



Texas Commission on Environmental Quality (TCEQ) 2010 Flare Study & Supplemental Flare Operations Training

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Division

Presented To:

Association of Air Pollution Control
Agencies (AAPCA)

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Overview

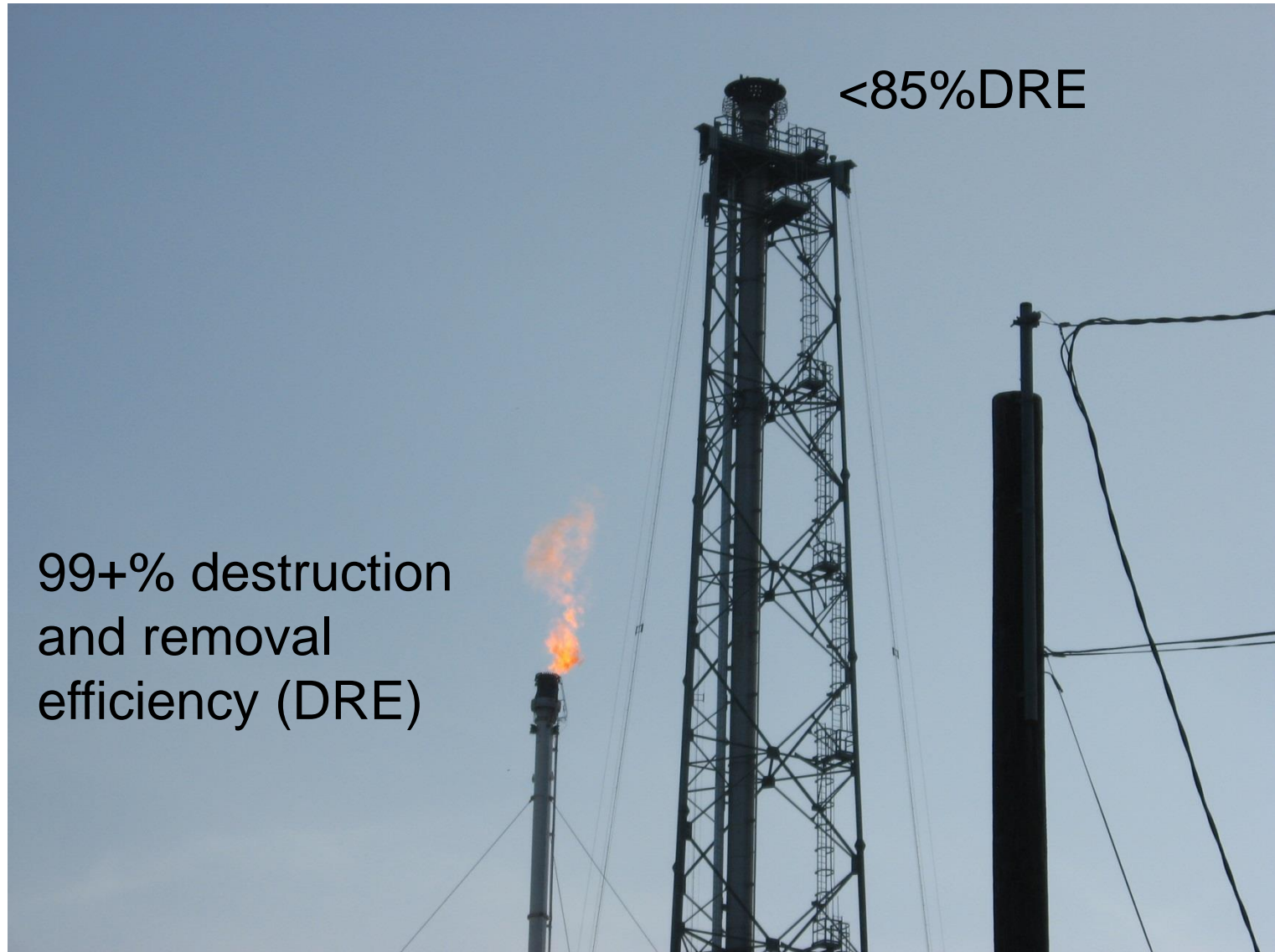
- Previous TCEQ flare projects
- General industrial flare background information
- TCEQ flare test objectives
- TCEQ flare test results
- TCEQ flare training information

Air-Assisted Flare Infrared Video





TCEQ 2007 Differential Absorption Lidar (DIAL) Project





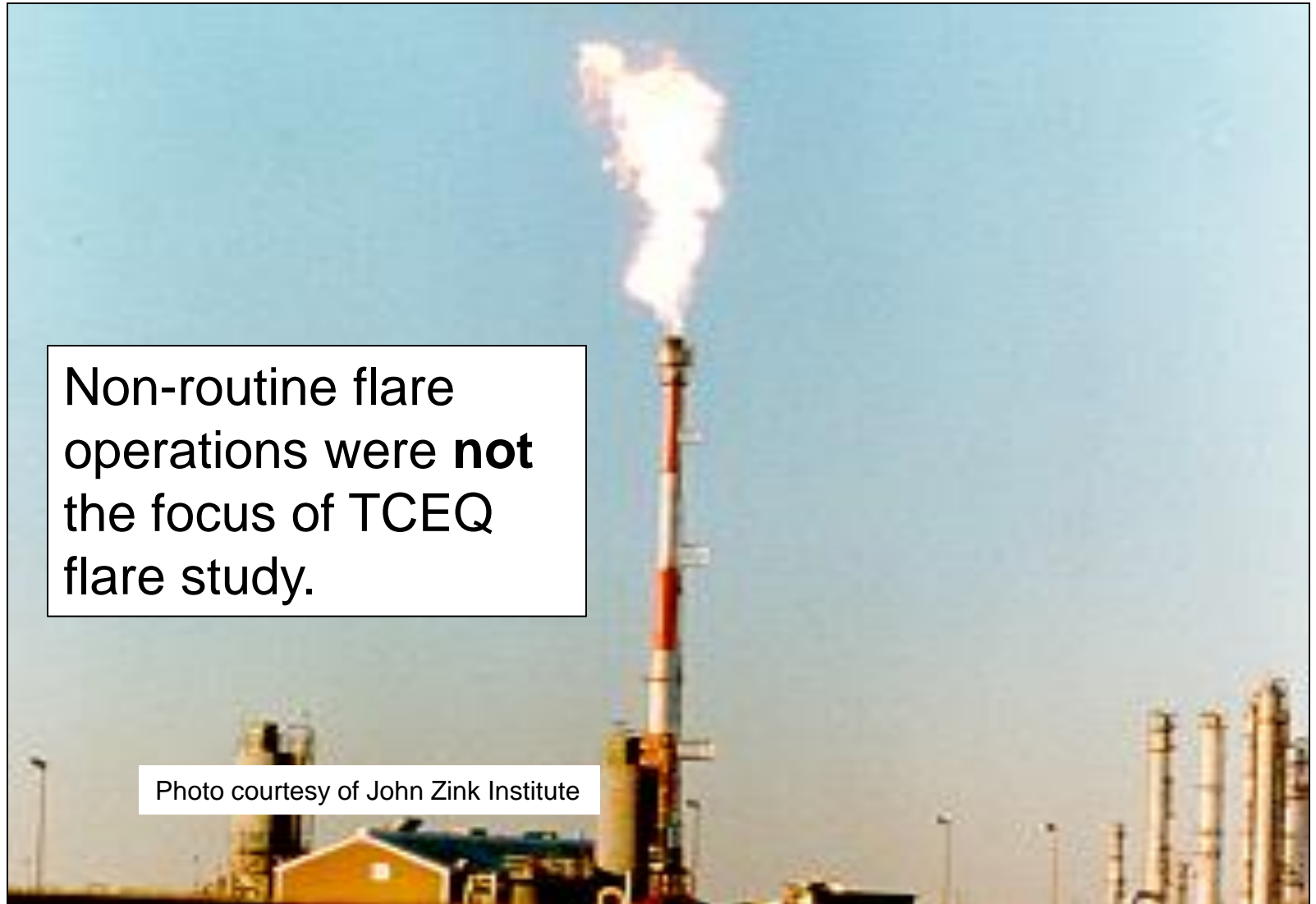
Flare Operations

- The TCEQ categorizes industrial flares by function.
- Three categories of flares:
 - Non-routine (emergency) operations flares
Safety devices that combust waste gas during power outages, emergency conditions, or plant maintenance activities
 - Routine process flares
Control and safety devices that combust waste gas from normal plant operations instead of releasing this gas to the atmosphere
 - **Dual-service flares**
 - **Flares that are used to burn routine and non-routine (emergency) waste gas**
 - **Largest category of industrial flares**
 - **Focus of TCEQ 2010 Flare Study**

Non-Routine (Emergency) Flare Operation

Non-routine flare operations were **not** the focus of TCEQ flare study.

Photo courtesy of John Zink Institute



Dual-Service Flare

Dual-service flares in routine service were the focus of the TCEQ 2010 Flare Study.

Photo of flare tip used during TCEQ 2010 Flare Study.

The flare tip was designed to burn 1 million pounds of hydrocarbons per hour.





Current Flare Requirements

- Flares that meet federal requirements have:
 - a pilot (similar to a pilot on a natural gas oven, range, or water heater) that must always be lit;
 - waste gas that meets certain criteria; and
 - **no visible emissions (e.g., smoke) for more than five minutes during a two-hour period.**
- **Assumes the flare destroys at least 98% of the waste gas stream if the requirements are met.**
 - For example, using current assumptions, if 100 pounds of waste gas are routed to a flare:
 - 98 pounds would be destroyed; and
 - 2 pounds would be vented to the atmosphere
 - This is referred to as the flares destruction and removal efficiency (DRE). We will refer to it as flare efficiency.



Why Does A Flare Smoke?

- Smoke can form when the flame does not have enough oxygen to completely burn the waste gas into carbon dioxide and water resulting in carbon (smoke) being produced.
- Steam or air is mixed into the flame to reduce smoking.
 - Steam or air injection, known as assist, brings oxygen into the flame.
 - The assist helps shape the flame and mix the air and waste gas to reduce smoke.
 - TCEQ study focused on steam- and air-assisted dual-service flares.

Flare Without Steam Assist

A photograph of a flare stack at night. The flare is burning with a bright orange and yellow flame. A large, dark, billowing cloud of smoke or gas is rising from the base of the flare, partially obscuring the sky. The sky is a deep blue. The entire image is framed by a black border.

Steam assist off

Photo courtesy of John Zink Institute

Flare With Steam Assist

A photograph of a tall industrial flare stack against a clear blue sky. At the top of the stack, a large, bright orange and yellow flame is burning. A plume of white steam or smoke is visible rising from the base of the stack and spreading out to the right. The entire image is framed by a black border.

Steam assist on

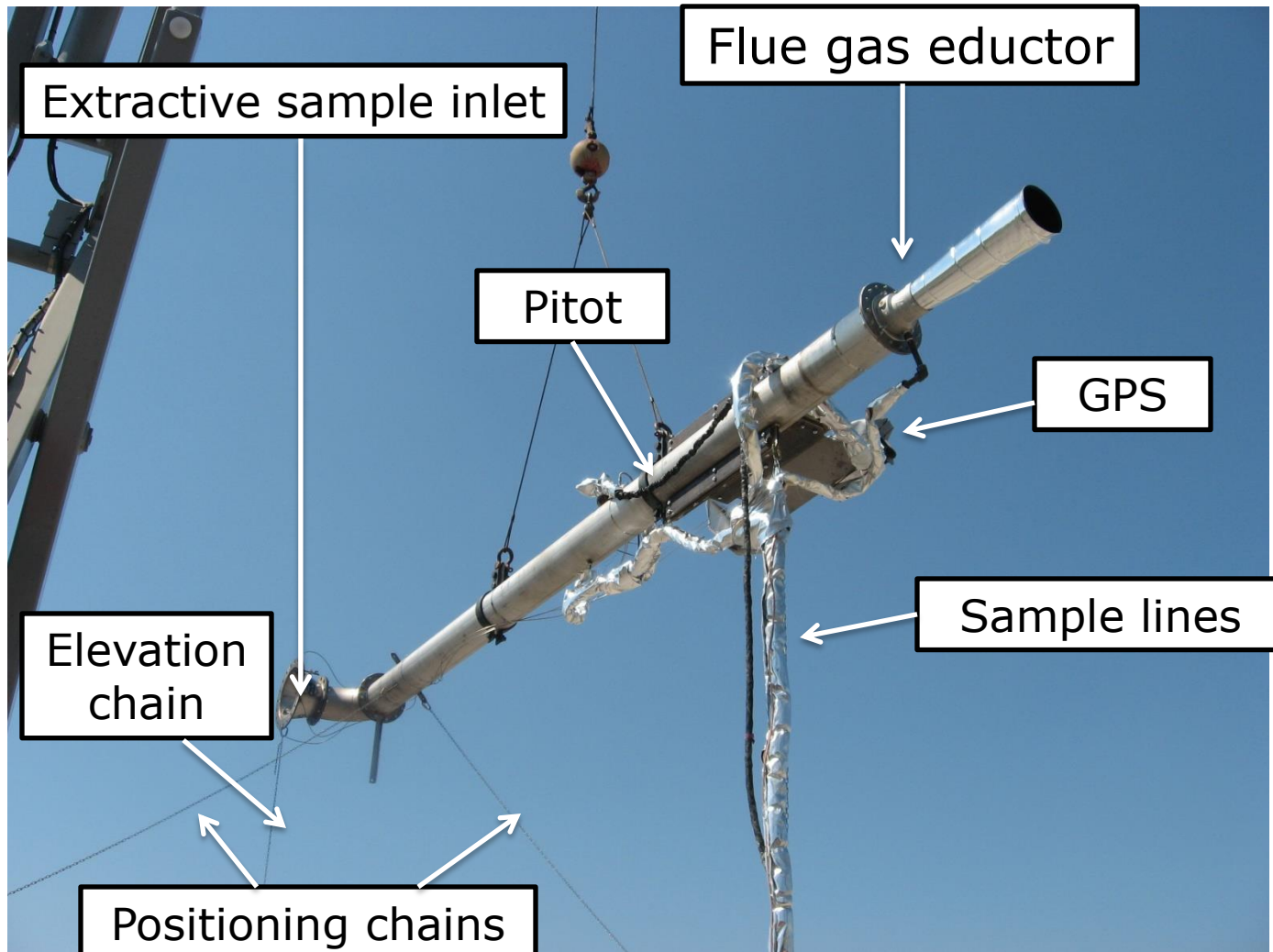
Photo courtesy of John Zink Institute



Flare Test Objectives

- Assess the impact of high turndown (low flow) rate of vent gas on flare DRE and combustion efficiency (CE)
- Assess if flares operating within 40 Code of Federal Regulations (CFR) §60.18 (CFR §60.18) can achieve the assumed hydrocarbon DRE of at least 98% at high turndown, varying assist ratios, and vent gas heat content
- Test air and steam-assisted dual-service flares

Extractive Sampler

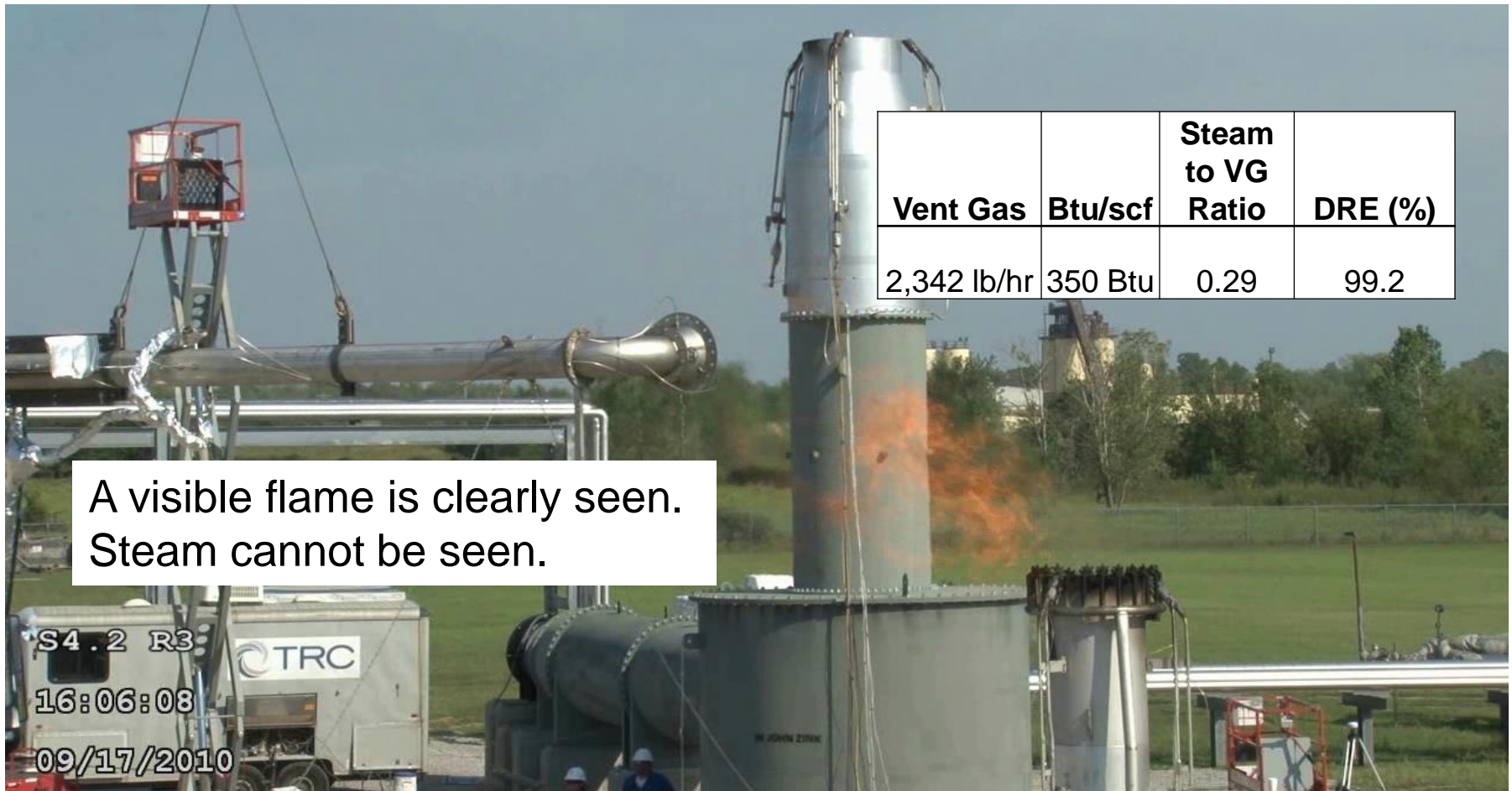




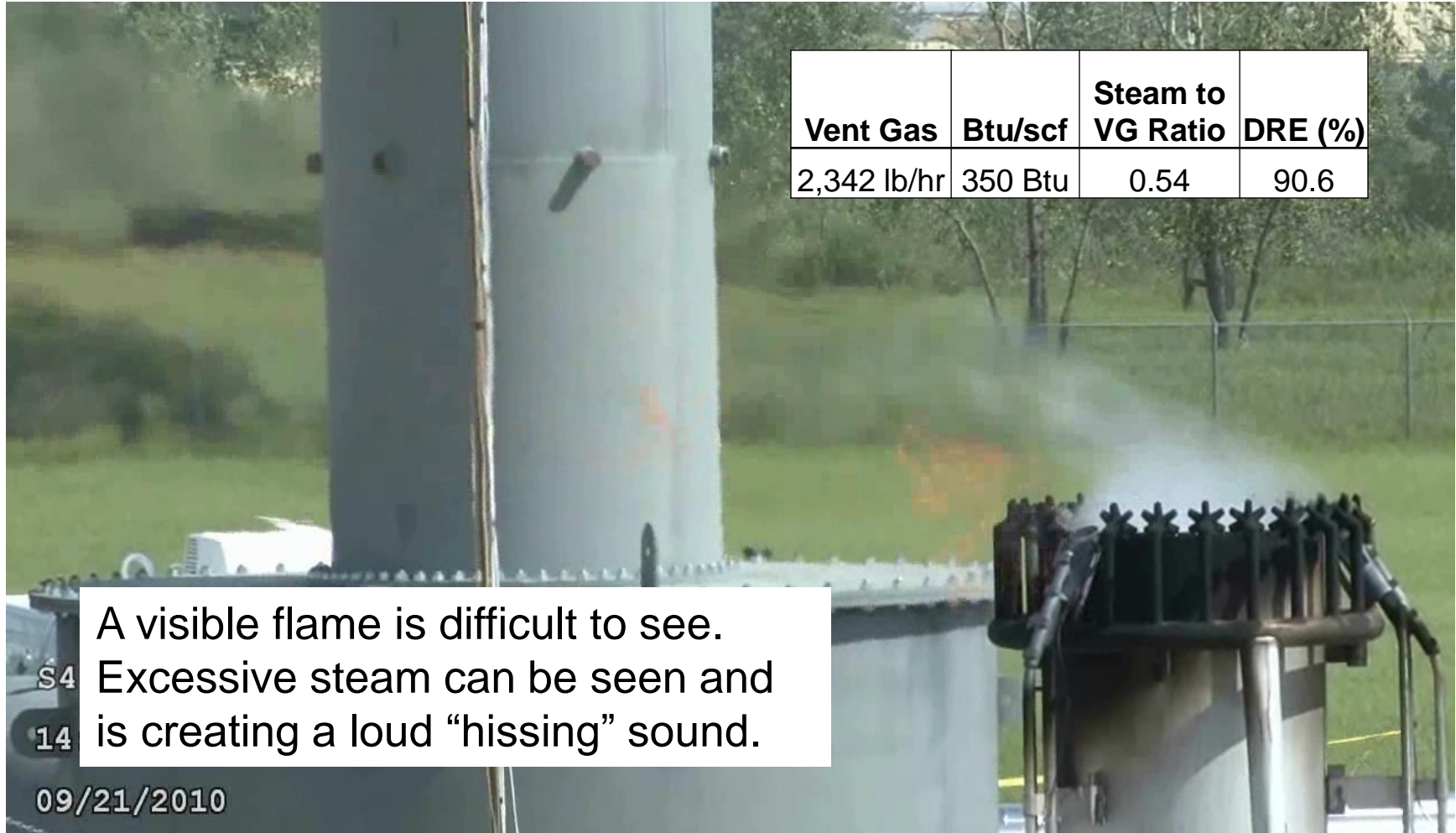
Results: High and Low DRE Values Were Measured

- The flares tested were able to achieve greater than 99% DRE and combustion efficiency (CE) for vent gas streams with low heating value at low flow rate conditions.
- For the conditions tested, the highest DRE and CE was achieved at or near the incipient smoke point.
- As the air or steam-assist was added to the flare, DRE dropped significantly.
- The flares were easily over assisted.

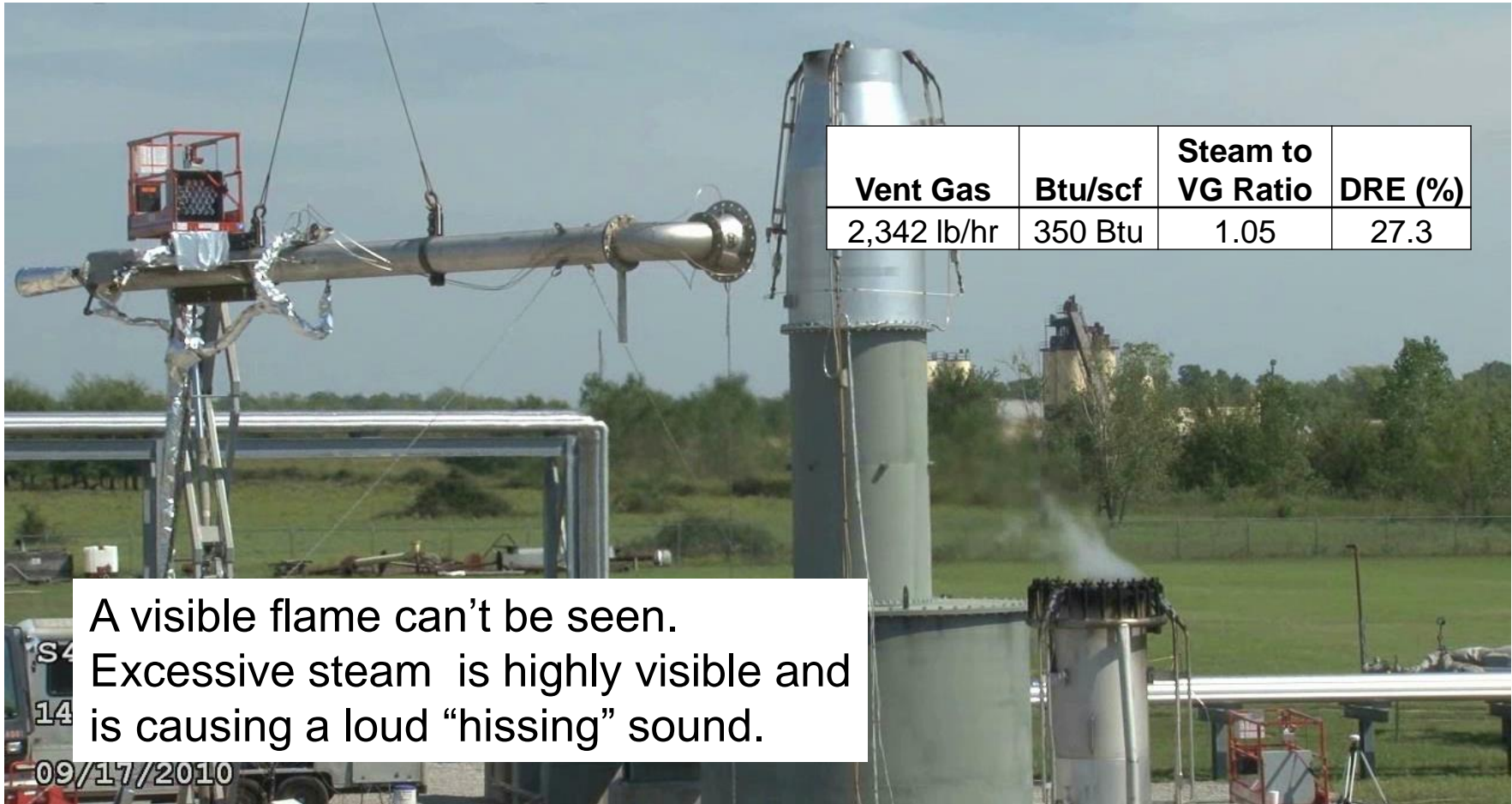
Test Point S4.2



Test Point S4.7



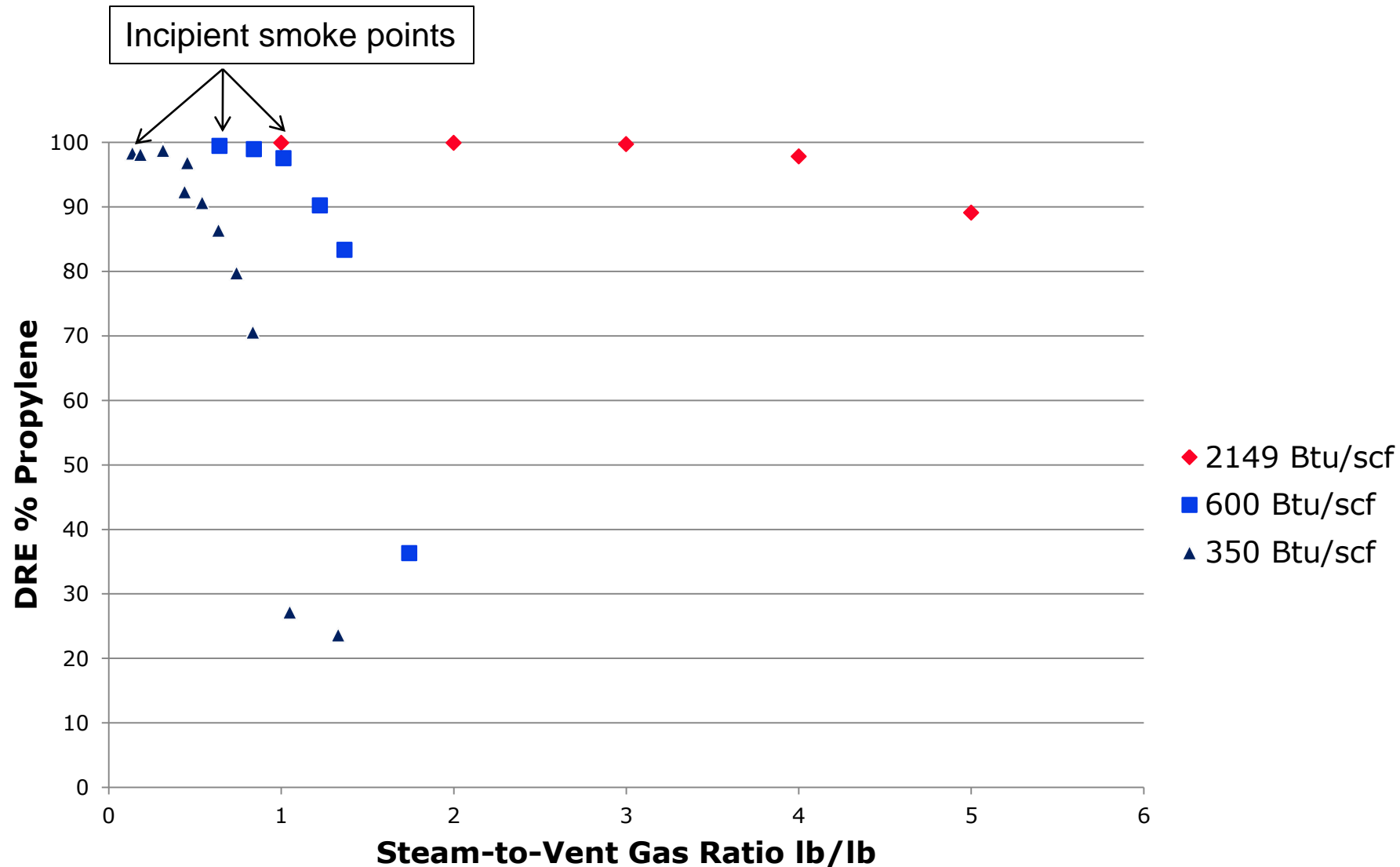
Test Point S4.3





Steam-Assisted Flare DRE

Constant Vent Gas Flow Rate of 2,342 lb/hr



Steam-Assisted Flare DRE

A flare can be operated according to CFR §60.18 requirements and not achieve 98% DRE.

Flares were easily over-assisted.



Flare **DRE 99.2%** at steam-to-vent gas (SVG) ratio of 0.29.

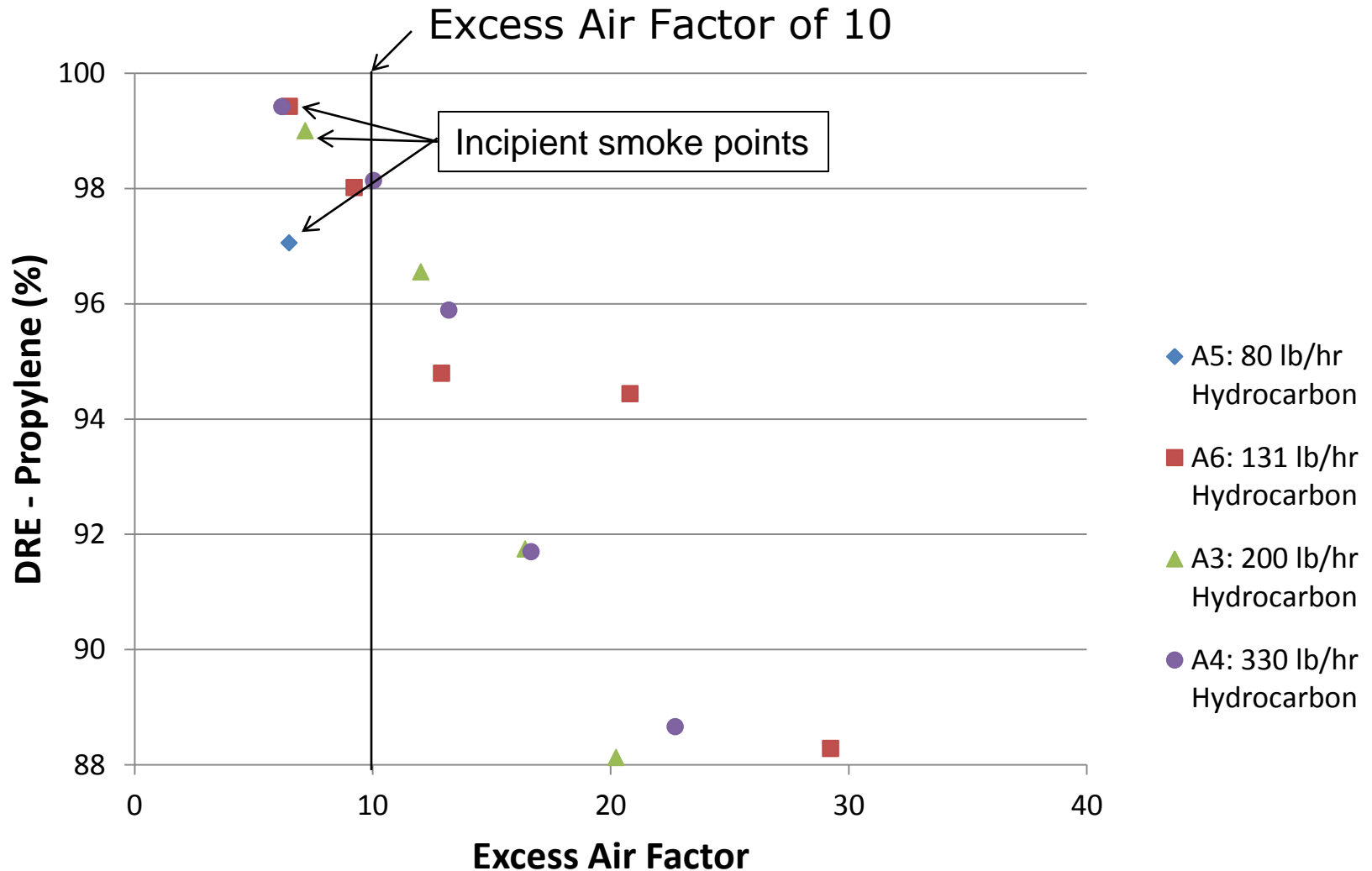


As the SVG almost doubles to 0.54, the flare DRE decreases to **90.6%**. Note the flame is disappearing.

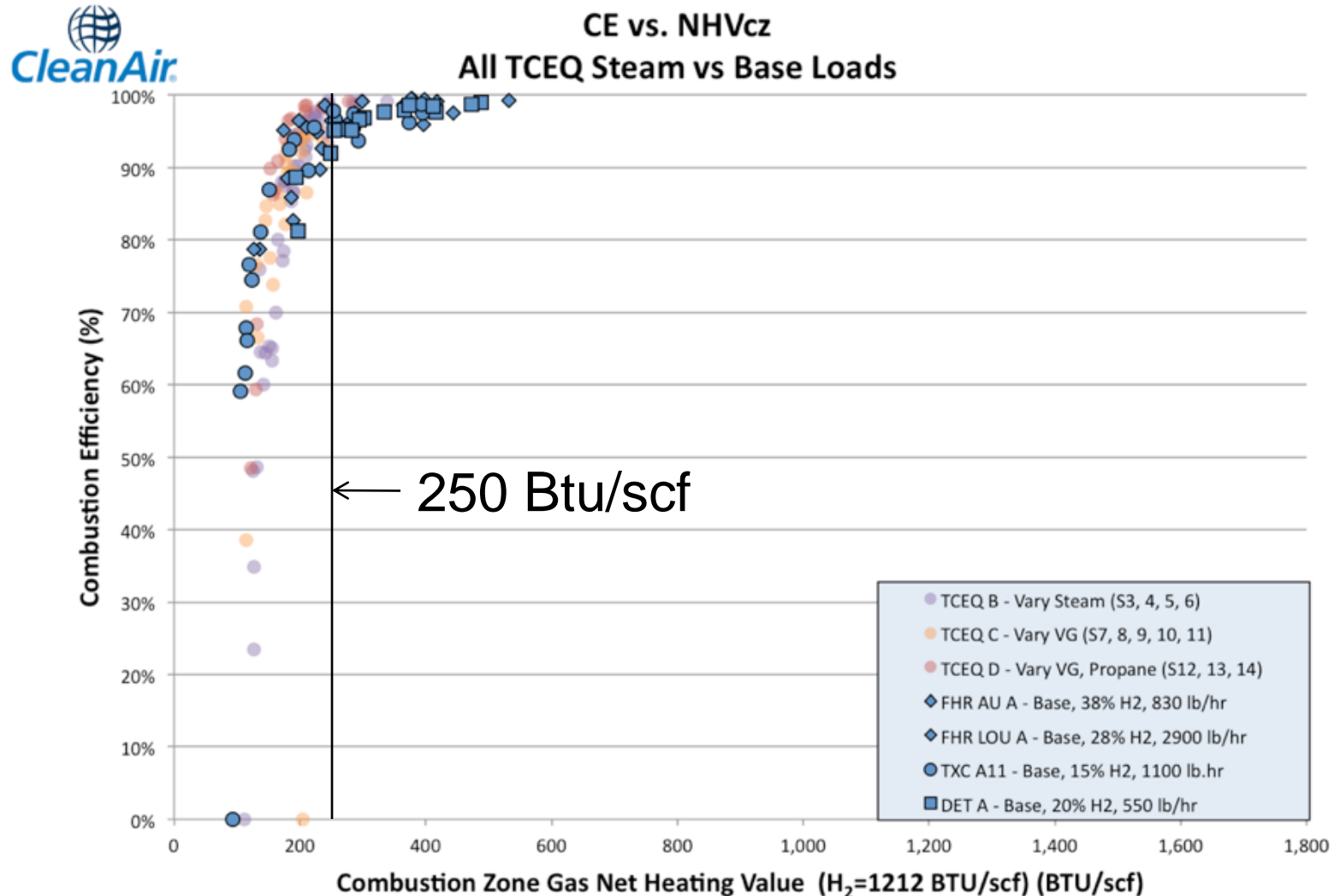


As the SVG almost doubles again to 1.05, the flare DRE drops to **27%**. Note the flame has disappeared.

Air-Assisted Flare DRE



Results From Five Different Flare Tests



Information courtesy of Clean Air Engineering



Flare Training

- Historically, flare operations have been focused on compliance with CFR §60.18 with an emphasis on smoke prevention.

Flare operators mostly concerned about smoke

- Training to maximize flare DRE did not exist.
- TCEQ partnered with The University of Texas at Austin to develop the free Internet-based training.
 - \$330,000 investment to develop the training.
 - The training heavily relies on flame appearance and sounds.



Flare Operations Training Objectives

- Provide tools to facilitate more efficient operation of dual-service flares during low flow, high turndown operation
 - Focus on elevated, assisted flares
 - Maximize dual-service flare efficiency **using existing on-site resources**
- Share knowledge and understanding of flare operations from the TCEQ 2010 Flare Research Project and other recent flare projects
- **Clearly explain the impact of supplying too much steam- or air-assist during routine flaring operations**



Technical Review Panel

- Diverse membership included:
 - Flare manufacturers
 - Zeeco and John Zink
 - Industry representatives:
 - LyondellBasell, Dow, ExxonMobil, Phillips 66, Lubrizol, Shell, and Valero
 - Texas Chemical Council and Texas Oil and Gas Association
 - Flare experts
 - Environmental advocacy groups
 - Air Alliance Houston
 - Industrial Professionals for Clean Air
 - Consultants
- Open to other interested participants



Flare Training Development

- Traditional narrated video, charts, and graphs format
- Freely available to the general public
- Approximate two-hour investment in time
- Minimal registration requirements
- Consists of five independent concept modules
- **The free training is located at:
<https://sfot.ceer.utexas.edu/>**



Flare Training Modules

- **Module 1: Introduction**
Understand the purpose and importance of the training program
- **Module 2: History of flares, applicable regulatory requirements, and flare types**
Understand the history and evolution of the design and operation of industrial flares
- **Module 3: Optimizing flare performance**
Select the appropriate assist rates as well as understand operational considerations of flares to achieve optimal flare performance



Flare Training Modules (cont.)

- Module 4: Flare performance parameters investigated in recent industrial flare studies
Apply lessons learned from recent industrial flare studies to improve flare performance
- Module 5: Approaches to Monitoring Flare Performance
Effectively use practical available instrumentation and process control technology to monitor and improve flare performance



Flare Training Modules (cont.)

- Refresher training module
 - Approximately 15 minutes in length
 - Composed of key objectives from all learning modules
- Quiz at end of each module
- Optional final exam
 - Comprehensive test
 - Completion certificate available after passing final exam



Expected Outcomes

- Improve air quality:
 - Improve flare efficiencies
 - **Reduced emissions**
- Visible flames may be seen more often from industrial flares.
- Greater understanding by stakeholders of flaring operations.

Quiz: Is this Low or High DRE?



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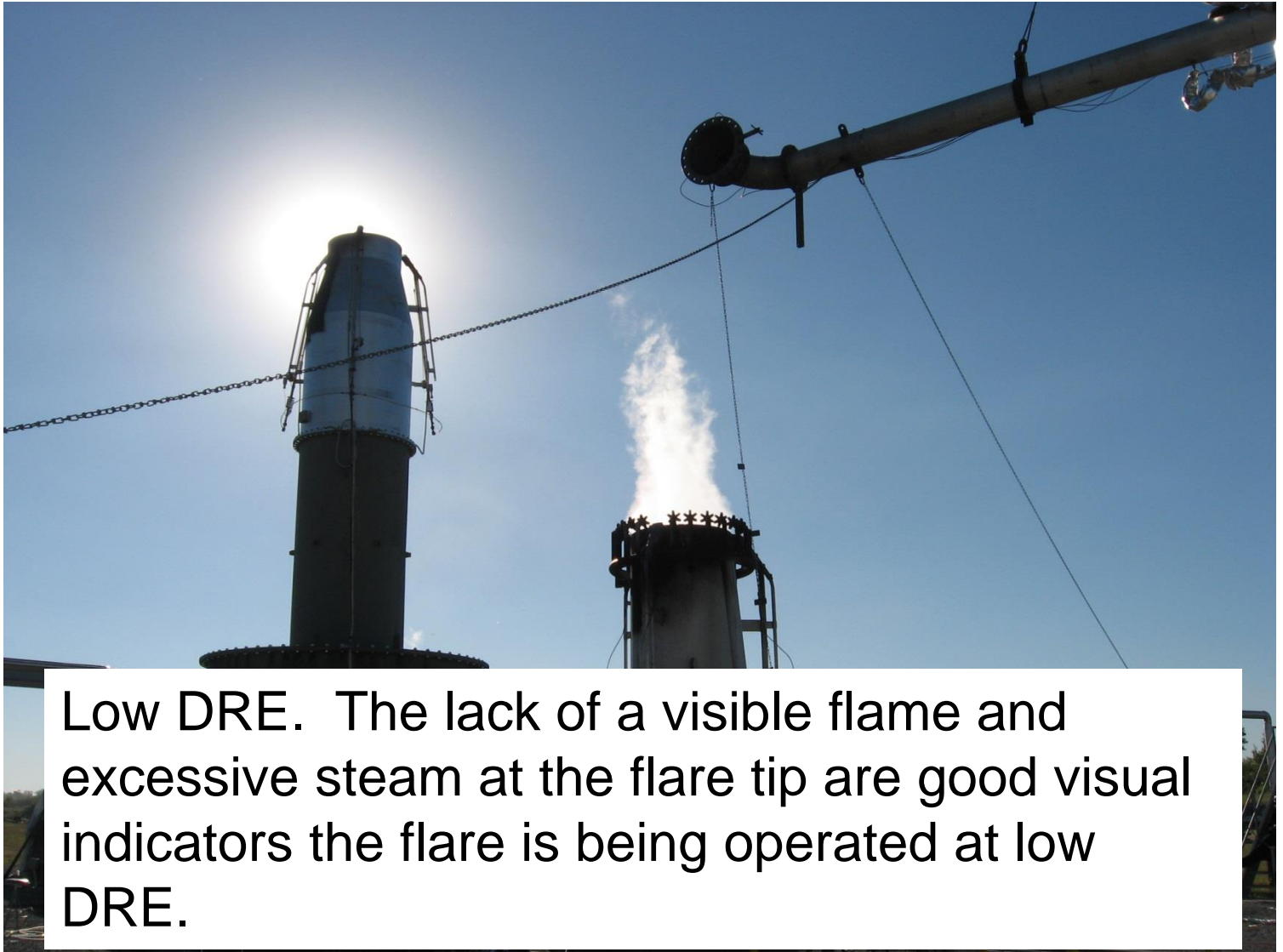


High DRE. The dark orange flame and lack of visible steam are excellent visual indicators of the flare being operated at high DRE.

Quiz: Is this Low or High DRE?



Quiz: Is this Low or High DRE?



Low DRE. The lack of a visible flame and excessive steam at the flare tip are good visual indicators the flare is being operated at low DRE.



Contact Information

- Russell Nettles, Emissions Assessment Section
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- Study results are posted at:
 - TCEQ's Flare Task Force Stakeholder Group Web site
http://www.tceq.texas.gov/airquality/stationary-rules/flare_stakeholder.html
 - Sign up for e-mail updates through TCEQ's GovDelivery listserver. Select "*SIP Hot Topics*" under the "*Air Quality*" heading to receive Flare Task Force updates.
- The free training is located at this website:
<https://sfot.ceer.utexas.edu/>