Field Report for Airborne Data Collected In Support of US EPA Region VI South 4 Group Fire 30 November 2019 Flight 7

Background

On 27 November 2019 an explosion and subsequent fire was reported at the South 4 Group facility located near Port Neches, TX. Local information indicated that at approximately 0100 (central) a large explosion rocked the area. The explosion subsequently caused a massive fire at the facility in a short amount of time. Local officials ordered an initial evacuation order of 0.5 miles on 27 November 2019 which was extended to 4 miles around 1430 (central). The evacuation order was lifted at 1000 (central) on 29 November 2019. Reported onsite products include various olefins, butadiene, and isobutylene. The geographical coordinates of the facility are 29.9222N, 95.0547W (figure 1).

The US EPA Region VI requested that the ASPECT system be deployed to provide monitoring support beginning on 27 November 2019. This report summarizes findings observed during the missions flown on 30 November 2019.

Figure 1: South 4 Group Facility, Port Neches, TX

ASPECT response to this Mission/Incident was in support of:
US EPA Region 6. OSC: Adam Adams

On 27 November 2019 ASPECT was dispatched to collect aerial remote sensing data over the South 4 Group facility located near Port Neches, TX and conducted three data collection missions. An explosion and fire involving a production unit and subsequent tank farms resulted in a black plume moving toward the south. Reports from the air crew indicated that significant lofting was occurring with smoke reaching 4000 feet above ground. Collected spectral data from both the IRLS and FTIR did not show any chemical detections. Data analysis from the second and third mission showed consistency to that of the first with the presence of a large thermal signature with the absence of detected compounds.

Due to poor weather and very low ceilings, ASPECT was only able to collect a few oblique images on 28 November 2019 and did not fly at all due to poor weather on 29 November 2019. On 30 November 2019, weather conditions improved, and a morning and afternoon flight was requested by the Region. This report details results and information obtained on the final mission of 30 November 2019.

ASPECT System

The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 3,000 ft AGL). The system consists of an airborne high-speed Fourier transform infrared spectrometer (FTIR) coupled with a wide-area IR line scanner (IRLS). The ASPECT IR systems can detect compounds in both the 8 to 12-micron (800 to 1200 cm-1) and 3 to 5 micron (2000 to 3200 cm-1) regions. The 8 to 12-micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon - non-carbon bonded compounds. The 3 to 5-micron region is also free of water and carbon dioxide but typically does not have enough energy for use. This band does show use in high-energy environments such as fires. The carbon - hydrogen stretch is very common in this region.

A digital Nikon DX2 camera (12.4 mega pixel CMOS 3:5 aspect ratio, 28 mm wide-angle lens) collects visible aerial imagery as part of the core data product package. The camera timing system is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. All imagery is geo-rectified using both aircraft attitude correction (pitch, yaw, and roll) and GPS positional information. Imagery can be processed while in flight or approximately 600 frames per hour can be processed once the data are downloaded from the aircraft.

An Imperx mapping camera (29 mega pixels; mapping focal plane array) provides a similar aspect ratio and aerial coverage. Like the Nikon DX2, it is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. These images are often digitally processed in lower resolution, so they can be transmitted via satellite communication. The high-resolution images (>20 MB each) are pulled from the ASPECT after the sortie and are available later.

All high resolution digital aerial photographic images collected by the ASPECT system are ortho-rectified and geospatially validated by the reach back team. In general, this consists of conducting geo-registration using a Digital Elevation Model (DEM) which promotes superior pixel computation and lessens topographic distortion. The image is then check by a team member (using a Google Earth base map) for proper location and rotation

Data is processed using automated algorithms onboard the aircraft with preliminary results being sent using a satellite system to the ASPECT reach back team for QA/QC analysis. Upon landing preliminary data results are examined and validated by the reach back team.

Flight 7 -- 30 November 2019

Weather Conditions and Crew Report

Weather for the mission is given in table 1.

Table 1. South 4 Group Mission Weather

Parameter	Surface (1500)	Surface (1600)
Wind direction	210 degrees	210 degrees
Wind speed	9.4 m/s (21 mph)	6.2 m/s (14 mph)
Temperature	25°C	24.5°C
Humidity	82%	85%
Dew Point	22°C	22°C
Pressure	1007 mb	1007
Ceiling	BKN 1500/2600	BKN 1300/1800

The crew reported that winds at altitude (2500 ft) were at about 50 kts (25 m/s) from the southeast. Very little smoke was observed from the site.

Flight Status

The aircraft was airborne at 1455 (central) was over the site at 1525 (central). A total of 2 test and 4 data collection passes were completed before IFR conditions forced a termination of the data collection due to low ceiling. Flight information is summarized in Appendix A and Figure 2.

Data Results

General Data Quality Objective

The following general data quality objectives are employed in conducting emergency response data collection with ASPECT:

1. To support overall situational analysis of the incident including aerial photography and IR imagery
2. To screen the incident for the presence of selected chemicals
3. To estimate the location and concentration of plumes being generated by the incident.

Figure 2: Data collection passes, South 4 Group Fire, Port Neches, TX. The blue lines represent the ASPECT flight path, green lines represent when the FTIR was actively collecting data, the yellow icons with star is the centroid of the line scanner image, and the camera icons represent when a photo was taken.

Line Scanner Data Results

A total of 2 test and 4 data collection passes were made in the proximity of the fire and an infrared line scanner image was generated for each pass. Figure 3 shows a typical 3-band infrared image obtained from data collected for Run 8. This image is somewhat distorted due an extreme crosswind at the flight altitude. Analysis of the image generally shows minimal elevated thermal sources with a cooler signature leaving the site; most likely water spray from the water cannon. No chemical plume can be seen being emitted from the site. Figure 4 was generated by flying the system over the Neches river in an effort to image any oil sheen in the waterway. No sheen was observed. It should be noted that the image features on the east side of the image are clouds below the aircraft.

FTIR Data Results

FTIR Spectral data at a resolution of 16 wavenumbers was collected for each pass. ASPECT uses an automated detection algorithm to permit compounds to be analyzed while the aircraft is in flight. 72 compounds are included in this algorithm and the list is given in Table 2. In addition, collected data are also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra.

Analysis of both automated and manual analysis of collected data showed no chemical detections. A summary of data of the data collection is given in table 3.

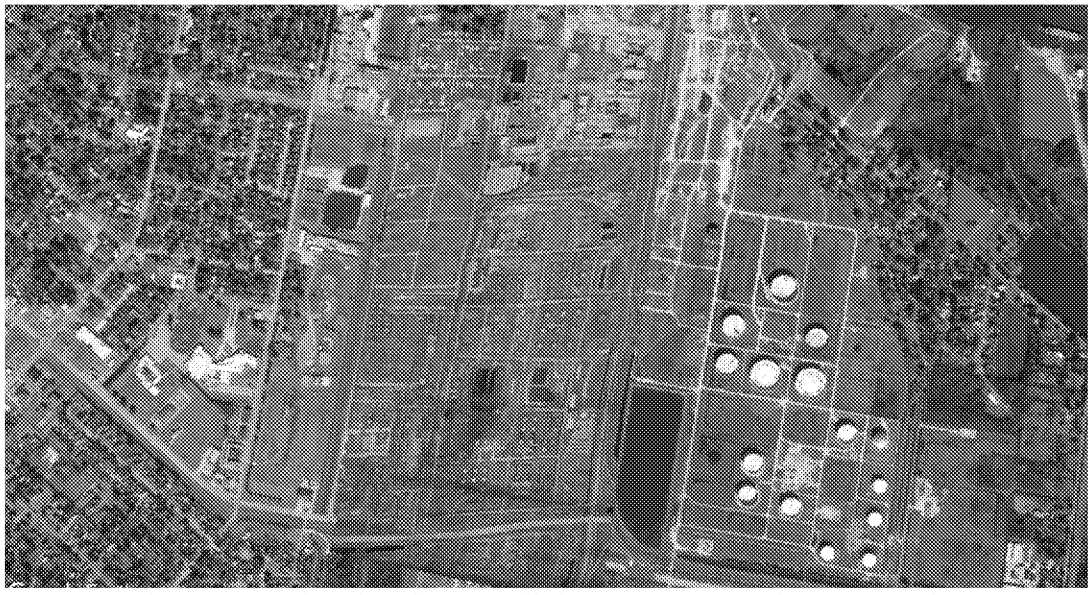

Figure 3: – 3 band IR image, Flight 7, Run 4, South 4 Group Fire

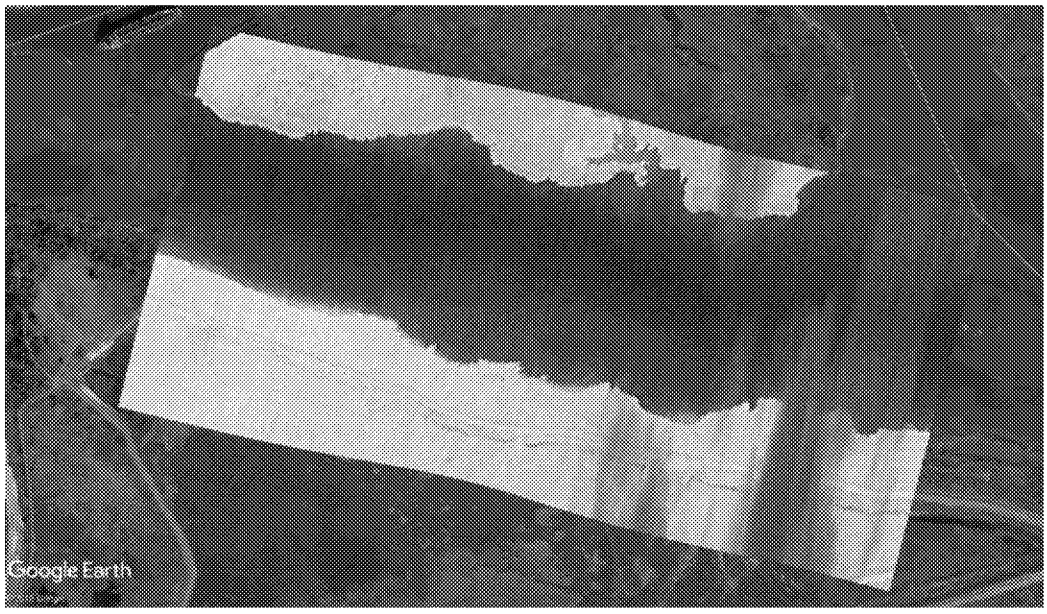

Figure 4: -- 3 band IR image, Flight 7, Run 5, South 4 Group Fire

TABLE 2 - Chemicals Included in the ASPECT Auto-Processing Library

Acetic Acid	Cumene	Isoprene	Propylene
Acetone	Diborane	Isopropanol	Propylene Oxide
Acrolein	1,1-Dichloroethene	Isopropyl Acetate	Silicon Tetrafluoride
Acrylonitrile	Dichloromethane	MAPP	Sulfur Dioxide
Acrylic Acid	Dichlorodifluoromethane	Methyl Acetate	Sulfur Hexafluoride
Allyl Alcohol	Difluoroethane	Methyl Ethyl Ketone	Sulfur Mustard
Ammonia	Difluoromethane	Methanol	Nitrogen Mustard
Arsine	Ethanol	Methylbromide	Phosgene
Bis-Chloroethyl Ether	Ethyl Acetate	Methylene Chloride	Phosphine
Boron Tribromide	Ethyl Formate	Methyl Methacrylate	Tetrachloroethylene
Boron Triflouride	Ethylene	MTEB	1,1,1-Trichloroethane
1,3-Butadiene	Formic Acid	Naphthalene	Trichloroethylene
1-Butene	Freon 134a	n-Butyl Acetate	Trichloromethane
2-Butene	GA (Tabun)	n-Butyl Alcohol	Triethylamine
Carbon Tetrachloride	GB (Sarin)	Nitric Acid	Triethylphosphate
Carbonyl Chloride	Germane	Nitrogen Trifluoride	Trimethylamine
Carbon Tetraflouride	Hexafluoroacetone	Phosphorus Oxychloride	Trimethyl Phosphite
Chlorodifluoromethane	Isobutylene	Propyl Acetate	Vinyl Acetate

Table 3. Chemical Results Summary

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	30 Nov 2019	1515	Test	Test
2		1516	Test	Test
3		1525	ND	None
4		1534	ND	None
5		1542	ND	None
6		1551	ND	None
Note: ND = No Detections				

Aerial Photography Results

A full set of high resolution aerial digital photography were collected as part of the flight. Figure 5 shows a representative image collected as part of each pass. Due to the time of day and cloud cover the image is dark. As with flight 6, the image shows that little if any smoke is being emitted from the site. At the time of collection, only one water cannon was in operation. Oblique image collection was not possible due to the onset of IFR (low ceiling) conditions.

Conclusions – Flight 7

The second flight on 30 November 2019 ASPECT indicated that thermal conditions at the site continue to show a decrease in intensity. No chemical plume or detections were observed being emitted by the site. Collected aerial imagery showed no significant change from the prior flight other than the presence of only one water cannon. IR imagery collected over the Neches River did not show any evidence of an oil sheen.

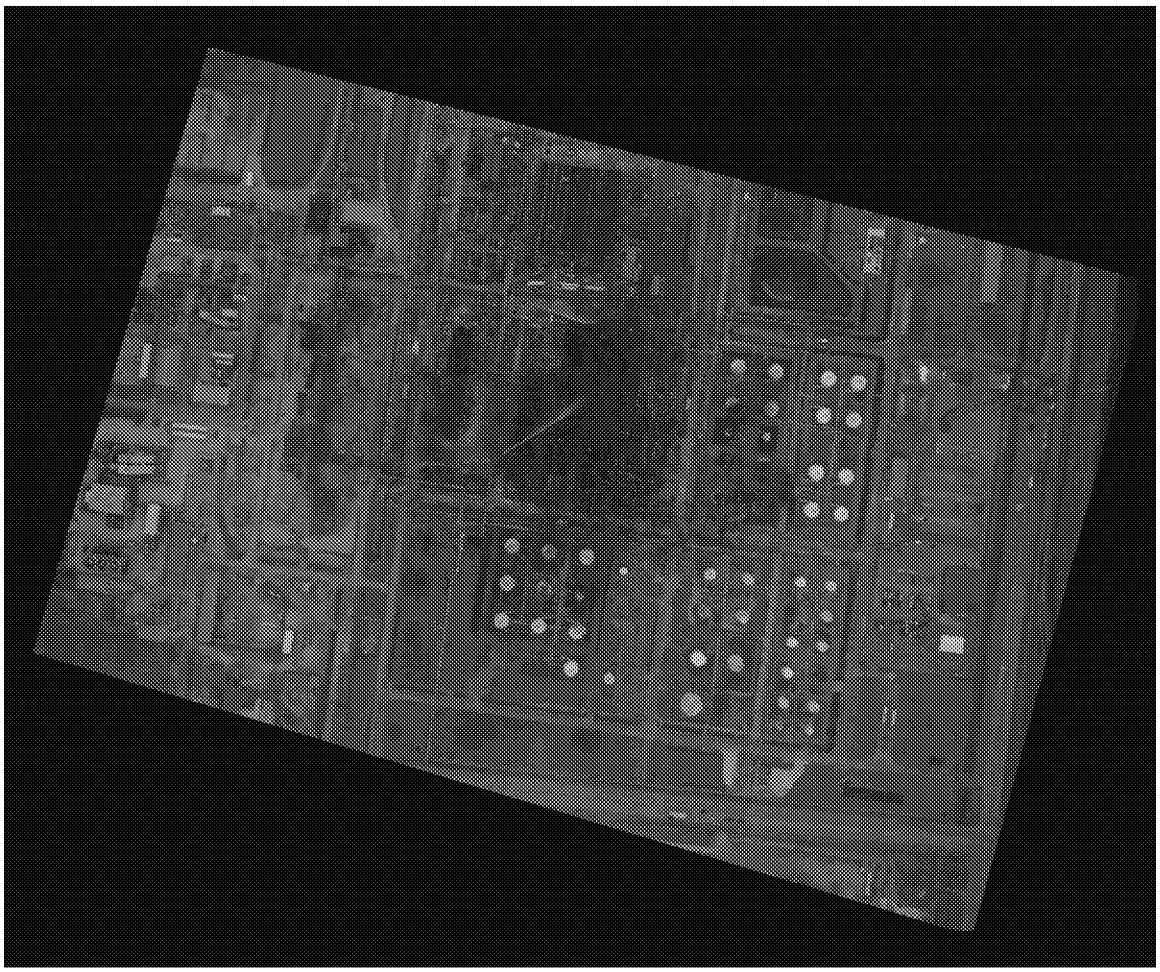

Figure 5: Aerial Image of the South 4Group Fire

Appendix A

Abbreviations:

DEM – Digital elevation model
Alt – Altitude (in feet)
MSL – Mean sea level altitude (in feet)
Digital – Digital photography file from the Nikon D2X camera
MSIC – Digital photography file from the Imperx mapping camera

FTIR – Spectral IR data collected with a Fourier Transform Infrared Spectrometer
IRLS – Infrared Line Scanner
Jpg – JPEG image format
UTC – Universal Time Coordinated
img – Spectral data format based on Grams format

```
Mission:   2019-11-30

Date:      11/30/2019
Time UTC: 20:60

Aircraft Number: N9738B
Pilot: Todd Seale
Copilot: James Glaviano
Operator: James Crisp
Aft Operator: Gerry Broyles
Ground Controller: Ahmed Hafez

DEM: Using elevation from DEM Database
-------------------------------------------------------------------

Run: 1 Time: 21:14:07 UTC
        Alt: 2499 ft MSL  Elev: -3 ft  Elevation from DEM Database
        Vel: 116 knots  Heading: 187

Digitals:  None
MSIC: 3
        20191130211412774.jpg
        20191130211419139.jpg
        20191130211426393.jpg
FTIR: 1
        20191130_211410_A.igm
IRLS: 1
        2019_11_30_21_14_11_R_01 TA=20.0;TB=40.0;Gain=3
Gamma Runs:  None

-------------------------------------------------------------------

Run: 2 Time: 21:16:52 UTC
        Alt: 2464 ft MSL  Elev: -4 ft  Elevation from DEM Database
        Vel: 149 knots  Heading: 27

Digitals:  None
MSIC: 3
        20191130211658010.jpg
        20191130211704359.jpg
        20191130211711622.jpg
FTIR: 1
        20191130_211654_A.igm
IRLS: 1
        2019_11_30_21_16_57_R_02 TA=14.2;TB=32.8;Gain=3
```

Gamma Runs: None

Run: 3 Time: 21:25:43 UTC
Alt: 2540 ft MSL Elev: 9 ft Elevation from DEM Database
Vel: 98 knots Heading: 261

Digitals: None
MSIC: 7
20191130212550025.jpg
20191130212556369.jpg
20191130212602737.jpg
20191130212609076.jpg
20191130212615433.jpg
20191130212621787.jpg
20191130212624514.jpg
FTIR: 1
20191130_212546_A.igm
IRLS: 1
2019_11_30_21_25_48_R_03 TA=10.6;TB=29.4;Gain=3
Gamma Runs: None

Run: 4 Time: 21:34:17 UTC
Alt: 2571 ft MSL Elev: 8 ft Elevation from DEM Database
Vel: 100 knots Heading: 198

Digitals: None
MSIC: 6
20191130213423873.jpg
20191130213430231.jpg
20191130213436580.jpg
20191130213442928.jpg
20191130213449290.jpg
20191130213456559.jpg
FTIR: 1
20191130_213421_A.igm
IRLS: 1
2019_11_30_21_34_23_R_04 TA=15.4;TB=35.4;Gain=3
Gamma Runs: None

Run: 5 Time: 21:42:49 UTC
Alt: 2482 ft MSL Elev: -4 ft Elevation from DEM Database
Vel: 107 knots Heading: 267

Digitals: None
MSIC: 5
20191130214254993.jpg
20191130214301354.jpg
20191130214308624.jpg

```
        20191130214314988.jpg
        20191130214321331.jpg
FTIR: 1
        20191130_214253_A.igm
IRLS: 1
        2019_11_30_21_42_54_R_05 TA=15.3;TB=35.3;Gain=3
Gamma Runs:  None

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Run: 6 Time: 21:51:24 UTC
        Alt: 2499 ft MSL  Elev: -4 ft  Elevation from DEM Database
        Vel: 104 knots  Heading: 272

Digitals:  None
MSIC: 8
        20191130215130680.jpg
        20191130215137035.jpg
        20191130215143386.jpg
        20191130215149744.jpg
        20191130215156093.jpg
        20191130215202458.jpg
        20191130215209711.jpg
        20191130215216076.jpg
FTIR: 2
        20191130_215128_A.igm
        20191130_215207_A.igm
IRLS: 1
        2019_11_30_21_51_29_R_06 TA=10.5;TB=29.9;Gain=3
Gamma Runs:  None


Mission Complete: 22:02 (UTC)
```