# Field Report for Airborne Data Collected In Support of US EPA Region 6 South 4 Group Fire 07 December 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 6 requested that the ASPECT system be deployed to provide monitoring support beginning on 27 November 2019. This report summarizes findings observed during the mission flown on 07 December 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 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 was clear in the aerial and obliques images.

ASPECT conducted two flights on 01 December 2019. Analysis of IR imagery collected during the morning flight on 01 December 2019 indicated that isolated elevated thermal locations still exist within the production unit. Visible imagery confirmed that crew reports of light gray smoke was being emitted from the facility and was moving in an easterly direction. FTIR data collected in the vicinity of the facility showed one detection of isobutylene near the Orchard Ave bridge. The estimated concentration was about 1 ppm. Analysis of IR imagery of the junction of the waterway east of the facility which intersects with the Naches River showed no evidence of oil sheen. The afternoon showed a low thermal environment within the process unit and minimal smoke being emitted from the site. The analysis of imagery showed that four water cannons were being employed at the facility. IR imagery did not show any oil sheen presence on the Neches River. Analysis of FTIR data showed detections of isobutylene south of the facility near the wastewater treatment plant. These detections were approximately 1.7 ppm on two separate passes.

Analysis of IR imagery collected during the morning flight on 02 December 2019 indicated that very little thermal content was present in the process unit other than one fire on the north side of the unit. Visible imagery showed one water cannon in operation and light gray smoke being emitted from the facility due to the one fire. There were no chemical detections in the proximity of the facility. Analysis IR imagery of the junction of the waterway east of the facility which intersects with the Naches River showed no evidence of oil sheen. Flight 11 conducted on the afternoon of 02 December 2019 showed one fire on the northern edge of the process unit. A light gray smoke plume was still being emitted and at the time of the flight moving toward the southeast. Several of the reactor towers tended to show elevated temperatures as compared to the surrounding unit. IR imagery did not show any oil sheen presence on the Neches River but did

suggest that water flow is going into the river. Analysis of FTIR data showed detections of isobutylene south of the facility near the wastewater treatment plant. These detections were approximately 1.57 ppm on two separate passes.

Analysis of IR imagery collected during the morning flight on 03 December 2019 showed no high temperature locations suggesting that no fire was present in the process unit. Overhead visible imagery showed at the time of collection one cannon directed on the northern portion of the unit. Oblique imagery showed 5 cannons being used over a large portion of the facility. No smoke was observed by either the crew or analysis of imagery. There were no chemical detections in the proximity of the facility. Analysis IR imagery of the junction of the waterway east of the facility which intersects with the Naches River showed on evidence of oil sheen. Data collected on the afternoon flight did show the presence of 1,3-butadiene and aromatics 1300 meters west of the facility. Detected levels were approximately 0.93 ppm for 1,3-butadiene and less than 1 ppm for aromatics.

Analysis of IR imagery collected during the morning flight on 04 December 2019 showed no elevated temperature sources other than local solar heating of metal surfaces. Analysis of imagery showed no indication of an active fire. Aerial imagery showed one cannon being employed to spray a spherical tank south of the production unit. No smoke or emissions were detected in any imagery. Analysis of FTIR data showed no detections over and in the vicinity of the facility. Data collected on the afternoon 04 December 2019 indicated what appears to be solar heating of metal surfaces in the process unit and no signature of smoke or chemical emissions being generated by the process unit. Water cannons were observed on both flights with a spray being directed to a spherical tank south of the facility. Analysis of IR imagery collected at the confluence of the waterway and the Naches River showed no sheen signature.

Analysis of IR imagery collected during the morning flight on 05 December 2019 showed no elevated temperature sources within the process unit. 5 water cannons were visible in all imagery. On data collection line 4, very low levels of ethylene (0.522 ppm) were detected in two spectra. No other chemical detections were made during the mission. Analysis of IR imagery at the confluence of the drainage waterway and the Naches River showed no oil sheen signature. Data collected on the afternoon of 05 December 2019 showed no elevated temperature sources other than solar heating of tanks and metal surfaces. No chemical detections were made on the afternoon flight. Analysis of afternoon IR imagery at the confluence of the drainage waterway and the Naches River showed no oil sheen signature on either mission.

IR imagery collected during the flight on 06 December 2019 showed no elevated temperature sources within the process unit and the absence of water cannon. No emissions were observed in any data and no chemical detections were noted on any of the data collection passes. Analysis of IR imagery at the confluence of the drainage waterway and the Naches River and a smaller waterway showed no oil sheen signatures.

As part of the continuing South 4 Group fire response, ASPECT was requested by Region 6 to conduct a data collection flight downwind, upwind, up the wind axis in reference to the facility and over adjacent residential areas and the waterways leading to the Neches River. This report details results and information from those missions.

**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 Results for Flight 19, 07 December 2019

### Weather Conditions and Crew Report

Weather for the morning mission are given in table 1.

**Table 1. South 4 Group Mission Weather**

| Parameter | Surface (1200) | Surface (1300) |
|---|---|---|
| Wind direction | 000 degrees | 000 degrees |
| Wind speed | 4.9 m/s (7 mph) | 4.0 m/s (9 mph) |
| Temperature | 19.4°C | 21.1°C |
| Humidity | 52% | 53% |
| Dew Point | 11.1°C | 11.1°C |
| Pressure | 1024 mb | 1023 mb |
| Ceiling | Clear | Clear |

The crew reported that winds at altitude (2800 ft) were 15 kts (7.7 m/s) from 016 degrees. There was no visible plume leaving or reported activity at the site.

### Flight Status

The order to launch flight 18 was given at 1200 central on 7 December 2019 with the aircraft reporting wheels up at 1210. The initial data collection run over the site was at 1241 (central) The aircraft made a total of 9 data collection passes; flight information is summarized in Appendix Flight #18 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.

#### Line Scanner Data Results

A total of 1 test and 9 data collection passes were made in the proximity of the facility 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 5. The image shows a flat thermal environment for the process unit other than heating due to solar radiation. No plume is present in the image. To assess possible oil sheen presence on the Naches River and a nearby drainage channel, ASPECT collected IR data along the drainage waterways; no oil sheen signatures were detected (figures 4 and 5).

### 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.

On data collection Run 3, isobutylene was detected at a maximum concentration of 1.63 ppm about 550 meters Southwest of the facility (figure 6). At the time of collection, winds were from the North. To further assess this detection, a line was flown between Run 2 and Run 3 which showed no detections. The wind direction during this collection was also from the north. A summary of data of the data collection is given in table 3.

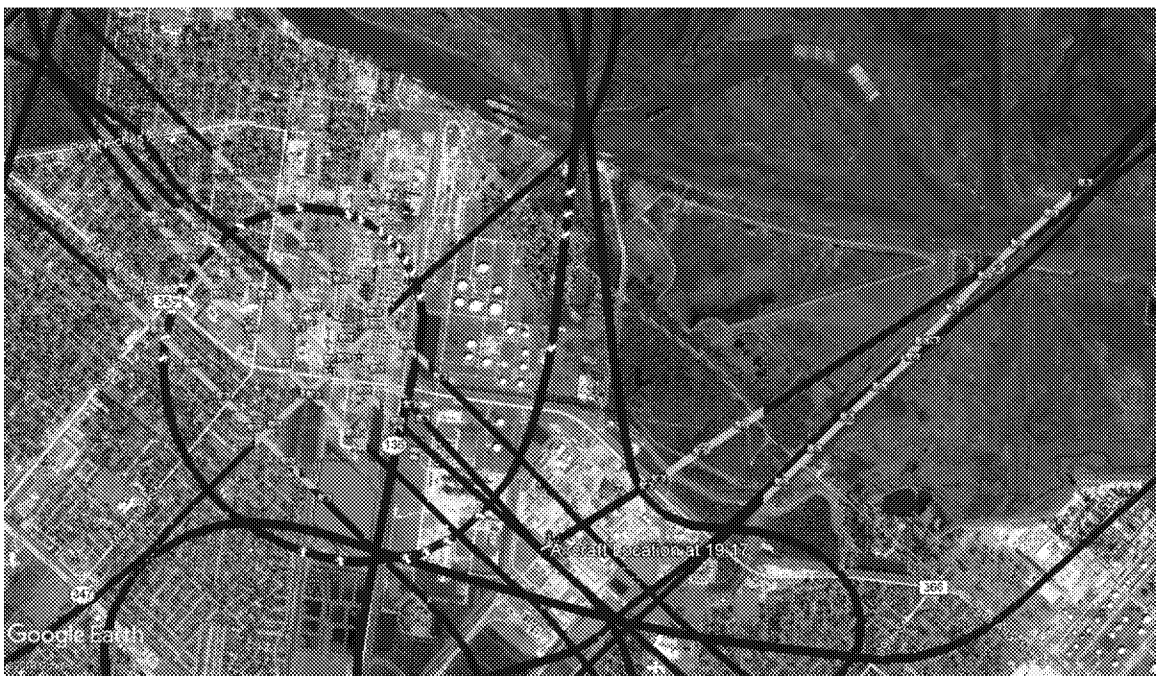


Figure 2: Data collection passes, Flight 19, South 4 Group Fire, Port Neches, TX. The blue lines represent the ASPECT flight path, green lines represent when the FTIR was actively collecting data, the yellow icons with star is the centroid of the line scanner image, and the camera icons represent when a photo was taken.

Figure 3: – 3 band IR image, Flight 19, Run 5, South 4 Group Fire

Figure 4: -- 3 band IR Image, Flight 19, Run 9, South 4 Group Naches River Confluence

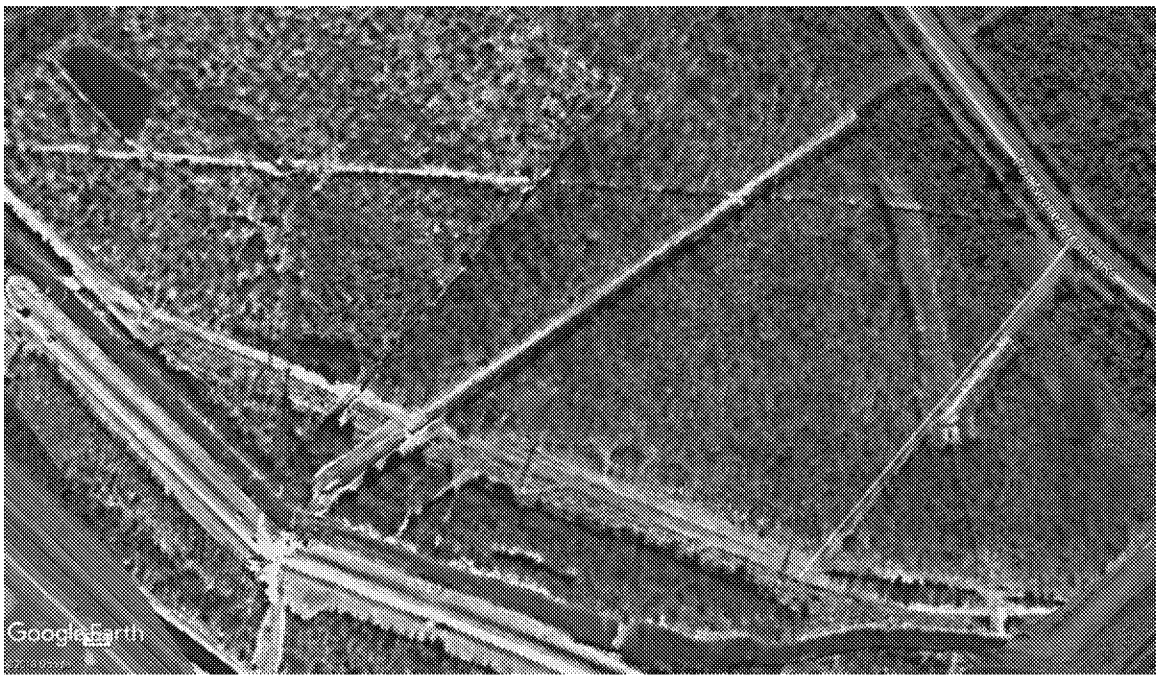

Figure 5: -- 3 band IR Image, Flight 19, Run 10, South 4 Group Waterway Image

**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 |

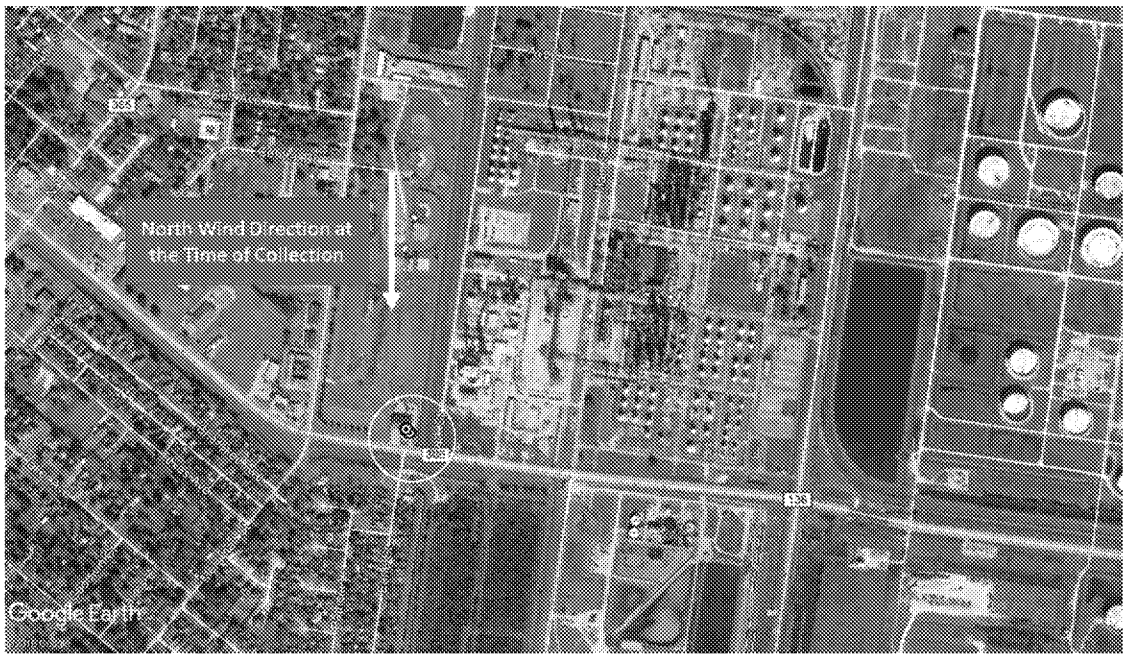

Figure 6: -- Isobutylene Detection, Flight 19, Run 3, South 4 Group Waterway Image

**Table 3. Chemical Results Summary**

| Run | Date | Time (UTC) | Chemical | Max Concentration ppm |
|---|---|---|---|---|
| 1 | 07 Dec 2019 | 1813 | Test | Test |
| 2 | | 1828 | ND | None |
| 3 | | 1832 | Isobutylene | 1.63 |
| 4 | | 1837 | ND | None |
| 5 | | 1842 | ND | None |
| 6 | | 1848 | ND | None |
| 7 | | 1857 | ND | None |
| 8 | | 1903 | ND | None |
| 9 | | 1911 | ND | None |
| 10 | | 1917 | 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 7 and 8 show representative views of the process unit. No emissions are visible in these images. In addition, the images and crew reports indicated that no water cannon was in use.

**Conclusions – Flight 19**

Analysis of IR imagery collected during the morning flight on 7 December 2019 showed no elevated temperature sources within the process unit and the absence of water cannon. No emissions were observed in any imagery. Isobutylene at an approximate concentration of 1.63 ppm was detected 550 meters to the southwest of the facility. At the time of collection, the winds were from the north. Analysis of IR imagery at the confluence of the drainage waterway and the Naches River and a smaller waterway showed no oil sheen signatures.

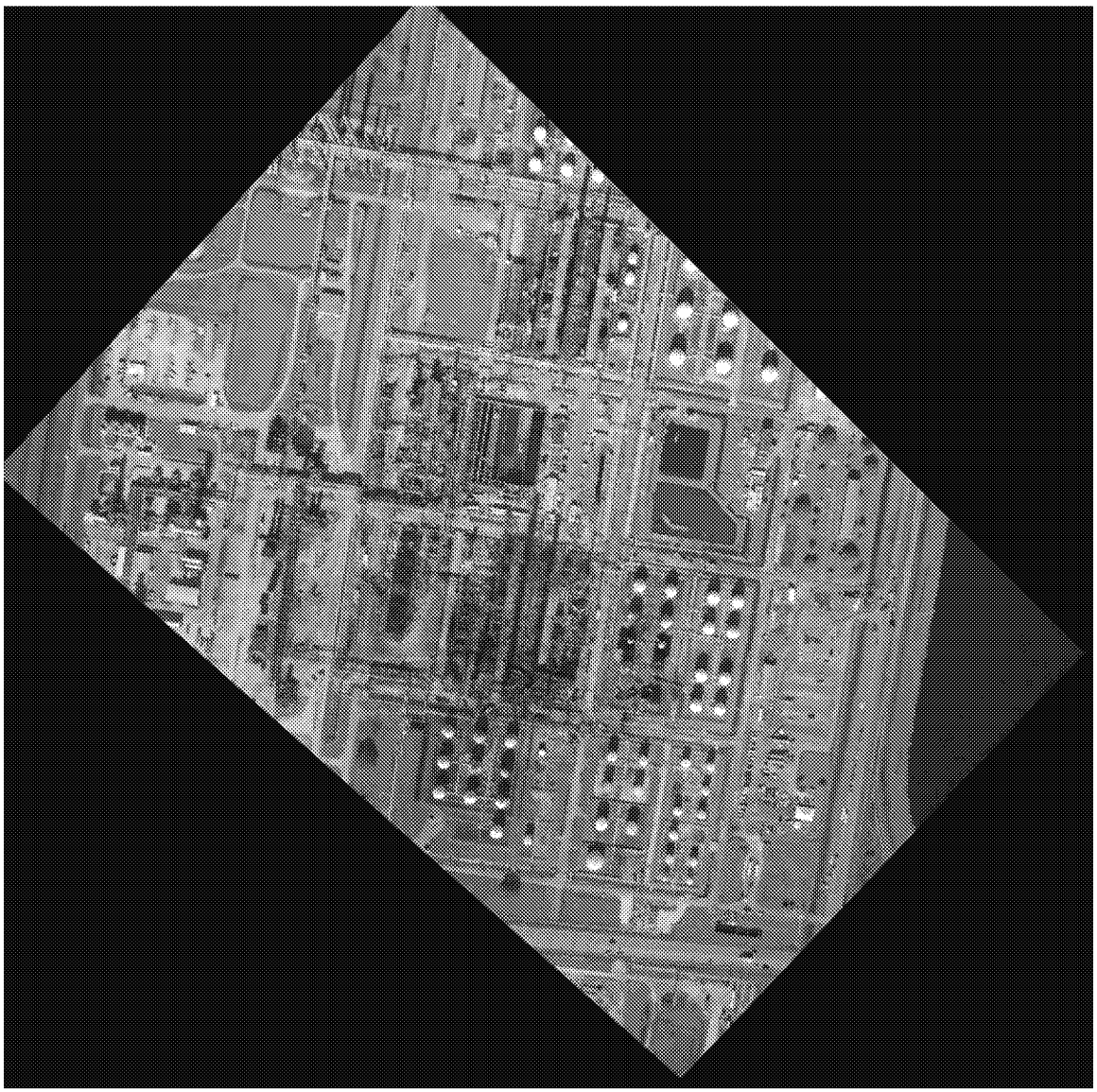

Figure 6: Aerial Image, Flight 19 South 4 Group Fire.

Figure 7: Oblique Image, Flight 18 South 4 Group Fire

Appendix Flight #19

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:  2019-12-07 South 4 Group Fire

Date:  12/7/2019
Time UTC: 18:07

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
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Run: 1 Time: 18:13:54 UTC
Alt: 2781 ft MSL  Elev: 4 ft  Elevation from DEM Database
Vel: 158 knots  Heading: 273

Digitals:  None
MSIC: 3
20191207181400639.jpg
20191207181406988.jpg
20191207181413337.jpg
FTIR: 1
20191207_181400_A.igm
IRLS: 1
2019_12_07_18_13_59_R_01 TA=16.0;TB=35.9;Gain=3
Gamma Runs:  None

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Run: 2 Time: 18:28:03 UTC
Alt: 2784 ft MSL  Elev: 7 ft  Elevation from DEM Database
Vel: 96 knots  Heading: 125

Digitals:  None
MSIC: 5
20191207182809488.jpg
20191207182815852.jpg
20191207182822201.jpg
20191207182829471.jpg
20191207182832185.jpg
FTIR: 1
20191207_182806_A.igm
IRLS: 1
2019_12_07_18_28_08_R_02 TA=16.0;TB=36.0;Gain=3
Gamma Runs:  None

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Run: 3 Time: 18:32:14 UTC
Alt: 2906 ft MSL Elev: 9 ft Elevation from DEM Database
Vel: 105 knots Heading: 325

Digitals: None
MSIC: 7
20191207183220060.jpg
20191207183227329.jpg
20191207183233678.jpg
20191207183240043.jpg
20191207183246392.jpg
20191207183252756.jpg
20191207183259105.jpg
FTIR: 2
20191207_183217_A.igm
20191207_183256_A.igm
IRLS: 1
2019_12_07_18_32_18_R_03 TA=18.9;TB=38.9;Gain=3
Gamma Runs: None

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Run: 4 Time: 18:37:01 UTC
Alt: 2803 ft MSL Elev: 8 ft Elevation from DEM Database
Vel: 103 knots Heading: 125

Digitals: None
MSIC: 7
20191207183707865.jpg
20191207183714214.jpg
20191207183720579.jpg
20191207183726928.jpg
20191207183733277.jpg
20191207183739641.jpg
20191207183746895.jpg
FTIR: 2
20191207_183706_A.igm
20191207_183743_A.igm
IRLS: 1
2019_12_07_18_37_06_R_04 TA=19.1;TB=39.1;Gain=3
Gamma Runs: None

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Run: 5 Time: 18:42:24 UTC
Alt: 2836 ft MSL Elev: 7 ft Elevation from DEM Database
Vel: 100 knots Heading: 43

Digitals: None
MSIC: 4
20191207184230167.jpg

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        20191207184236516.jpg
        20191207184243785.jpg
        20191207184250134.jpg
FTIR: 1
        20191207_184227_A.igm
IRLS: 1
        2019_12_07_18_42_28_R_05 TA=18.6;TB=38.6;Gain=3
Gamma Runs:  None

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Run: 6 Time: 18:48:40 UTC
        Alt: 2745 ft MSL  Elev: 9 ft  Elevation from DEM Database
        Vel: 105 knots  Heading: 125

Digitals:  None
MSIC: 7
        20191207184846024.jpg
        20191207184852373.jpg
        20191207184859642.jpg
        20191207184905991.jpg
        20191207184912356.jpg
        20191207184918705.jpg
        20191207184925054.jpg
FTIR: 2
        20191207_184843_A.igm
        20191207_184922_A.igm
IRLS: 1
        2019_12_07_18_48_45_R_06 TA=18.5;TB=38.5;Gain=3
Gamma Runs:  None

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Run: 7 Time: 18:57:04 UTC
        Alt: 2785 ft MSL  Elev: 8 ft  Elevation from DEM Database
        Vel: 103 knots  Heading: 123

Digitals:  None
MSIC: 7
        20191207185710798.jpg
        20191207185717163.jpg
        20191207185723512.jpg
        20191207185729877.jpg
        20191207185736226.jpg
        20191207185742575.jpg
        20191207185748939.jpg
FTIR: 2
        20191207_185708_A.igm
        20191207_185747_A.igm
IRLS: 1
        2019_12_07_18_57_09_R_07 TA=19.2;TB=39.2;Gain=3
Gamma Runs:  None

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Run: 8 Time: 19:03:50 UTC
        Alt: 2837 ft MSL  Elev: 2 ft  Elevation from DEM Database
        Vel: 101 knots  Heading: 44

Digitals:  None
MSIC: 6
        20191207190356624.jpg
        20191207190402989.jpg
        20191207190409338.jpg
        20191207190415702.jpg
        20191207190422051.jpg
        20191207190425686.jpg
FTIR: 1
        20191207_190354_A.igm
IRLS: 1
        2019_12_07_19_03_55_R_08 TA=19.3;TB=39.3;Gain=3
Gamma Runs:  None

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Run: 9 Time: 19:11:26 UTC
        Alt: 2838 ft MSL  Elev: 0 ft  Elevation from DEM Database
        Vel: 100 knots  Heading: 43

Digitals:  None
MSIC: 6
        20191207191132385.jpg
        20191207191138749.jpg
        20191207191145099.jpg
        20191207191151448.jpg
        20191207191157812.jpg
        20191207191204161.jpg
FTIR: 1
        20191207_191129_A.igm
IRLS: 1
        2019_12_07_19_11_30_R_09 TA=15.3;TB=35.3;Gain=3
Gamma Runs:  None

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Run: 10 Time: 19:17:05 UTC
        Alt: 2773 ft MSL  Elev: 7 ft  Elevation from DEM Database
        Vel: 110 knots  Heading: 241

Digitals:  None
MSIC: 4
        20191207191711023.jpg
        20191207191717388.jpg
        20191207191723737.jpg
        20191207191725563.jpg
FTIR: 1
        20191207_191708_A.igm
IRLS: 1
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2019_12_07_19_17_09_R_10 TA=10.6;TB=30.3;Gain=3
Gamma Runs: None