

CE utilizes the VISR Method



- 🔥 Video Imaging Spectral Radiometer (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 flare tip velocity.



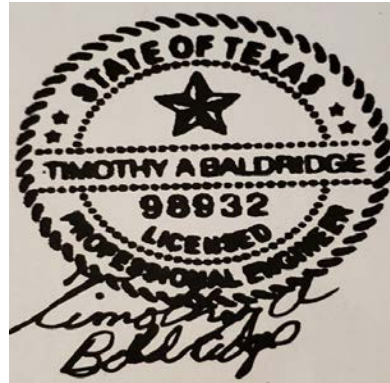
CE utilizes the VISR Method

- 🔥 **Flare CE** is determined by measuring relative concentrations of CO₂ and HC on the combustion envelope where combustion has ceased.
- Spatially averaged across all pixels on the combustion envelope
 - Temporally averaged across all frames captured in 1 second (typically about 30)
 - Data reduction is automatic with no latency.



Summary Results

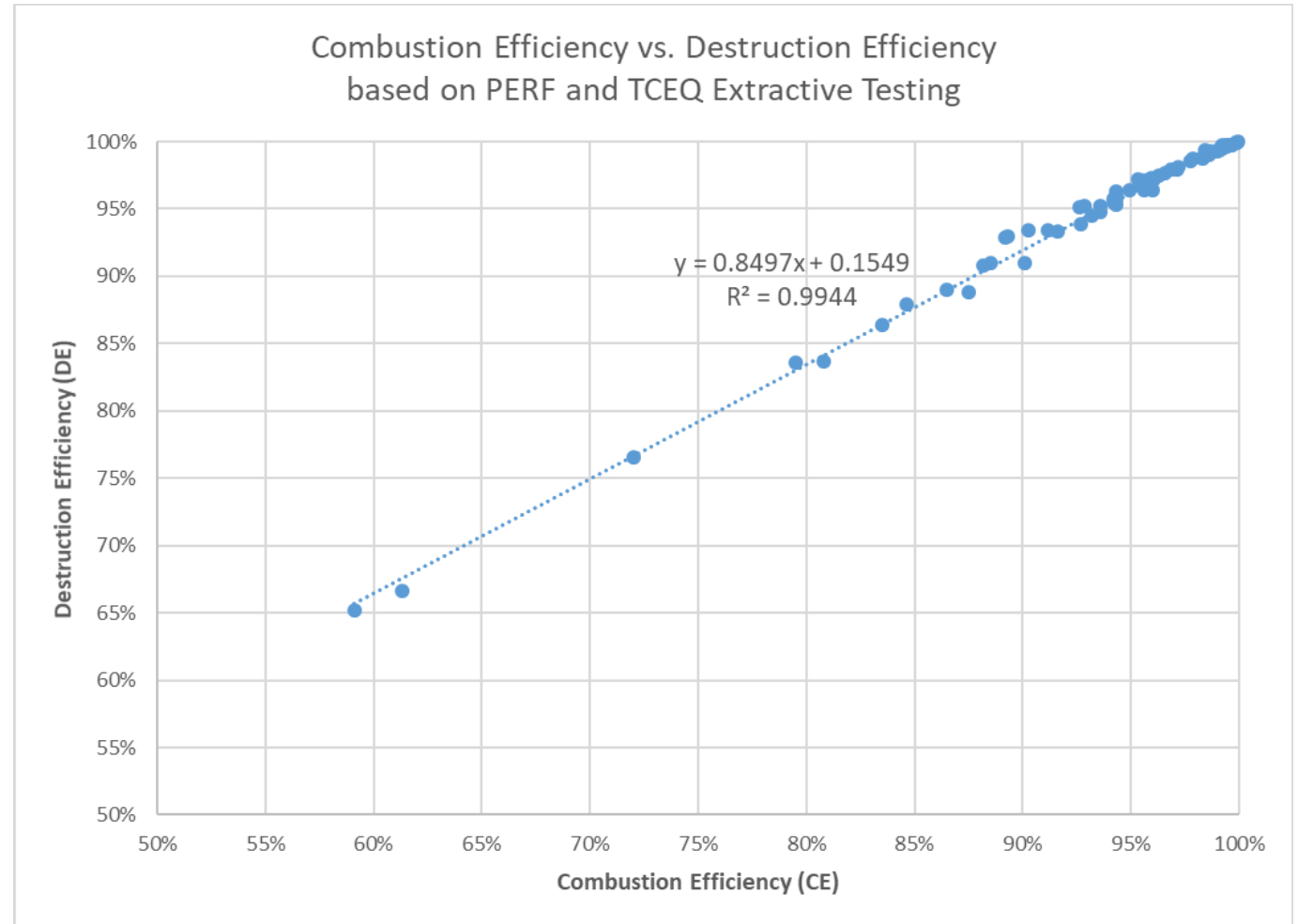
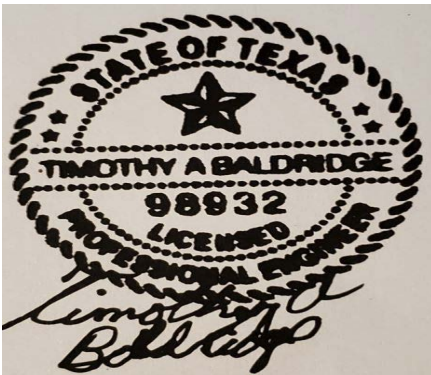
- Two flare tests and one flaring event were measured.
- The first flare test has limited data.
- The second flare test and flaring event have continuous 1-second data.



Date	Start Time (Local)	End Time (Local)	Process Condition	CE Avg (%)	DRE Avg (%)	SI Avg	FF Avg (m2)	FH Avg (MMBTU/HR)
1/20/2021	1:45 PM	1:53 PM	Flare test - Methane/Hydrogen	98.39	99.24	0.7	187	0.31
1/20/2021	11:25 AM	12:23 PM	Flare test - Ethane/Methane	98.93	99.55	0.7	195	0.49
1/20/2021	8:03 AM	9:02 AM	Flare test- Propane/Butane	99.01	99.62	1.2	150	0.21

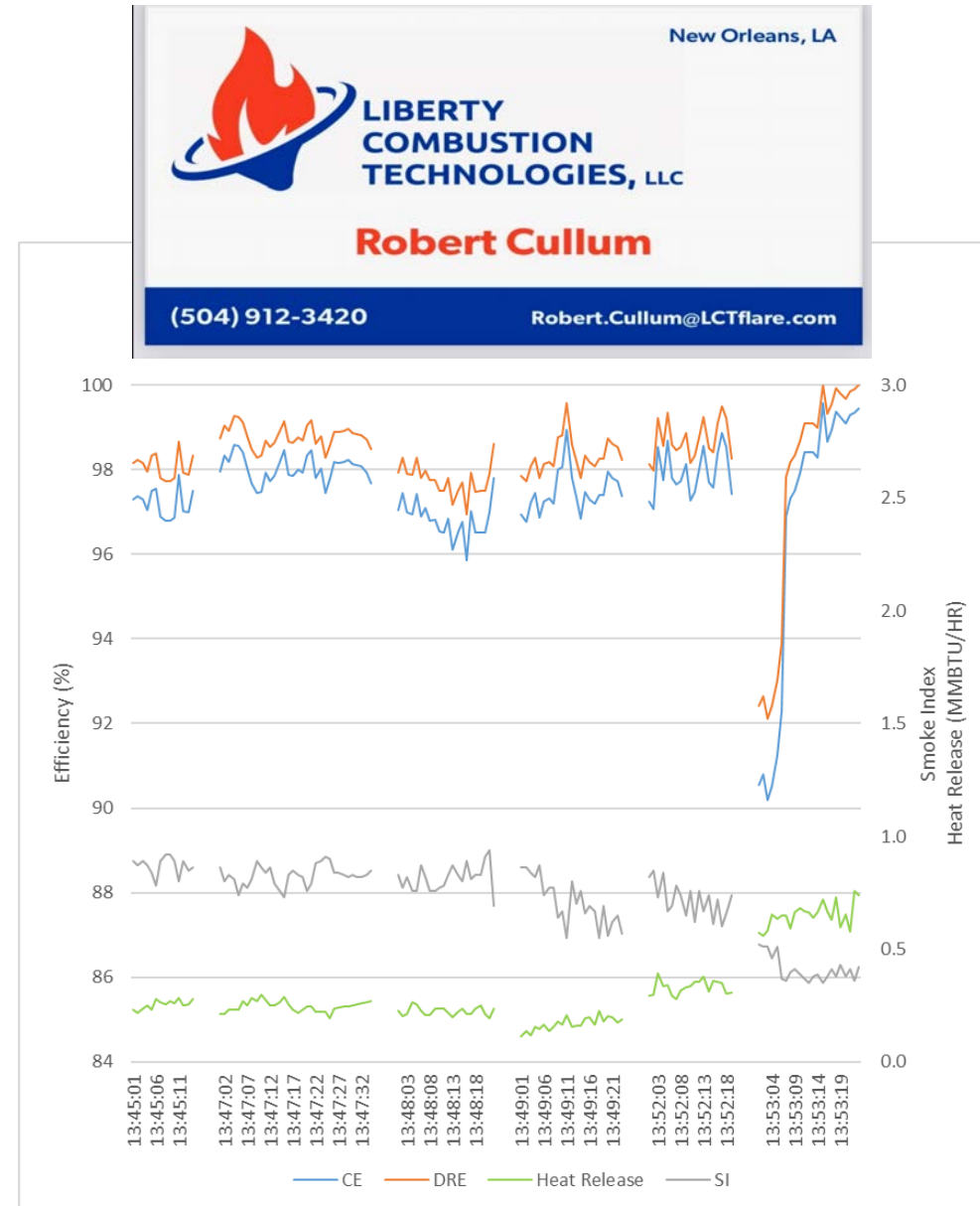
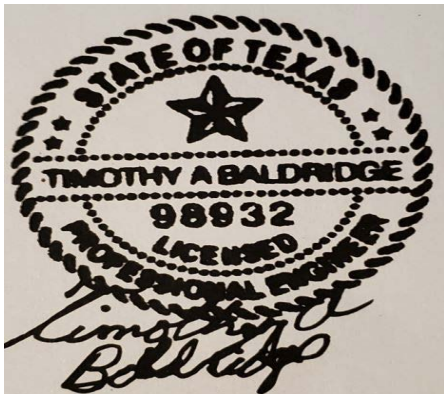
Combustion Efficiency vs Destruction Efficiency

- 🔥 MWIR-CE measures combustion efficiency (CE)
- 🔥 Extractive testing during 2010 TCEQ test and 2018 PERF test provides correlation between CE and destruction efficiency (DE)
- 🔥 Used these correlations, we can convert CE to DRE



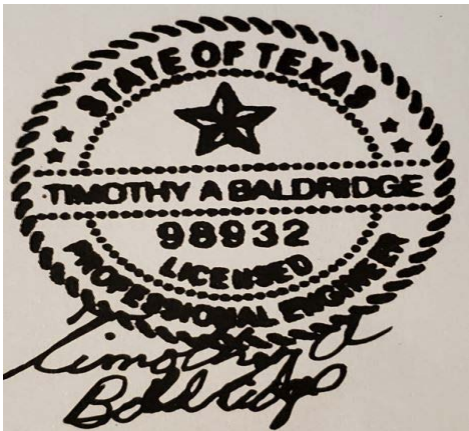
Methane/Hydrogen Flare Test – Jan. 20 , 2021

- 🔥 Data is not continuous.
- 🔥 Short radiometric recordings are post processed to provide semi-continuous results.
- 🔥 Collected 2 minutes of the 15-minute flare test.
- 🔥 No haze was observed throughout the test
- 🔥 Average DRE was 99.09%

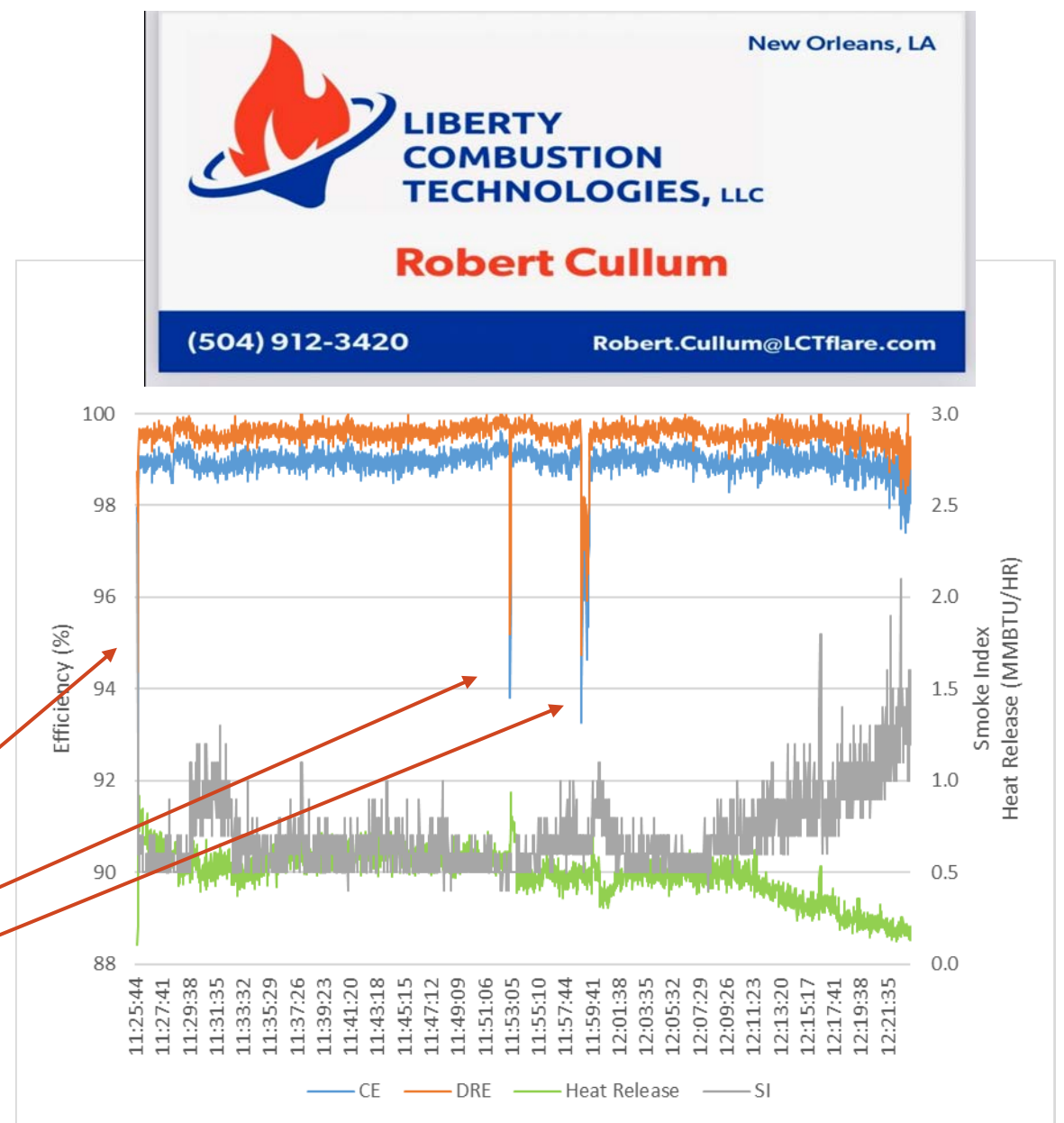


Ethane/Methane Flare Test – Jan. 20, 2021

- 🔥 Data is continuous
- 🔥 Approximately 1 hour of data.
- 🔥 Light Grey haze was observed when stages were opened.
- 🔥 Corresponding dip in efficiency was observed when stages were opened.
- 🔥 Average DRE is 99.55 %

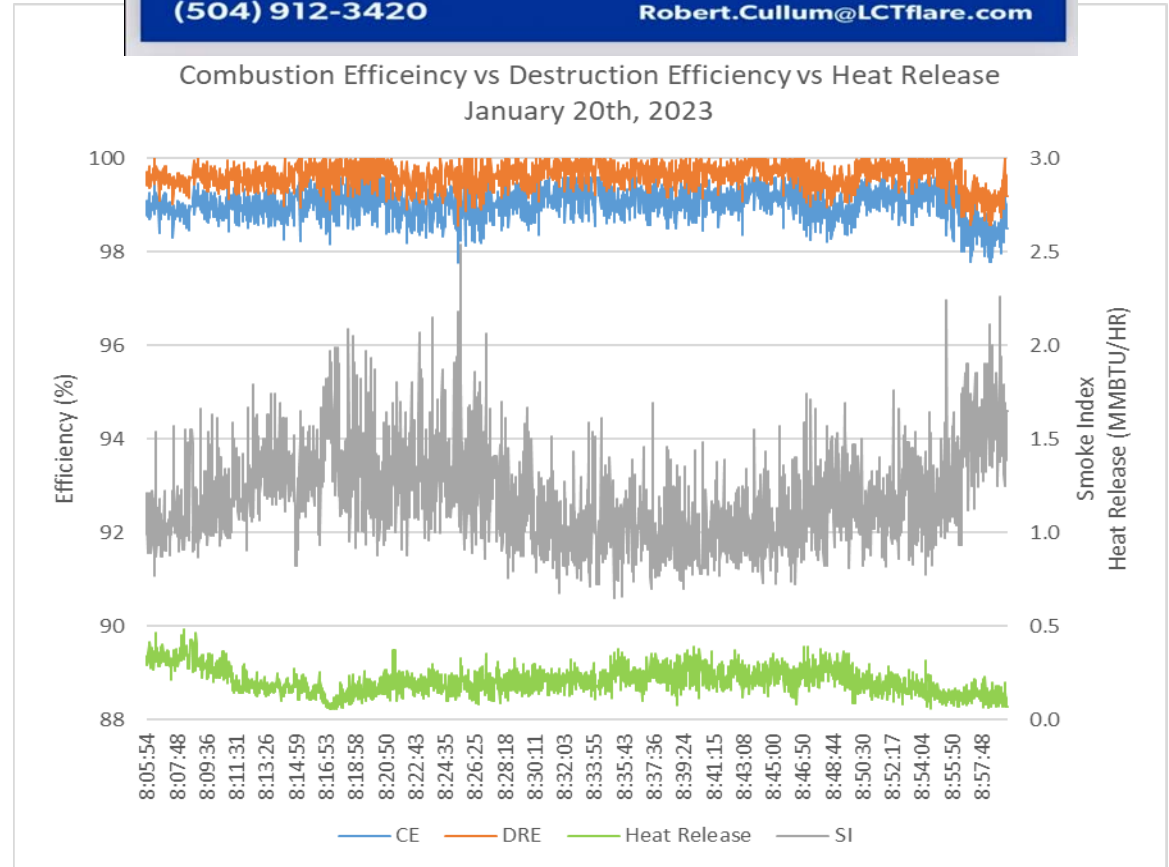
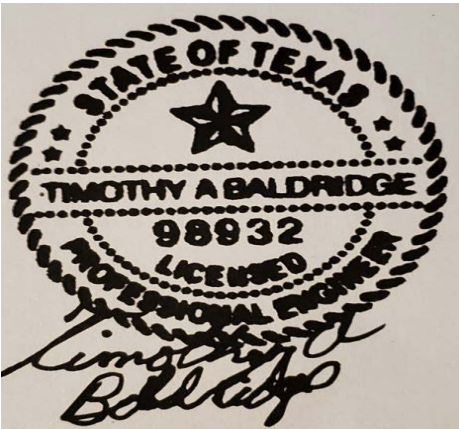


Stages opened



Flaring Test Propane – Jan. 20th, 2021

- 🔥 Flaring test event occurred on January 20th, 2021
- 🔥 Approximately 1 hour of data
- 🔥 Data is continuous 1-second
- 🔥 Average DRE 99.62 %





RE: LCT HV-6 MPRO Combustion DRE Measurements

January 20, 2021 (Test Date)

To whom it may concern,

The **VISR flare monitor** was deployed to ascertain the **combustion performance/DRE** of the stationary air assist flares with **MPRO** burners at the Progressive Engineering test facility in East Texas. This technology is a unique remote optical monitoring device investigating the infrared spectral radiance of combustion products and remnant unburnt hydrocarbons in the combustion plume to determine the combustion performance of flares. The **VISR** device directly measures combustion efficiency in the plume of the flame.

The accuracy and efficacy of this technique has been demonstrated through a large body of testing consisting of hundreds of unique test points over the last decade. In various testing conditions, the VISR method has been validated against the EPA-founded extractive method, which was used in both the 1983 CMA and 2010 TCEQ flare studies. Validation testing has been conducted internally by **LCT** and its technology partners, by third-party industry consortium's, as well as the US EPA. The body of testing has demonstrated statistical agreement (using a 97% confidence interval) between the VISR and extractive sampling method. The extractive sampling method is measuring **Destruction or Removal Efficiency (DRE)**, which is the **EPA** evaluation basis. The large body of prior testing has established very clear and defined relationships between **Combustion Efficiency** and **DRE**, fully allowing the **VISR** technology to be a valid surrogate for determination of the DRE of combustion equipment of many types.

In the testing at the **Texas facility**, the combustion products measured out of the flare were of sufficient temperature and radiance to render useful and accurate the **VISR** combustion calculations and methodology. The vantage point, distance to the flare, flare gas composition, and environmental conditions were all within previously established **VISR** method parameters. The combination of the performance history of this device, the parameters which were tested at **the Texas facility**, and the resulting spectrometry measurements gives **Liberty Combustion Technologies** confidence the resulting combustion calculations are true and accurate. See attached studies.

Best regards,

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