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

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 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 flight was requested over and downwind of the facility by Region 6. This report details results and information from that mission.

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 6 -- 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 (0700)	Surface (0800)	Surface (0900)
Wind direction	180 degrees	180 degrees	180 degrees
Wind speed	3.6 m/s (8 mph)	5.8 m/s (13 mph)	7.2 m/s (16 mph)
Temperature	22°C	22°C	24°C
Humidity	96%	94%	82%
Dew Point	21°C	21°C	21°C
Pressure	1012 mb	1012	1012
Ceiling	Clear	BKN 3100	Clear

The crew reported that winds at altitude (2800 ft) were at about 33 kts (9 m/s) from the southeast. Light grey smoke was being emitted from the facility with small fires visible.

Flight Status

Note that flights 1,2, and 3 were conducted on 27 November. On 28 November 2019 flight 4 was conducted but weathered out due to port conditions. On 29 November 2019 while transiting to the site, an attempt was made to see if enough of a clearing was available to collect data. This mission was labeled as flight 5 and did not result in any data due to a low ceiling. The order to launch flight 6 was given at 0630 central on 30 November 2019 with the aircraft reporting wheels up at 0635. The initial data collection run over the site was at 0754 (central) The aircraft made a total of 8 data collection passes; 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 9 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 was generated by flying approximately directly over the facility on a northerly flight path. The color of the image is a result of the blackbody settings and generally shows greatly reduced thermal content from prior flights. Figure 4 shows a close-up of the facility. The white content of the image shows the hottest targets which corresponds to reactors,

piping, and tanks within the production unit. Close examination of the image does show the presence of water streams directed into the unit. There does not appear to be any plumes leaving the site.

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.

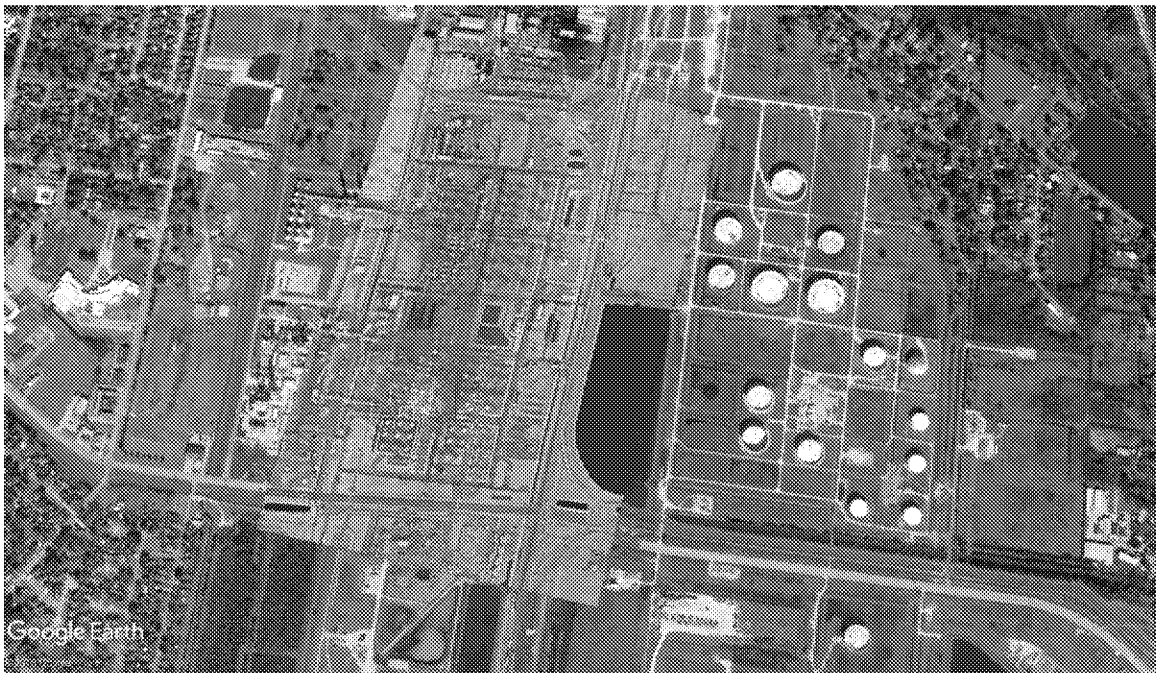

Figure 3: – 3 band IR image, Run 8, South 4 Group Fire

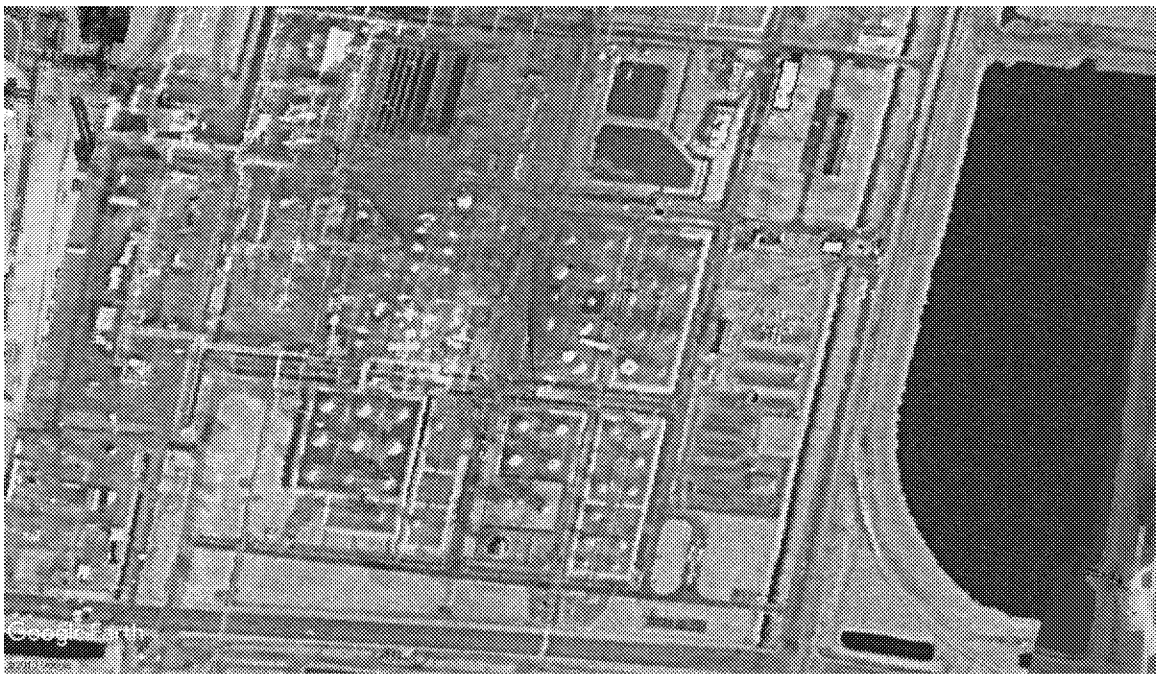

Figure 4: -- 3 band IR Image, Run 8, South 4 Group Fire Closeup

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	1340	Test	Test
2		1342	Test	Test
3		1354	ND	None
4		1410	ND	None
5		1424	ND	None
6		1430	ND	None
7		1436	ND	None
8		1443	ND	None
9		1449	ND	None
10		1500	ND	None
11		1506	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. The confirms finding from IR analysis that the active fires at the facility appear to be suppressed. In addition to damage at the reactor area, several spherical tanks to the east of the unit appear to be damaged. Light grey smoke can be seen leaving the site. Figure 6 shows a representative oblique collected from the copilot station. This image clearly shows damage to the reactor columns as brown looking discoloration to the structure. Mist from the water jets clearly shows that a brisk wind is blowing from the south pushing a light smoke plume to the north.

Conclusions – Flight 6

On 30 November 2019 ASPECT collected aerial remote sensing data over the South 4 Group facility located near Port Neches, TX. Analysis of FTIR data did not show any chemical detections. IR image analysis showed the presence of elevated temperatures within the reactor complex, but the magnitude was substantially reduced from prior missions. Visible imagery showed only a light grey plume being generated at the facility with no active fires immediately visible. Damage to the facility and nearby spherical tanks is clearly evident in the aerial and obliques images.

Figure 5: Aerial Image of the South 4Group Fire

Figure 6: Oblique Image of the South 4 Group 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 Port Neches

Date: 11/30/2019

Time UTC: 13:22

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: 13:40:51 UTC

Alt: 2559 ft MSL Elev: 0 ft Elevation from DEM Database

Vel: 142 knots Heading: 308

Digitals: None

MSIC: 3

20191130134057414.jpg

20191130134103764.jpg

20191130134110129.jpg

FTIR: 1

20191130_134054_A.igm

IRLS: None

Gamma Runs: None

Run: 2 Time: 13:42:36 UTC

Alt: 2554 ft MSL Elev: 0 ft Elevation from DEM Database

Vel: 146 knots Heading: 134

Digitals: None

MSIC: 3

20191130134242733.jpg

20191130134249098.jpg

20191130134255448.jpg

FTIR: 1

20191130_134239_A.igm

IRLS: None

Gamma Runs: None

Run: 3 Time: 13:54:53 UTC

Alt: 2553 ft MSL Elev: 9 ft Elevation from DEM Database

Vel: 106 knots Heading: 276

Digitals: None

MSIC: 6

20191130135459975.jpg

20191130135506340.jpg

20191130135512689.jpg

20191130135519038.jpg

20191130135525403.jpg

20191130135529943.jpg

FTIR: 1

20191130_135457_A.igm

IRLS: 1

2019_11_30_13_54_58_R_03 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 4 Time: 14:10:05 UTC

Alt: 2578 ft MSL Elev: 9 ft Elevation from DEM Database

Vel: 105 knots Heading: 280

Digitals: None

MSIC: 8

20191130141011536.jpg

20191130141017885.jpg

20191130141024250.jpg

20191130141030600.jpg

20191130141037869.jpg

20191130141044219.jpg

20191130141050584.jpg

20191130141052393.jpg

FTIR: 2

20191130_141009_A.igm

20191130_141048_A.igm

IRLS: 1

2019_11_30_14_10_10_R_04 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 5 Time: 14:24:12 UTC

Alt: 2648 ft MSL Elev: 9 ft Elevation from DEM Database

Vel: 105 knots Heading: 274

Digitals: None

MSIC: 7

20191130142418632.jpg

20191130142424982.jpg

20191130142431346.jpg

20191130142437696.jpg

20191130142444045.jpg

20191130142450410.jpg

20191130142454950.jpg

FTIR: 1

20191130_142416_A.igm

IRLS: 1

2019_11_30_14_24_17_R_05 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 6 Time: 14:30:07 UTC

Alt: 2549 ft MSL Elev: 8 ft Elevation from DEM Database

Vel: 97 knots Heading: 261

Digitals: None

MSIC: 10

20191130143012724.jpg

20191130143019073.jpg

20191130143026343.jpg

20191130143032692.jpg

20191130143039043.jpg

20191130143045407.jpg

20191130143051757.jpg

20191130143058122.jpg

20191130143104471.jpg

20191130143110820.jpg

FTIR: 2

20191130_143010_A.igm

20191130_143049_A.igm

IRLS: 1

2019_11_30_14_30_12_R_06 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 7 Time: 14:36:45 UTC

Alt: 2506 ft MSL Elev: 7 ft Elevation from DEM Database

Vel: 114 knots Heading: 340

Digitals: None

MSIC: 6

20191130143651299.jpg

20191130143657648.jpg

20191130143704013.jpg

20191130143710362.jpg

20191130143716727.jpg

20191130143721251.jpg

FTIR: 1

20191130_143649_A.igm

IRLS: 1

2019_11_30_14_36_50_R_07 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 8 Time: 14:43:38 UTC

Alt: 2577 ft MSL Elev: 8 ft Elevation from DEM Database

Vel: 102 knots Heading: 196

Digitals: None

MSIC: 5

20191130144344403.jpg

20191130144351666.jpg

20191130144358016.jpg

20191130144404381.jpg

20191130144410730.jpg

FTIR: 1

20191130_144341_A.igm

IRLS: 1

2019_11_30_14_43_43_R_08 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 9 Time: 14:49:27 UTC

Alt: 2559 ft MSL Elev: 8 ft Elevation from DEM Database

Vel: 100 knots Heading: 195

Digitals: None

MSIC: 5

20191130144933036.jpg

20191130144939401.jpg

20191130144945751.jpg

20191130144953020.jpg

20191130144959370.jpg

FTIR: 1

20191130_144931_A.igm

IRLS: 1

2019_11_30_14_49_32_R_09 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 10 Time: 15:00:04 UTC

Alt: 2648 ft MSL Elev: 9 ft Elevation from DEM Database

Vel: 102 knots Heading: 262

Digitals: None

MSIC: 11

20191130150010394.jpg

20191130150016759.jpg

20191130150023109.jpg

20191130150029473.jpg

20191130150035823.jpg

20191130150042172.jpg

20191130150048537.jpg

20191130150054886.jpg

20191130150101251.jpg

20191130150107600.jpg

20191130150109410.jpg

FTIR: 2

20191130_150007_A.igm

20191130_150046_A.igm

IRLS: 1

2019_11_30_15_00_09_R_10 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Run: 11 Time: 15:06:00 UTC

Alt: 2498 ft MSL Elev: 7 ft Elevation from DEM Database

Vel: 106 knots Heading: 263

Digitals: None

MSIC: 7

20191130150607209.jpg

20191130150613574.jpg

20191130150619924.jpg

20191130150626273.jpg

20191130150632638.jpg

20191130150638987.jpg

20191130150645336.jpg

FTIR: 1

20191130_150604_A.igm

IRLS: 1

2019_11_30_15_06_06_R_11 TA=19.0;TB=39.0;Gain=3

Gamma Runs: None

Mission Complete: 15:15 (UTC)