



BURNERS

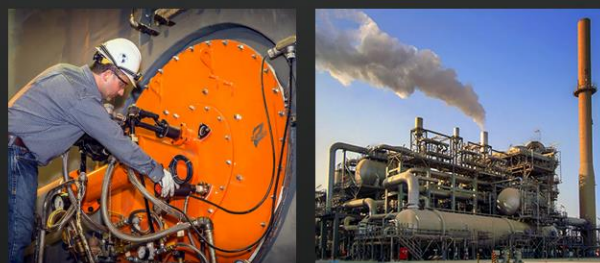
FLARES

THERMAL OXIDIZERS

VAPOR CONTROL

RENTALS

AFTERMARKET



ZEECO

New Technologies

Clayton Francis - Applications Manager, Aftermarket

Brian Duck - Global Business Manager, Flares

Global Sales 2019



New Technologies

- VerifEye: fiber optic pilot detection
- Steam Force HC: next generation steam flare
- Contour: direct smokeless control
- FlareGuardian: complete flare combustion monitoring

Zeeco VerifEye

Fiber Optic Pilot Detection



VerifEye: Fiber Optic Pilot Detection

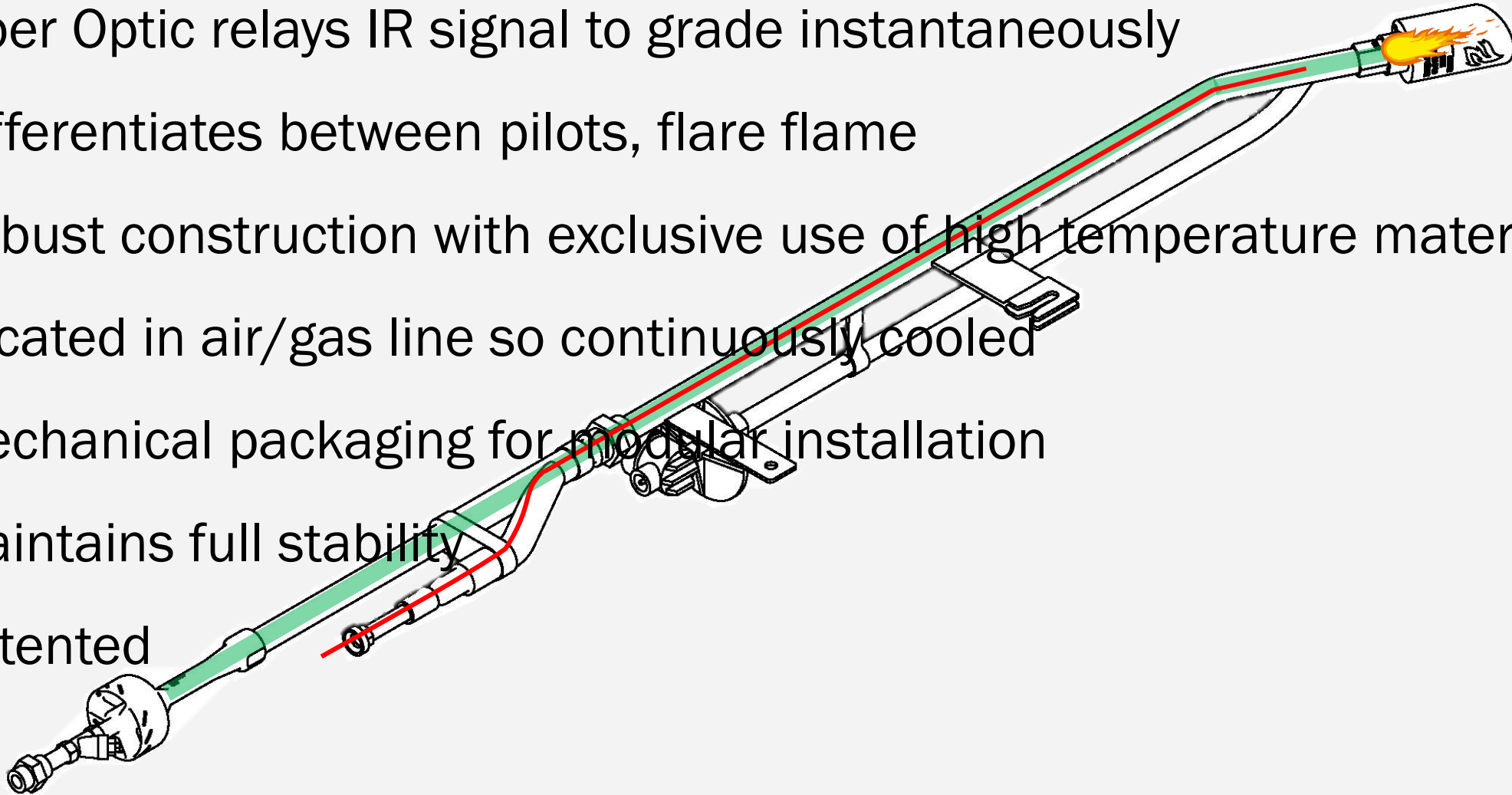
- Industry seeking a new pilot detection technology
 - Individual pilot confirmation
 - No consumable parts or maintainable online at grade
 - Instantaneous feedback
- All current technologies fall short in some aspect

| | INDIVIDUAL | MAINTAINABLE / ROBUST | INSTANTANEOUS |
|-----------------|------------|--------------------------|---------------|
| THERMOCOUPLE | ✓ | ✓ | ✗ |
| OPTICAL @ GRADE | ✗ | ✓ | ✓ |
| FLAME ROD | ✓ | ✗ | ✓ |
| ACOUSTIC | ✓ | ✗ | ✓ |

VerifEye: Fiber Optic Pilot Detection



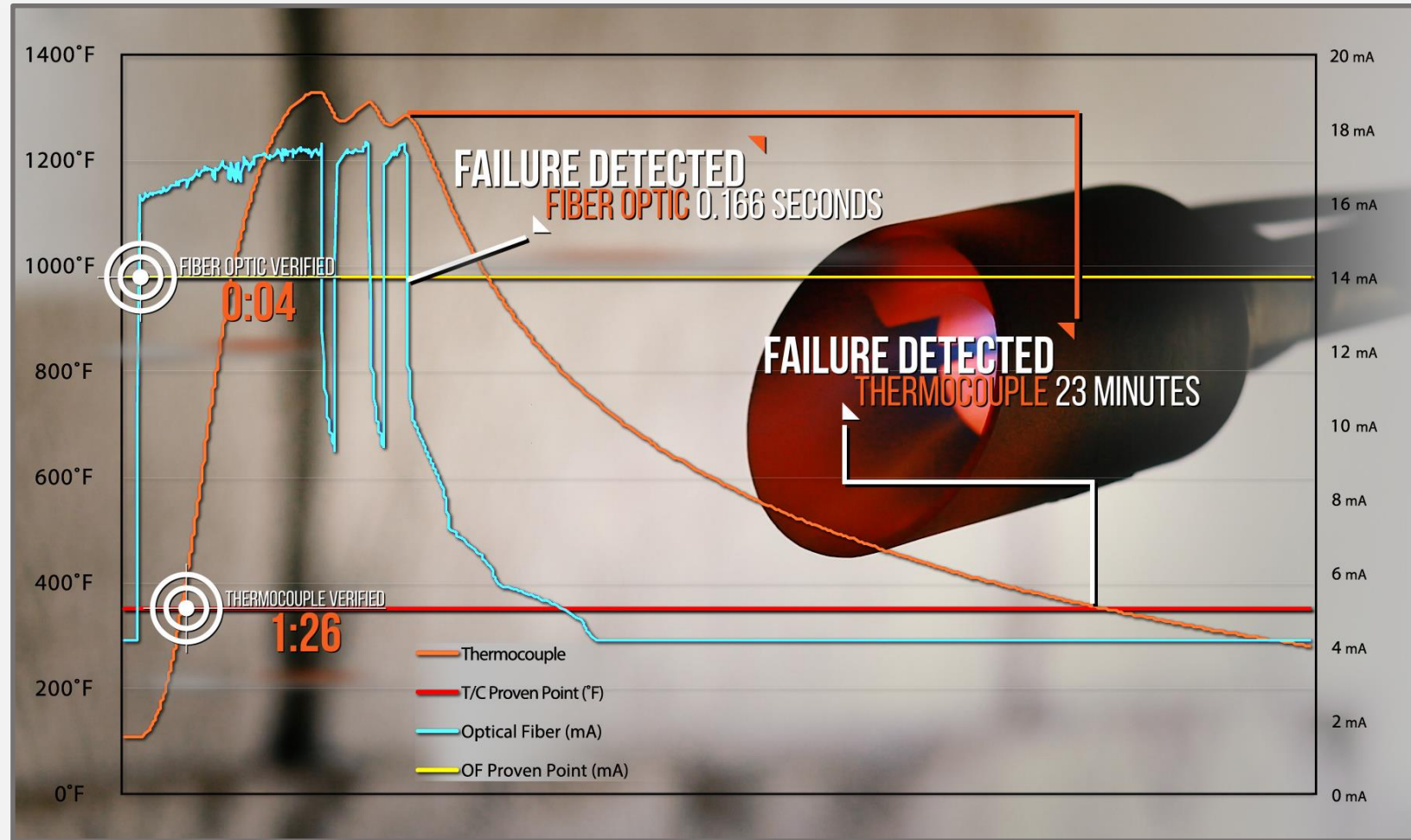
- Fiber Optic relays IR signal to grade instantaneously
- Differentiates between pilots, flare flame
- Robust construction with exclusive use of high temperature materials
- Located in air/gas line so continuously cooled
- Mechanical packaging for modular installation
- Maintains full stability
- Patented



VerifEye: Sales strategy



- For customers who have had problems with pilot flame detection
- Non contact
- Instantaneous
- Higher temperature



YouTube: Zeeco VerifEye

Steam Force HC

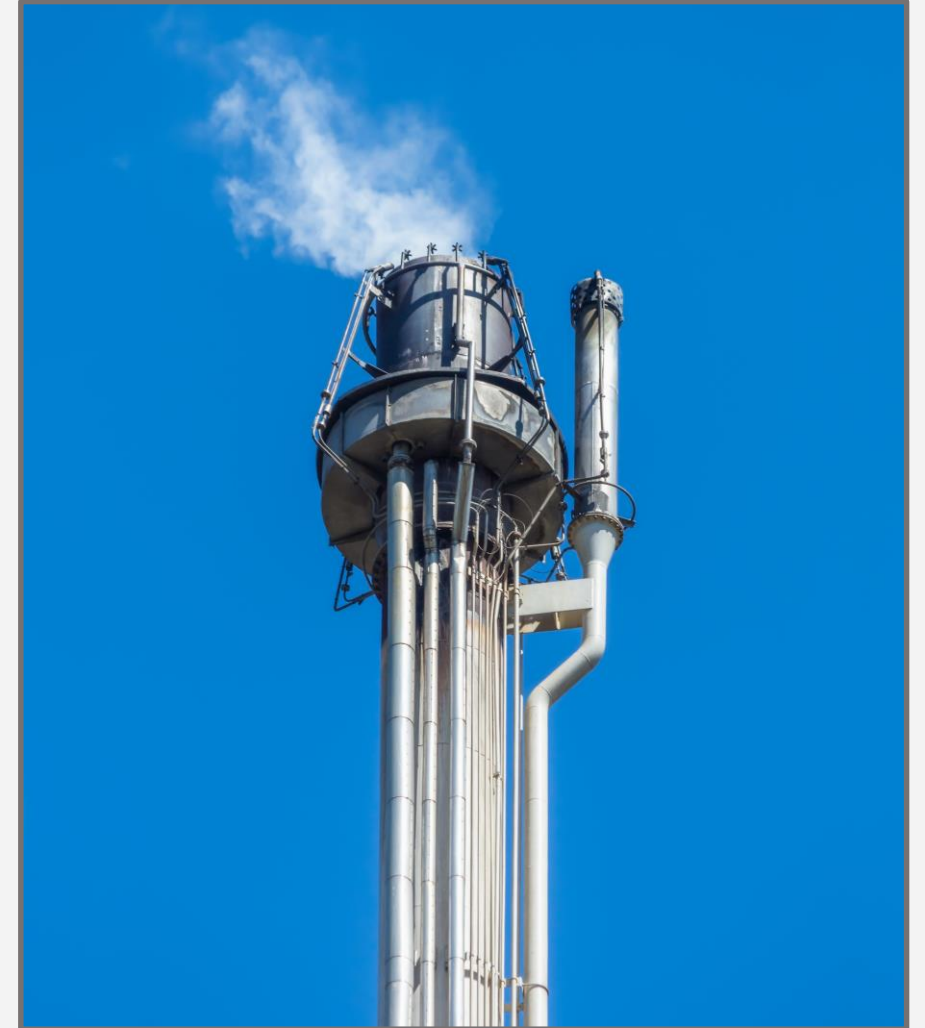
Next Generation Steam Flare



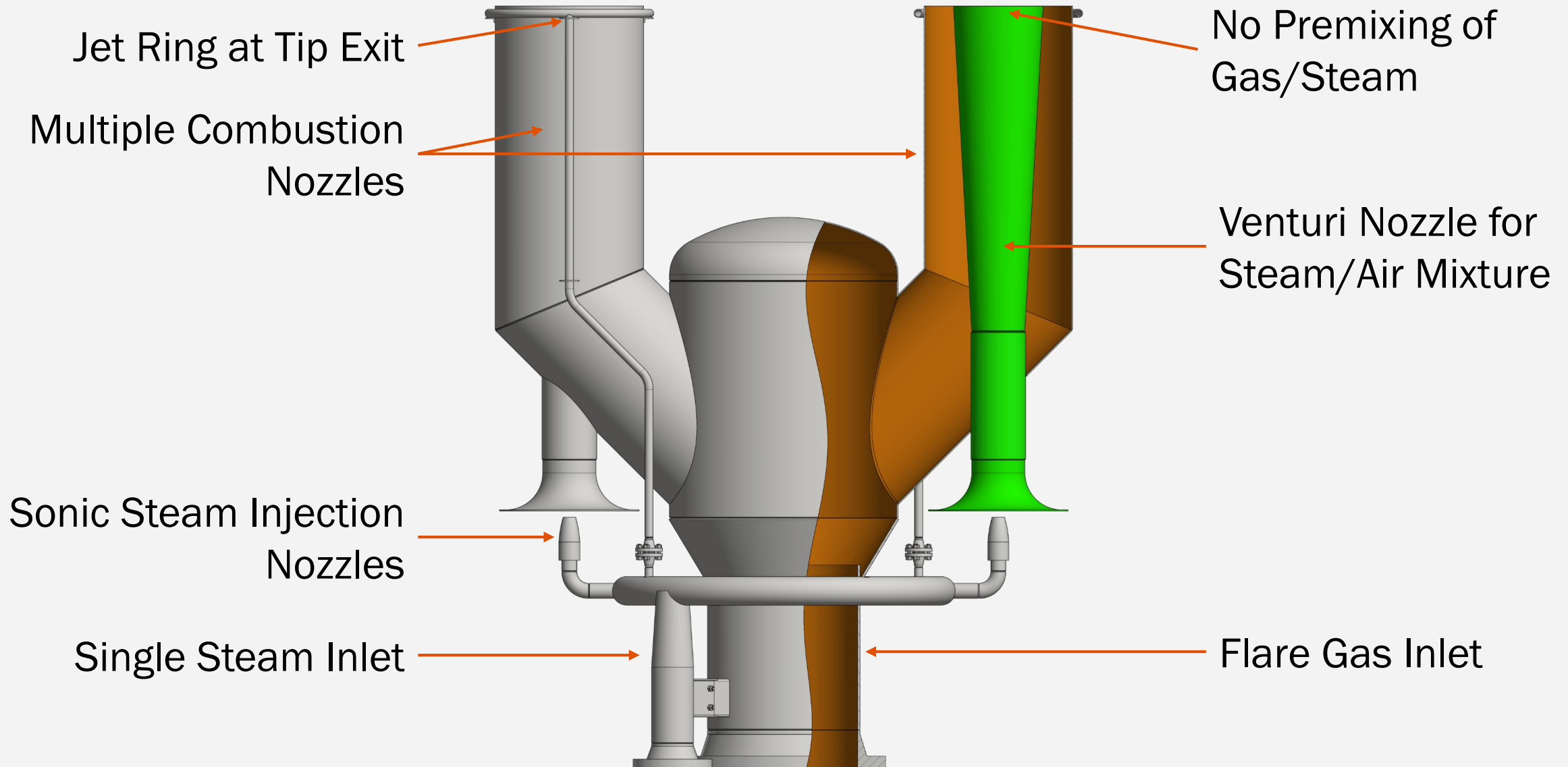
Ultra-Low Steam Consumption, High Capacity Smokeless Flaring



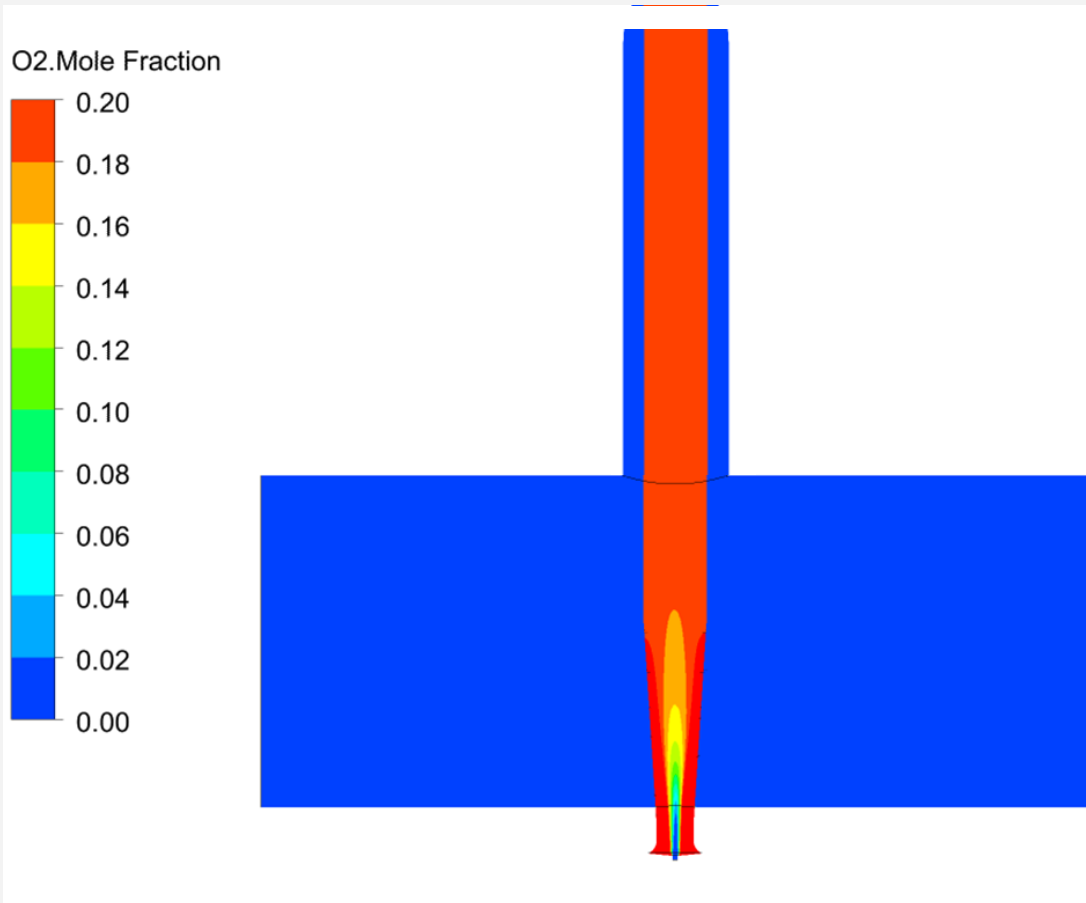
- SteamForce HC technology is to:
- Lower steam consumption
 - Normal operation & flaring scenario
- Meet MACT CC regulations effectively
- Robust, lasting equipment



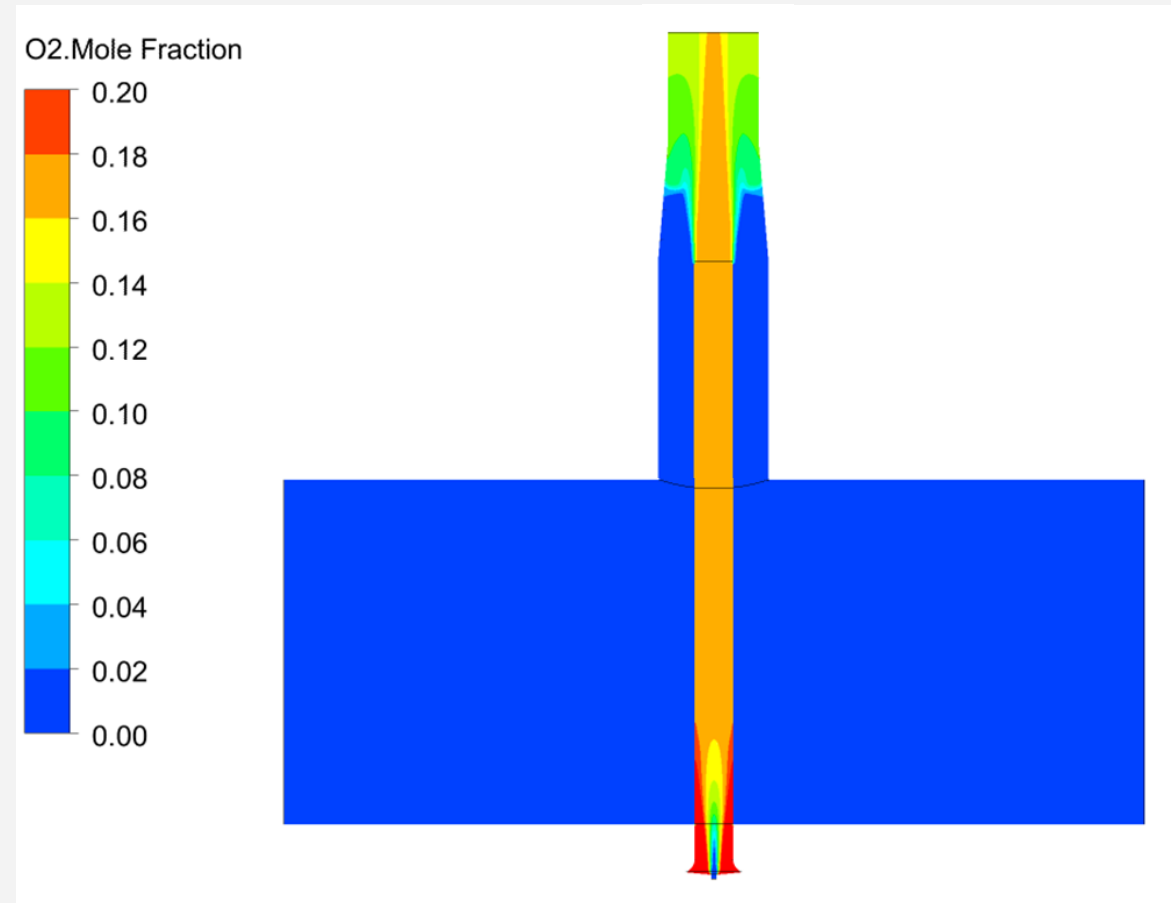
SteamForce HC: Configuration



SteamForce HC: Comparison to other next generation steam technology



➤ SteamForce venturi design increases the air flow per pound to around 14 # air / # steam



➤ A traditional straight tube, even next gen. tech, educts 8 # air / # steam as shown in CFD

SteamForce HC: Testing results

- Flare Gas = 100% Propylene
- Fuel Flow Rate = 13,820 #/hr
- Steam Flow Rate = 3,040 #/hr
- 0.22 # steam / # fuel
- Wind at 5 MPH
- Incipient Smoke Point

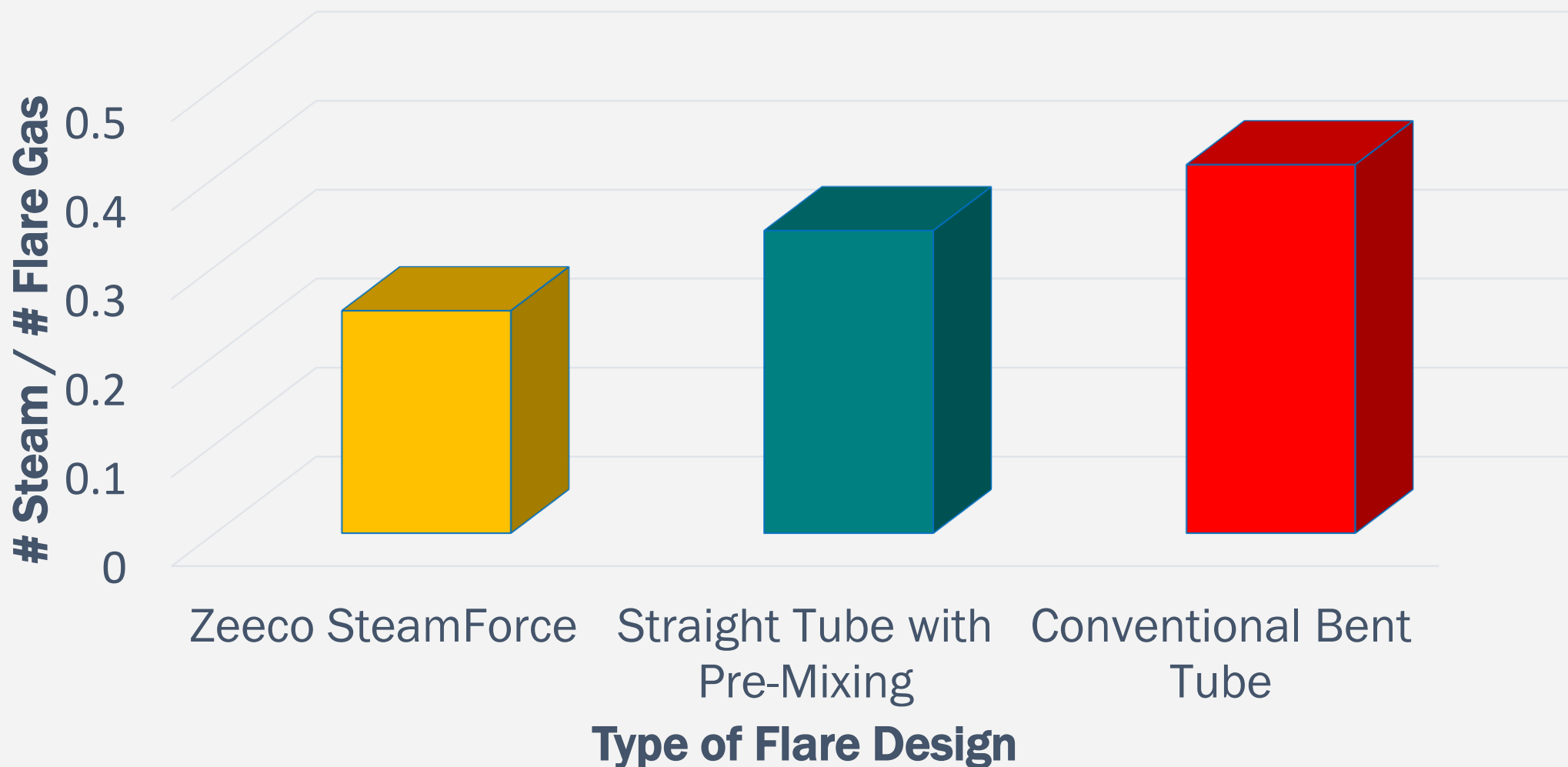


Incipient Smoke Point

SteamForce HC: Smokeless Comparison



Steam Consumption Rate at Incipient Point of Smoke Formation





SteamForce HC: Cost of ownership

- COO: normal rates largely govern op-ex
 - Purge 95% hourly consumption
 - Flaring 5% hourly consumption
- Steam costs only
 - Purge rates can increase SteamForce HC advantage
- Consider refinery vs. petrochemicals

SteamForce HC: Cost of ownership

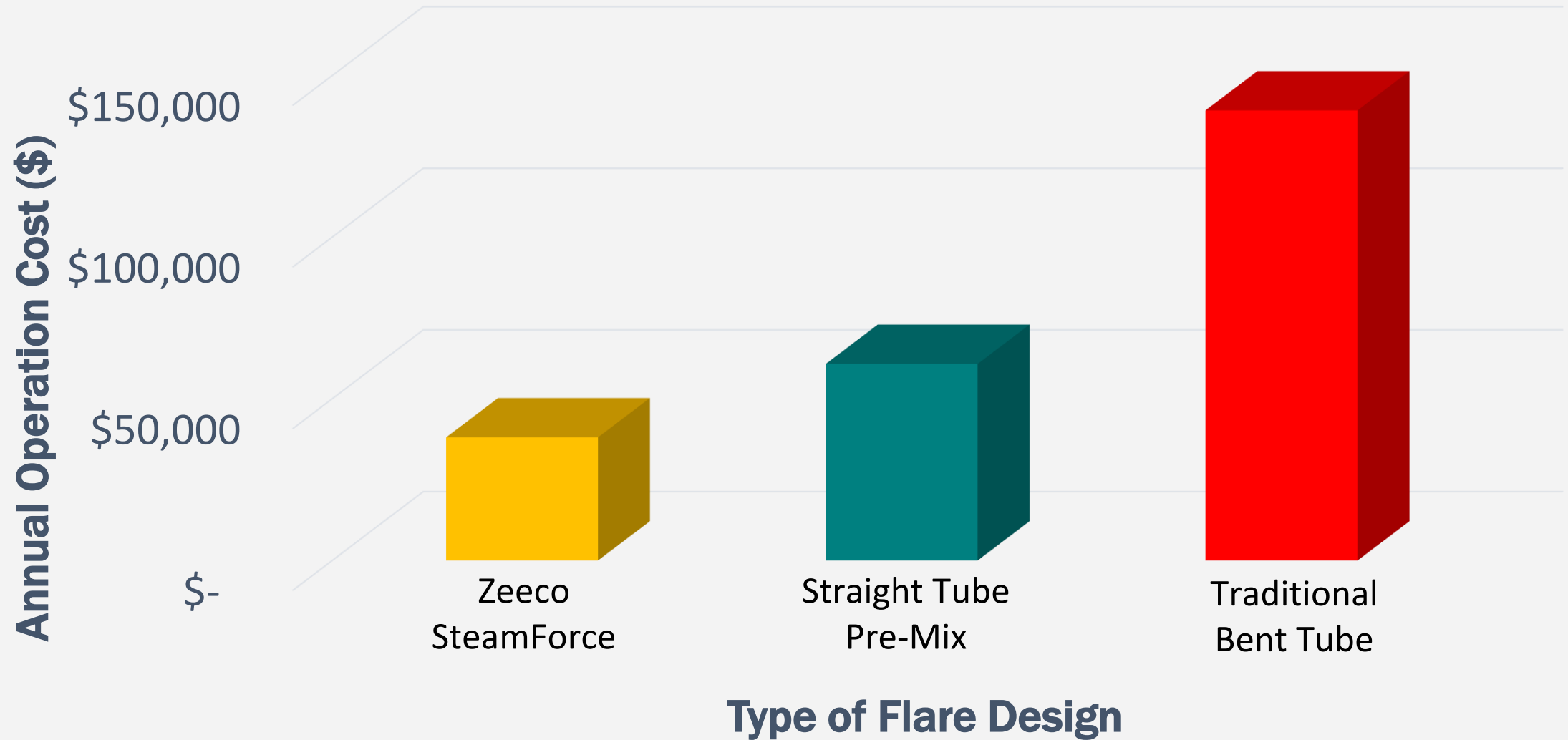


Illustration Example based upon a 24" Steam Assisted Flare

| Smokeless Flare Rate of Propylene (#/hr) | Required Injection Ratio (# stm/ # fuel) | Min.Steam Rate (#/hr) | Smokeless Steam Rate (#/hr) | % Time at Purge Rate | % Time at Smokeless Rate | Steam Use per Year (#/year) | Steam Cost Factor (\$/1000# stm) | Cost USD Per Year |
|--|--|-----------------------------|-----------------------------------|-------------------------|--------------------------------|--------------------------------|--|----------------------|
| 40,316 | 0.25 | 232 | 10,079 | 95% | 5% | 3,172,653 | \$ 12.00 | \$ 38,072 |
| 40,316 | 0.34 | 496 | 13,707 | 95% | 5% | 5,065,785 | \$ 12.00 | \$ 60,789 |
| 40,316 | 0.41 | 1,910 | 16,696 | 95% | 5% | 11,602,196 | \$ 12.00 | \$ 139,226 |

Smokeless defined at Incipient Point with 10 MPH Wind

SteamForce HC: Cost of ownership



STeamForce HC: Sales Strategy



- Ultra efficient steam consumption
 - Max steam rate improvement
 - Purge steam rate improvement
- Ready compliance with new regulations
- Simplified control
- Flexible geometry



Contour

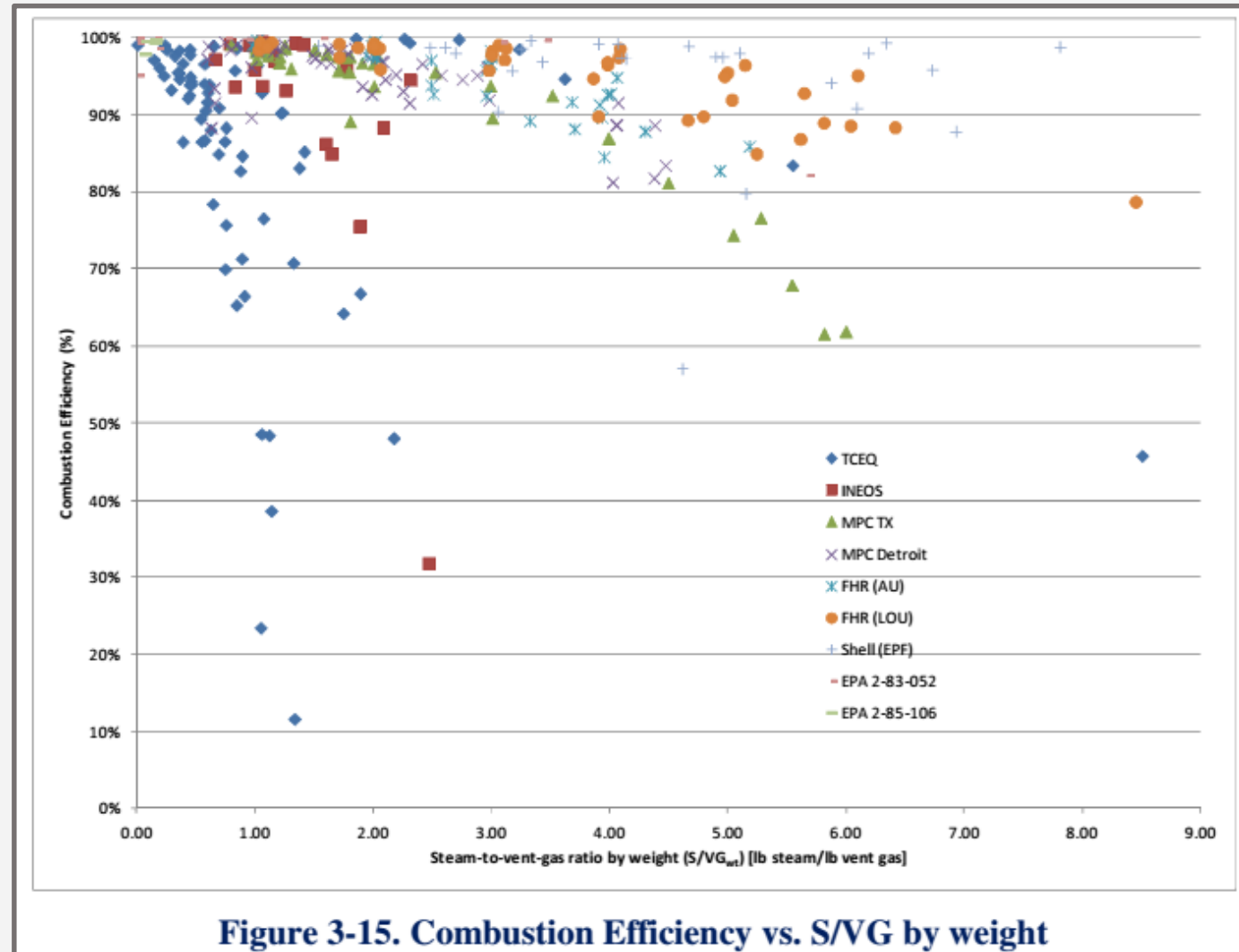
Automated, Direct Smokeless Control



Contour: Automatic steam or air injection



- Without speciation, control is imprecise
- More complex plants require
 - More input measurements
 - Quick speciation methods
- Besides information limitations, what is turndown?



Contour: Regulations for control



- US EPA 40 CFR 63.670 mandates flare control ensure healthy combustion
- Law rapidly promulgating through other countries

- $$NHV_{cz} = \frac{Q_{vg} \times NHV_{vg}}{(Q_{vg} + Q_s + Q_{a,premix})}$$

- $$NHV_{dil} = \frac{Q_{vg} \times Diam \times NHV_{vg}}{(Q_{vg} + Q_s + Q_{a,premix} + Q_{a,perimeter})}$$

- Require measurement or calculation of inputs
 - v_g , s , a premix, a perimeter

Contour: Advantages of direct control



Contour: Sales strategy



- Direct control
 - Superior control methodology compared to flow/pressure measurement
 - Correctly identifies over- and *under*-aeration
- Inexpensive and accurate approach
- Environmental regulations applicable
- Different than FlareGuardian technology



FlareGuardian

Complete Flare Combustion Monitoring



Monitoring Flare Performance with Video Imaging Spectro-Radiometer (VISR)



Introduction to VISR



- VISR is a multi-spectral imager. It directly measures relative concentrations of combustion product, carbon dioxide (CO_2), and unburned hydrocarbon (HC) in the flame, and calculates flare combustion efficiency (CE) in real time
- Directly measuring CE eliminates the uncertainty of using surrogate parameters such as Combustion Zone Net Heating Value (NHVCZ) and tip velocity

Benefits of FlareGuardian



- Provides real-time combustion efficiency, smoke index, flame stability, flame footprint, heat release, and pilot status
- Autonomous data collection (DCS or PLC) for optimized flare performance
- Simplify monitoring, reporting, and compliance activities
- Remote mounted, non-contact monitoring. Don't have to shut down to install
- More accurate results versus indirect monitoring
- Eliminates need for monitoring surrogate parameters. If any of the 12-15 devices for monitoring goes down the plant is in non-compliance.
- Short measurement cycle enables quick response and minimizes cost for supplemental fuel, steam, or air
- Industrial closed loop interface allows for flare operation and control based on direct combustion efficiency and smoke index values in real-time
- Easy installation and maintenance and no calibrations
- Eliminates need for visual verification of smokeless performance

VISR Capabilities



- Remotely, continuously, and autonomously monitor the following flare performance metrics:
 - **Combustion Efficiency (CE):** 0 -100%
 - **Smoke Index (SI):** 0 -10 for the level of smoke
 - **Flame Stability (FS):** 0 -100% (0=extremely unstable flame; 100=extremely stable flame)
 - **Flame Footprint (FF):** flame cross section area perpendicular to VISR line of sight; expressed as sq. ft.
 - **Heat Release (HR):** Amount of heat released by flare in the mid-wave infrared (MWIR) region, expressed as Btu/min
- Default time resolution: 1-sec, 1-min, and 15-min average
- The data can be sent to DCS or PLC for display or closed-loop control of flare

FlareGuardian: Sales strategy



- Less expensive than GC and calorimeter based regulatory methods
- Eliminates need for monitoring surrogate parameters
- The ONLY way to measure combustion efficiency of a flare in the field
- Much simpler installation





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