Field Report for Airborne Data Collected In Support of US EPA Region VI Intercontinental Terminals Company LLC Fire 22 March 2019

Background

On 17 March 2019 a large fire was reported at the Intercontinental Terminals Company LLC (ITC) located in Deer Park, TX. Local reports indicate that the fire started at about 1030 local in an 80,000 barrel (capacity) tank storing naphtha. The ITC facility is located on the southern shore of the Houston ship channel in the City of Deer Park, TX. The geographical coordinates of the facility are 19.7322N, 95.1236W (figure 1).

The material reported in the fire is Naphtha. Naphtha is generally composed of either the first or second sequence of distillate obtained during primary distillation. Light naphtha is composed of light fraction straight chain and simple aromatics, typically less than 6 carbons while heavy naphtha consist of larger compounds (C6 plus) which normally is used as feed for catalytic cracking. Since the fraction of Naphtha is crude dependent, there is not a simple formula for the material.

The US EPA Region VI requested that the ASPECT system be deployed to provide monitoring support on 17 March 2019 and ASPECT completed a 7 pass mission at 1847 local. Acetone was detected on the first 2 passes (data collection 3 and 4) which were near the fire at a concentration estimated below 1 ppm (0.154 ppm and 0.357 ppm, respectively). No other compounds were detected.

ASPECT conducted a second flight over the facility on 18 March 2019. Analysis of IR data confirmed reports that the fire had expanded to multiple tanks. Specifically, the thermal signature of the fire and resulting heated air plume was measurably larger than that observed in the first flight. Crew reports indicated that the plume rise was still active with the lofted plume occupying a region between 2000 and 6500 feet above ground with movement to the west. Spectral analysis of FTIR data indicated that compounds including 1-butene, 2-butene, isoprene, and acetone were detected primarily in a downwind portion of the plume with the highest values being just above 1 ppm.

ASPECT conducted a third flight over the ITC fire on 19 March 2019. Analysis of data indicated that the fire had grown as evident by the larger thermal signature and direct confirmation from aerial images. Plume geometry was assessed with the aircraft with findings showing the plume was about 47 miles in length, 17 miles wide at the largest extent and ranged in altitude from a floor of 1500 feet to a ceiling of 5000 feet. No chemical detections were reported on this flight.

ASPECT conducted a fourth flight over the ITC fire on 20 March 2019. Analysis of data indicated that the fire had been extinguished. Analysis of FTIR data showed detections of acetone and SO_2 to west of the farm and isobutylene and isoprene south of the farm. All concentrations were detected below 1 ppm.

Due to reports of vapors observed in the Deer Park vicinity ASPECT was requested to fly a fifth mission on 21 March 2019 near the impacted tank farm, and locations in Deer Park, La Porte, Galena Park and Jacinto City. Analysis of data showed normal temperatures within the farm and low levels of typical compounds within the urban atmosphere. Detected compounds included acetone and isobutylene at concentrations at or below 1 ppm.

As part of a general environmental surveillance methodology was requested to fly a sixth mission on 22 March 2019 to monitor for VOC in the downwind areas from the impacted tank farm. Later in the day, Region 6 ER requested that photo be collected of a possible secondary containment breach of the impacted tank farm. This report summaries those measurements.

Figure 1: ITC, Deer Park, TX

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

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 have the ability to 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 sufficient 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 at a later time.

All aerial photographic images collected by the ASPECT system are ortho-rectified and geospatially validated by the reachback 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 reachback team for QA/QC analysis. Upon landing preliminary data results are examined and validated by the reachback team.

Data Results Flight 6 7, 8 and 9 22 March 2019

Weather Conditions and Crew Report

Weather for the mission is given in table 1. The crew reported that winds at flight level (2800 ft) were generally from the NE at about 10 kts (5 m/s). Turbulence was moderate. No significant activity observed flights 6 and 7. During flight 8 foam and oil was observed traveling down the creek and then entering the channel. A contaminate boom was holding most but some was getting past the barrier.

Table 1. ITC Fire Mission Weather 22 March 2019

Parameter	Surface (0915)	Surface (1430)
Wind direction	180 degrees	030 degrees
Wind speed	0.5 m/s	2.7 m/s
Temperature	16.6ºC	27.2ºC

Humidity	87%	30%
Dew Point	13ºC	9ºC
Pressure	1023 mb	1021 mb
Ceiling	Not Reported	Not Reported

The order to launch the aircraft was given at 0630 local on 22 March 2019 and the aircraft was airborne at 0721. The initial data collection run over the site was at 0727 (local) and the aircraft made a total of 6 data collection passes. At the completion of the final pass, the aircraft was returned to the airport to test a system. At approximately 0830 the aircraft returned and conducted additional collection over the tank farm and area north of the site. No detections were observed.

At 1230 ASPECT was dispatched to image potential discharges from the tank farm secondary containment. The aircraft was airborne at 1240 and was collecting data at 1306. A total of 4 data passes were collected in the immediate vicinity of the farm and drainage system. Low level detections of acetone and 1,3-butadiene were made in the area. Finally, due to a report that a fire had started in the tank farm, ASPECT was dispatched to collect imagery and chemical data in the area associated with the potential fire. The aircraft was airborne at 1547 and 1553 the first set of data was collected. Flight information is summarized in Appendix A and Figure 2A, 2B, 2C, and 2D.

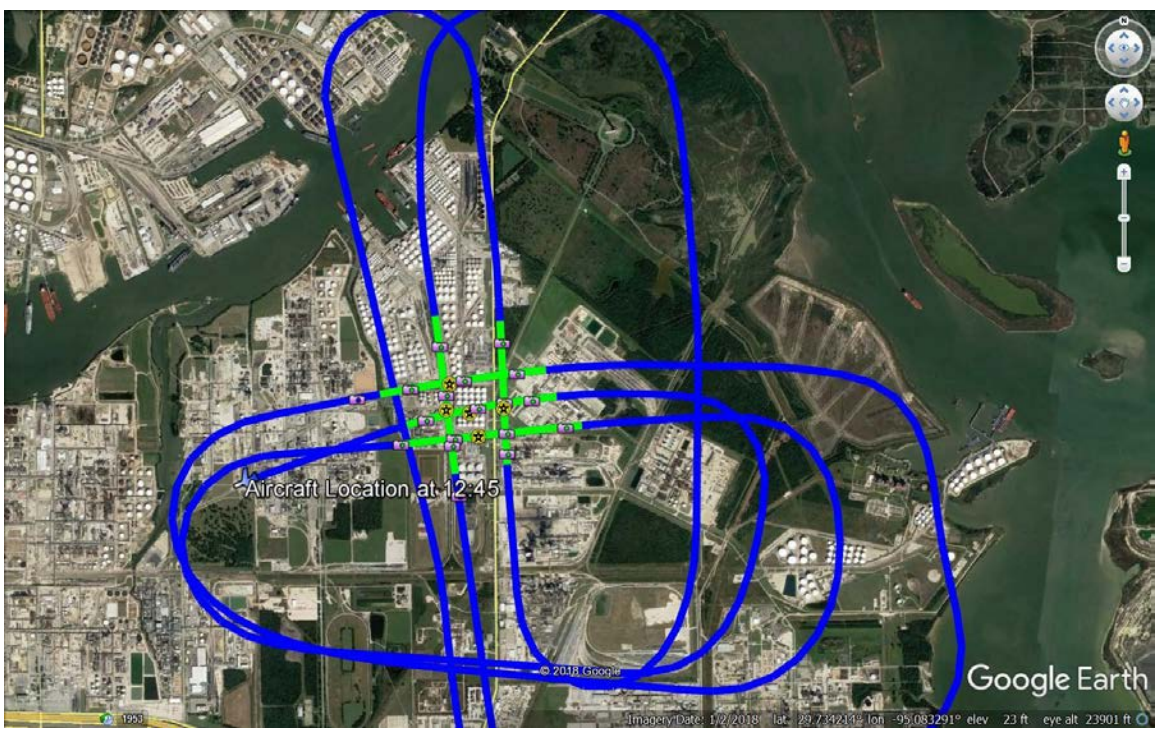

Figure 2A: Flight line data for 22 March 2019, Flight 6. The blue lines represent the ASPECT flight path, green lines represent when the Infrared Line Scanner was actively collecting data, and the camera icons represent when a photo was taken.

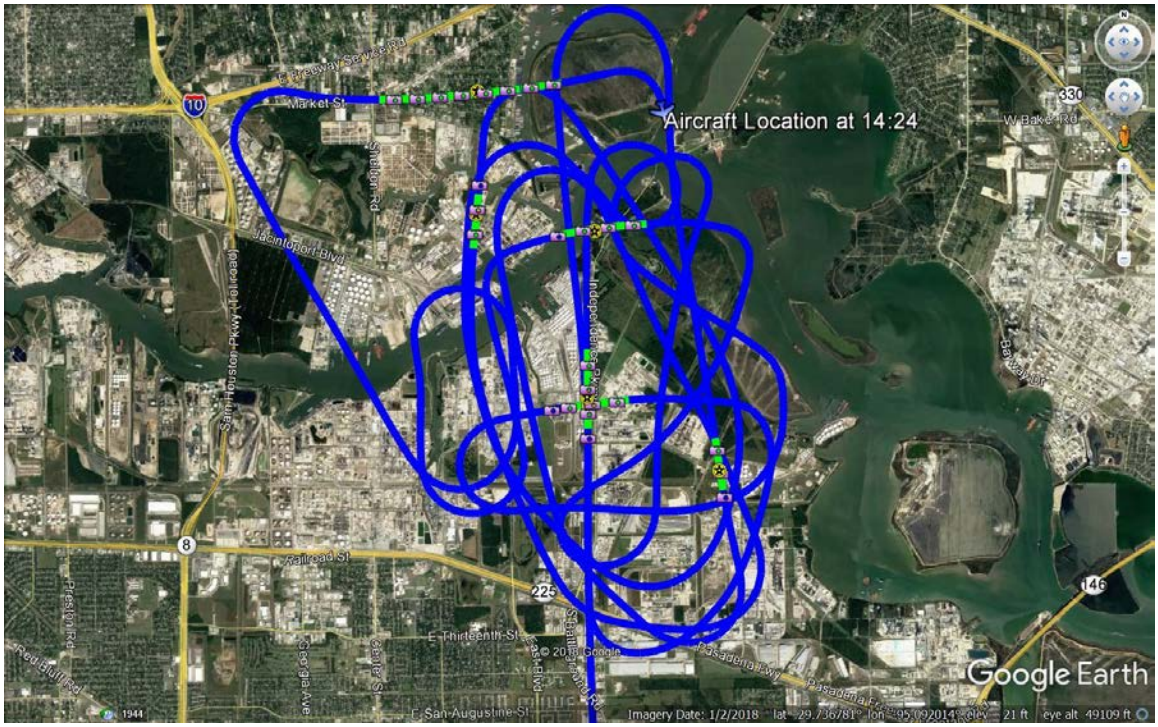

Figure 2B: Flight line data for 22 March 2019, Flight 7.

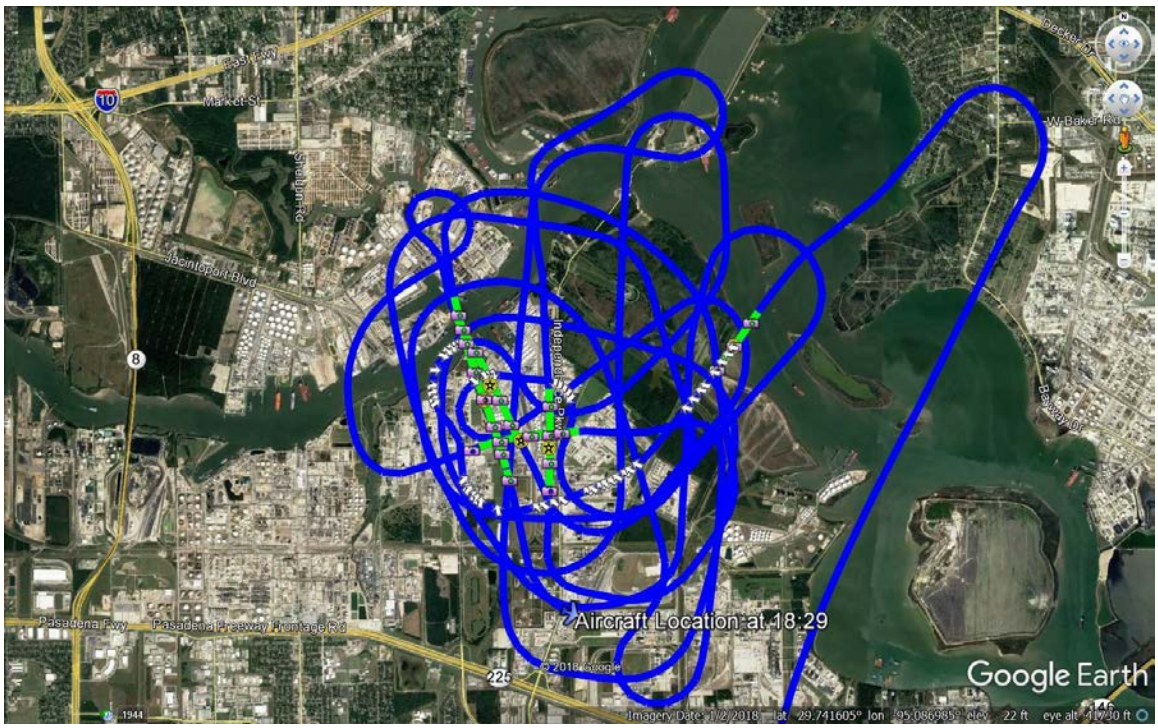

Figure 2C: Flight line data for 22 March 2019, Flight 8.

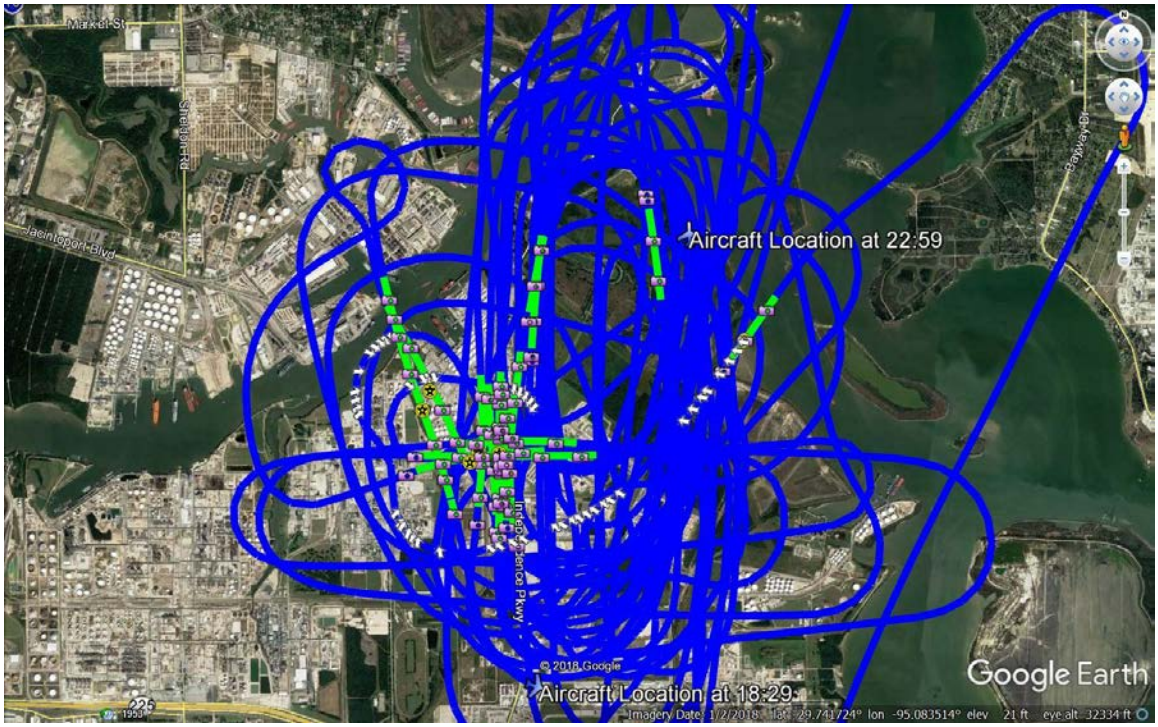

Figure 2D: Flight line data for 22 March 2019, Flight 9.

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 4 test and 17 data passes were made in the proximity of the impacted tank farm and also in extended areas surrounding the site and infrared line scanner images were generated for each pass. Figure 3 shows a typical 3-band infrared image obtained from data collected for Run 5. Examination of the IR image shows the tank farm with a black color within the secondary containment. This is actually white foam which is cooler than the surrounding oil and environment. A thermal analysis was conducted on a similar image with the results given in Figure 4 and tends to show that the tanks on the western end are actually the hottest with the NW tank consistently showing an elevated temperature remotely estimated to be about 70ºC.

Fights 8 and 9 were prompted by a report that secondary containment had failed at the tank farm. Figure 5 shows an image collected along the drainage channel leading the ship channel. A white signature substance can be seen being trapped at the confluence of

the drainage channel. Again the image is effectively showing a thermal signature so the while color is warmer than the black which is cooler; the oil is trapping solar radiation and heating up while the foam is reflective and cooler. Further analysis of the image shows that some material is leaking past the boom and entering the ship channel.

While the system was collecting data associated with the containment breach, a report was given that a fire restarted in the tank farm. Figure 6 is an example of IR imagery developed with the ASPECT night-vision thermal camera. Although this image is not calibrated, the content does show agreement with the thermal analysis conducted with data collected with line scanner. The image (which is flipped in direction) is showing the NW tank hotter than the surrounding but also is showing the tank south is hot around the edges and that a hot object is located further south and between the tanks.

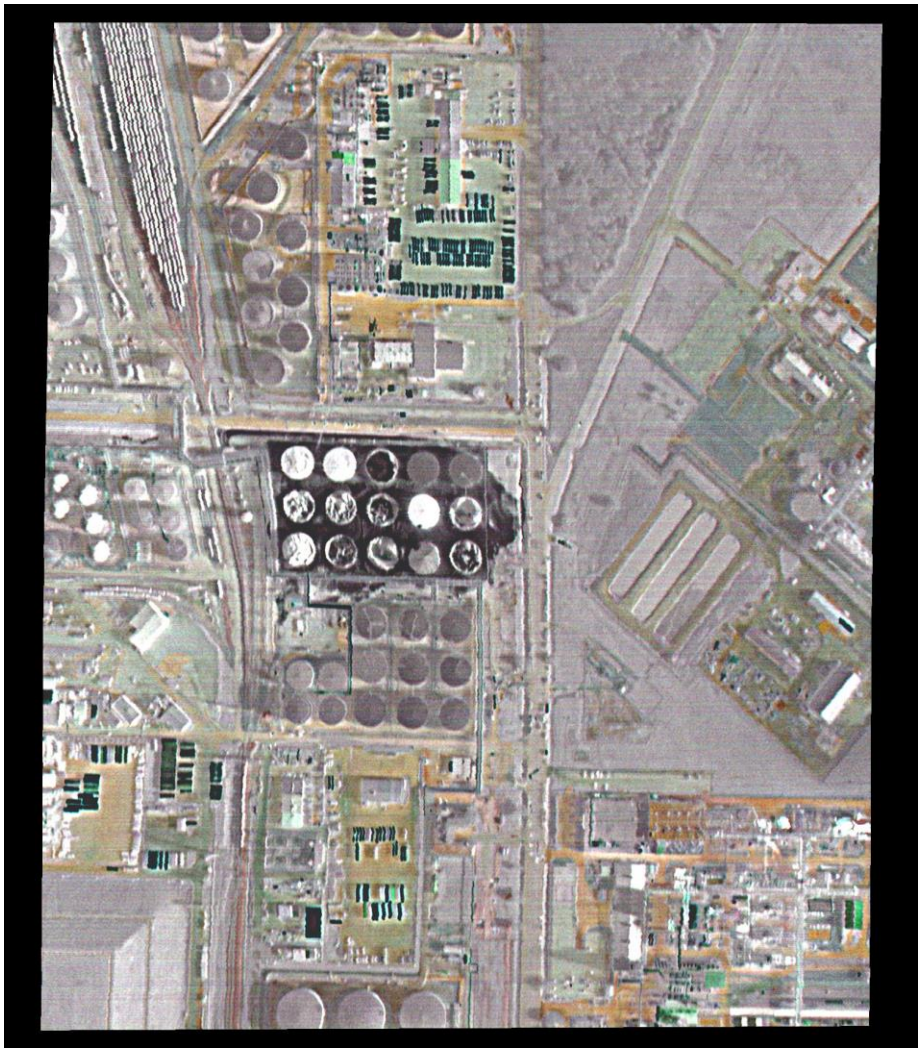

Figure 3: IR image of ITC data for 22 March 2019, Flight 7 Run 3

Figure 4: IR Thermal Analysis 22 March 2019, Flight 9, Run 3

Figure 5: IR Image 22 March 2019, Flight 8, Run 5

Figure 6: Night Vision image 22 March 2019, Fight 9, Run 8

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 and associated detection limits are given in Tables 2. In addition, collected data are also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra.

An examination of FTIR data collected on this mission showed low level detections in the general vicinity around the tank farm (Figure 7). These detections included acetone, 1,3-butadiene, 1-butene, isobutylene and isoprene. Compounds detected prior to the reported fire were isolated and low in concentrations (<.5 ppm) for all readings. Data collected during the reported fire did show a cluster north of the tank farm at slightly higher concentrations or less than 2 ppm. A summary is given in table 3A through 3D.

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 7: ITC Fire, Chemical Detection Locations – 22 March 2019

Table 3A. Chemical Results Summary, Flight 6

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	22 March 2019	0725	Test	Test
2		0727	Test	Test
3		0731	ND	None
4		0734	ND	None
5		0738	ND	None
6		0741	ND	None
7		0744	ND	None
ND – Non-detect				

Table 3B. Chemical Results Summary, Flight 7

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	22 March 2019	0837	Test	Test
2		0855	ND	None
3		0903	ND	None
4		0906	ND	None
5		0915	ND	None
6		0922	ND	None
ND – Non-detect				

Table 3C. Chemical Results Summary, Flight 8

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	22 March 2019	1252	Test	Test
2		1306	Butadiene	0.290
3		1309	Acetone	0.109
4		1324	ND	None
5		1328	ND	None
ND – Non-detect				

Table 3D. Chemical Results Summary, Flight 9

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	22 March 2019	1553	Test	Test
2		1559	ND	None
3		1524	ND	None
4		1531	ND	None
5		1540	Isobutylene	1.52
6		1543	1-butene Butadiene Isobutylene Isoprene	1.33 1.80 1.55 4.09
7		1546	Isoprene	0.95
8		1550	ND	None
9		1555	Isobutylene	1.70
10		1559	ND	None
11		1616	ND	None
12		1641	ND	None
13		1646	ND	None
ND – Non-detect				

Aerial Photography Results

A full set of high resolution aerial digital photography was collected as part of the flight. Figure 8 shows a representative overhead image collected as part of each pass over the tank farm. Evident in this image is the white material in the drainage ditch located on the north side of the secondary containment. This does suggest that the containment structure may have been compromised. Figure 9 shows an oblique image of the tank farm and the fire that reignited. Note that the top of the image is toward the south. The location of the fire is generally consistent with IR thermal and night vision analysis described in the above section.

Figure 8: Aerial Image of the ITC Tank Farm, Flight 9

Figure 9: Oblique Image of the ITC Tank Farm, Flight 5

Conclusions

ASPECT conducted a series of flight on 22 March 2019 with the focus being a possible breach of the tank farm secondary containment structure, discharge of foam and other material from the tank farm migrating into the ship channel and investigation of a re-ignition of a fire in the tank farm. IR results clearly showed the presence of material migrating into the ship channel and the presence of hot spots within the tank farm (corresponding to the fire). Detected compounds included acetone, 1,3-butadiene, 1-butene, isobutylene and isoprene. Compounds detected in the general vacuity had concentrations less than 0.5 ppm while detections north of the tank farm during the fire showed levels less than 2 ppm.

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

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Mission:   2019-03-22 ITC Fire
, Flight 6


Date:      3/22/2019

Time UTC: 12:18



Aircraft Number: N9738B

Pilot: Todd Seale

Copilot: Beorn Ledger

Operator: Bob Kirby

Aft Operator: Bob Kirby

Ground Controller: Mark Thomas



DEM: Using elevation from DEM Database

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Run: 1 Time: 12:25:29 UTC
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Alt: 3019 ft MSL Elev: 4 ft Elevation from DEM Database

Vel: 118 knots Heading: 345

Digitals: None

MSIC: 3

20190322122535488.jpg

20190322122542758.jpg

20190322122549107.jpg

FTIR: 1

20190322_122533_A.igm

IRLS: 1

2019_03_22_12_25_34_R_01 TA=4.1;TB=23.9;Gain=3

Gamma Runs: None

Run: 2 Time: 12:27:07 UTC

Alt: 2945 ft MSL Elev: 15 ft Elevation from DEM Database

Vel: 119 knots Heading: 345

Digitals: None

MSIC: 4

20190322122712630.jpg

20190322122719900.jpg

20190322122726249.jpg

20190322122728075.jpg

FTIR: 1

20190322_122710_A.igm

IRLS: 1

2019_03_22_12_27_12_R_02 TA=3.0;TB=22.2;Gain=3

Gamma Runs: None

Run: 3 Time: 12:31:15 UTC

Alt: 2909 ft MSL Elev: 18 ft Elevation from DEM Database

Vel: 114 knots Heading: 173

Digitals: None

MSIC: 3

20190322123120502.jpg

20190322123127756.jpg

20190322123134121.jpg

FTIR: 1

20190322_123118_A.igm

IRLS: 1

2019_03_22_12_31_19_R_03 TA=-1.2;TB=18.0;Gain=3

Gamma Runs: None

Run: 4 Time: 12:34:35 UTC

Alt: 2778 ft MSL Elev: 17 ft Elevation from DEM Database

Vel: 112 knots Heading: 169

Digitals: None

MSIC: 4

20190322123441152.jpg

20190322123447501.jpg

20190322123453866.jpg

20190322123500215.jpg

FTIR: 1

20190322_123438_A.igm

IRLS: 1

2019_03_22_12_34_39_R_04 TA=1.4;TB=20.8;Gain=3

Gamma Runs: None

Run: 5 Time: 12:38:08 UTC

Alt: 2741 ft MSL Elev: 14 ft Elevation from DEM Database

Vel: 120 knots Heading: 259

Digitals: None

MSIC: 4

20190322123814516.jpg

20190322123820865.jpg

20190322123827214.jpg

20190322123833579.jpg

FTIR: 1

20190322_123812_A.igm

IRLS: 1

2019_03_22_12_38_13_R_05 TA=0.8;TB=20.8;Gain=3

Gamma Runs: None

Run: 6 Time: 12:41:28 UTC

Alt: 2765 ft MSL Elev: 18 ft Elevation from DEM Database

Vel: 116 knots Heading: 264

Digitals: None

MSIC: 4

20190322124134260.jpg

20190322124141514.jpg

20190322124147863.jpg

20190322124154228.jpg

FTIR: 1

20190322_124132_A.igm

IRLS: 1

2019_03_22_12_41_33_R_06 TA=0.9;TB=20.9;Gain=3

Gamma Runs: None

Run: 7 Time: 12:44:35 UTC

Alt: 2712 ft MSL Elev: 17 ft Elevation from DEM Database

Vel: 118 knots Heading: 256

Digitals: None

MSIC: 3

20190322124441274.jpg

20190322124447639.jpg

20190322124453988.jpg

FTIR: 1

20190322_124439_A.igm

IRLS: 1

2019_03_22_12_44_40_R_07 TA=0.2;TB=20.3;Gain=3

Gamma Runs: None

Mission Complete: 13:06 (UTC)

Mission: ITC Fire, Flight 7

Date: 3/22/2019

Time UTC: 13:37

Aircraft Number: N9738B

Pilot: Beorn Ledger

Copilot: Beorn Ledger

Operator: Steven Brister

Aft Operator: Jimmy Crisp

Ground Controller: Bob Kirby

DEM: Using elevation from DEM Database

Run: 1 Time: 13:46:55 UTC

Alt: 2747 ft MSL Elev: 21 ft Elevation from DEM Database

Vel: 107 knots Heading: 167

Digitals: None

MSIC: 3

20190322134701838.jpg

20190322134708187.jpg

20190322134714552.jpg

FTIR: 1

20190322_134659_A.igm

IRLS: 1

2019_03_22_13_46_59_R_01 TA=4.1;TB=24.0;Gain=3

Gamma Runs: None

Run: 2 Time: 13:55:12 UTC

Alt: 2782 ft MSL Elev: 7 ft Elevation from DEM Database

Vel: 111 knots Heading: 7

Digitals: None

MSIC: 3

20190322135518445.jpg

20190322135524794.jpg

20190322135531159.jpg

FTIR: 1

20190322_135516_A.igm

IRLS: 1

2019_03_22_13_55_16_R_02 TA=1.9;TB=16.5;Gain=3

Gamma Runs: None

Run: 3 Time: 14:03:27 UTC

Alt: 2667 ft MSL Elev: 18 ft Elevation from DEM Database

Vel: 111 knots Heading: 177

Digitals: None

MSIC: 4

20190322140334134.jpg

20190322140340499.jpg

20190322140346848.jpg

20190322140353213.jpg

FTIR: 1

20190322_140330_A.igm

IRLS: 1

2019_03_22_14_03_32_R_03 TA=2.2;TB=22.2;Gain=3

Gamma Runs: None

Run: 4 Time: 14:06:57 UTC

Alt: 2775 ft MSL Elev: 17 ft Elevation from DEM Database

Vel: 111 knots Heading: 262

Digitals: None

MSIC: 4

20190322140702949.jpg

20190322140709314.jpg

20190322140715663.jpg

20190322140720202.jpg

FTIR: 1

20190322_140700_A.igm

IRLS: 1

2019_03_22_14_07_01_R_04 TA=3.9;TB=23.6;Gain=3

Gamma Runs: None

Run: 5 Time: 14:15:54 UTC

Alt: 2717 ft MSL Elev: 0 ft Elevation from DEM Database

Vel: 116 knots Heading: 261

Digitals: None

MSIC: 4

20190322141600416.jpg

20190322141606766.jpg

20190322141613131.jpg

20190322141619480.jpg

FTIR: 1

20190322_141557_A.igm

IRLS: 1

2019_03_22_14_15_58_R_05 TA=5.2;TB=25.2;Gain=3

Gamma Runs: None

Run: 6 Time: 14:22:49 UTC

Alt: 2931 ft MSL Elev: 16 ft Elevation from DEM Database

Vel: 105 knots Heading: 84

Digitals: None

MSIC: 8

20190322142256227.jpg

20190322142302592.jpg

20190322142308941.jpg

20190322142315290.jpg

20190322142321655.jpg

20190322142328004.jpg

20190322142334369.jpg

20190322142340718.jpg

FTIR: 2

20190322_142252_A.igm

20190322_142332_A.igm

IRLS: 1

2019_03_22_14_22_54_R_06 TA=4.9;TB=24.9;Gain=3

Gamma Runs: None

Mission Complete: 14:40 (UTC)

Mission: 2019-03-22 ITC Fire Flight 8

Date: 3/22/2019

Time UTC: 17:45

Aircraft Number: N9738B

Pilot: James Glaviano

Copilot: Beorn Ledger

Operator: Bob Kirby

Aft Operator: Bob Kirby

Ground Controller: Mark Thomas

DEM: Using elevation from DEM Database

Run: 1 Time: 17:52:25 UTC

Alt: 3017 ft MSL Elev: -3 ft Elevation from DEM Database

Vel: 110 knots Heading: 214

Digitals: None

MSIC: 3

20190322175231427.jpg

20190322175237792.jpg

20190322175244142.jpg

FTIR: 1

20190322_175229_A.igm

IRLS: 1

2019_03_22_17_52_29_R_01 TA=15.1;TB=34.9;Gain=3

Gamma Runs: None

Run: 2 Time: 18:06:52 UTC

Alt: 2866 ft MSL Elev: 15 ft Elevation from DEM Database

Vel: 120 knots Heading: 254

Digitals: None

MSIC: 4

20190322180658503.jpg

20190322180704853.jpg

20190322180711202.jpg

20190322180717567.jpg

FTIR: 1

20190322_180655_A.igm

IRLS: 1

2019_03_22_18_06_56_R_02 TA=5.5;TB=25.5;Gain=3

Gamma Runs: None

Run: 3 Time: 18:09:25 UTC

Alt: 2832 ft MSL Elev: 7 ft Elevation from DEM Database

Vel: 103 knots Heading: 153

Digitals: None

MSIC: 5

20190322180931945.jpg

20190322180938294.jpg

20190322180944644.jpg

20190322180951003.jpg

20190322180957352.jpg

FTIR: 1

20190322_180929_A.igm

IRLS: 1

2019_03_22_18_09_30_R_03 TA=5.5;TB=25.5;Gain=3

Gamma Runs: None

Run: 4 Time: 18:24:37 UTC

Alt: 2879 ft MSL Elev: 18 ft Elevation from DEM Database

Vel: 109 knots Heading: 178

Digitals: None

MSIC: 4

20190322182444393.jpg

20190322182450758.jpg

20190322182457107.jpg

20190322182503472.jpg

FTIR: 1

20190322_182441_A.igm

IRLS: 1

2019_03_22_18_24_42_R_04 TA=5.5;TB=25.5;Gain=3

Gamma Runs: None

Run: 5 Time: 18:28:06 UTC

Alt: 2857 ft MSL Elev: 9 ft Elevation from DEM Database

Vel: 111 knots Heading: 162

Digitals: None

MSIC: 7

20190322182813220.jpg

20190322182819600.jpg

20190322182825934.jpg

20190322182832283.jpg

20190322182838648.jpg

20190322182844997.jpg

20190322182851362.jpg

FTIR: 2

20190322_182810_A.igm

20190322_182849_A.igm

IRLS: 1

2019_03_22_18_28_11_R_05 TA=5.5;TB=25.5;Gain=3

Gamma Runs: None

Mission Complete: 19:41 (UTC)

Mission: 2019-03-22 ITC Fire, Flight 9

Date: 3/22/2019

Time UTC: 20:47

Aircraft Number: N9738B

Pilot: Todd Seale

Copilot: Beorn Ledger

Operator: Steven Brister

Aft Operator: Jimmy Crisp

Ground Controller: Bob Kirby

DEM: Using elevation from DEM Database

Run: 1 Time: 20:53:49 UTC

Alt: 2508 ft MSL Elev: -1 ft Elevation from DEM Database

Vel: 108 knots Heading: 190

Digitals: None

MSIC: 3

20190322205356283.jpg

20190322205402632.jpg

20190322205408997.jpg

FTIR: 1

20190322_205353_A.igm

IRLS: None

Gamma Runs: None

Run: 2 Time: 20:59:12 UTC

Alt: 2961 ft MSL Elev: 9 ft Elevation from DEM Database

Vel: 102 knots Heading: 108

Digitals: None

MSIC: 3

20190322205918585.jpg

20190322205924950.jpg

20190322205931299.jpg

FTIR: 1

20190322_205916_A.igm

IRLS: None

Gamma Runs: None