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

DATE: OCT 17 2018

SUBJECT: CLEAN AIR ACT INSPECTION REPORT
Kraton Polymers U.S. LLC

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

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

TO: File

BASIC INFORMATION

Facility Name: Kraton Polymers U.S. LLC

Facility Location: 2419 Sate Route 618, Belpre, OH

Date of Inspection: September 21, 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. Danielle D. Axsom, Environmental Engineer, Kraton Polymers U.S. LLC
5. Ken Hunt, HSES Manager, Kraton Polymers U.S. LLC
6. David Mongilio, Plant Manager, Kraton Polymers U.S. LLC
7. Robert Law, Kraton Polymers U.S. LLC

Contact Email: danielle.axson@kraton.com

Purpose of Inspection: CAA Compliance

Facility Type: Thermoplastic elastomers manufacturing

Facility Name: Kraton Polymers U.S. LLC
Facility Location: 2419 Sate Route 618, Belpre, OH
Date of Inspection: September 21, 2018

Regulations Central to Inspection: SIP, NSPS and MACT

Arrival Time: 0810 hrs
Departure Time: 1400 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:
Kraton Polymers U.S. LLC (Kraton) manufactures thermoplastic elastomers principally using the raw materials of cyclohexane, styrene and butadiene. They principally manufacture synthetic rubber. These raw products are reacted at various temperatures and pressures with various catalysts to produce thermoplastic elastomers. The processes includes hydrogenation, steam addition, polymerization, desolventing and dewatering to produce crumbs, pellets, grains or bails of product.

The facility has four process lines. The G-1 and K-1 process lines are located on the south portion of the facility (South side) while the G-2 and K-3 process lines are located on the north portion of the facility (North side). Most process emissions from each of these processes are routed to a control device: for G-1, a regenerative thermal oxidizer (RTO); K-1, a catalytic oxidizer; G-2, a catalytic oxidizer; and K-3, a vapor combustor.

Two steam-assisted flares are also used at this facility. The South flare controls emissions from the South side pressure relief valves (PRV), the tank farm and the wastewater treatment plant, while the North flare controls PRV emissions from the North side. Vent gas (VG) routed to these flares is continuous and is monitored with a calorimeter at each flare. Supplemental gas (pipeline natural gas) may be added to each flare to help maintain a minimum VG net heating value (NHV), which is set at 600 BTU/scf for the South flare and 450 BTU/scf for the North flare. Steam flow is measured at each flare and may be controlled by a valve on the steam line. A camera is on each flare and is shown on a screen in the corresponding control room. The last time either flare was observed to be smoking was during a power outage in 2013. EPA/Providence observations of the flares are summarized below.

Facility Name: Kraton Polymers U.S. LLC
Facility Location: 2419 Sate Route 618, Belpre, OH
Date of Inspection: September 21, 2018

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 Kraton 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 flares and collect images.

At the time of inspection, the facility was operating normally. Observations of the flares were:

South flare – The VISR indicated CE was approx. 95% during the observation period and was lowest when wind speed was high. FLIR video collected correspond with the VISR observations.

North flare – CE ranged was approx. 75% during the test period and varied rapidly. FLIR video collected correspond with the VISR observations.

A report from Providence on the VISR data with images is provided in Appendix A.

EPA observed the flare operating parameters in both control rooms and took screenshots (camera pictures) of the flare SCADA showing conditions at the time of inspection. Control room data showed the NHV for VG routed to the South flare was 629.5 BTU/scf and to the North flare was 443 BTU/scf.

While Providence personnel and C. Secrest were conducting flare observations, G. Gehrig and K. Ruffatto conducted a limited tour of the South side. Specifically, EPA saw the G-1 and K-1 process units, focusing on G-1. EPA walked the units with a FLIR camera. Possible VOC emissions were seen coming from a product drying (dewatering) oven exhaust on G-1. EPA also observed the inlet and initial treatment area of the wastewater treatment plant.

Field Measurements: were taken during this inspection.

RECORDS REVIEW

None

CLOSING CONFERENCE

Requested documents (to be sent via email):

Facility Name: Kraton Polymers U.S. LLC
Facility Location: 2419 Sate Route 618, Belpre, OH
Date of Inspection: September 21, 2018

- 2018 LDAR quarterly reports.
- Design and operating information for both flares, including recent preventative maintenance procedures.

SIGNATURES

Lead Inspector: _____ Date: 10-17-18

Section Chief: _____ Date: 10/17/18

Facility Name: Kraton Polymers U.S. LLC
Facility Location: 2419 Sate Route 618, Belpre, OH
Date of Inspection: September 21, 2018

DIGITAL IMAGE LOG*

1. **Inspector Name:** Gregory Gehrig	2. **Date(s) of Inspection:** September 21, 2018
3. **Company/Facility Name:** Kraton Polymers U.S. LLC	4. **Street Address, City, State:** 2419 Sate Route 618, Belpre, OH
5. **Number of Images:** 10	6. **Archival Record Location:** CD-R labeled Kraton Images 9.21.2018

Image name	Time (EDT)	Description
IMG_0150	1139	G-1 RTO
IMG_0151	1139	K-1 catalytic oxidizer
IMG_0152	1159	Screen shot of South flare control screen
IMG_0153	1234	Screen shot of North flare control screen
IMG_0154	1234	Screen shot of North flare control screen
MOV_310	1041	FLIR video of South flare. CE was 97% but dropped to 90% with increased wind speed.
MOV_314	1143	FLIR video of G-1 dryer (dewatering) vent
MOV_315	1229	FLIR video of North flare. CE ranged from 69 to 80%, varied rapidly.
MOV_316	1240	FLIR video of North flare
MOV_317	1313	FLIR video of North flare

*Additional images of the flares were collected by Providence Photonics as detailed in their report in Appendix A.

Facility Name: Kraton Polymers U.S. LLC
Facility Location: 2419 Sate Route 618, Belpre, OH
Date of Inspection: September 21, 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: Kraton Polymers U.S. 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

Table of Contents

Introduction

EPA Region 5 retained Providence Photonics, LLC (Providence) to assist the inspection of Kraton Polymers U.S. LLC (Kraton) located at 2419 State Route 618, Belpre, OH. Providence measured the combustion efficiency (CE) and other performance metrics of Kraton's two flares using the Video Imaging Spectral Radiometry (VISR) method.

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 (CO2, 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 21, 2018

Personnel:

Gregory Gehrig (EPA Region 5)
Kenneth Ruffatto (EPA Region 5)
Cary Secrest (EPA OECA)
Yousheng Zeng (Providence)
Jon Morris (Providence)
Sri Mutyala (Providence)

Facility: Kraton Polymers U.S. LLC

2419 State Route 618, Belpre, Ohio 45714

Location of Flares and VISR Instrument: see Figures 1 and 2.

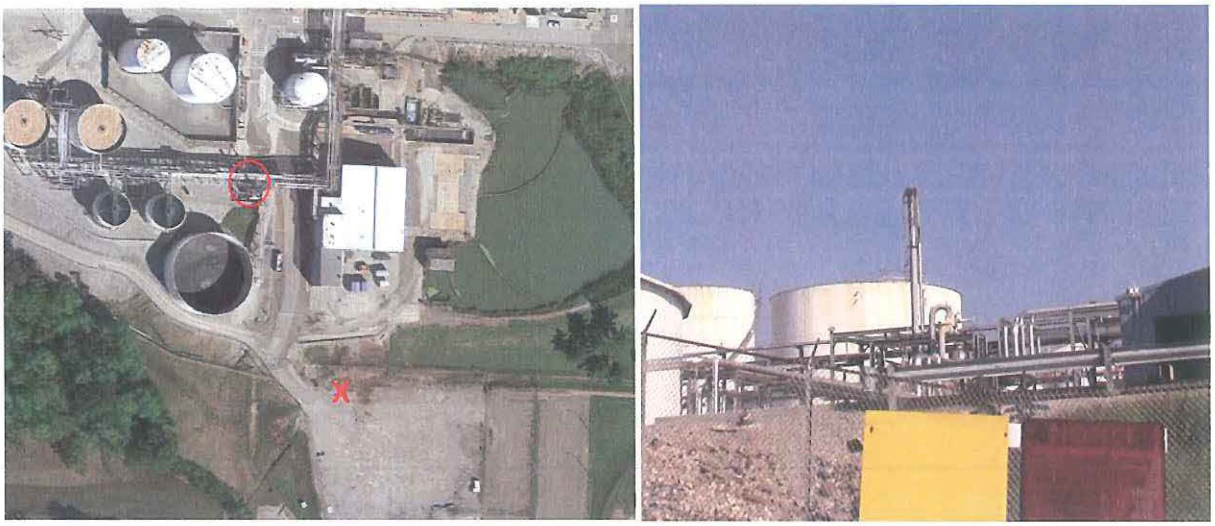

Figure 1. South flare. A steam assisted flare.
Left: Google map with a red circle indicating the location of the flare and a red "X" indicating the location of the VISR instrument. Distance: 276 ft.
Right: A photo of the flare taken during the test.

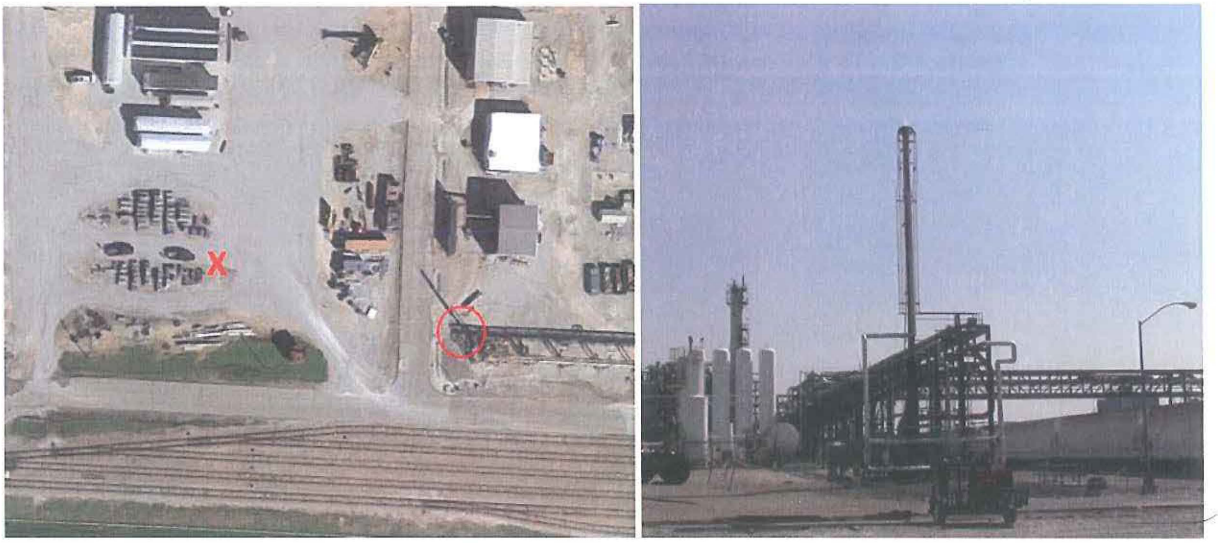

Figure 2. North flare. A steam assisted flare.
Left: Google map with a red circle indicating the location of the flare and a red "X" indicating the location of the VISR instrument. Distance: 180 ft.
Right: A photo of the flare taken during the test.

Test Results and Observations – South Flare

Test results for the South Flare are summarized in Table 1. Variability (or trending) of the flare during the test can be seen in Figures 3-5. Figure 6 provides a snapshot of the spectral image and a visible image of the flare.

A lower CE was observed when wind picked up and vent gas flow rate appeared to be low (low exit velocity). When vent gas flow increased, CE generally improved. At about 11:37 am, the vent gas increased evidenced by the sound of the flare and visually observed exit velocity. The VISR results showed increased FF, increased HR, and improved CE from about 11:37 am to the end of the test– see Figure 4.

Table 1. VISR test results for the South Flare

	Average for the Duration (10:41 am – 11:47 am)	1-sec (Avg.-SD, Avg.+SD)	1-min (Avg.-SD, Avg.+SD)
Combustion Efficiency (%)	95.5	(92.6, 98.5)	(93.7, 97.4)
Smoke Index (unitless)	0.78	(0.63, 0.93)	(0.68, 0.87)
Flame Stability (unitless)	94.9	(91.9, 97.8)	(93.8, 95.9)
Flame Footprint (ft^2)	161.36	(108.80, 213.92)	(112.51, 210.67)
Heat Release (Btu/min)	2,286	(1,315, 3,256)	(1,376, 3,193)

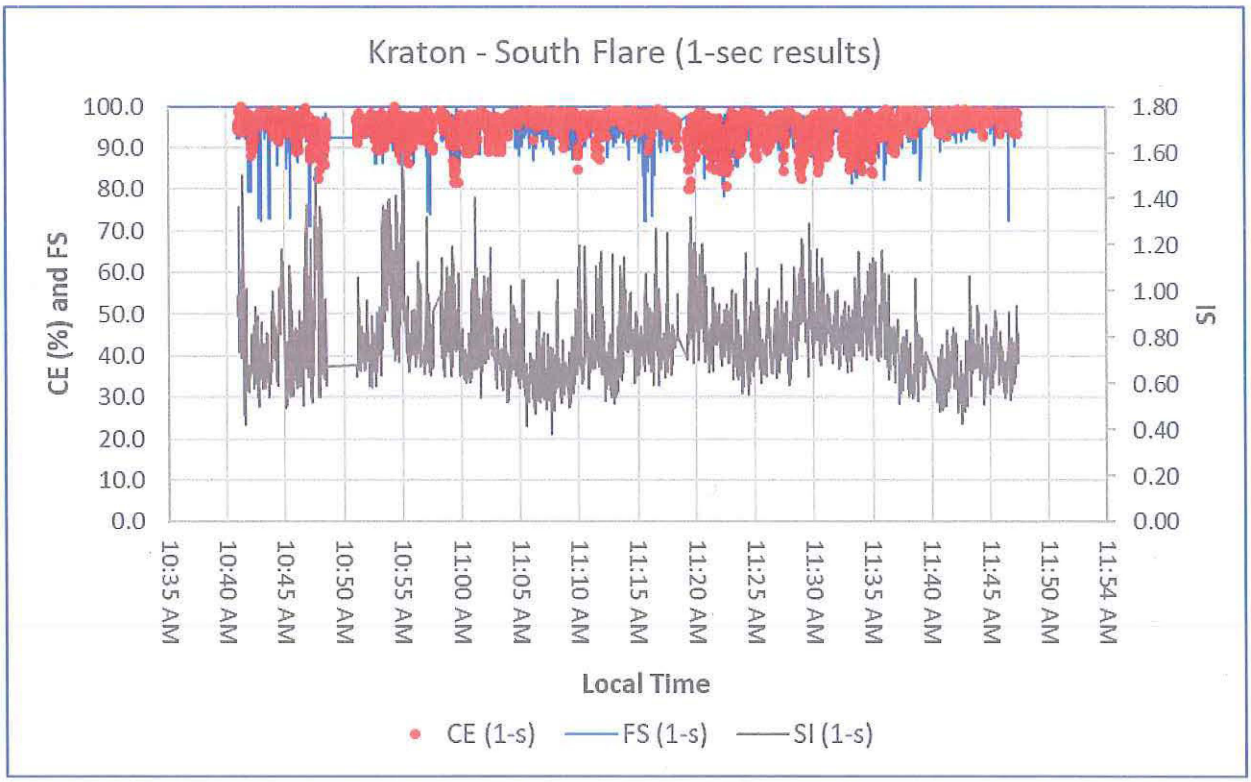

Figure 3. South Flare. Time series plot of 1-second results for CE, FS, and SI.

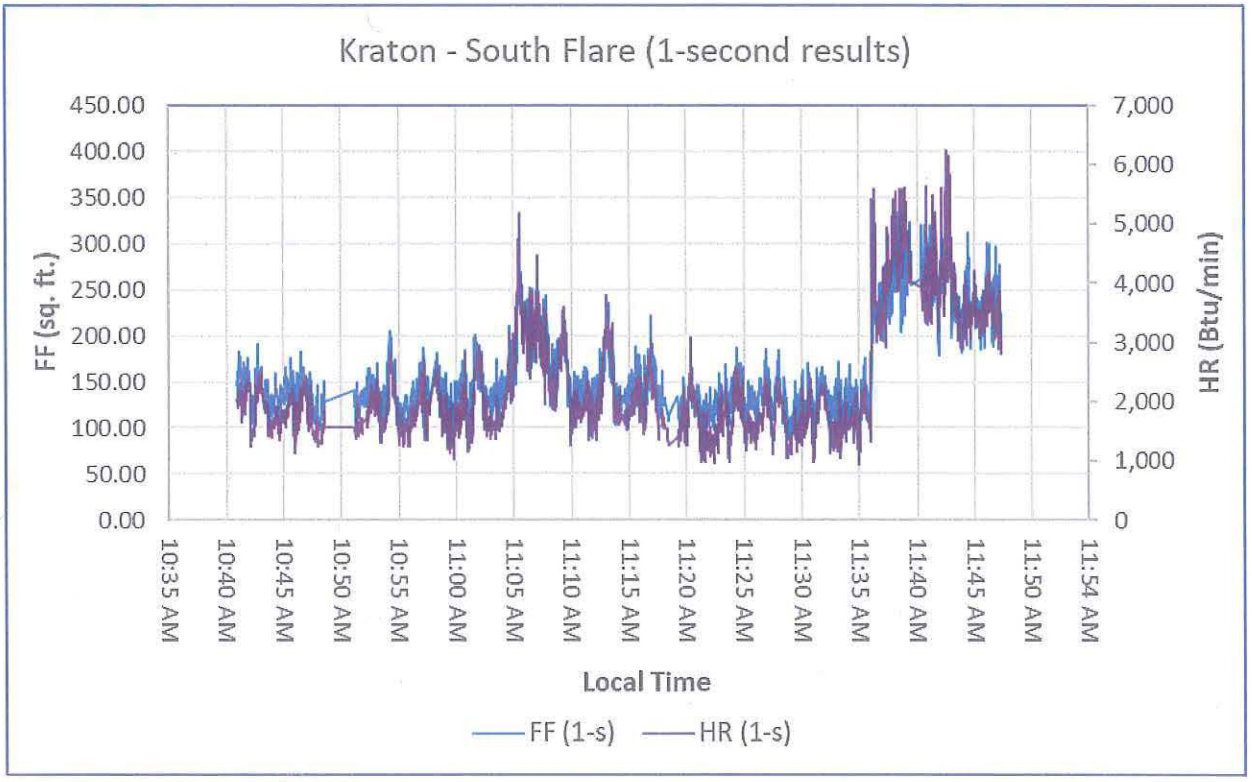

Figure 4. South Flare. Time series plot of 1-second results for FF and HR.

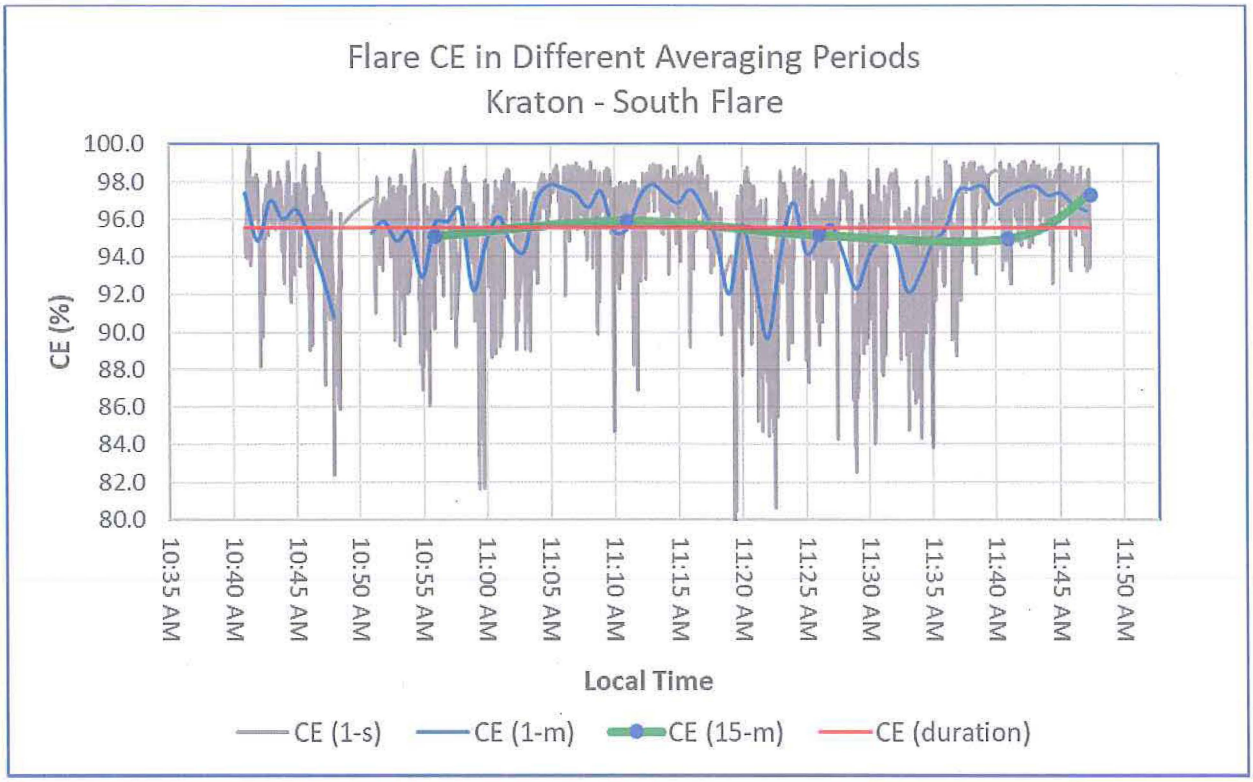

Figure 5. South Flare. Time series plot of CE with different averaging periods.

Figure 6. South Flare.
Left: A representative composite spectral image generated by VISR instrument. Red color represents CO_2; 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 – North Flare

Test results for the North Flare are summarized in Table 2. Variability (or trending) of the flare during the test can be seen in Figures 7-9. Figure 10 provides a snapshot of the spectral image and a visible image of the flare.

Low CE at the North flare was observed during the entire test period and appeared to be due to excess steam. Unburned hydrocarbon was noticeable in the spectral image (green color in Figure 10). The flame was completely quenched at times, but would then be reignited. The flame was very unstable during a period between 1:00 pm and 1:10 pm – see Figures 7 and 8. The quenches and reignitions can be vividly seen in a short spectral video clip (Kraton North Flare Run 9.wmv).

Table 2. VISR test results for the North Flare

	Average for the Duration (12:18 pm – 1:23 pm)	1-sec Avg. ± SD	1-min Avg. ± SD
Combustion Efficiency (%)	75.1	(69.0, 81.2)	(72.4, 77.8)
Smoke Index (unitless)	1.00	(0.84, 1.16)	(0.88, 1.13)
Flame Stability (unitless)	86.4	(74.3, 98.4)	(77.2, 95.0)
Flame Footprint (ft^2)	42.58	(23.00, 62.16)	(25.62, 59.00)
Heat Release (Btu/min)	478	(207, 750)	(242, 709)

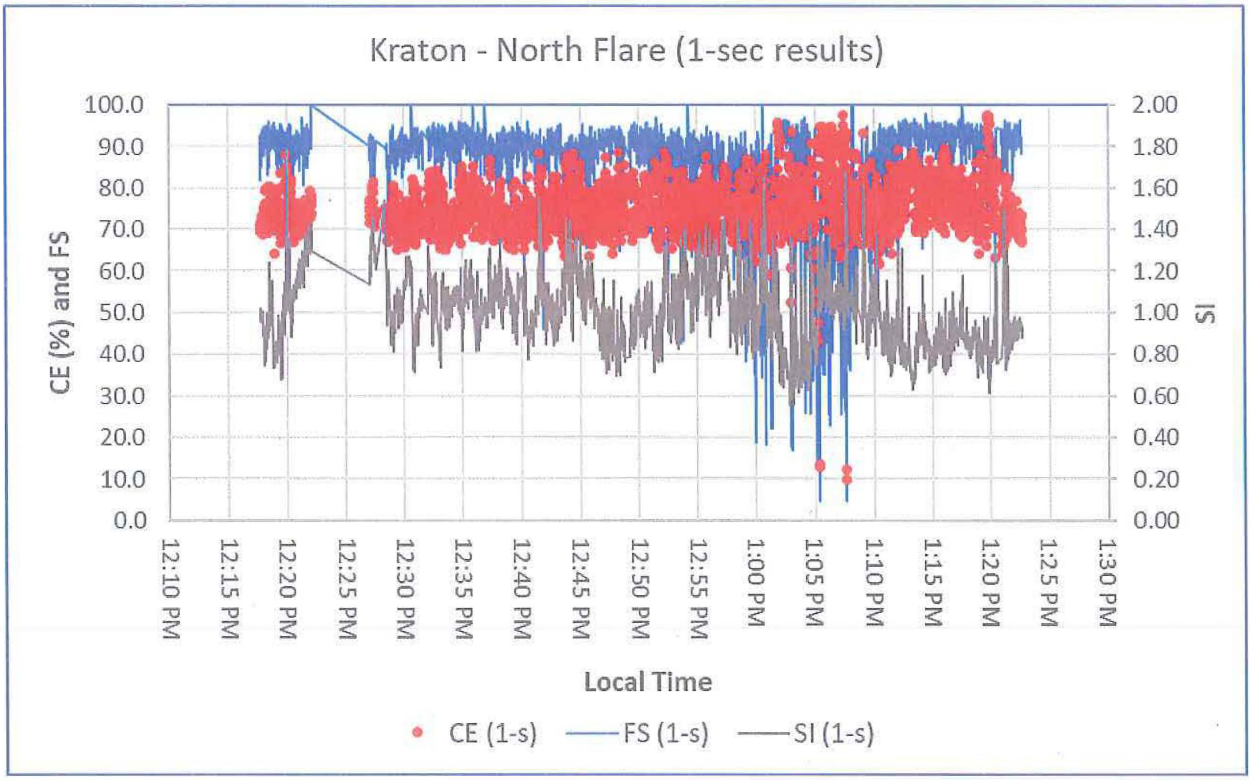

Figure 7. North Flare. Time series plot of 1-second results for CE, FS, and SI.

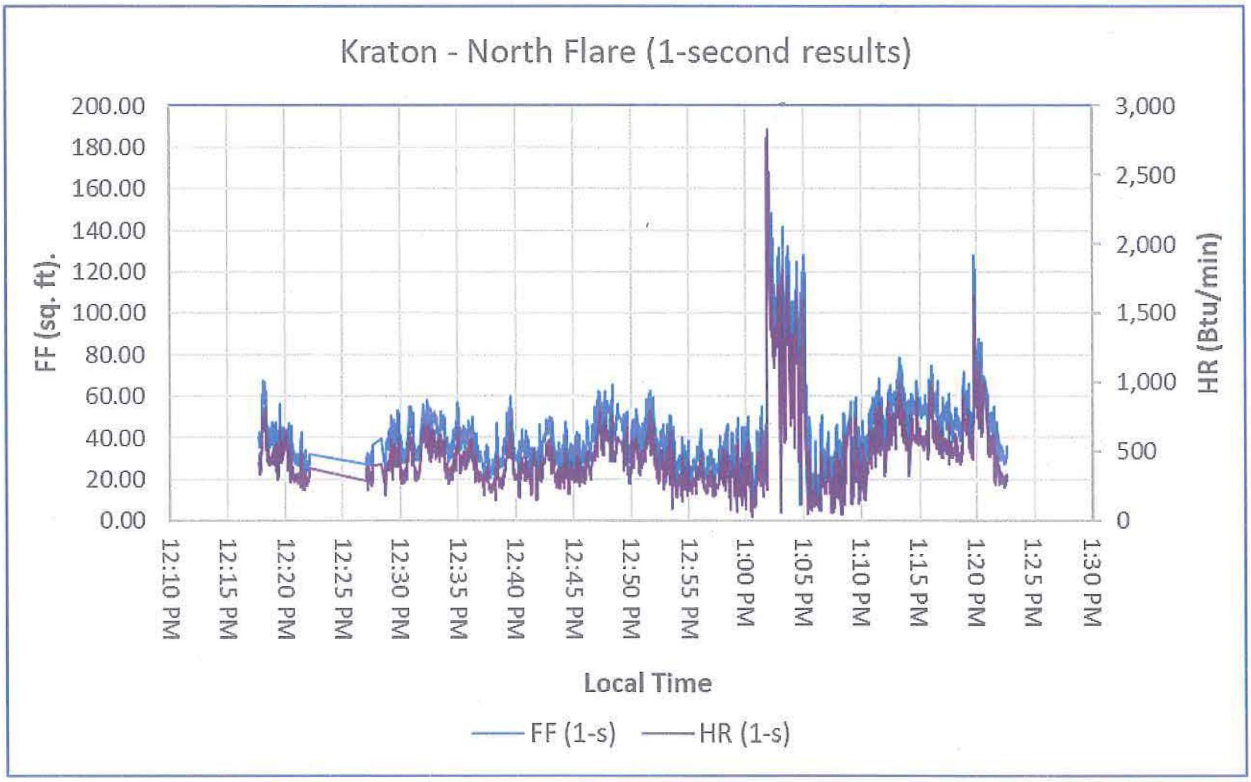

Figure 8. North Flare. Time series plot of 1-second results for FF and HR.

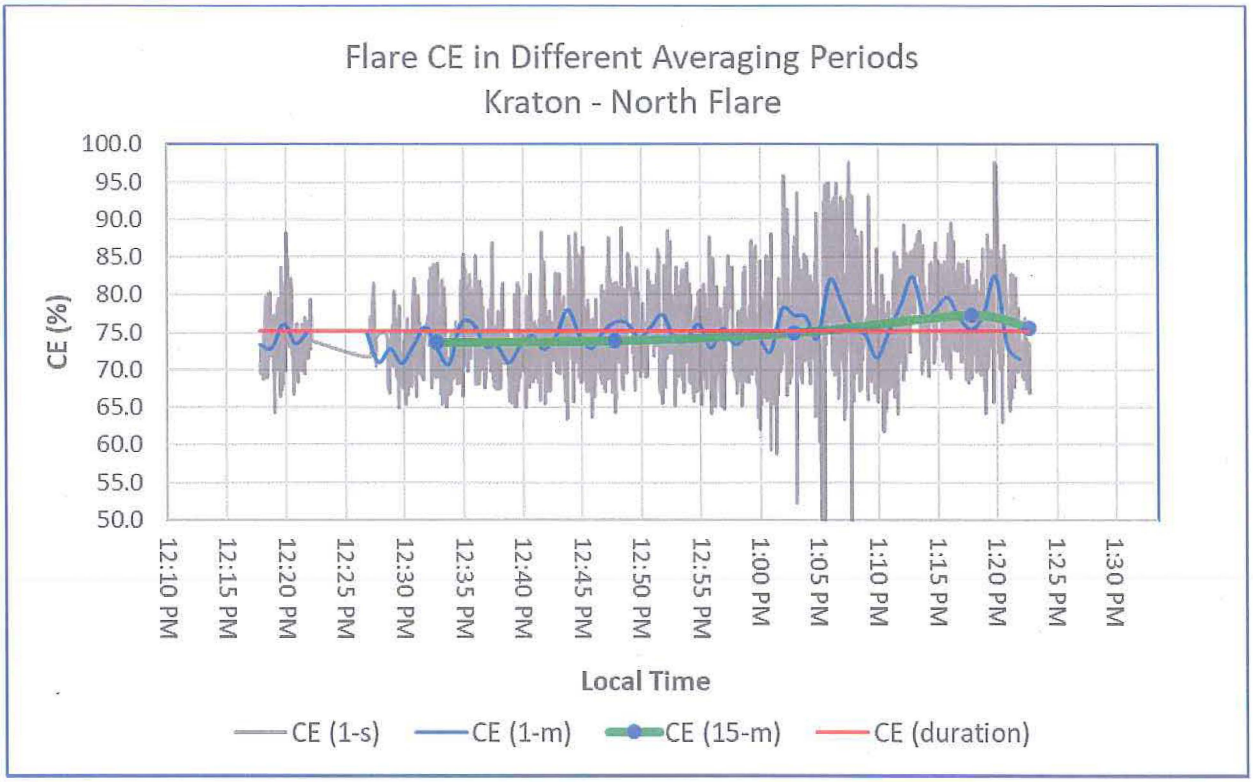

Figure 9. North Flare. Time series plot of CE with different averaging periods.

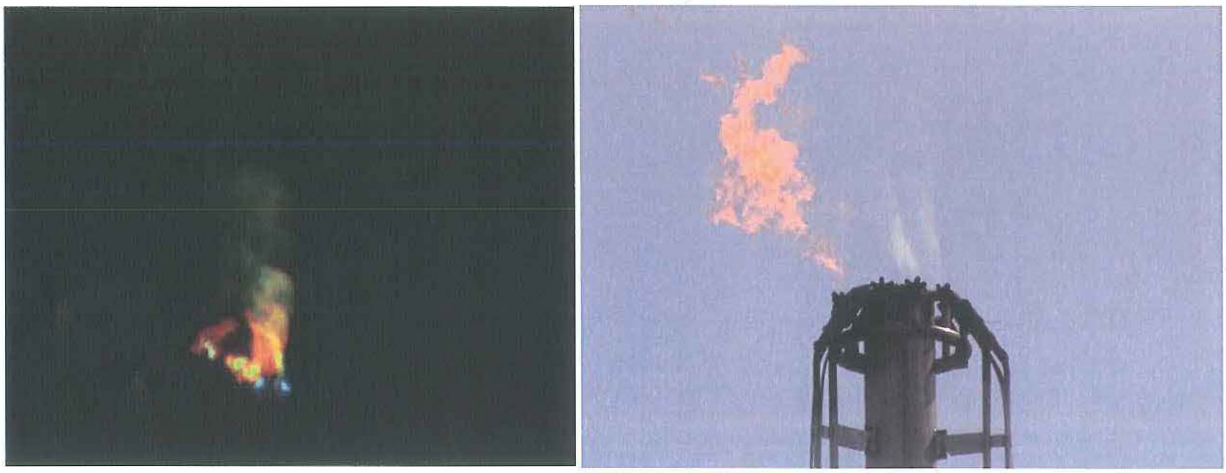

Figure 10. North Flare.
Left: A representative composite spectral image generated by VISR instrument. Red color represents CO_2; green color represents hydrocarbon; and blue or bluish white color represents aerosol (e.g., soot) or hot solid object (e.g., the shield for pilots).
Right: A representative 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, including a clip the North Flare (Kraton North Flare Run 9.avi)

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.