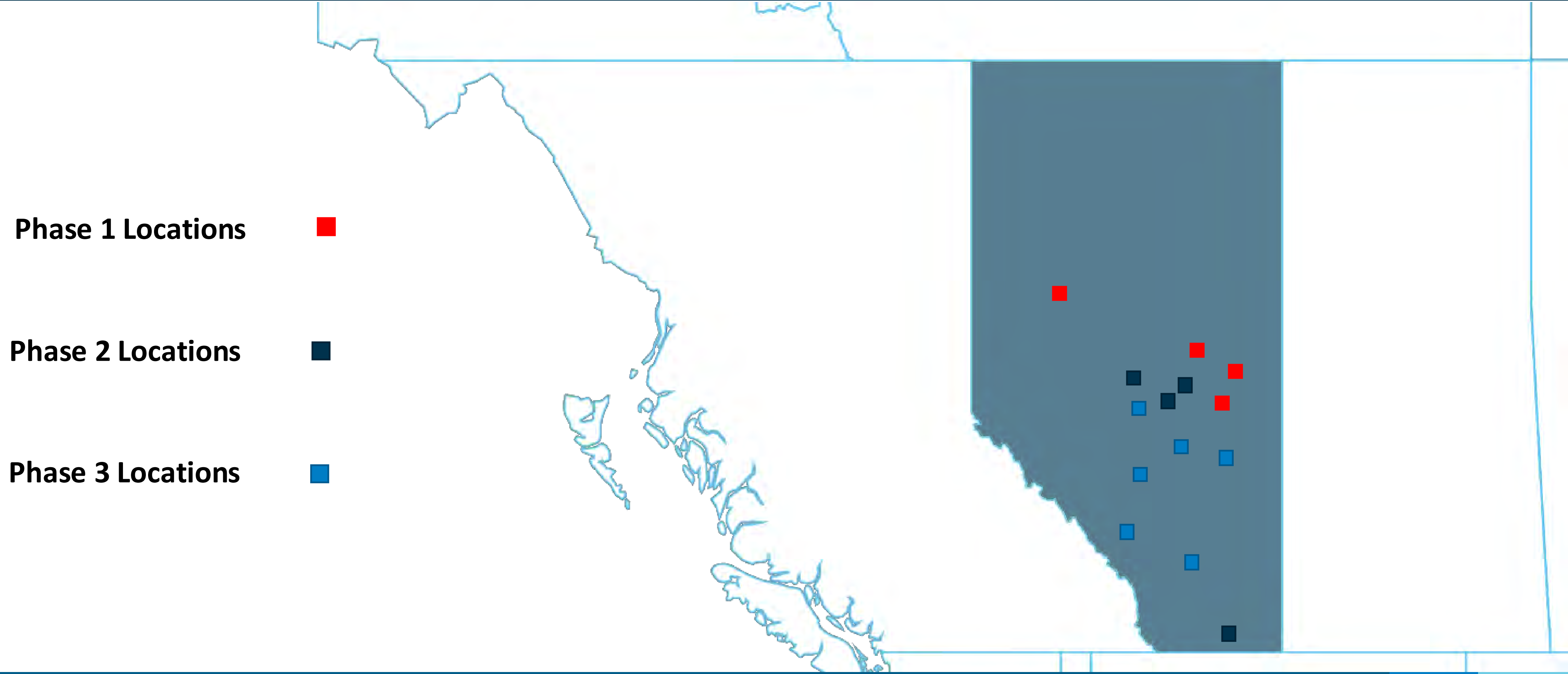
Meters

Sensors/Analyzers

Continuous Monitoring

Data Integration

- SCADA
- Cellular
- Cybersecurity


Phase 1 Locations
Phase 2 Locations
Phase 3 Locations

SUMMARY

32 Total Projects

14 Locations

128 New Measurement Assets

Areas of Focus

- Stationary Fuel Usage
- Venting
- Methane Slip
- Fugitive Emissions
- Data Integration

Q4 2024 — Breaking Ground

Q2 2025 — Complete Installs

What can we do with the data?

- Understand operational differences
  - Geographical
  - O&M
- Refine emissions reporting
  - Continuous monitoring → Compliment LDAR surveys
  - Real NG consumption for metered devices
  - Inform assumed consumption for unmetered devices
- Document results to inform future decisions
  - Successes and challenges

What can we do with the data? Cont'd

- Assess performance of combustion assets
  - Cat heaters
    - Lifespan → Odourized vs unodourized supply gas
  - Line heaters
    - High flue gas temperatures
    - Burner issues
    - Overheating NG
    - Pros/cons of different LH technologies

Example: Line Heaters

What are they for?

- Counter Joule-Thomson (J-T) Effect
    - Inside the pipe
        - Hydrate/ice formation
        - Soft parts performance
    - Outside the pipe
        - T_{steel} above 0°C

LH Sizing

- Determine increase in temperature we want. (T_{rise})
    - T of gas coming into the station?
    - T of gas we want after the pressure cut?
    - ΔT of gas due to J-T?
        - ~7 deg F per 100 psi drop
- Determine maximum flow rate. (Q_{max})
- Determine duty of line heater we need.
    - $T_{rise} * Q_{max} * C_p * \rho_{gas}$
- Round up to next common LH size


Net Duty
750,000
Design
500,000
Rounding Up
250,000

Combustion

- Complete combustion:
  - $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
- Incomplete combustion:
  - $2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$
- 100 moles of air contain:
  - $21O_2 + 78N_2 + Ar$

"Net Duty" vs "Gross Duty": ~10% Energy Loss

- Gross Duty is Higher Heating Value (HHV)
- Net Duty is Lower Heating Value (LHV)
- HHV = LHV + Moisture Losses
- HHV of methane is 1012 BTU/scf, LHV is 911 BTU/scf. 911/1012 = 90%
- Making steam from water takes a lot of energy!
    - Sensible heats of water *and* steam.
    - Latent heat of water *to* steam

Dry Gas Losses and Incomplete Combustion: 8% Loss

- Other flue gases:
  - Stoichiometric: CO_2, N_2, Ar
  - Excess Air: extra O_2, N_2, Ar
  - Sensible heats
- High flue gas temperature:
  - More sensible heat in flue gases
- Incomplete combustion:
  - CH4 → CO2 releases 1012 BTU/scf
  - CH4 → CO releases 691 BTU/scf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Design
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Rounding Up
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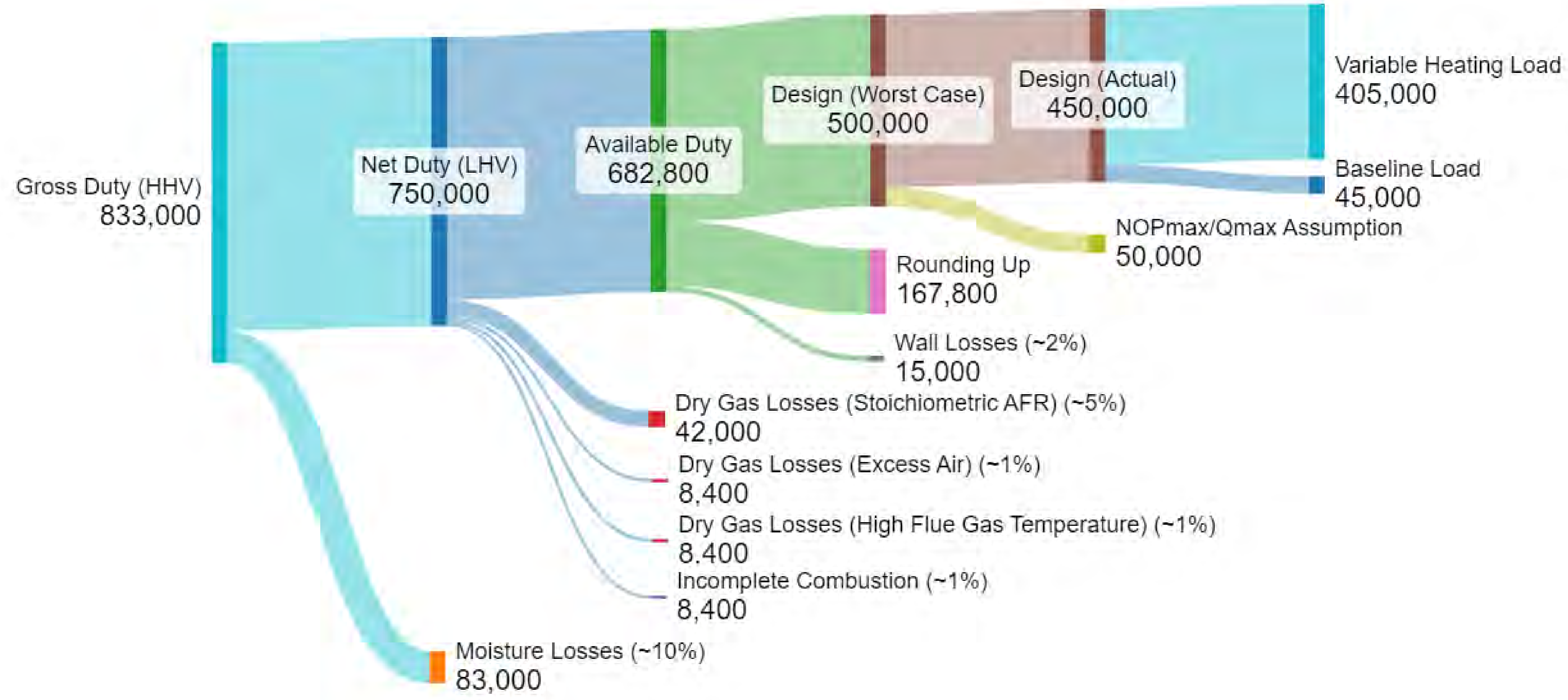
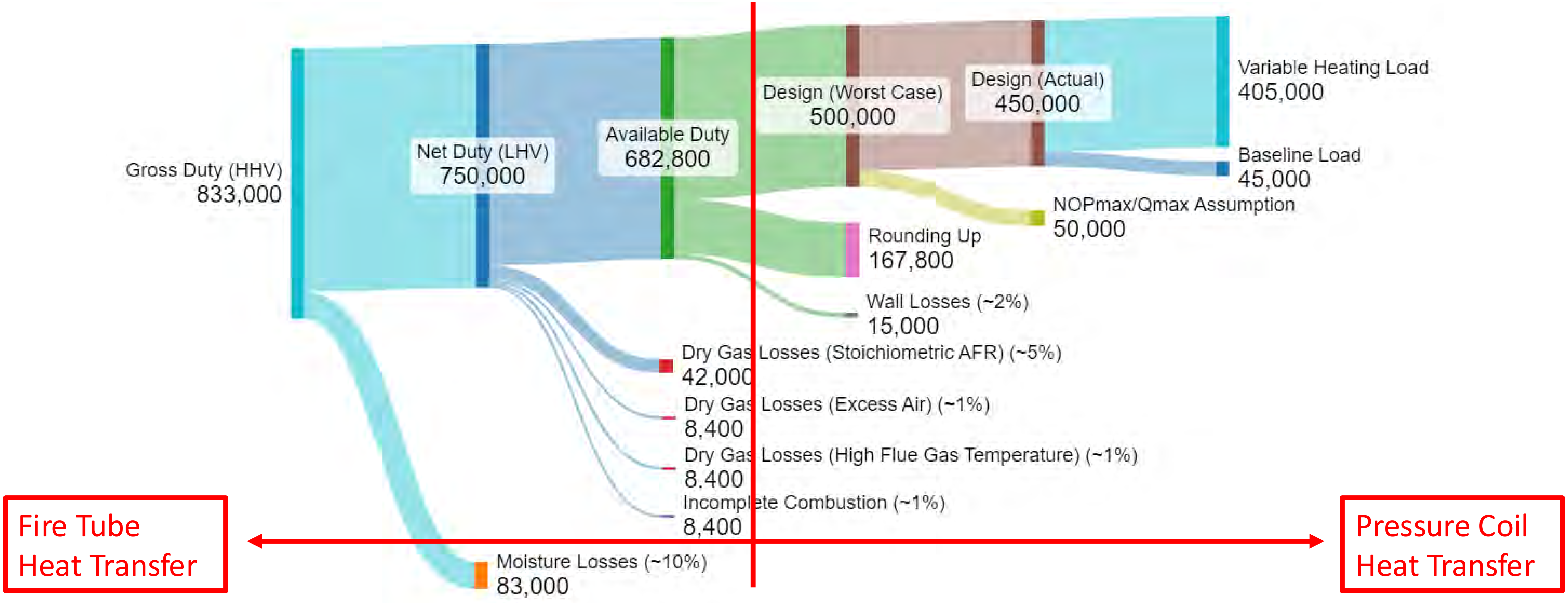

Gross Duty (HHV)
833,000
Net Duty (LHV)
750,000
Available Duty
682,800
Design (Worst Case)
500,000
Design (Actual)
450,000
Variable Heating Load
405,000
Baseline Load
45,000
NOPmax/Qmax Assumption
50,000
Rounding Up
167,800
Wall Losses (~2%)
15,000
Dry Gas Losses (Stoichiometric AFR) (~5%)
42,000
Dry Gas Losses (Excess Air) (~1%)
8,400
Dry Gas Losses (High Flue Gas Temperature) (~1%)
8,400
Incomplete Combustion (~1%)
8,400
Moisture Losses (~10%)
83,000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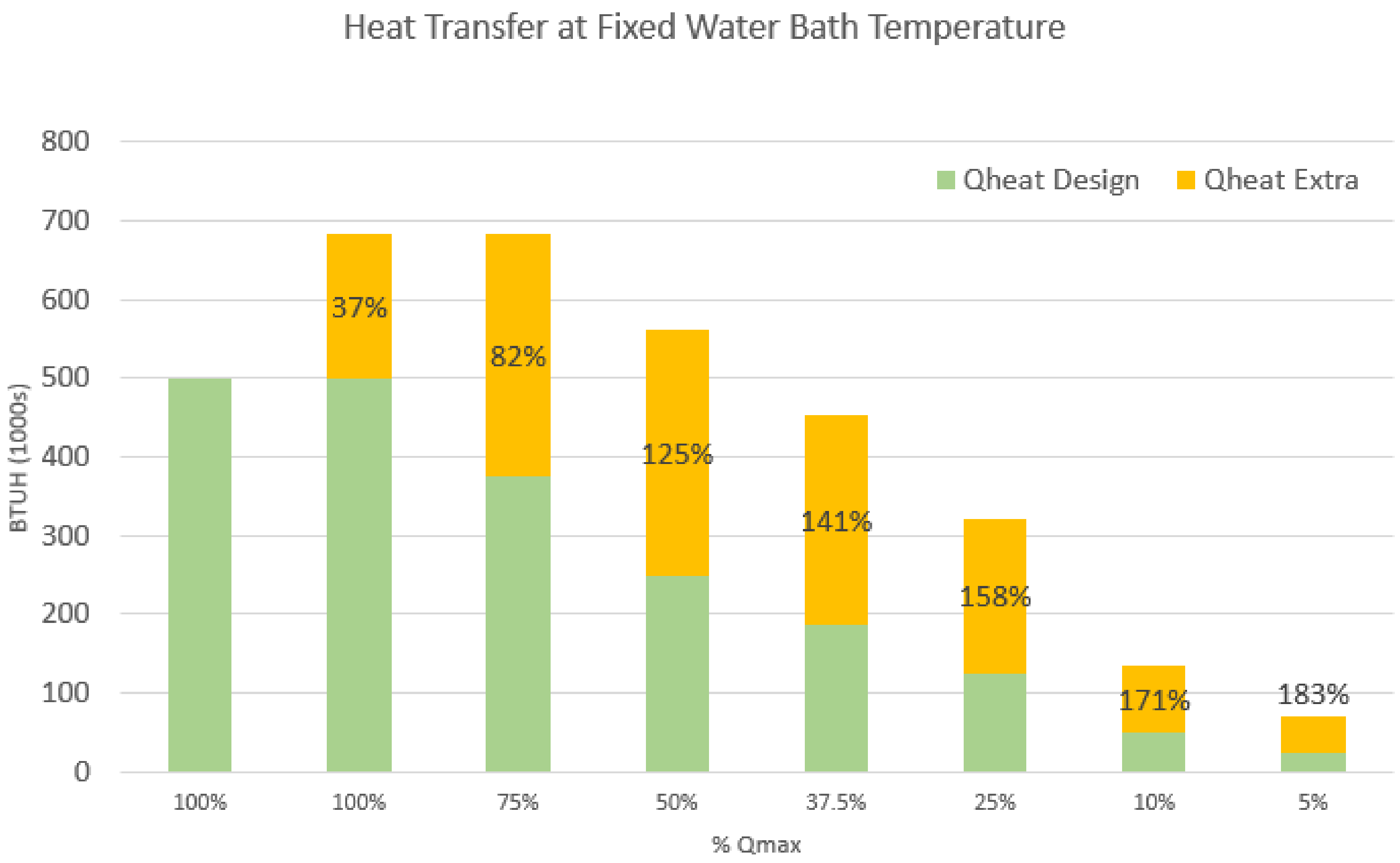
Fire Tube Heat Transfer
Pressure Coil Heat Transfer

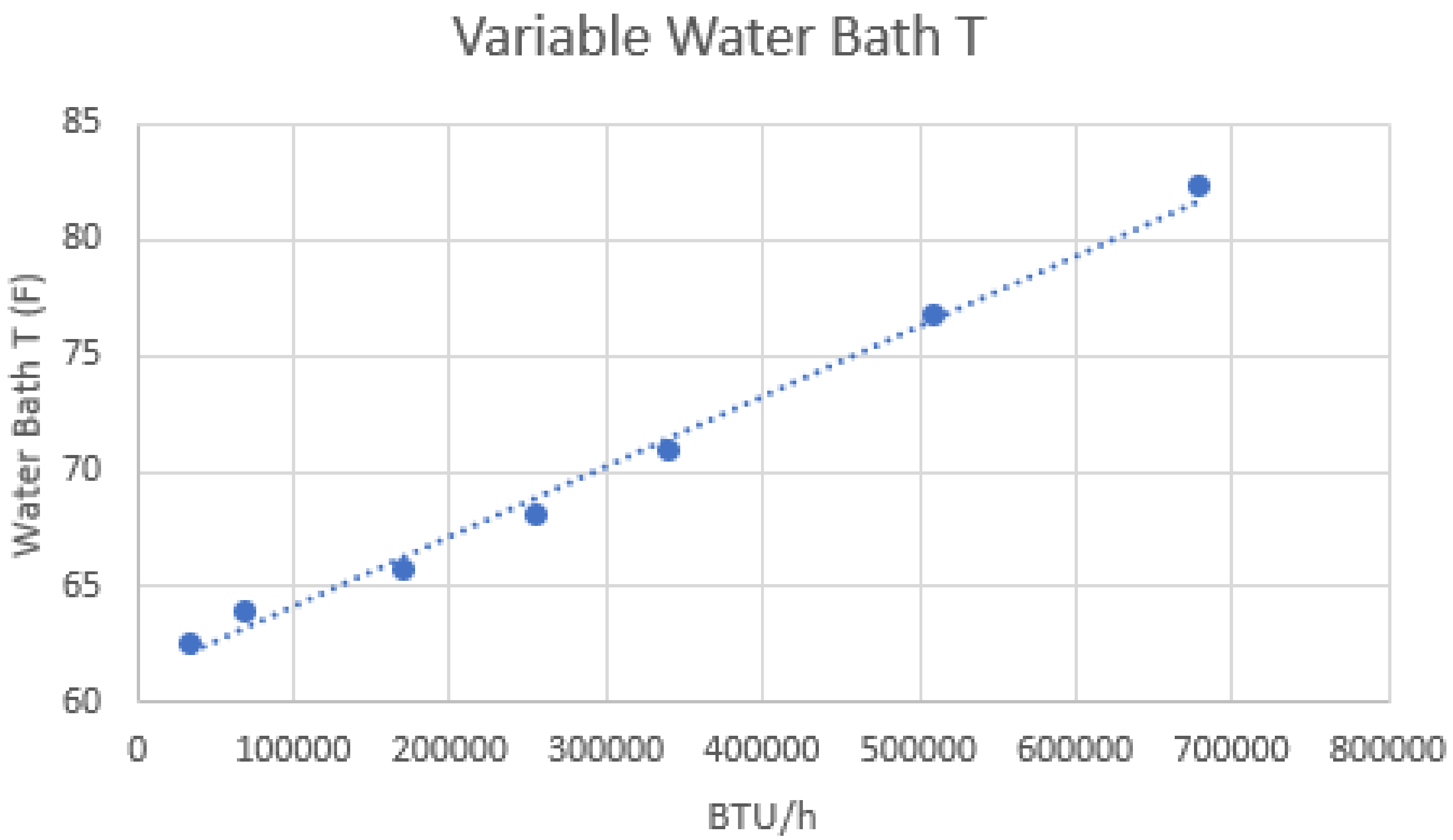
Pressure Coil Sizing – Example

- Q_{max} = 680000 SCFH, T_{rise} = 27 F
- $Duty_{max} = Q_{heat}$ = 500000 BTU/h
- Standard 750000 BTU/h LH selected
  - Pressure coil: 4 in XH, 8 x 17 ft loops
  - A = 160 ft^2
- Heat Transfer Equation:
  - $Q_{heat} = U_o*A*T_m$ where,
    - Q_{heat} is Total Heat Transfer (BTU/h)
    - U_o is Heat Transfer Coefficient (BTU/(h*ft^2*F)), which is dependent on Q_{max} and P_{inlet}
    - A is Total Heat Transfer Area (ft^2)
    - T_m is Log Mean Temperature Difference (F)

Pressure Coil Sizing – Example, Cont'd

- Heat Transfer Equation, re-arranged:
  - $A = Q_{heat} / (U_o * T_m)$ where,
    - Q_{heat} = 500000 BTU/h
    - U_o = 84 BTU/(hr*ft^2*F)
    - T_m = 78 F, based on $T_{LH,inlet}$ = 30 F, $T_{LH,outlet}$ = 57 F, $T_{LH,bath}$ = 122 F
    - A = 77 ft^2
- But the coil is 160 ft^2! What happens?
- Let's solve for Q_{heat} using $Q_{heat} = U_o*A*T_m$
- Qheat = ~1050000 BTU/h?!?
- $T_{LH,outlet}$ = 77.9 F results in 879247 BTU/h


Heat Transfer at Fixed Water Bath Temperature
800
700
600
500
400
300
200
100
0
BTUH (1000s)
Qheat Design
Qheat Extra
37%
82%
125%
141%
158%
171%
183%
100%
100%
75%
50%
37.5%
25%
10%
5%
% Qmax


Variable Water Bath T
Water Bath T (F)
85
80
75
70
65
60
0
100000
200000
300000
400000
500000
600000
700000
800000
BTU/h

What can we do with the data? Cont'd

- Build improvement programs
- Update internal design standards
- Sober look at cost vs emissions targets
    - Strong understanding of \$/tonne $CO_{2,e}$
    - Pace of improvements vs targets

Side benefits of this program

- Better understanding of:
    - Combustion
    - Different types of “efficiency”
    - Decades of design/operational practice and identifying inconsistencies
    - Emissions factors that are being
    - Areas of focus for emission mitigation
    - How to handle future regulatory challenges
- Engaging internal teams and stakeholders about emissions, their importance, and the path forward to success. Allows for increased understanding and involvement, and raises issues to a broader group of people in the company.

What can we learn from our peers?

- Majority of evaluated tech around for decades (meters)
- Less familiar:
- Continuous combustion gas analyzers

- Continuous Monitoring
  - Structural
  - Power
  - Data Management/Security/IT

Conclusion

- Although only partway through execution, this program has been valuable on multiple levels
    - Engagement within the company
    - Re-affirmation that what we are targeting is meaningful
    - Discovery of other opportunities along the way
    - Proactively tackling future regulatory changes
    - Development of internal skills and SMEs in this space
- The measure of success of this program is to have better measurement and understanding of our emissions.
    - Assuming the scoping, technology analysis, and installation are done correctly:
        - If the new data comes back with very minimal emissions, or perhaps in some cases no emissions, that is a success
        - If data comes back with higher than expected emissions, that is a success
        - If data comes back with different emissions than expected, that is a success