



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION 5  
77 WEST JACKSON BOULEVARD  
CHICAGO, ILLINOIS 60604**

**DATE:** OCT 31 2018

**SUBJECT:** CLEAN AIR ACT INSPECTION REPORT  
H.B. Fuller, Morris, Illinois

**FROM:** Gregory Gehrig, Environmental Engineer  
AECAB (MI/WI)

**THRU:** Sarah Marshall, Section Chief  
AECAB (MI/WI)

**TO:** File

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**BASIC INFORMATION**

**Facility Name:** H.B. Fuller

**Facility Location:** 7440 W DuPont Road, Morris, IL

**Date of Inspection:** September 17, 2018

**EPA Inspectors:**

1. Gregory Gehrig, Environmental Engineer
2. Kenneth Ruffatto, Environmental Engineer
3. Cary Secrest, Environmental Protection Specialist

**Other Attendees:**

1. Yousheng Zeng, Providence Photonics
2. Sri Motyala, Providence Photonics
3. Jon Morris, Providence Photonics
4. Dan Deacon, Plant Manager, H.B. Fuller

**Contact Email Address:** dan.deacon@hbfuller.com

**Purpose of Inspection:** CAA Compliance

**Facility Type:** Adhesives manufacturing

**Regulations Central to Inspection:** SIP, NSPS and MACT

**Facility Name:** H.B. Fuller  
**Facility Location:** 7440 W DuPont Road, Morris, IL  
**Date of Inspection:** September 17, 2018

**Arrival Time:** 0810 hrs  
**Departure Time:** 1110 hrs

**Inspection Type:**

- ☒ Unannounced Inspection  
☐ Announced Inspection

**OPENING CONFERENCE**

- ☒ Credentials Presented  
☒ CBI warning to facility provided

The following information was obtained verbally from facility personnel.

**Process Description:**

H.B. Fuller manufactures adhesives in batch processes utilizing 3 reactors. Each reactor makes between 4 to 7 batches per day, depending on the exact product specifications required. The facility operates '24/7' with 45 employees. The adhesives are not sold retail, but used in a variety of other products, including dry wall, laminate flooring, and packaging materials. Raw materials include ethylene, vinyl acetate and water. These processes vent to flares associated with each reactor (1, 2 and 3). The reactor 1 flare is northern most flare, the reactor 2 flare is in the middle and the reactor 3 flare is to the south. Each flare was manufactured by John Zink Co. and is air-assisted. John Zink Co. came to the facility and made recommendations for improvements on flare operations approx. two years ago that were implemented by H.B. Fuller. Preventative maintenance was conducted on the flares about two weeks ago during a planned maintenance shutdown. Neither vent gas nor assist air are directly measured. H.B. Fuller plans to install variable frequency drives on all three air assist fans starting next month with the fan on the reactor 1 flare.

**TOUR INFORMATION**

**EPA toured the facility:** Yes

**Data Collected and Observations:** EPA contracted Providence Photonics (Providence) of Baton Rouge, LA to conduct flare observations at H.B. Fuller using a Video Imaging Spectro-Radiography (VISR) imaging device, or VISR. VISR uses infrared sensing and imaging technology to determine the combustion efficiency (CE) of hydrocarbons combusted by a flare with a visible flame. Providence used the VISR to observe the flaring along with a dedicated standard video camera. EPA also utilized a FLIR camera to observe the flare and collect images.

At the time of inspection, reactor 1 was venting ethylene to the reactor 1 flare. Also, during the inspection reactor 2 vented a de-foaming 'blow over', which routed ethylene, vinyl acetate and water to the reactor 2 flare for approximately 5 minutes.

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The VISR indicated an average CE over 99% on both flares for the periods observed. A description of FLIR and camera images is provided in the digital image log below. A report from Providence on the VISR data and images is provided in Appendix A.

EPA toured the facility and observed the flare control panel, the adhesive making process, including the reactors, the ethylene offloading area, and a carbon absorber used to control

EPA G. Gehrig and K. Ruffatto conducted the opening conference, closing conference and toured the facility, while C. Secrest worked with the Providence crew and took FLIR observations and images.

**Field Measurements:** were taken during this inspection.

#### RECORDS REVIEW

- Basic information on flares (taken)
- Facility diagram (taken)

#### CLOSING CONFERENCE

##### **Requested documents:**

- Specifications of flares, including O&M manuals/procedures, design information, a summary of recent preventative maintenance activities and 2016 recommendations by John Zink Co. (to be sent via email).

#### SIGNATURES

Lead Inspector:

*Gregory Kelly*

Date:

*10-31-18*

Section Chief:

*Samuel M. [Signature]*

Date:

*10/31/18*

**Facility Name:** H.B. Fuller

**Facility Location:** 7440 W DuPont Road, Morris, IL

**Date of Inspection:** September 17, 2018

**DIGITAL IMAGE LOG\***

|                                                 |                                                                                  |
|-------------------------------------------------|----------------------------------------------------------------------------------|
| <b>1. Inspector Name:</b><br>Gregory Gehrig     | <b>2. Date(s) of Inspection:</b><br>September 17, 2018                           |
| <b>3. Company/Facility Name:</b><br>H.B. Fuller | <b>4. Street Address, City, State:</b><br>7440 W DuPont Road, Morris, IL         |
| <b>5. Number of Images:</b><br>12               | <b>6. Archival Record Location:</b><br>CD-R labeled H.B. Fuller Images 9.17.2018 |

| <b>Image name</b> | <b>Time<br/>(CDT)</b> | <b>Description</b>                                                |
|-------------------|-----------------------|-------------------------------------------------------------------|
| MVI_126           | 1029                  | Video of three flare system with Reactor #2 flare flaring.        |
| IMG_0124          | 0900                  | Providence crew preparing to collect VISR data and images.        |
| IMG_0125          | 0901                  | Cary Secrest collecting OGI images.                               |
| IMG_0127          | 1030                  | Flare control panel                                               |
| IMG_0128          | 1031                  | View of ethylene process                                          |
| IMG_0129          | 1035                  | Glue (product) at solids separation phase                         |
| IMG_0130          | 1037                  | Carbon absorber, slated for replacement by TO next year           |
| MOV_0285          | 0850                  | FLIR video of reactor 1 flare.                                    |
| MOV_0286          | 0853                  | FLIR video of reactor 1 flare with slightly larger VOC signature. |
| MOV_0288          | 0929                  | FLIR video of reactor 1 flare with CE of 99 to 100%.              |
| MOV_0291          | 1043                  | FLIR video of reactor 1 flare sudden increase, then shut down.    |
| DC_0289           | 1011                  | VISR set-up.                                                      |

\*Note additional images of flares were collected by Providence as detailed in Appendix A.

**Facility Name:** H.B. Fuller

**Facility Location:** 7440 W DuPont Road, Morris, IL

**Date of Inspection:** September 17, 2018

**APPENDIX A: FIELD NOTES AND FIELD MEASUREMENT DATA**

Video Imaging Spectro-Radiography Report provided by Providence Photonics



PROVIDENCE  
PHOTONICS

## **Flare VISR Test Report**

**Facility: H.B. Fuller Adhesives, LLC**

*September 2018*

Prepared for  
**US Environmental Protection Agency**  
**Region 5**  
**77 West Jackson Boulevard**  
**Chicago, IL 60604**

PROVIDENCE PHOTONICS PROJECT NO. 1198-001

PREPARED BY  
Providence Photonics, LLC | 1201 Main Street, Baton Rouge, LA 70802

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## Introduction

EPA Region 5 retained Providence Photonics, LLC (Providence) to assist the inspection of H.B. Fuller Adhesives, LLC (HB Fuller) located at 7440 West DuPont Road, Morris, Illinois. Providence measured the combustion efficiency (CE) and other performance metrics of HB Fuller's North Flare and Middle Flare using the Video Imaging Spectral Radiometry (VISR) method. The South Flare was idling during the time of the inspection and therefore was not measured.

The VISR method utilizes a multi-spectral mid-wave infrared imager to remotely and continuously measure relative concentrations of combustion gases. Based on these relative concentrations, flare CE is calculated. The VISR method provides continuous measurement of the following five flare performance metrics at 1-second data rate.

- **Combustion Efficiency (CE):** This is the primary metric that VISR measures. CE is the concentration of unburned hydrocarbons relative to the concentration of carbon dioxide (CO<sub>2</sub>, the end product of combustion) in the post-combustion gases. CE is expressed in percentage. If combustion is complete and there are no unburned hydrocarbons in the post-combustion gases, CE will be 100%.
- **Smoke Index (SI):** SI is used to indicate the level of smoke in the flare flame. It has a range of 0 to 10. When flare has no smoke, the SI is very low (generally below 1 to 2). As smoke level increases, the SI monotonically (but not linearly) increases.
- **Flame Stability (FS):** FS is used to measure the degree of flare radiance fluctuation within 1 second, which indicates stability of the flare. It has a range of 0-100. When the FS value is in about 80 or higher, it generally indicates a very stable flare.
- **Flame Footprint (FF):** FF represents the flame cross section area (in square feet) of the flare and associated hot post-combustion gases perpendicular to the VISR instrument. The footprint is based on the Infrared radiance, and it is generally larger than the size of the flame observed in the visible spectrum by the naked eye.
- **Heat Release (HR):** HR measures the amount of heat released by the flare in regions of the mid-wave Infrared (MWIR) spectrum monitored by the VISR instrument. HR is reported as Btu/min. Because the HR only represents the energy released by the flare in the MWIR, the total heat released by the flare is larger than the HR metric reported by VISR.

More information about the VISR method and its validation is provided at <https://www.providencephotonics.com/flare-monitoring>.

## Summary of VISR Test Results and Observations

**Date:** September 17, 2018

**Personnel:**

Gregory Gehrig (EPA Region 5)

Yousheng Zeng (Providence)

Kenneth Ruffatto (EPA Region 5)

Jon Morris (Providence)

Cary Secrest (EPA OECA)

Sri Mutyala (Providence)

**Facility:** H.B. Fuller Adhesives, LLC  
7440 West DuPont Road, Morris, Illinois 60450

**Location of Flares and VISR Instrument:** see Figures 1.

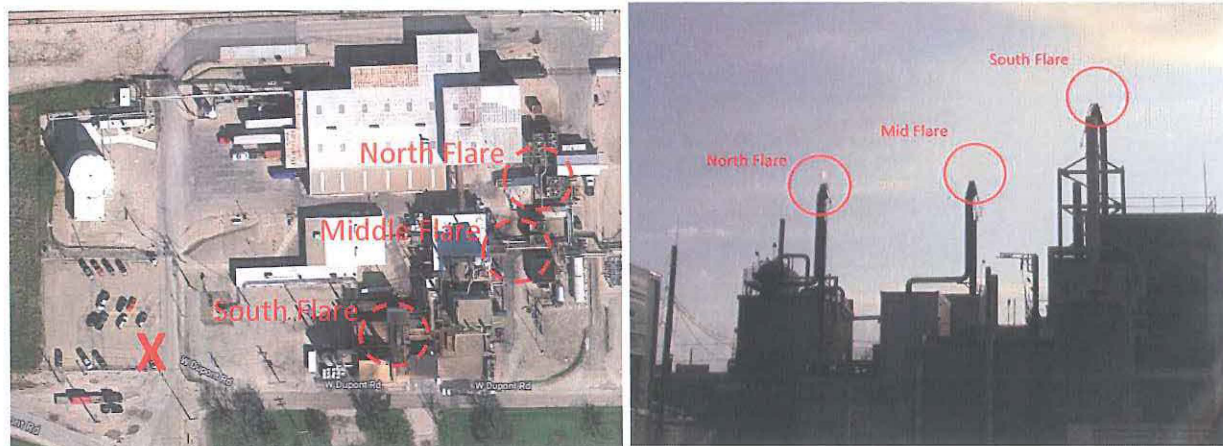


Figure 1. Three air assisted flares at HB Fuller.  
Left: Google map with a red "X" indicating the location of the VISR instrument and red circles indicating the locations of three flares. Distance:  
North Flare: 324 ft.  
Middle Flare: 315 ft.  
South Flare: 243 ft. This flare was in an idle condition and was not measured.  
Right: A photo of the three flares taken during the test.

### Test Results and Observations – North Flare

Three flaring events were observed, in whole or in part. Test results for the North Flare are summarized in Table 1. Variability (or trending) of the flare during the test can be seen in Figures 2-4. Figure 5 provides a snapshot of the spectral image and a visible image of the flare.

Table 1. VISR test results for the North Flare

|                                    | Average for the Duration<br>(8:40 am – 10:45 am) | 1-sec<br>(Avg.-SD, Avg.+SD) | 1-min<br>(Avg.-SD, Avg.+SD) |
|------------------------------------|--------------------------------------------------|-----------------------------|-----------------------------|
| Combustion Efficiency (%)          | 99.8                                             | (99.3, 100.0)*              | (99.6, 100.0)               |
| Smoke Index (unitless)             | 1.08                                             | (0.90, 1.26)                | (0.94, 1.25)                |
| Flame Stability (unitless)         | 85.1                                             | (79.4, 90.9)                | (80.4, 90.0)                |
| Flame Footprint (ft <sup>2</sup> ) | 23.36                                            | (13.24, 33.49)              | (13.41, 32.26)              |
| Heat Release (Btu/min)             | 212                                              | (29, 394)                   | (42, 363)                   |

\*: (Avg.+SD) > 100, the value of 100 is assigned to the upper bound.

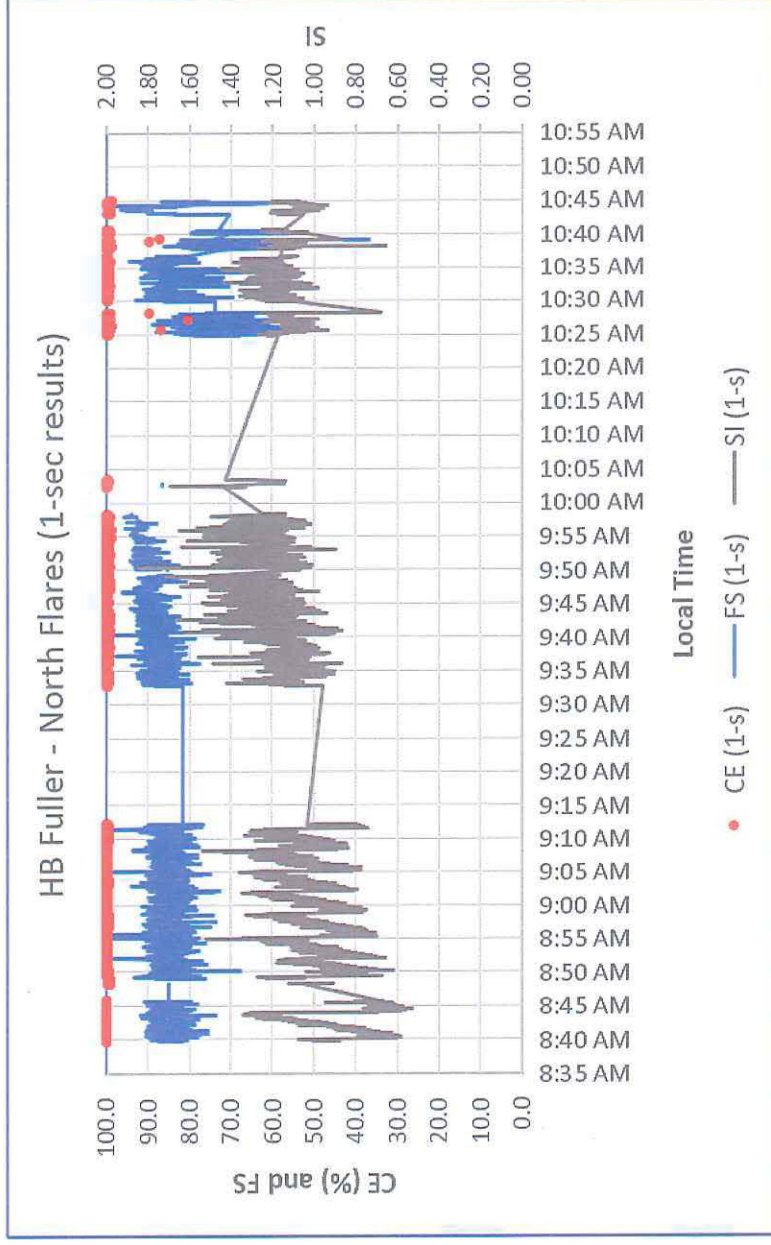


Figure 2. North Flare. Time series plot of 1-second results for CE, FS, and SI.

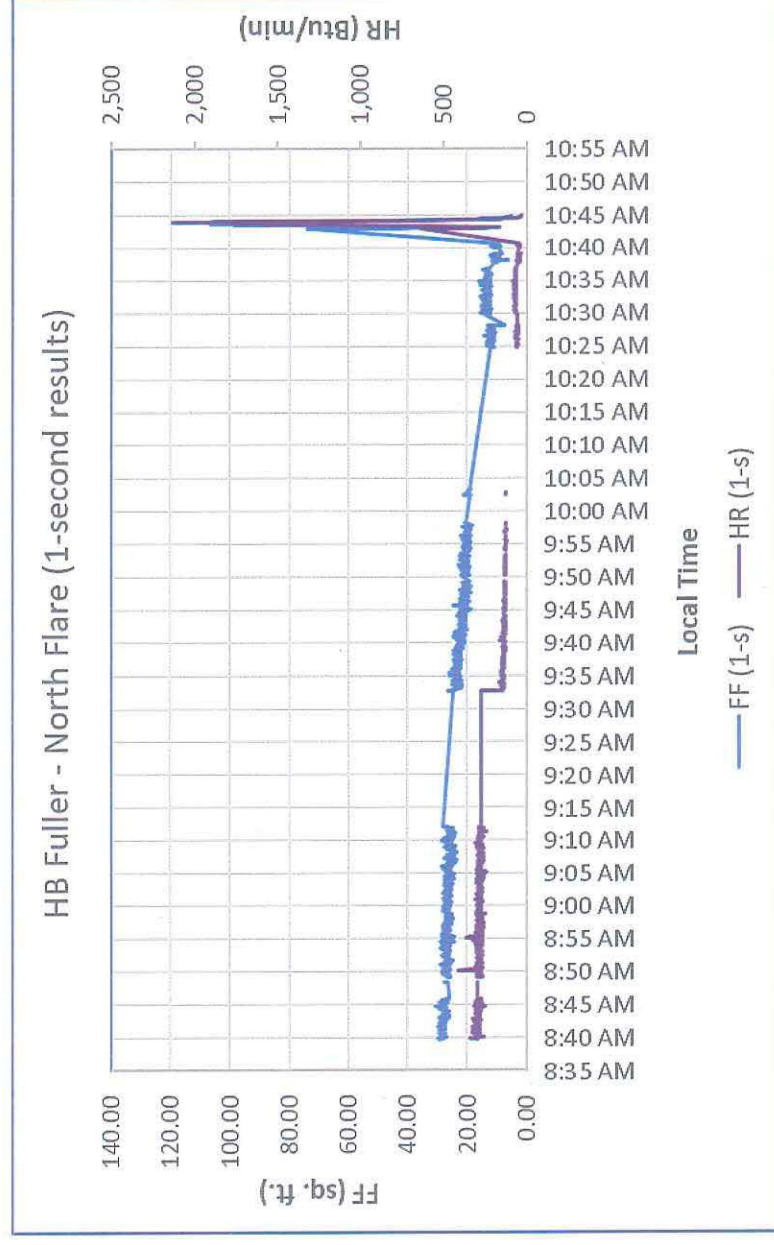


Figure 3. North Flare. Time series plot of 1-second results for FF and HR.

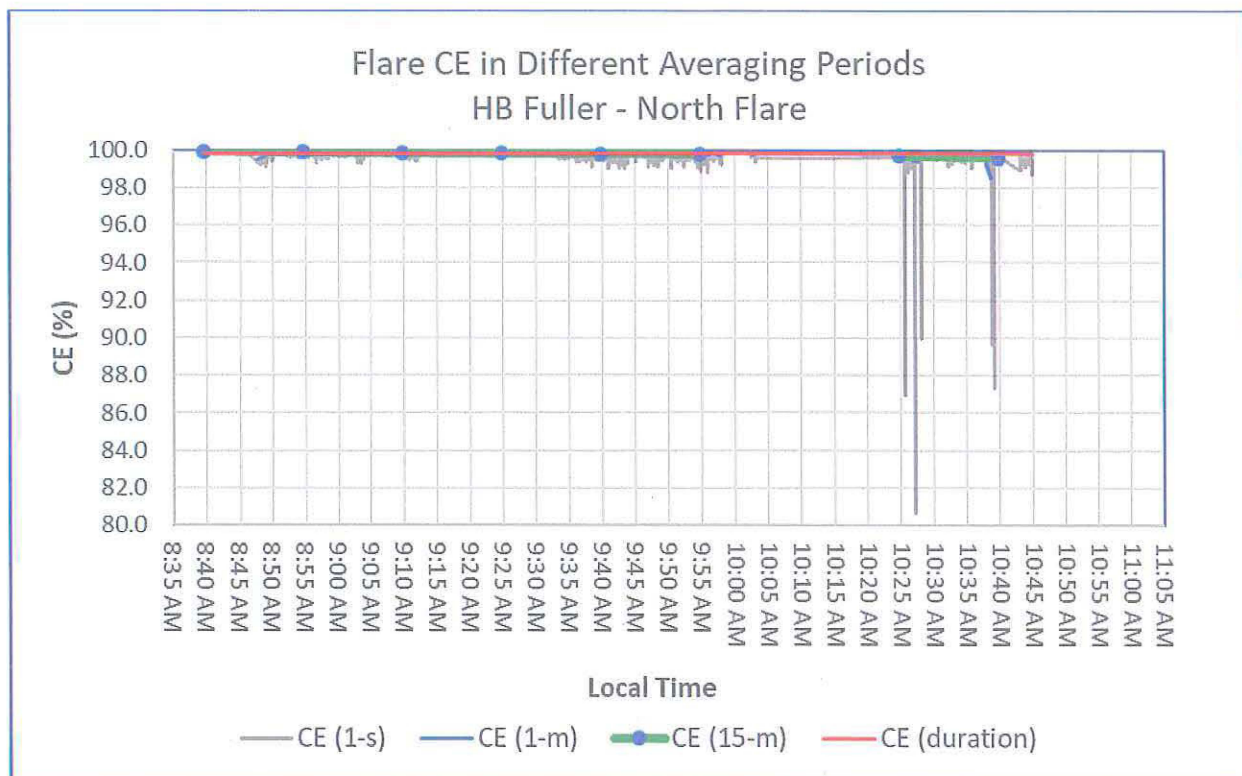


Figure 4. North Flare. Time series plot of CE with different averaging periods.

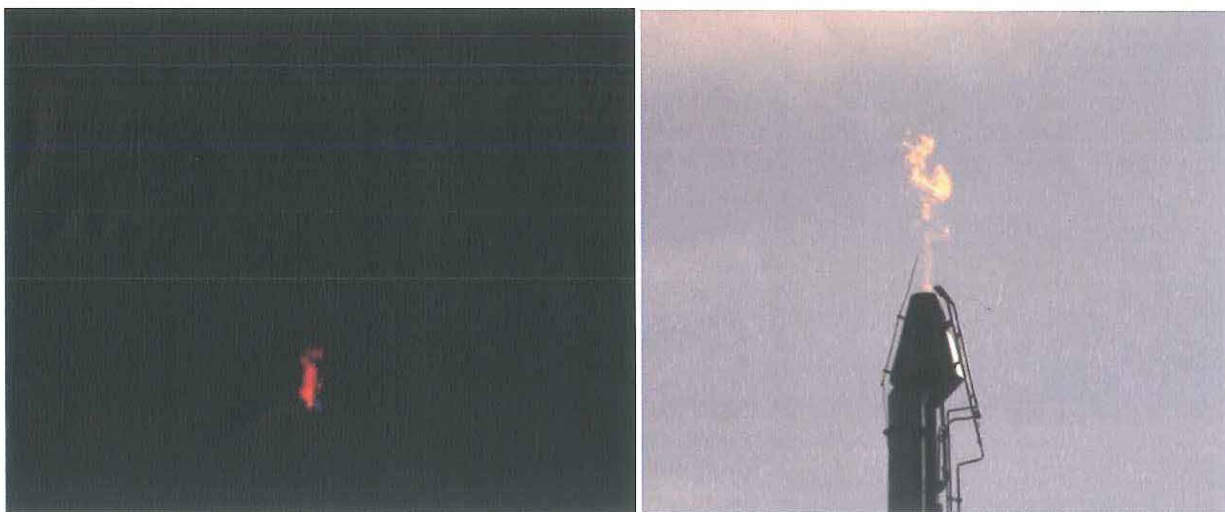


Figure 5. North Flare.  
Left: A representative composite spectral image generated by VISR instrument. Red color represents CO<sub>2</sub>; green color represents hydrocarbon; and blue or bluish white color represents aerosol (e.g., soot) or hot solid object (e.g., the shield for pilots).  
Right: A representative image in visible spectrum.

## Test Results and Observations – Middle Flare

Flaring was observed for only several minutes and the test results for the Middle Flare are summarized in Table 2. Variability (or trending) of the flare during the test can be seen in Figures 6-8. Figure 9 provides a snapshot of the spectral image and a visible image of the flare.

Table 2. VISR test results for the Middle Flare

|                                    | Average for<br>the Duration<br>(10:08 am – 10:14 am) | 1-sec<br>Avg. $\pm$ SD | 1-min<br>Avg. $\pm$ SD |
|------------------------------------|------------------------------------------------------|------------------------|------------------------|
| Combustion Efficiency (%)          | 99.4                                                 | (99.2, 99.6)           | (99.3, 99.5)           |
| Smoke Index (unitless)             | 0.89                                                 | (0.75, 1.03)           | (0.76, 1.02)           |
| Flame Stability (unitless)         | 95.0                                                 | (93.3, 96.6)           | (94.7, 95.2)           |
| Flame Footprint (ft <sup>2</sup> ) | 178.24                                               | (159.06, 197.42)       | (163.16, 195.06)       |
| Heat Release (Btu/min)             | 3,181                                                | (2,689, 3,673)         | (2,725, 3,704)         |

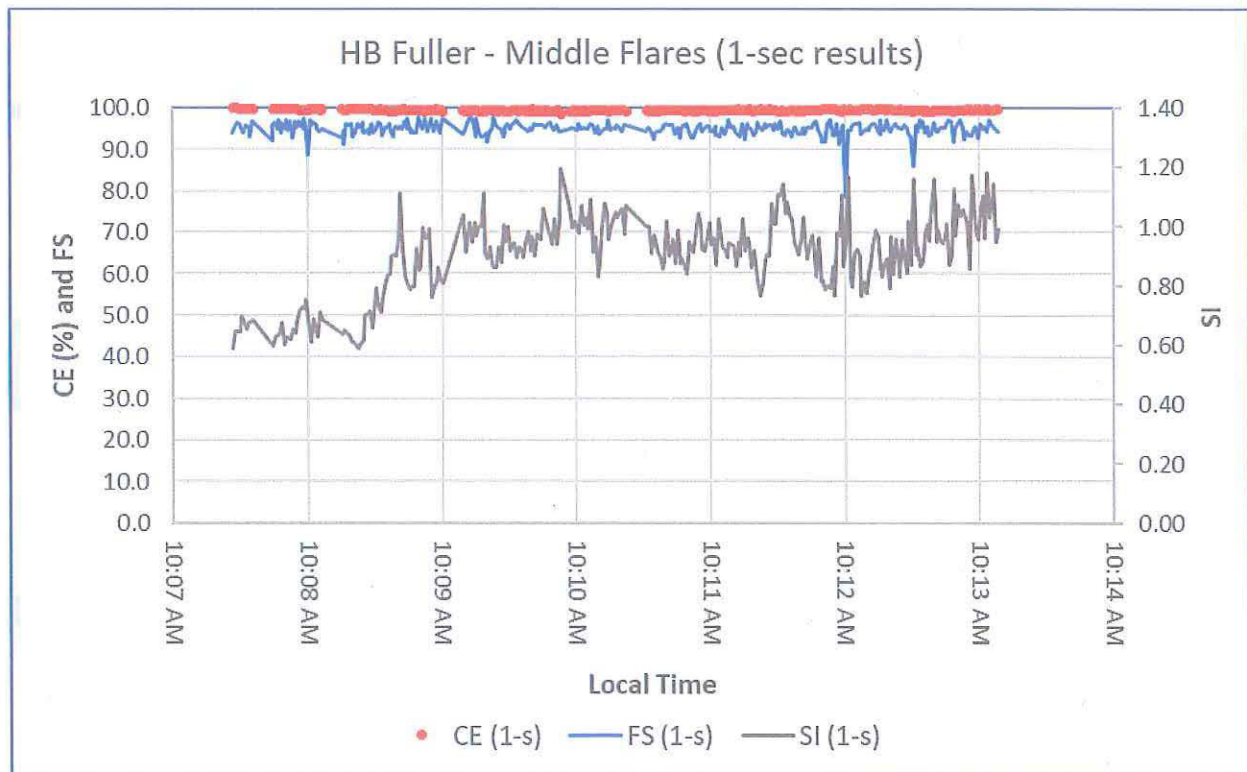


Figure 6. Middle Flare. Time series plot of 1-second results for CE, FS, and SI.

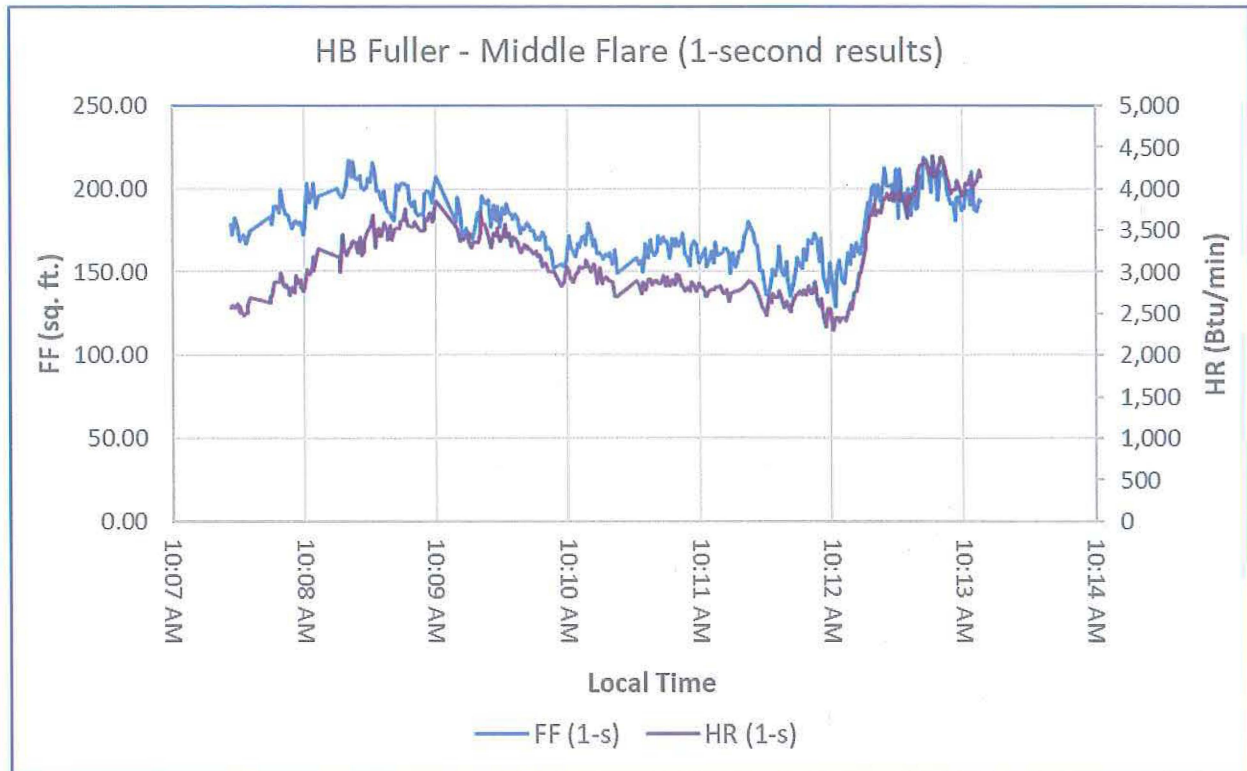


Figure 7. Middle Flare. Time series plot of 1-second results for FF and HR.

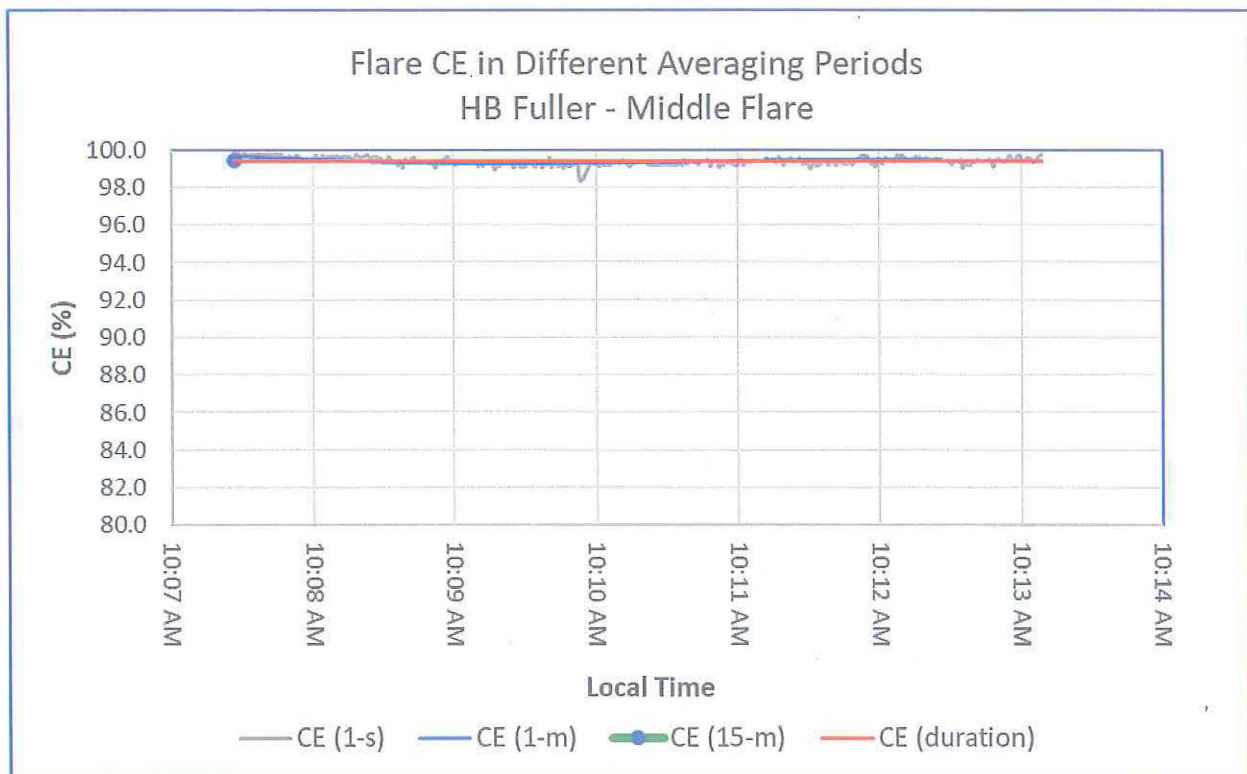


Figure 8. Middle Flare. Time series plot of CE with different averaging periods.

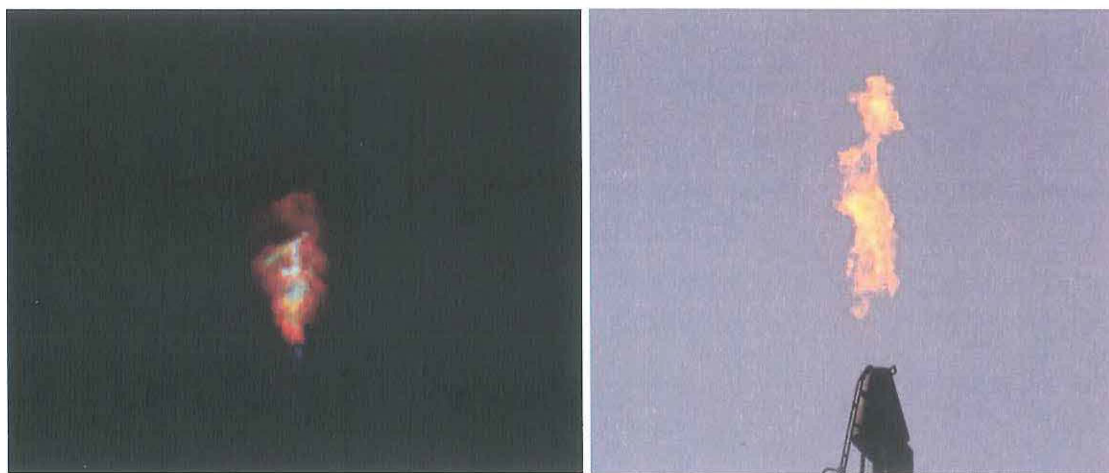


Figure 9. Middle Flare.

Left: A representative composite spectral image generated by VISR instrument. Red color represents CO<sub>2</sub>; green color represents hydrocarbon; and blue or bluish white color represents aerosol (e.g., soot) or hot solid object (e.g., the shield for pilots).  
Right: A representative image in visible spectrum.

## Electronic Data Generated from the Test

The following electronic data are submitted to the US EPA Region 5 as part of this report:

- A Microsoft Excel file containing second-by-second results from the VISR instrument, derived 1-minute average results, and 15-minute average results when applicable.
- Video recording of the flare during the test, taken by a regular video camera in visible spectrum.
- Spectral video generated by the VISR instrument.

## References

1. Validation of a New Method for Measuring and Continuously Monitoring the Efficiency of Industrial Flares, Y. Zeng, J. Morris, M. Dombrowski, J. Air & Waste Manage. Assoc. 66:76-86 (2016).
2. Performance Review of Remote and Direct Flare Combustion Efficiency Monitor, Y. Zeng and J. Morris, presented at American Fuel & Petrochemical Manufacturers (AFPM) 2017 Environmental Conference, Denver, Colorado, October 15-17, 2017
3. Video Imaging Spectral Radiometer (VISR) Based Flare Monitor, Y. Zeng, presented at Air Quality Measurement Methods and Technologies, Long Beach, California, November 7-9, 2017

More information about the VISR method and its validation can be found at  
<https://www.providencephotonics.com/flare-monitoring>.