

Airborne Spectral Photometric Environmental Collection Technology

ASPECT Air Quality Survey for Hurricane Ida Baton Rouge, LA. September 02 2021



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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

Hurricane Ida made landfall at 11:55 AM CDT Sunday, August 29 as a high-end category-4 hurricane, with maximum sustained winds of 150 mph. The storm moved ashore near Port Fourchon, Louisiana after a period of rapid intensification, tying for the fifth strongest landfalling continental US hurricane on record with Hurricane Laura of 2020, among three other hurricanes. Severe wind and large-scale flood damage have been reported to property and infrastructure in much of southeast Louisiana, including significant damage in New Orleans, Louisiana. In addition, Ida has caused widespread damage across the Mid-Atlantic and Northeast US.

On September 2nd, the State of Louisiana requested ESF-10 assistance through FEMA and Region 6 asked for the ASPECT plane to be deployed in support of the response to Hurricane Ida. The state wanted assistance monitoring facility emissions in the industrial area between Baton Rouge and New Orleans, where flaring is resulting in the visible emission of black smoke.

ASPECT was tasked to perform remote chemical sensing over target properties to screen for airborne chemicals and take high-resolution photos to provide situational awareness. Potential areas identified for monitoring included: East Baton Rouge, Ascension, Iberville, St. James, St. John, St. Charles, Jefferson, and Orleans.

To support the Hurricane Ida response effort a total of 11 data collection runs (3 tests and 8 site passes) were made. Weather was conducive to successful data collection. Winds were light and predominantly from the West. Some scattered storms formed near Baton Rouge in the late afternoon that were routed around en route to the airport.

ASPECT Air Quality Survey

Hurricane IDA

Baton Rouge, LA

September 2, 2021

Background and Operational Overview

Hurricane Ida made landfall at 11:55 AM CDT Sunday, August 29 as a high-end category-4 hurricane, with maximum sustained winds of 150 mph. The storm moved ashore near Port Fourchon, Louisiana after a period of rapid intensification, tying for the fifth strongest landfalling continental US hurricane on record with Hurricane Laura of 2020, among three other hurricanes. Severe wind and large-scale flood damage have been reported to property and infrastructure in much of southeast Louisiana, including significant damage in New Orleans, Louisiana. In addition, Ida has caused widespread damage across the Mid-Atlantic and Northeast US.

On September 2, ASPECT was tasked to conduct a wide area air quality screening level assessment of areas populated with Risk Management Plan (RMP) sites and petrochemical facilities using the ASPECT system for detections of any airborne contaminants from ASPECT's 76 chemical detection library in the areas affected by Ida. The Region wanted to know if any detections were found, the location of the detection, and the concentration detected.

The first data collection was done over the Shell Norco East facility. After collecting two data sets over the Marathon Petroleum Company, the plane returned to the West side of the Shell Norco Facility and collected data there. There were two flares producing black smoke plumes at the Shell Norco East facility. Next, the plane headed to the Phillips 66 pipeline site. The ground crew provided two coordinates to the flight crew with instructions to fly from south to north between the two points. The first point started at the coordinate provided by Region 6, and the second point was chosen along a linear clearing which was presumed to be an indication of where the pipeline was buried. Just north of this site was one of the LDEQ priority sites, the Union Carbide Corp. Because it was so close, the flight crew was instructed to collect data there as well before flying to Baton Rouge to refuel and upload data. All sites surveyed are shown in Table 1.

There were no chemical detections at the sites surveyed. Extremely slow satellite transmission speeds (possibly due to high bandwidth use by other first responders) resulted in long delays in data collection. Some chemical photos were pulled down during flight, with the majority needing to be pulled down with a more high-speed internet connection on the ground. Unfortunately, when attempting to process the data on the

ground, the computer crashed multiple times, resulting in the decision to return to home base in Addison, TX to switch to a backup computer. The mission will resume on September 3. It should be noted that flight 1 was a system test mission and is not included in this report. Accordingly, all data collection begins with flight 2.

Table 1. Sites Covered on 02 September 2021 Flight

Facility	Lat	Lon
Shell Chemical LP - Norco Chemical Plant - East Site	29.995556	-90.4097
Marathon Petroleum Company LP - Louisiana Refining Division - Garyville Refinery	30.061322	-90.5935
Shell Chemical LP - Norco Chemical Plant West Site	30.004925	-90.4224
PHILLIPS 66 PIPELINE LLC	29.923889	-90.4825
Union Carbide Corp - St. Charles Plant	29.982289	-90.4556

General Mission Objectives

Once granted access to fly over the sites, the following general mission objectives were employed in conducting 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 summary of the ground weather conditions during the missions can be found in Table 2.

**Table 2. Ground Weather for Baton Rouge, LA, Flight 2
2 September 2021**

Time	1153	1253	1353	1453	1550	1653
Wind direction	0 degrees	0 degrees	0 degrees	0 degrees	22.5 degrees NNE	315 degrees NW
Wind speed	1.3 m/s (3.0 mph)	3.1 m/s (7.0 mph)	1.3 m/s (3.0 mph)	2.2 m/s (5.0 mph)	4.0 m/s (9.0 mph)	3.1 m/s (7.0 mph)
Temperature	31.1 C	31.7 C	31.7 C	32.2 C	31.1 C	27.8 C
Relative humidity	63	63	63	64	71	70
Dew point	23.3 C	23.9 C	23.9 C	24.4 C	25.0 C	21.7 C
Pressure	1012.9 mb	1012.6 mb	1011.9 mb	1011.6 mb	1010.6 mb	1010.2 mb
Ceiling	Clear	Clear	Clear	Clear	Few 4100 Ft	Few 3800 Ft

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 2 the Baton Rouge area was surveyed, and the flight path is shown in Figure 1.

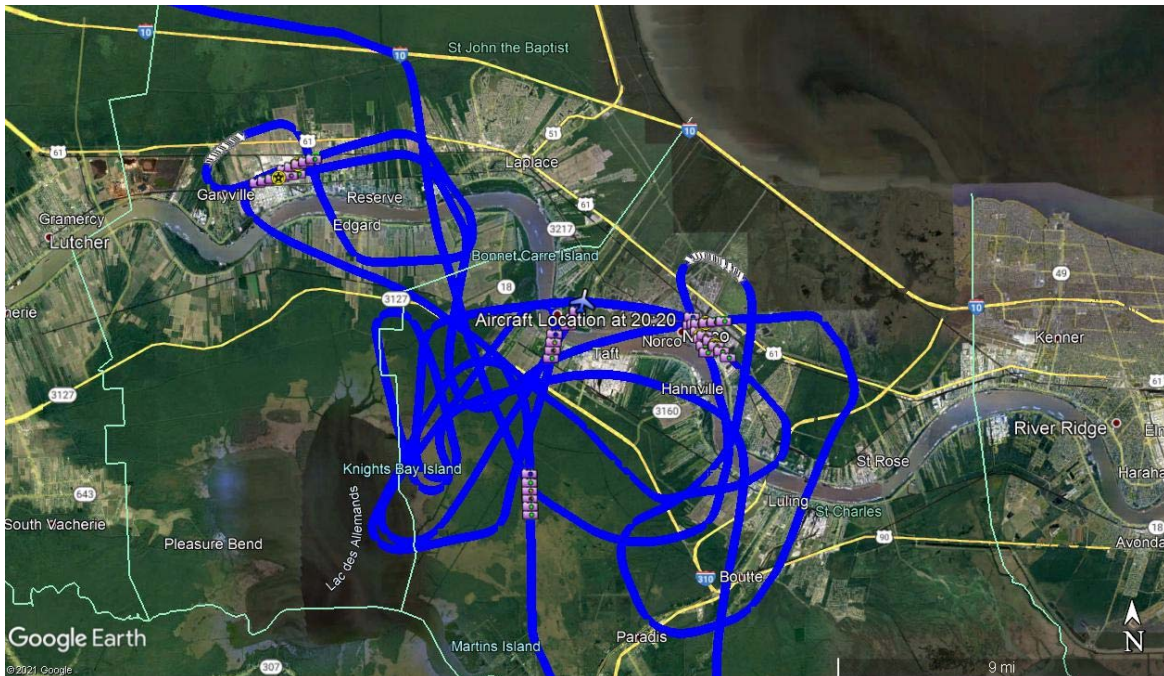


Figure 1. Data Collection Flight Path over the Baton Rouge Area Fight 2,
September 2 2021

Line Scanner Data Results

A total of 11 data collection runs were made over the Baton Rouge area and during each collection run an infrared line scanner image was generated. Figure 2 shows a 3-band infrared image collected over a facility within the survey area. Examination of the image shows two small flares on the western side of the facility. Process piping throughout the facility shows ambient temperatures. No chemical plumes can be observed being emitted from the facility.

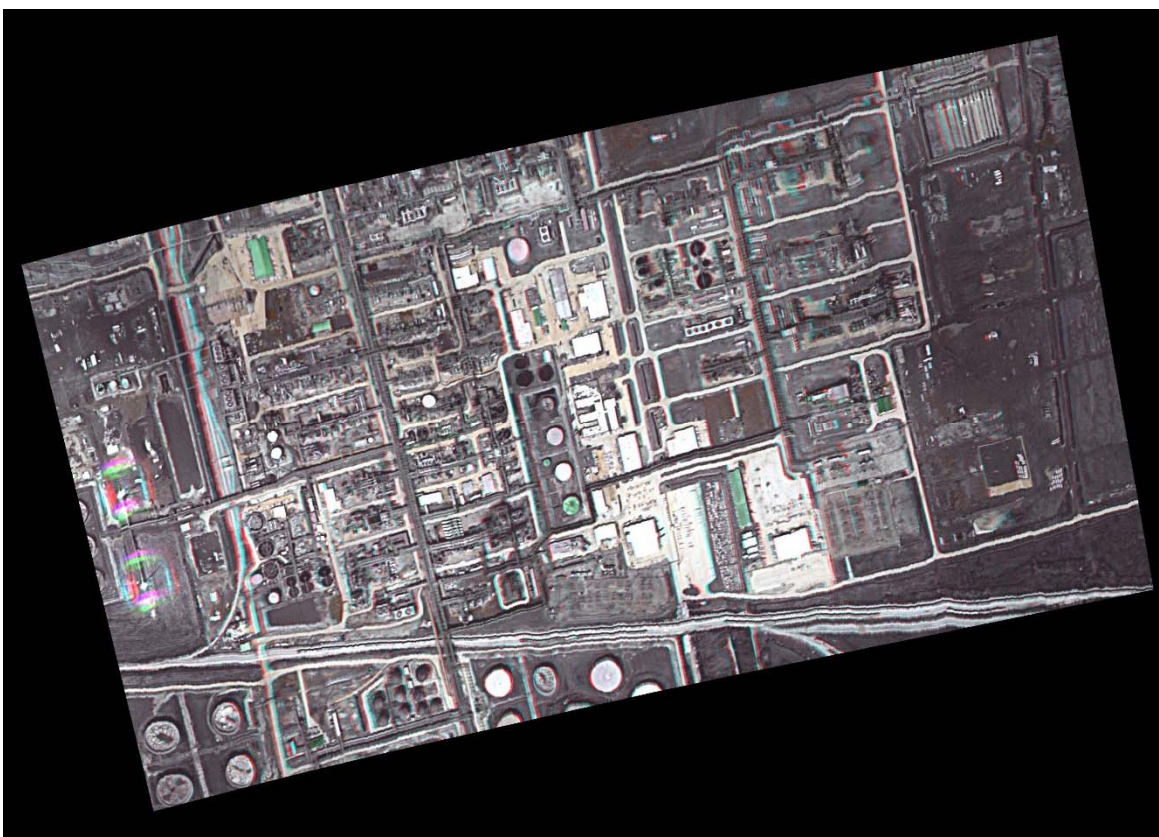


Figure 2. Three band IR image, Baton Rouge Area, Run 5, Flight 2, September 2 2021

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 C, Table 1). In addition, collected data was also manually quality checked against a collection of published library spectra for each chemical detected.

ASTECT did not detect any programmed compounds (those found in Appendix B, Table 1) as part of the mission over the Baton Rouge areas on September 2. Details of the monitoring results can be found in Table 2.

**Table 2. Chemical Results Summary
Baton Rouge Collection Area, Flight 2**

Pass	Date	Time (UTC)	Chemical	Max Concentration (ppm)
1	2021-09-02	17:21:59	ND	ND
2		17:46:10	ND	ND
3		18:05:06	ND	ND
4		18:57:35	ND	ND
5		19:10:35	ND	ND
6		19:19:22	ND	ND
7		19:28:16	ND	ND
8		19:38:51	ND	ND
9		20:02:54	ND	ND
10		20:11:35	ND	ND
11		20:20:00	ND	ND

Aerial Photography Results

A full set of high-resolution aerial digital photography were collected as part of each data collection pass. Weather conditions over the New Orleans area allowed high quality aerial images to be collected. Figures 3 and 4 show representative overhead and oblique images of the Shell Norco Plant East Site imaged on Flight 2.

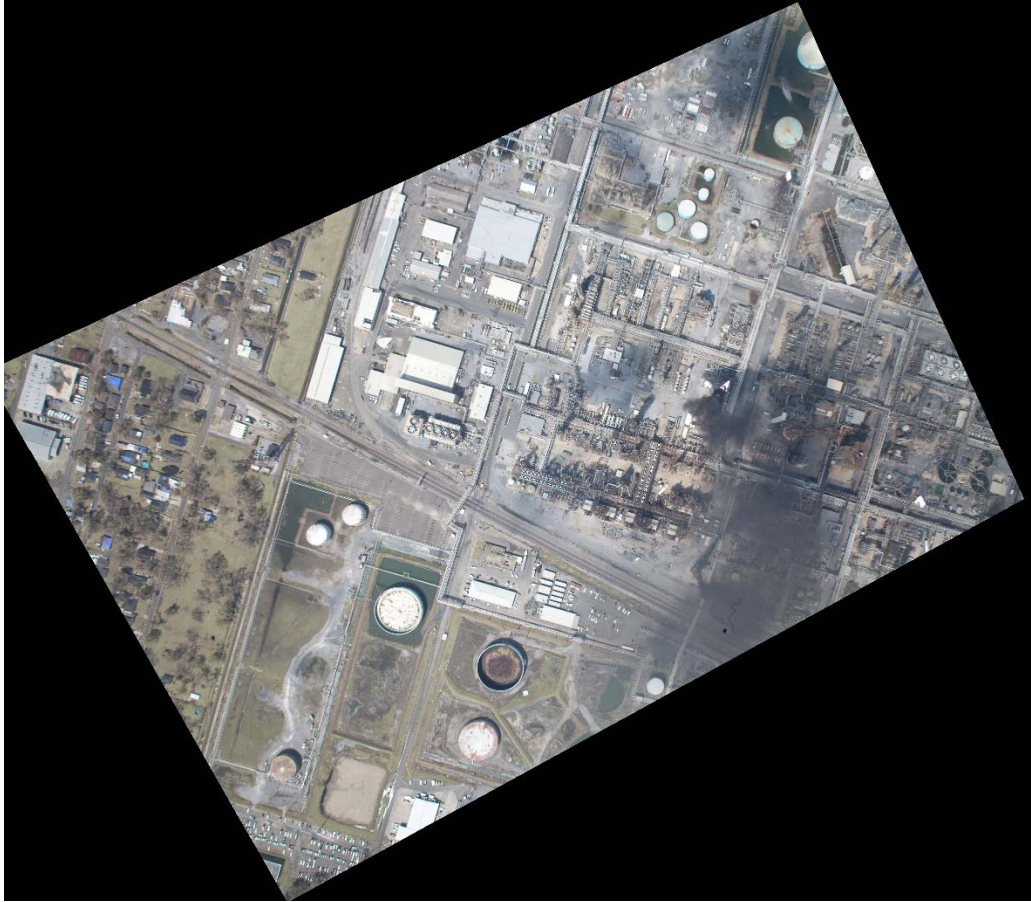


Figure 1. MSIC photo taken over the Shell Norco Plant East Site in Garyville, LA on September 2, 2021



Figure 2. Oblique photo taken over the Shell Norco Plant East Site in Garyville, LA on September 2, 2021

Conclusion

ASPECT conducted one flight mission on September 2 including air monitoring survey collections over the New Orleans area. Weather conditions were favorable for all types of data collection. Although two black plumes were visible over one of the sites, no major emissions were detected with the FTIR.

Appendix A: File Names of Data Collected During Flight
Baton Rouge Collection Areas, Flight 2, September 2, 2021

Run#	Time (UTC)	Altitude (MSL)	Velocity (knots)	MSIC Data Files	FTIR Data Files	IRLS Data Files	Gamma Files
1	17:21:59	5185	146	20210902172205321.jpg 20210902172212572.jpg 20210902172218935.jpg	20210902_172201_A.igm	2021_09_02_17_22_04_R_01 TA=28.9;TB=49.5;Gain=3	
2	17:46:10	5179	151	20210902174616618.jpg 20210902174622981.jpg 20210902174629329.jpg	20210902_174612_A.igm	2021_09_02_17_46_16_R_02 TA=24.8;TB=44.8;Gain=3	
3	18:05:06	5177	155	20210902180512152.jpg 20210902180519405.jpg 20210902180525768.jpg	20210902_180508_A.igm	2021_09_02_18_05_12_R_03 TA=12.5;TB=32.4;Gain=3	
4	18:57:35	2900	104	20210902185742116.jpg 20210902185748465.jpg 20210902185754814.jpg 20210902185801178.jpg 20210902185807527.jpg 20210902185813891.jpg	20210902_185738_A.igm	2021_09_02_18_57_41_R_04 TA=24.2;TB=44.2;Gain=3	
5	19:10:35	2960	106	20210902191041025.jpg 20210902191048278.jpg 20210902191054643.jpg 20210902191100991.jpg 20210902191107340.jpg	20210902_191038_A.igm	2021_09_02_19_10_41_R_05 TA=24.2;TB=44.4;Gain=3	
6	19:19:22	2968	107	20210902191928464.jpg 20210902191934828.jpg 20210902191942082.jpg 20210902191948446.jpg 20210902191954795.jpg 20210902192001143.jpg	20210902_191925_A.igm	2021_09_02_19_19_29_R_06 TA=29.1;TB=49.2;Gain=3	
7	19:28:16	2971	105	20210902192823176.jpg 20210902192829541.jpg 20210902192835889.jpg 20210902192842254.jpg 20210902192848602.jpg	20210902_192819_A.igm	2021_09_02_19_28_23_R_07 TA=31.4;TB=51.4;Gain=3	
8	19:38:51	2906	104	20210902193856857.jpg 20210902193904126.jpg 20210902193910475.jpg 20210902193916824.jpg 20210902193923188.jpg	20210902_193853_A.igm	2021_09_02_19_38_58_R_08 TA=30.2;TB=50.0;Gain=3	
9	20:02:54	2916	106	20210902200300337.jpg 20210902200306702.jpg 20210902200313051.jpg 20210902200319415.jpg 20210902200325764.jpg 20210902200333033.jpg	20210902_200257_A.igm	2021_09_02_20_03_01_R_09 TA=33.0;TB=52.8;Gain=3	
10	20:11:35	2921	106	20210902201141464.jpg 20210902201147813.jpg 20210902201154162.jpg 20210902201200527.jpg	20210902_201138_A.igm	2021_09_02_20_11_42_R_10 TA=31.4;TB=51.5;Gain=3	
11	20:20:00	2919	105	20210902202006230.jpg 20210902202013499.jpg 20210902202019848.jpg	20210902_202004_A.igm	2021_09_02_20_20_07_R_11 TA=24.3;TB=44.5;Gain=3	

**Appendix B: Priority Sites Provided by EPA Region 6 & Louisiana Department of
Environmental Quality**

Facility_Name	Latitude	Longitude	Parish
Deltech LLC - Baton Rouge Facility	30.552892	-91.200536	East Baton Rouge
ExxonMobil Chemical Co - Baton Rouge Plastics Plant	30.551419	-91.175611	East Baton Rouge
ExxonMobil Baton Rouge Chemical Plant	30.484336	-91.169644	East Baton Rouge
Marathon Petroleum Co LP	30.068394	-90.596364	St. John the Baptist
Westlake Vinyls Co LP	30.209167	-91.017222	Ascension
Valero Refining - Meraux LLC - Meraux Refinery	29.930222	-89.944917	St. Bernard
Cornerstone Chemical Company	29.964722	-90.264722	Jefferson
Chalmette Refining LLC	29.937903	-89.969903	St. Bernard
ExxonMobil Chemical Company - Baton Rouge Chemicals North Plant	30.50465	-91.173219	East Baton Rouge
Equilon Enterprises LLC - Norco Refinery	29.995372	-90.410167	St. Charles
The Dow Chemical Company - Louisiana Operations	30.313927	-91.240586	Iberville
Rubicon LLC - Geismar Facility	30.20139	-91.01222	Ascension
BASF Corp - Geismar Site	30.18425	-91.002778	Ascension
Union Carbide Corp - St. Charles Plant	29.982289	-90.455622	St. Charles
Phillips 66 Co - Alliance Refinery	29.68406	-89.98145	Plaquemines
Axiall LLC - Plaquemine Facility	30.267167	-91.184258	Iberville
ExxonMobil Fuels & Lubricants Co - Baton Rouge Refinery	30.484392	-91.169444	East Baton Rouge
Equilon Enterprises LLC dba Shell Oil Products US - Convent Refinery	30.107684	-90.890796	St. James
Marathon Petroleum Company LP - Louisiana Refining Division - Garyville Refinery	30.061322	-90.593528	St. John the Baptist
BASF Corp - Zachary Site	29.547603	-90.523231	East Baton Rouge
Occidental Chemical Corporation - Geismar Facility	30.18819	-90.98188	Ascension
St Rose Refinery LLC - St Rose Refinery	29.950875	-90.328497	St. Charles
ExxonMobil Chemical Co - Baton Rouge Polyolefins Plant	30.56215	-91.20387	East Baton Rouge
Shell Chemical LP - Norco Chemical Plant West Site	30.004925	-90.422381	St. Charles
NOVA Chemicals Olefins LLC - Geismar Ethylene Plant	30.230619	-91.052884	Ascension
Roehm America LLC - MMA Plant	29.9575	-90.265833	Jefferson
Valero Refining - New Orleans LLC - St Charles Refinery	29.985781	-90.3955	St. Charles
Shell Chemical LP - Norco Chemical Plant - East Site	29.995556	-90.409722	St. Charles
BASF Corp - North Geismar Site	30.20594	-90.99195	Ascension

Stolthaven New Orleans, LLC - Braithwaite Facility	29.870919	-89.949339	Plaquemines
Shintech Louisiana LLC - Shintech Plaquemine Plant	30.273611	-91.173333	Iberville
Denka Performance Elastomer LLC	30.053928	-90.524792	St. John the Baptist
Formosa Plastics Corp Louisiana	30.501722	-91.185944	East Baton Rouge
DuPont Specialty Products USA LLC - Pontchartrain Site	30.05388	-90.52472	St. John the Baptist
Occidental Chemical Corp - Taft Plant	29.987222	-90.454722	St. Charles
Syngenta Crop Protection LLC - St Gabriel Plant	30.246728	-91.103508	Iberville
Mosaic Fertilizer LLC - Faustina Plant	30.083914	-90.91345	St. James
Mosaic Fertilizer LLC - Uncle Sam Plant	30.037222	-90.8275	St. James
LBC Baton Rouge LLC - Sunshine Terminal	30.294444	-91.148333	Iberville
Occidental Chemical Corporation - Convent Facility	30.055885	-90.830594	St. James
TOTAL Petrochemicals & Refining USA Inc - Carville Polystyrene Plant	30.229786	-91.073631	Iberville
Targa Midstream Services LLC	29.237034	-89.384977	Plaquemines
EnLink LIG Liquids LLC - Plaquemine Gas Processing Plant	30.236389	-91.241389	Iberville
EnLink LIG Liquids LLC - Gibson Gas Processing Plant	29.643056	-90.961944	Terrebonne
NuStar Logistics LP - St James Terminal	30.030065	-90.843463	St. James
Enterprise Gas Processing LLC - Norco Fractionation Plant	30.015411	-90.402958	St. Charles
Lone Star NGL Refinery Services LLC - Geismar Fractionation Plant	30.218889	-91.035833	Ascension
INEOS Oxide - A Division of INEOS Americas LLC	30.313889	-91.240278	Iberville
Discovery Producer Services LLC - Discovery Paradis Fractionation Plant	29.858889	-90.453333	St. Charles
Plains Marketing LP - St James Terminal	30.004341	-90.848449	St. James
Methanex USA Services LLC - Geismar Methanol Plant	30.206667	-91.020833	Ascension
Dyno Nobel LA Ammonia LLC - Ammonia Production Facility	29.964789	-90.264625	Jefferson
Kinder Morgan Liquids Terminals LLC - Geismar Methanol Terminal	30.205389	-91.023792	Ascension
South LA Methanol LP - St James Methanol Plant	30.039917	-90.863819	St. James
YCI Methanol Plant	29.97481	-90.86775	St. James
IGP Methanol LLC - Gulf Coast Methanol Complex	29.625453	-89.926611	Plaquemines
KMe St James Holdings LLC - Methanol Terminal	29.990919	-90.841239	St. James
Kemira Chemicals Inc	29.964722	-90.264722	Jefferson
PHILLIPS 66 PIPELINE LLC	29.923889	-90.482498	St. Charles
CF INDUSTRIES	30.08328	-90.957665	Ascension

Appendix C: 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 later.

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)