

Airborne Spectral Photometric Environmental Collection Technology

ASPECT Texas Air Quality Survey Corpus Christi and Point Comfort, TX 12 March 2021



ASPECT Mission Supporting:

Matthew Loesel
Region 6 On-Scene Coordinator

Initial Mission Request

Kelly Cook
Deputy Director
Critical Infrastructure Division
Office of Compliance and Enforcement
Texas Commission on Environmental
Quality

ASPECT TEAM

John Martin

Project Officer/Planning Support
Martin.John@EPA.gov
214-789-1994

Jill Taylor

Chemical/Photometric Lead
Taylor.Jillianne@EPA.gov
214-406-9896

Lyndsey Nguyen

Radiation/Nuclear Lead
Nguyen.Lyndsey@EPA.gov
702-373-3756

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Acronyms and Abbreviations

Alt	Altitude (in feet)
AGL	Above Ground Level
cm	centimeter
CST	Central Standard Time
DEM	Digital Elevation Model
Digital	Digital photography file from the Nikon D2X camera
ft	feet
FTIR	Fourier Transform Infrared Spectrometer
igm	Spectral data format based on grams format
IR	Infrared
IRLS	Infrared Line Scanner
jpg	JPEG image format
kts	knots
mph	miles per hour
m/s	meters per second
MSIC	Digital photography file from the Imperx mapping camera
MSL	Mean Sea Level Altitude (in feet)
ppm	parts per million
UTC	Universal Time Coordinated

Executive Summary

During the week of 15 February 2021, a strong Polar air mass extended over a large portion of the United States pushing temperatures into the negative digits. The State of Texas experienced frozen precipitation and low temperatures culminating in stress to the power grid resulting in brown and blackout conditions. Due to the widespread power loss within the State, most petrochemical and other Risk Management Plan facilities were forced to shut down. During the week of 22 February 2021 plans were made to restart many of these facilities with concern that the restarts may impact air quality. The U.S. Environmental Protection Agency Region 6 was requested by the State of Texas to deploy the ASPECT aircraft for the purpose of area-wide air monitoring over the Beaumont, Houston, and Corpus Christi regions commencing on 27 February 2021. This report provides a summary of the findings made during the survey.

ASPECT missions conducted on 27 Feb 2021 were hampered by poor weather and low cloud ceilings which prevented data collection in the Beaumont area. ASPECT was able to collect a limited set of data near Crosby, TX and 5 collection runs over the Corpus Christi area. No compounds were detected on these missions.

On 28 Feb 2021 ASPECT conducted an air monitoring mission for both the Corpus Christi and Houston areas with low levels of 1-butene, isoprene, 1,3-butadiene, acetone, and ammonia were detected at low levels in the collection areas. Visible and IR imagery both showed hot flare and steam vents suggesting that facilities are operational.

ASPECT conducted two flight missions (Flight 4 and 5) on 2 March 2021 including air monitoring survey collections over Corpus Christi, Freeport, Houston, Port Arthur, and Beaumont areas. Weather conditions for both flights was favorable with some elevated turbulence reported on the afternoon flight. Imagery (visible and IR) showed typical steam and cooling tower and flare signatures. Compounds detected in the Corpus Christi area consisted of acetone (1.536 ppm), isoprene (1.250 ppm) and 1-butene (1.391 ppm). Isobutylene was detected in the Beaumont area at a level of 1.577 ppm.

Two air quality surveys were collected on 3 March 2021 over Beaumont and Houston areas (Flight 6) and mission over the Corpus Christi areas (Flight 7). Weather conditions for both surveys was favorable for all types of data collection. Visible and IR imagery showed normal facility operations including elevated process unit piping and visible steam plumes. Compounds detected on the Beaumont and Houston flight showed detections of 1-butene (7.230 ppm), 2-butene (5.443 ppm), 1,3-butadiene (1.537 ppm), ethylene (2.075 ppm), isoprene (4.055 ppm) and isobutylene (5.267 ppm). On Flight 7 the following compounds were detected including sulfur dioxide (1.517 ppm), 1-butene (1.792 ppm), 1,3-butadiene (0.994 ppm), isoprene (1.232 ppm) and isobutylene (1.505 ppm).

The collection objectives for 4 March 2021 included a continuation of air monitoring collection activities at selected sites within the Beaumont, Houston, and Corpus Christi areas. Weather forecast in the collection areas were acceptable for all types of data collection. No chemical plumes were detected on any of the IR imagery. Compounds

detected on Flight 8 included acetone (0.793 ppm) and isobutylene (1.929 ppm) in the Corpus Christi area and ammonia (0.477 ppm), 1,3-butadiene (6.788 ppm), 1-butene (6.140 ppm), 2-butene (7.930 ppm), ethylene (0.845 ppm), isobutylene (3.299 ppm), isoprene (2.678 ppm) and sulfur dioxide (2.218 ppm) in the Freeport and Houston areas. Compounds detected on the second flight of the day over Beaumont showed 1-butene (1.766 ppm), 1,3-butadiene (0.983 ppm), and isobutylene (1.531 ppm).

ASPECT conducted two flight missions on 5 March 2021 including air monitoring survey collections over Houston (Flight 10) and Corpus Christi (Flight 11). Weather conditions were generally favorable with some clouds in the early portion of the Houston area. No chemical plumes were detected on IR imagery. IR imagery did indicate a possible sheen within a containment basin in the Houston area. Compounds detected as part of the Houston survey consisted of 1-butene (1.244 ppm), acetone (0.855 ppm) and isoprene (4.398 ppm). Compounds detected in the Corpus Christi area consisted of 1-butene (1.862 ppm), 2-butene (2.634 ppm), isobutylene (1.527 ppm) and isoprene (0.883 ppm). No chemical plumes were detected on any of the collection passes.

Flight objectives for 6 March 2021 included conducting air monitoring surveys over the Beaumont and Houston areas. Weather conditions were favorable for all types of data collection with exception of moderate to strong turbulence on the Houston data collection. Compounds detected in the Beaumont area (Flight 12) included 1-butene (1.656 ppm) and 1,3-butadiene (0.743 ppm). Flight 13 had an absence of targeted organics but the presence of peroxyacetyl nitrate (PAN) and ozone was frequently detected. Oblique imagery during the Houston flight indicated a haze of smog, consistent with the PAN observations.

Objectives for 7 March 2021 included surveys over the La Port and Corpus Christi areas (Flight 14) and a mission over Freeport (Flight 15). A single compound was detected in the La Porte area consisting of acetic acid (1.518 ppm) which was associated with a flare that appeared to be in the startup process. Compounds detected in the Corpus Christi area included acetone (0.984 ppm), 1-butene (1.912 ppm), 2-butene (2.198 ppm), isoprene (1.184 ppm) and isobutylene (1.736 ppm). Isobutylene (2.022 ppm) was the only compound that was detected in the Freeport area.

ASPECT conducted two flights on 8 March 2021 consisting of an air monitoring survey over the Houston area followed by an afternoon mission over the Beaumont/Port Arthur area. Compounds detected associated with the Houston mission (Flight 16) included acetone (0.642 ppm), 1-butene (1.283 ppm), and isoprene (1.846 ppm). Compounds detected on over the Beaumont/Port Arthur areas included 1-butene (1.711 ppm), isobutylene (1.703 ppm), isoprene (1.221 ppm) and SO₂ (1.612 ppm).

Flights on 9 March 2021 included missions over Houston, Corpus Christi and the extended Corpus Christi areas. Compounds detected on Flight 18 (Houston and Freeport areas) included acetone (0.655 ppm), ammonia (10.19 ppm), 1-butene (1.250 ppm), 2-butene (1.921 ppm), 1,3-butadiene (0.514 ppm), isobutylene (1.788 ppm) and isoprene (0.682 ppm). Compounds observed over the Corpus Christi and extended areas on Flight 19

consisted of acetone (0.611 ppm), 1-butene (2.352 ppm), 2-butene (2.242 ppm), isobutylene (1.531 ppm), isoprene (1.016 ppm) and n-butyl alcohol (1.327 ppm).

Only one compound was detected on the morning mission Flight 20, 10 March 2021 over the Beaumont/Port Arthur areas and consisted of 1-butene (1.238 ppm). Flight conditions for an afternoon mission over the Houston area were marginal and forced the system to be operated at about 1200 ft AGL. No programmed compounds were detected but common air pollution compounds were observed in the FTIR system.

ASPECT did not detect any programmed compounds (those found in Appendix B, Table 1) as part of the mission over the Beaumont/Port Arthur areas on 11 March 2021. On Flight 23 ASPECT detected 1-butene (2.071 ppm) over a facility in the Port Comfort area and 1-butene (1.543 ppm) and 1,3-butadiene (0.696 ppm) over the Corpus Christi area.

Poor morning weather conditions in the Corpus Christi area on 12 March 2021 forced the ASPECT system to delay active collection until the afternoon. Even with the delay, the Corpus Christi area still experienced low cloud content and the system was diverted to the Victoria/Point Comfort area resulting in some data collection. No compounds were detected in the area (other than normal air pollutants). After the completion of the mission, the aircraft was released from the area and returned to the home base in Addison, TX.

ASPECT Texas Air Quality Survey Corpus Christi and Point Comfort, TX 12 March 2021

Background and Operational Overview

During the week of 15 February 2021, a strong Polar air mass extended over a large portion of the United States pushing temperatures into the negative digits. The State of Texas experienced snow, ice, and low temperatures. These conditions culminated in a stress to the power grid resulting in brown and blackout conditions in many parts of the State. Petrochemical facilities in many locations were forced to shut down. During the week of 22 February 2021 plans were made to restart many of these facilities with concern that the restarts may impact air quality. The U.S. Environmental Protection Agency Region 6 was requested by the State of Texas to deploy the ASPECT aircraft for the purpose of area-wide air monitoring over the Beaumont, Houston, and Corpus Christi regions commencing on 27 February 2021.

The overall objective of this survey was to examine the air quality of areas populated with Risk Management Plan (RMP) sites and petrochemical facilities using the ASPECT system. No specific sites were specified other than generic survey areas. Figures 1, 2, 3 and 4 show those areas corresponding to the Beaumont/Port Arthur, Houston, Corpus Christi and extended Corpus Christi survey locations. Within these areas, a series of guidance flight lines were developed to assist the flight crew in data collection using the ASPECT system. The ASPECT system has a set of automated compounds that can be automatically detected and if any of these compounds were detected, the location and approximate quality of the compound would be reported to EPA Region 6.

An ASPECT series of missions were flown on 27 Feb 2021 as part of a request from EPA Region 6 to support air monitoring within the Beaumont, Houston, and Corpus Christi areas. The ASPECT aircraft attempted to collect data at each of the general areas and was only able to obtain 1 collection pass near Crosby, TX and 5 collection runs over the Corpus Christi area. Poor weather hampered all collection activities due to low cloud levels and dark conditions. The limited FTIR data that was collected and analyzed showed no detections on any collection passes.

ASPECT conducted a mission on 28 Feb 2021 consisting of an air monitoring survey over selected areas of the Corpus Christi and Houston collection areas. Weather conditions in both locations were marginal due to low ceilings but a set of data was collected for both locations. Imagery collected showed that facilities appear to be operational with both

steam and active flares. Compounds including 1-butene (2.665 ppm), isoprene (3.065), 1,3-butadiene (2.56 ppm), acetone (0.688 ppm), and ammonia (0.440 ppm) were detected at low levels in the Houston area and 1-butene (1.219 ppm) and isoprene (1.012 ppm) were detected in the Corpus Christi area.

ASPECT conducted two flight missions on 2 March 2021 including air monitoring survey collections over Corpus Christi, Freeport, Houston, Port Arthur, and Beaumont areas. Weather conditions for both surveys was generally favorable with some elevated turbulence reported on the afternoon flight. Visible imagery collected showed what appears to be normal steam and cooling tower emissions. Examination of IR imagery showed numerous flares and hot process piping and units. Compounds detected on the flight over Corpus Christi included acetone (1.536 ppm), isoprene (1.250 ppm) and 1-butene (1.391 ppm) all associated with one facility. The flight over the Freeport and Houston locations showed no detections. Isobutylene was detected in the Beaumont area at a level of 1.577 ppm.

On 3 March 2021 air monitoring surveys were collected over the Beaumont and Houston areas (Flight 6) and a mission over the Corpus Christi areas (Flight 7). Weather conditions for both surveys was favorable for all types of data collection. Visible and IR imagery showed normal facility operations including elevated process unit piping and visible steam plumes. Compounds detected on the Beaumont and Houston flight showed detections of 1-butene (7.230 ppm), 2-butene (5.443 ppm), 1,3-butadiene (1.537 ppm), ethylene (2.075 ppm), isoprene (4.055 ppm) and isobutylene (5.267 ppm). On Flight 7 the following compounds were detected including sulfur dioxide (1.517 ppm), 1-butene (1.792 ppm), 1,3-butadiene (0.994 ppm), isoprene (1.232 ppm) and isobutylene (1.505 ppm).

ASPECT conducted two flight missions on 4 March 2021 including air monitoring survey collections over Corpus Christi and Houston areas (Flight 8) and a mission over the Beaumont/Port Arthur (Flight 9). Weather conditions were favorable for all types of data collection. No chemical plumes were detected on IR imagery. Compounds detected on flight 8 included acetone (0.793 ppm) and isobutylene (1.929 ppm) in the Corpus Christi area and ammonia (0.477 ppm), 1,3-butadiene (6.788 ppm), 1-butene (6.140 ppm), 2-butene (7.930 ppm), ethylene (0.845 ppm), isobutylene (3.299 ppm) isoprene (2.678 ppm) and sulfur dioxide (2.218 ppm) in the Freeport and Houston area. Flight 9 over the Beaumont area showed 1-butene (1.766 ppm), 1,3-butadiene (0.983 ppm), and isobutylene (1.531 ppm). As with flight 8, visible and IR imagery indicated that facilities are showing normal thermal signatures.

The ASPECT objectives on 5 March 2021 included two flight missions over Houston (Flight 10) and Corpus Christi (Flight 11). Weather conditions were generally favorable with some clouds in the early portion of the Houston area. No chemical plumes were detected on IR imagery. IR imagery did indicate a possible sheen within a containment basin in the Houston area. Compounds detected as part of the Houston survey consisted of acetone (0.855 ppm) and isoprene (4.398 ppm). Compound detected in the Corpus Christi

area consisted of 1-butene (1.862 ppm), 2-butene (2.634 ppm), isobutylene (1.527 ppm) and isoprene (0.883 ppm). No chemical plumes were detected on any of the collection passes.

Flight objectives for 6 March 2021 included conducting air monitoring surveys over the Beaumont and Houston areas. Weather conditions were favorable for all types of data collection with exception of moderate to strong turbulence on the Houston data collection. Compounds detected in the Beaumont area (Flight 12) included 1-butene (1.656 ppm) and 1,3-butadiene (0.743 ppm). Flight 13 had an absence of targeted organics but the presence of peroxyacetyl nitrate (PAN) and ozone was frequently detected. Oblique imagery during the Houston flight indicated a haze of smog, consistent with the PAN observations.

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Focus areas of monitoring for 9 March 2021 included flights over Houston and the Corpus Christi and extended area. Compounds detected on Flight 18 (Houston and Freeport areas) included acetone (0.655 ppm), ammonia (10.19 ppm), 1-butene (1.250 ppm), 2-butene (1.921 ppm), 1,3-butadiene (0.514 ppm), isobutylene (1.788 ppm) and isoprene (0.682 ppm). Compounds observed over the Corpus Christi and extended areas consisted of acetone (0.611 ppm), 1-butene (2.352 ppm), 2-butene (2.242 ppm), isobutylene (1.531 ppm), isoprene (1.016 ppm) and n-butyl alcohol (1.327 ppm).

Only one compound was detected on the mission (Flight 20) over the Beaumont/Port Arthur areas and consisted of 1-butene (1.238 ppm). Flight conditions for an afternoon mission over the Houston area were marginal and forced the system to be operated at about 1200 ft AGL. No programmed compounds were detected but common air pollution compounds were observed in the FTIR system.

ASTECT did not detect any programmed compounds (those found in Appendix B, Table 1) as part of the mission over the Beaumont/Port Arthur areas on 11 March 2021. On flight 23 ASTECT detected 1-butene (2.071 ppm) over a facility in the Port Comfort area and 1-butene (1.543 ppm) and 1,3-butadiene (0.696 ppm) over the Corpus Christi area

The collection objectives for 12 March 2021 included a continuation of air monitoring collection activities at selected sites within the Corpus Christi and Point Comfort areas, pending weather. Weather conditions for the survey areas are marginal but forecast to improve by 1000. This report summarizes the results of the mission.

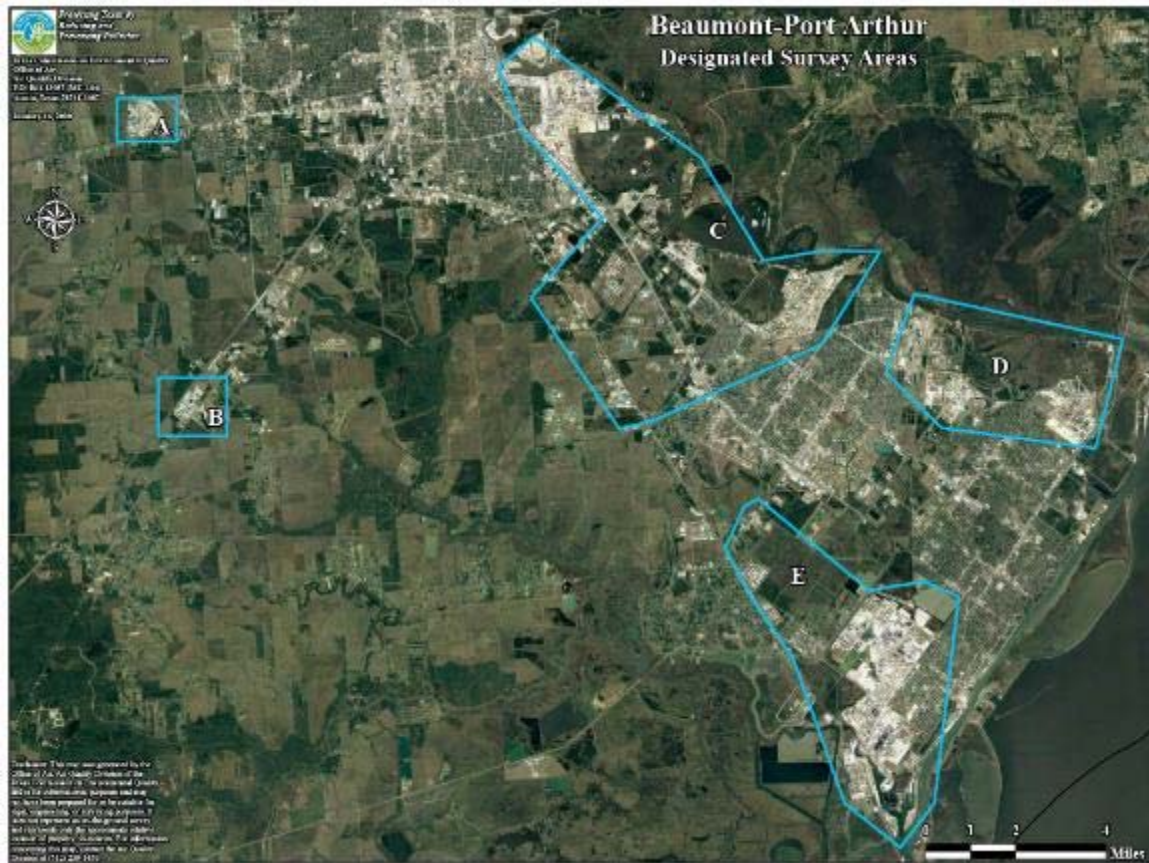


Figure 1: Beaumont/Port Arthur, TX Survey Area



Figure 2. Houston, TX Survey Area

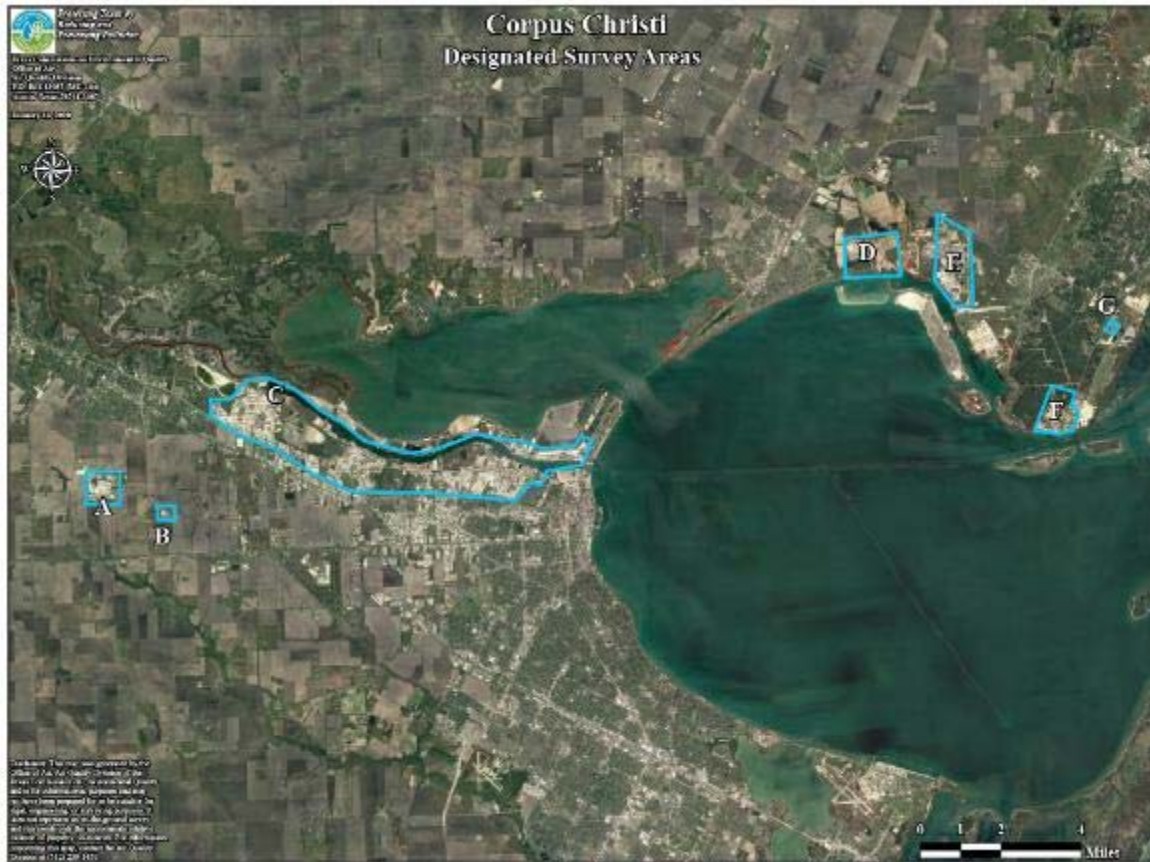


Figure 3. Corpus Christi, TX Survey Area

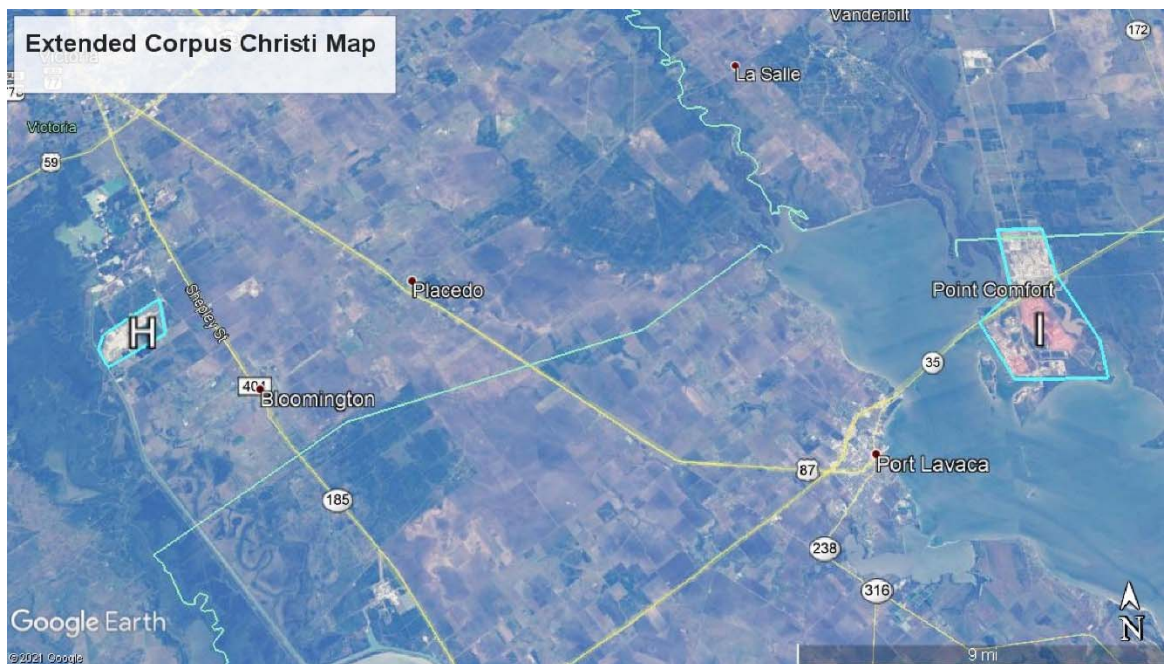


Figure 4. Extended Corpus Christi TX Survey Area

General Mission Objectives

Once granted access to fly over the sites, the following general mission objectives were employed in conducting emergency response data collection with ASPECT:

1. To capture an overall, situational awareness of the incident using aerial photography with:
 - Oblique camera—photos taken by hand from the view/position of the co-pilot, and
 - MSIC photos—advanced camera mounted underneath the plane for a top-down view of the designated sites.
2. To qualitatively locate and characterize any the visible and non-visible components of a plume, as well as any areas on fire:
 - Using the Infrared Line Scanner (IRLS)
3. To screen for the presence and location of specific chemicals within ASPECT's automated chemical detection library:
 - Using the Fourier Transform Infrared (FTIR) Spectrometer

Flight Conditions and Status

Weather and Site Conditions

Prior to each flight, an updated status of the current and forecasted weather, site conditions and any potential flight obstacles including radio towers impacting safety is assessed by the crew. A complete timeline of the ground weather conditions during the mission can be found in Tables 1 and 2.

Table 1. Ground Weather for Corpus Christi, TX

Time	851	951	1051	1151	1251
Wind direction	157.5 degrees SSE	157.5 degrees SSE	157.5 degrees SSE	157.5 degrees SSE	157.5 degrees SSE
Wind speed	7.6 m/s (17.0 mph)	8.9 m/s (20.0 mph)	9.4 m/s (21.0 mph)	9.8 m/s (22.0 mph)	11.2 m/s (25.0 mph)
Temperature	23.3 C	24.4 C	25.0 C	26.7 C	27.2 C
Relative humidity	82%	74%	69%	64%	62%
Dew point	20.0 C	19.4 C	18.9 C	19.4 C	19.4 C
Pressure	1021.4 mb	1021.7 mb	1022.1 mb	1021.4 mb	1020.4 mb
Ceiling	Scattered 1400 Ft	Scattered 2000 Ft	Scattered 2400 Ft	Scattered 2500 Ft	Scattered 2300 Ft

Table 2. Ground Weather for Victoria and Point Comfort, TX

Time	1351	1451	1551	1651
Wind direction	157.5 degrees SSE	157.5 degrees SSE	157.5 degrees SSE	112.5 degrees ESE
Wind speed	11.2 m/s (25.0 mph)	10.7 m/s (24.0 mph)	8.9 m/s (20.0 mph)	8.9 m/s (20.0 mph)
Temperature	27.8 C	27.8 C	27.2 C	24.4 C
Relative humidity	51%	51%	53%	71%
Dew point	16.7 C	16.7 C	16.7 C	18.9 C
Pressure	1018.4 mb	1018.0 mb	34581.4 mb	1017.3 mb
Ceiling	Scattered 3900 Ft	Scattered 4100 Ft	Few 3800 Ft	Broken 2600 Ft

The aircraft departed Houston, TX at approximately 1000 CST due to a weather delay and attempted to collect data in the Corpus Christi area. While the KCRP station reported clouds at 2300 ft AGL, the crew reported low level clouds (scud) at 1100. No data was collected, and the aircraft landed in Corpus Christi. At 1348 the aircraft departed Corpus Christi and reported low level clouds over the facilities in the immediate area. A decision was made to divert to the Victoria/Port Comfort area to test for better conditions. Once on station the aircraft reported acceptable conditions and made several data collection runs. Winds at collection altitude were reported as 175 deg at 18 kts (2500 ft AGL).

Data Results

The following data is provided as a summary analysis. All data products are available for the Region to access on a shared FTP site. For a complete list of available products, see Appendix A. The data collected during these missions included a flight path summary, IRLS images, FTIR chemical identification and quantification, high resolution MSIC photos, and oblique photos.

Flight Paths

Wide, slow turns are required to be made in between runs to keep the instruments stable. The blue lines indicate the flight path while the green lines indicate the specific sections of the flight where chemical data was collected and processed. On Flight 24 the Victoria/Point Comfort area was surveyed, and the flight path is shown in Figure 5.

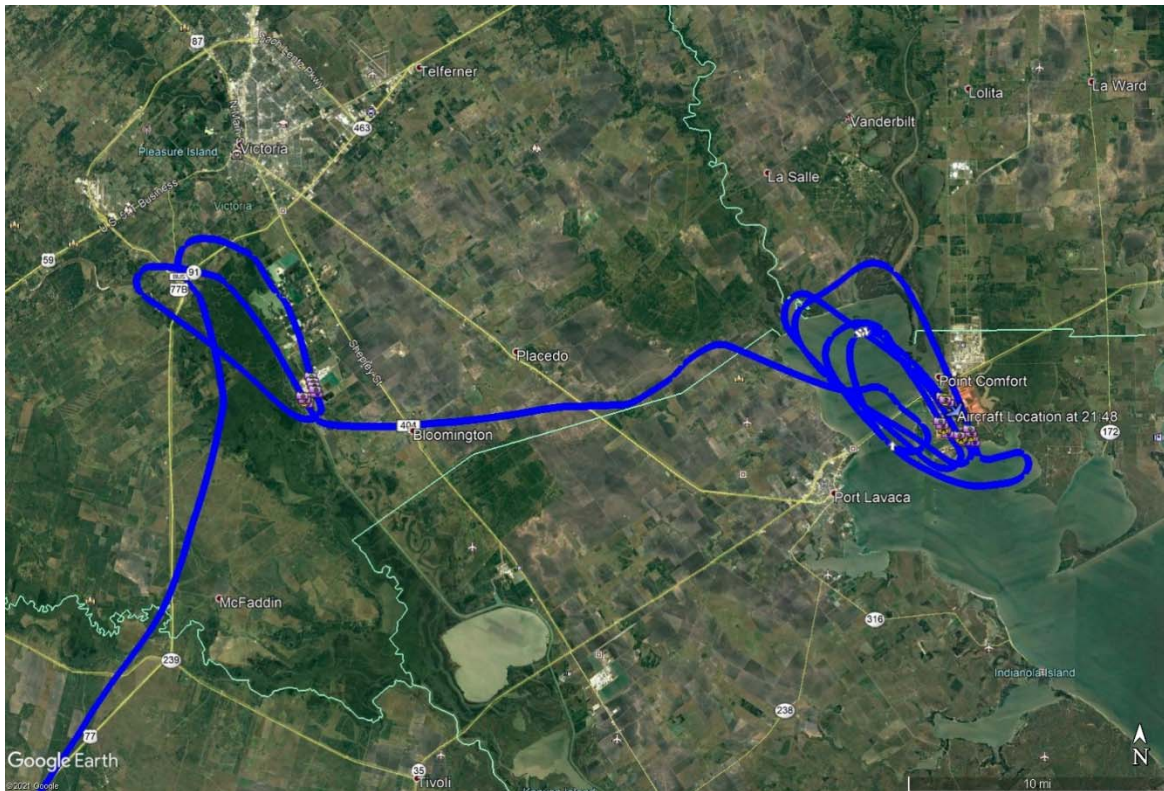


Figure 5. Data Collection Flight Path over the Victoria/Point Comfort area, Flight 24, 12 March 2021

Line Scanner Data Results

A total of 8 data collection runs were made over the Port Arthur area and during each collection run an infrared line scanner image was generated. Figure 6 shows a 3-band infrared image collected over the survey area. Examination of the image shows hot process/piping in the mid portion of the image. No chemical plumes can be observed being emitted from the facility.

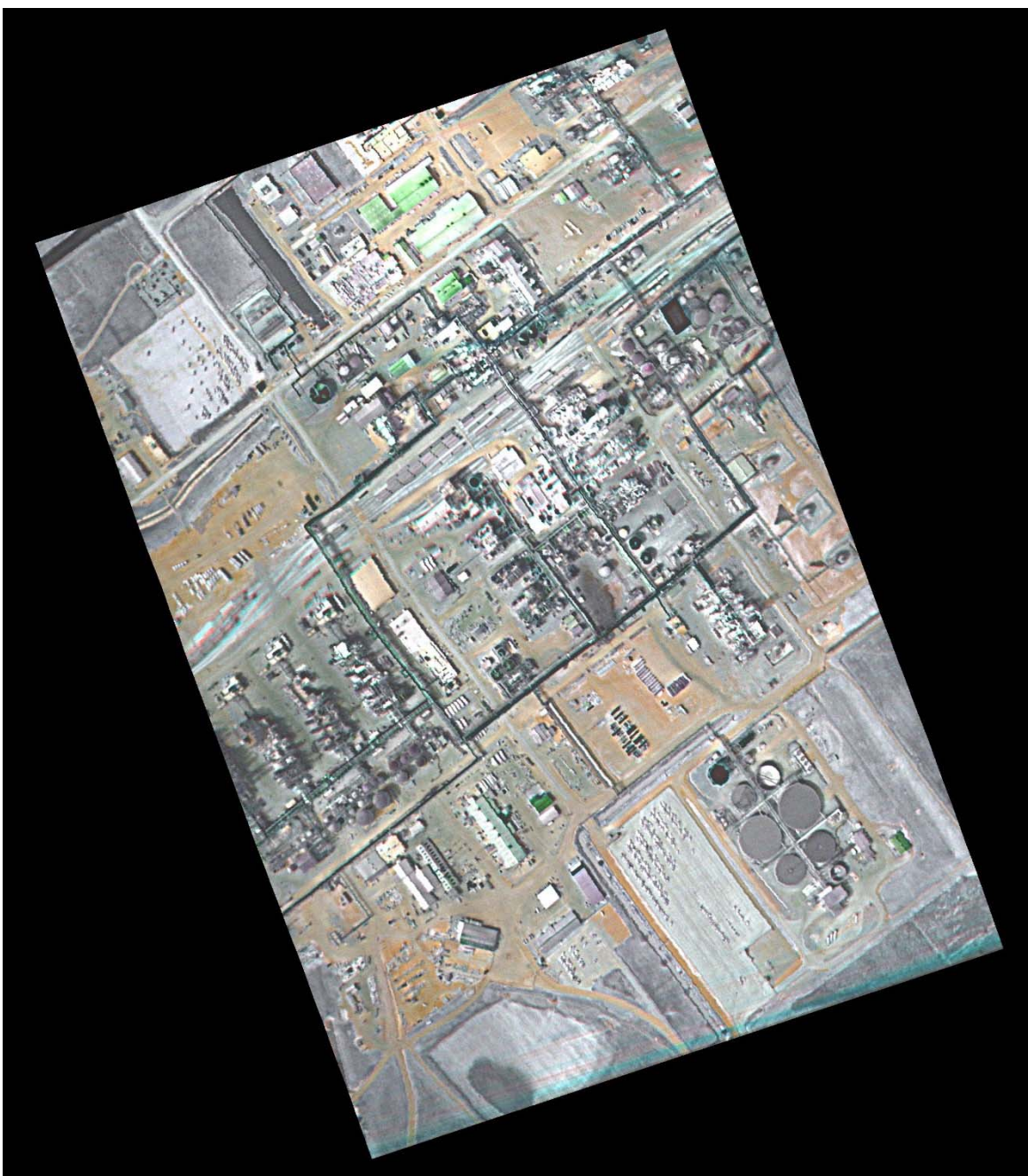


Figure 6. Three band IR image, Victoria/Point Comfort Area, Run 3, Flight 24, 12 March 2021

FTIR Data Results

FTIR spectral data at a resolution of 16 wavenumbers was collected for each run. ASPECT uses an automated detection algorithm to permit compounds to be automatically analyzed while the aircraft is in flight. Seventy-six chemical compounds are included in the airborne

algorithm library (the list is provided in Appendix B, Table 1). In addition, collected data was also manually quality checked against a collection of published library spectra for each chemical detected.

ASPECT did not detect any programmed compounds (those found in Appendix B, Table 1) during the air monitoring survey over the Victoria/Point Comfort area but the sensor did detection common air pollutants. Figure 7 shows peroxyacetyl nitrate (PAN) with the large feature centered at approximately 1120 cm^{-1} . Details of the monitoring results can be found in Table 3.

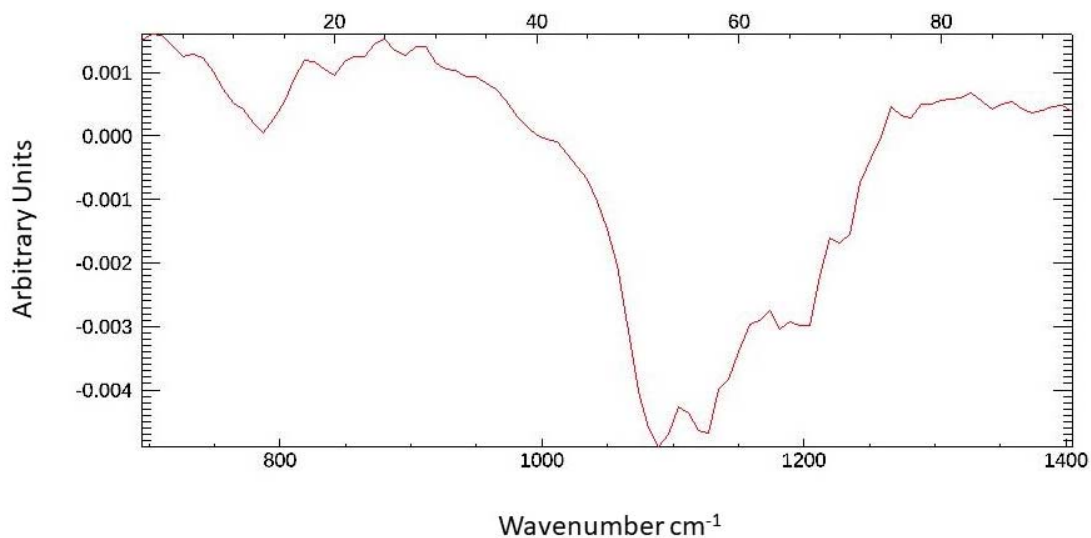


Figure 7. PAN Spectrum, Victoria/Point Comfort Area, Flight 24, 12 March 2021

**Table 3. Chemical Results Summary
Victoria/Point Comfort Area, Flight 24**

Pass	Date	Time (UTC)	Chemical	Max Concentration* (ppm)
1	2021-03-12	20:06:56	ND	ND
2		20:31:22	ND	ND
3		20:58:58	ND	ND
4		21:07:18	ND	ND
5		21:22:24	ND	ND
6		21:30:45	ND	ND
7		21:39:50	ND	ND
8		21:47:56	ND	ND
ND = No Detections				

** The ASPECT FTIR is a standoff detector – measurements are taken >1,000 ft above the ground, and assumptions are made about the path length of the plume to calculate a concentration estimate. For this reason, these measurements should not be considered equivalent to volumetric measurement, but instead serve as a reasonable estimate of the concentration within the plume. They are not necessarily representative of concentrations at the ground level. Any measurements that appear out of the norm should be confirmed with ground measurements.*

Aerial Photography Results

A full set of high-resolution aerial digital photographs were collected as part of each data collection pass. Weather conditions over the Victoria/Point Comfort areas acceptable for visible image collection. Figure 8 shows an image collected in the survey area with little dynamic content in the frame. Figure 6 (IR image) above does indicate that the facility is in a state of operation, but no visible emissions such as steam are evident.

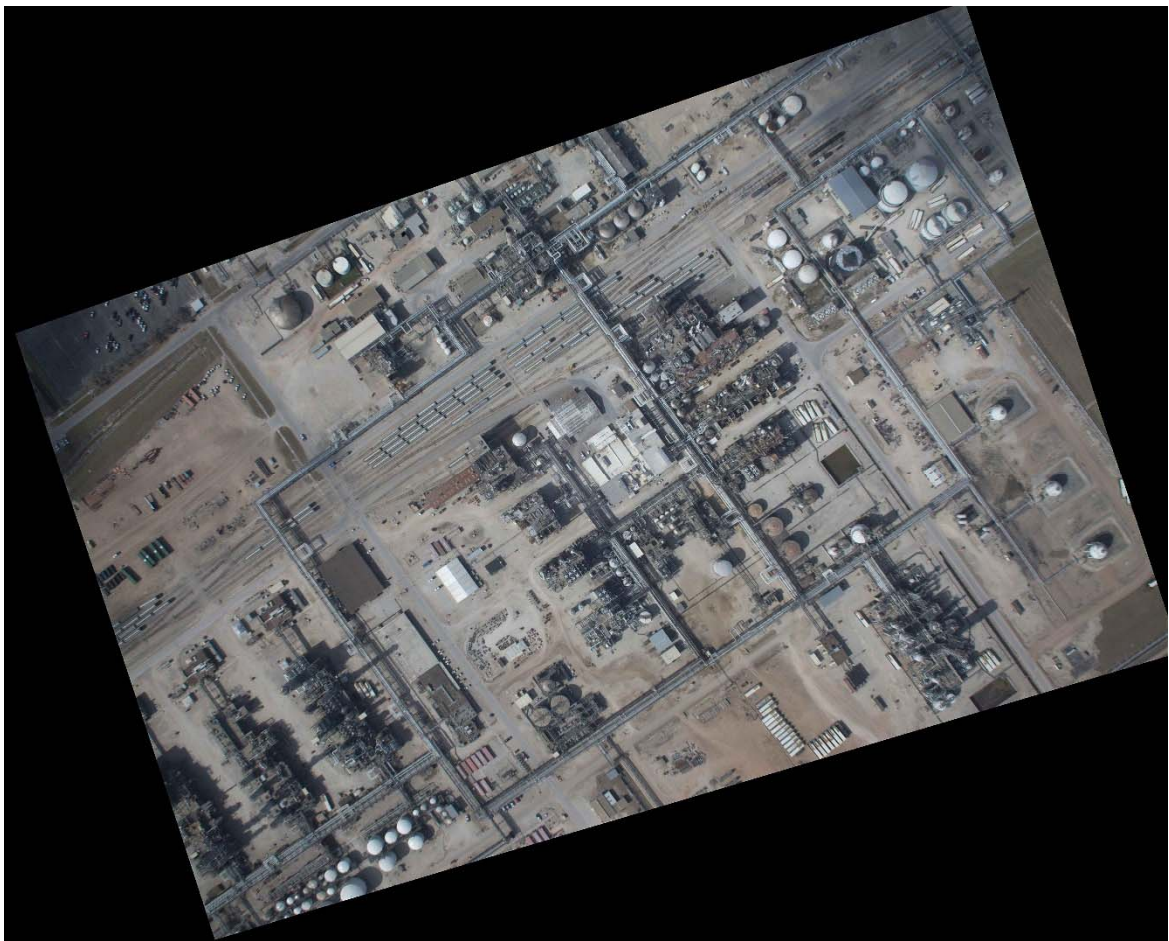


Figure 8. MSIC Aerial Image, Victoria/Point Comfort Area, Flight 24

Conclusion

Poor morning weather conditions in the Corpus Christi area on 12 March 2021 forced the ASPECT system to delay active collection until the afternoon. Even with the delay, the Corpus Christi area still experienced low cloud content and the system was diverted to the Victoria/Point Comfort area resulting in some data collection. No compounds were detected in the area (other than normal air pollutants). After the completion of the mission, the aircraft was released from the area and returned to the home base in Addison, TX.

Appendix A: File Names of Data Collected During Flight
Port Comfort Area, Flight 24, 12 March 2021

Run#	Time (UTC)	Altitude (MSL)	Velocity (knots)	MSIC Data Files	FTIR Data Files	IRLS Data Files	Gamma Files
1	20:06:56	1532	117	20210312200702505.jpg 20210312200706141.jpg 20210312200708856.jpg	20210312_200700_A.igm	2021_03_12_20_07_01_R_01 TA=20.9;TB=41.5;Gain=3	
2	20:31:22	1549	112	20210312203128985.jpg 20210312203131715.jpg	20210312_203126_A.igm	2021_03_12_20_31_27_R_02 TA=35.0;TB=55.2;Gain=3	
3	20:58:58	2609	98	20210312205903375.jpg 20210312205909725.jpg 20210312205915186.jpg 20210312205920631.jpg 20210312205926076.jpg	20210312_205901_A.igm	2021_03_12_20_59_02_R_03 TA=26.8;TB=46.8;Gain=3	
4	21:07:18	2582	103	20210312210724588.jpg 20210312210730033.jpg 20210312210735478.jpg	20210312_210723_A.igm	2021_03_12_21_07_23_R_04 TA=28.5;TB=48.4;Gain=3	
5	21:22:24	2467	111	20210312212229837.jpg 20210312212235282.jpg 20210312212240726.jpg 20210312212246171.jpg	20210312_212227_A.igm	2021_03_12_21_22_28_R_05 TA=15.2;TB=35.1;Gain=3	
6	21:30:45	2582	100	20210312213051038.jpg 20210312213056482.jpg 20210312213101927.jpg	20210312_213048_A.igm	2021_03_12_21_30_49_R_06 TA=23.6;TB=43.7;Gain=3	
7	21:39:50	2534	105	20210312213956712.jpg 20210312214002157.jpg 20210312214007602.jpg 20210312214013062.jpg	20210312_213954_A.igm	2021_03_12_21_39_55_R_07 TA=21.6;TB=41.4;Gain=3	
8	21:47:56	2539	97	20210312214802461.jpg 20210312214807921.jpg 20210312214813366.jpg	20210312_214759_A.igm	2021_03_12_21_48_00_R_08 TA=20.9;TB=40.7;Gain=3	

Appendix B: ASPECT Systems

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 Infra-Red (FTIR) spectrometer coupled with a wide-area IR Line Scanner (IRLS). The ASPECT IR systems can detect chemical compounds in both the 8 to 12 micron (800 to 1200 cm^{-1}) and 3 to 5 micron (2000 to 3200 cm^{-1}) regions. List of chemicals and detection limits are listed in Table 1. 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.

An Imperx mapping camera (29 mega pixels; mapping focal plane array) is concurrently operated as part of all chemical collections. These images are often digitally processed in lower resolution, so they can be transmitted via satellite communication. 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. 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 scientific reach back team. In general, this consists of conducting geo-registration using a USGS Digital Elevation Model (DEM) which promotes superior pixel computation and lessens topographic distortion. The image is checked by the team (using a Google Earth base map) for proper location and rotation.

Airborne radiological measurements are conducted using three fully integrated multi-crystal sodium iodide (NaI) RSX4 gamma ray spectrometers. Each RSX4 spectrometer contains four 4"x2"x16" doped NaI crystals each having an independent photomultiplier/spectrometer assembly. One RSX unit is configured with an additional upward NaI crystal utilized to provide real-time cosmic ray correction. Count and energy data from each crystal and pack is combined using a self-calibrating signal processor to generate a virtual detector output. All radiological spectrometer "packs" are further combined using a signal console controlled by the on-board central computer in the aircraft. Altitude correction data is provided by a radar altimeter with internal GPS systems within the packs serving as a backup. It should be noted that no radiological measurements were conducted on this mission.

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

scientific reach back team.

Table 1. ASPECT Automated Compounds

This table contains ASPECT's library of automated compounds.

Detection limits are for each chemical is found in parenthesis in units of parts per million (ppm)

Acetic Acid (2.0)	Cumene (23.1)	Isoprene (6.5)	Phosphine (8.3)
Acetone (5.6)	Diborane (5.0)	Isopropanol (8.5)	Phosphorus Oxychloride (2.0)
Acrolein (8.8)	1,1-Dichloroethene (3.7)	Isopropyl Acetate (0.7)	Propyl Acetate (0.7)
Acrylonitrile (12.5)	Dichloromethane (6.0)	MAPP (3.7)	Propylene (3.7)
Acrylic Acid (3.3)	Dichlorodifluoromethane (0.7)	Methyl Acetate (1.0)	Propylene Oxide (6.8)
Allyl Alcohol (5.3)	1,1-Difluoroethane (0.8)	Methyl Acrylate (1.0)	Silicon Tetrafluoride (0.2)
Ammonia (2.0)	Difluoromethane (0.8)	Methyl Ethyl Ketone (7.5)	Sulfur Dioxide (15)
Arsine (18.7)	Ethanol (6.3)	Methanol (5.4)	Sulfur Hexafluoride (0.07)
Bis-Chloroethyl Ether (1.7)	Ethyl Acetate (0.8)	Methylbromide (60)	Sulfur Mustard (6.0)
Boron Tribromide (0.2)	Ethyl Acrylate (0.8)	Methylene Chloride (1.1)	Sulfuryl Fluoride (1.5)
Boron Trifluoride (5.6)	Ethyl Formate (1.0)	Methyl Methacrylate (3.0)	Tetrachloroethylene (10)
1,3-Butadiene (5.0)	Ethylene (5.0)	MTEB (3.8)	1,1,1-Trichloroethane (1.9)
1-Butene (12.0)	Formic Acid (5.0)	Naphthalene (3.8)	Trichloroethylene (2.7)
2-Butene (18.8)	Freon 134a (0.8)	n-Butyl Acetate (3.8)	Trichloromethane (0.7)
Carbon Tetrachloride (0.2)	GA (Tabun) (0.7)	n-Butyl Alcohol (7.9)	Triethylamine (6.2)
Carbonyl Fluoride (0.8)	GB (Sarin) (0.5)	Nitric Acid (5.0)	Triethylphosphate (0.3)
Carbon Tetrafluoride (0.1)	Germane (1.5)	Nitrogen Mustard (2.5)	Trimethylamine (9.3)
Chlorodifluoromethane (0.6)	Hexafluoroacetone (0.4)	Nitrogen Trifluoride (0.7)	Trimethyl Phosphite (0.4)
Chloromethane (12)	Isobutylene (15)	Phosgene (0.5)	Vinyl Acetate (0.6)