# *2017 ASPECT Preliminary Report*
# *Arkema Plant Response*
# *Crosby, TX*

***August 31, 2017***
***0600 hrs to 1900 hrs***

*Figure 1: Google Earth Image of the facility, February 2017*

# 1 Background

On 30 August 2017 at 0445 hrs the US EPA Region 6 On Scene Coordinator Byrant Smalley contacted ASPECT Program Manager, Dr. Mark Thomas, to activate the ASPECT aircraft and respond to the Arkema Facility explosion located in Crosby, Texas. The facility produces liquid organic peroxides that are used mainly in the production of plastic resins. The explosion was a result of a loss of refrigeration in temporary storage trailers.

A mission order was developed and a pre-flight briefing was completed by 0550 hrs. ASPECT was airborne at 0605 hrs and was over the target at 0720 hrs.

A second flight was initiated at 1050 hrs and the team continues to monitor the site.

# 2 Aircraft Capabilities used on this survey

**Chemical Detection:**
The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 2,800 AGL). The ASPECT System is an emergency response aircraft permitting remote chemical detection in support of the first responder. The system consists of an airborne high speed Fourier transform infrared spectrometer (FTIR) coupled with a wide-area IR line scanner. 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.

**Photo Capabilities:**
A still digital Nikon DX2 camera collects visible aerial imagery as part of the core data product package. It consists of a 12.4 mega pixel CMOS camera supporting a 3:5 aspect ratio frame. The system uses a 28 mm wide-angle lens and is slaved 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 the aircraft is in flight status or approximately 600 frames per hour can be automatically batch processed once the data is downloaded from the aircraft.

An Imperx mapping camera provides a similar aspect ratio and aerial coverage at a much higher resolution (29 mega pixels). Like the Nikon DX2, it is slaved to the primary IR sensors and provided 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 are pulled from the ASPECT after the sortie and often made available at a later time.

Data are processed using onboard algorithms while the aircraft is in flight and preliminary results are sent using a satellite system to the ASPECT reach back team for QA/QC analysis. The reach back team is operating from small hanger offices located at Million Air, Addison, TX.

# 3 Results

Weather Conditions and Crew Report

0725 hrs: Weather conditions (Crosby, TX) at the time of data collection consisted of cloudy skies with about 10 miles of visibility. Winds were reported from the northwest at 1-2 Kts at ground level (pressure 1013 mbar). Upper level winds up to about 3,000 the winds remain calm. Above this altitude the wind speeds increase from the west to about 40 Kts. The surface temperature was 23°C with a humidity of 85%. Flight conditions at altitude were reported to be turbulent. The crew reported that they can see the fire but there was no visible plume over the facility.

1230 hrs: Weather conditions (Crosby, TX) at the time of data collection are clear with about 10 miles of visibility. Flight conditions at altitude were reported to be smooth.

Aerial Photographs

Figures 2 & 3 show a visible image of the facility with no observed plume and the flight path highlighted when IR sensors were active.

*Figure 2: Low resolution aerial images pulled from the aircraft while in flight over the facility, 30 August 2017 at about 0730 hrs CST.*

Oblique Photos:

High-resolution oblique photos provide an alternative view of the area. Figures 3 - 4 show visual conditions when the aircraft arrived on site. Cloudy weather combined with low light conditions are reflected in these images.

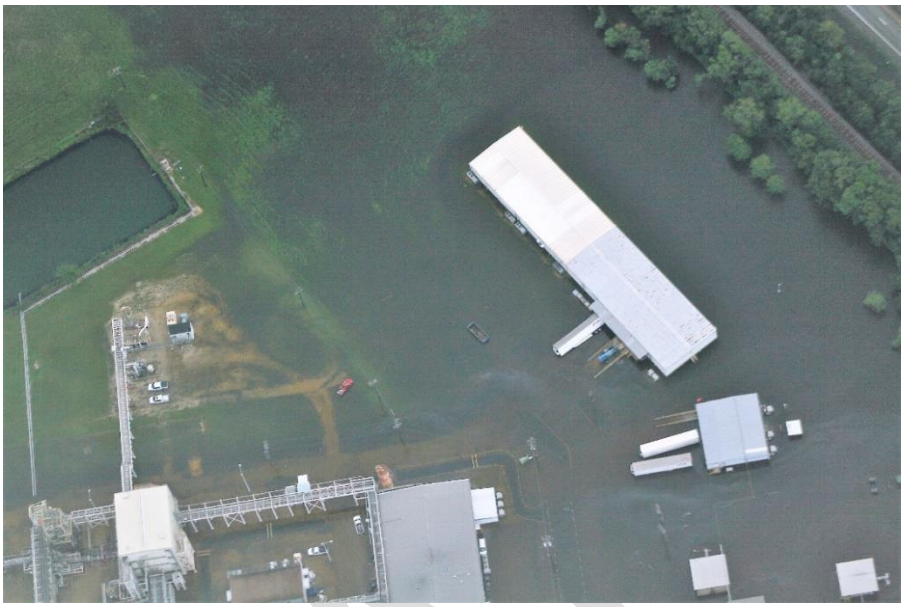

*Figure 3: Oblique photo prior to explosion/fire on 30 August 2017.*

*Figure 4: Oblique photo after explosion/fire on 31 August 2017*

High-resolution aerial photos provide downward view of the area. Figures 5 has been enhanced due to poor visual conditions when the aircraft arrived on site. Foggy weather combined with low light conditions is reflected in this image.

*Figure 5: Aerial photo over the site captured during the morning flight on 31 August 2017.*

*Figure 6: Low resolution aerial image retrieved from the aircraft during the afternoon sortie, approximately 1335 hrs. A copy of the entire image will be provided in an email. A portion of the photo was enlarged to show the affected building.*

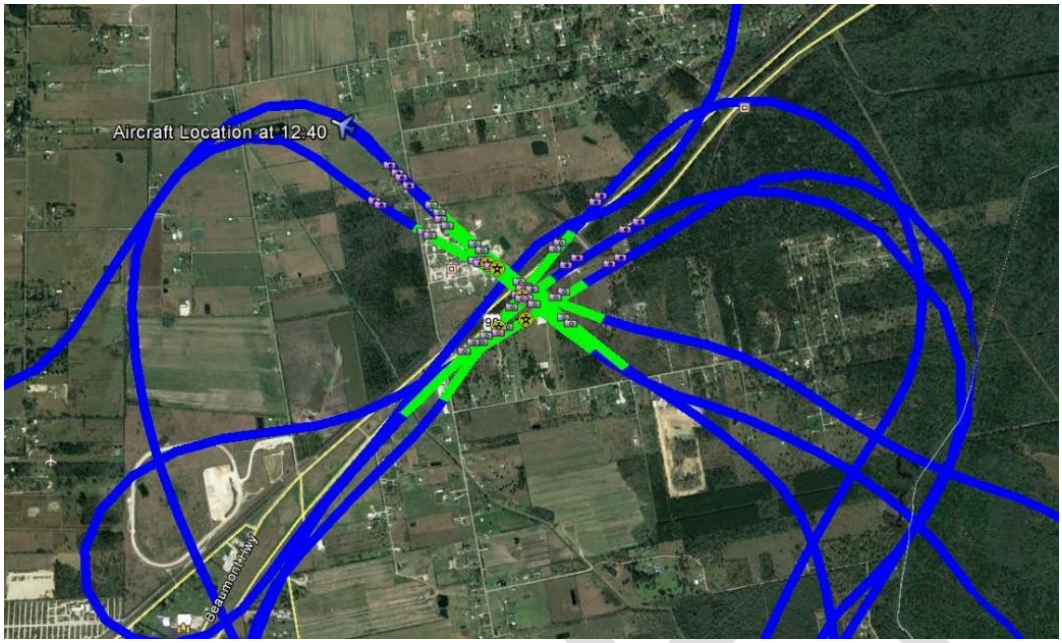


*Figure 7: Flight path over the facility at 0731 hrs CST (1231 hrs UTC) showing several passes where aerial imagergy and IR sensors were active.*

0810 hrs: The aircraft crew reported that it appears the fires has burned out.

0830 hrs: The aircraft was requested to return to base for high resolution data download.

There were ***no automated chemical detections in the morning sortie.*** There are no significant or anomaly detections reported during the afternoon sortie, which is currently ongoing.

The ASPECT technical reach back team manually inspected and analyzed 21,000 FTIR spectral measurements from the morning sortie. No significant deviations or anomalies were associated with the explosion and subsequent fire, however ozone was detected which was likely created during the fire.

Commonly occurring air pollutants such as ozone and PAN (Peroxyacytyl nitrate) are being detected which confirms that the FTIR spectrometer is operating properly. Spectra images of these constituents are shown in Figures 8 & 9.

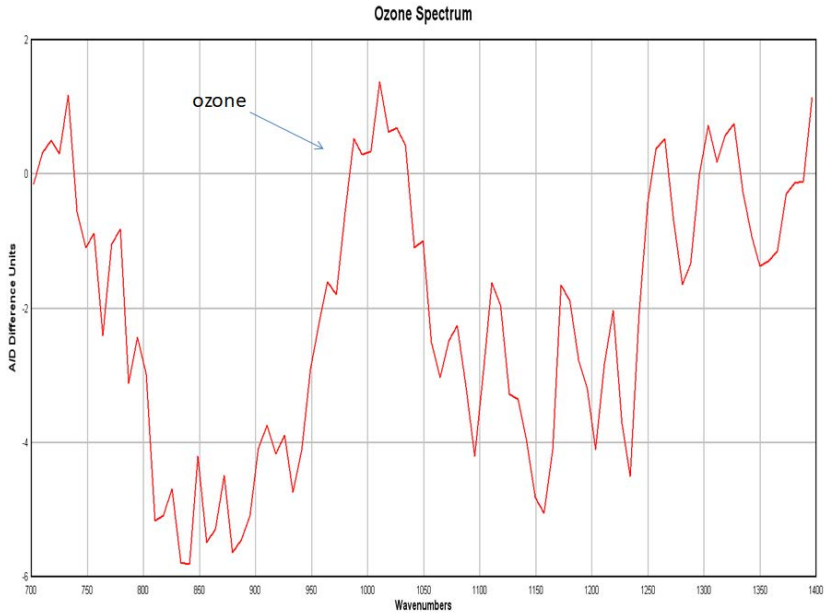


*Figure 8: Passive (remotely detected at 2,800 ft AGL) FTIR spectra showing ozone, a commonly occurring air pollutant, but this measurement suggests that ozone is being generated by the fire (e.g., the spectral image shows that the ozone is hotter than the background). This also confirms that the instrument was operating properly.*

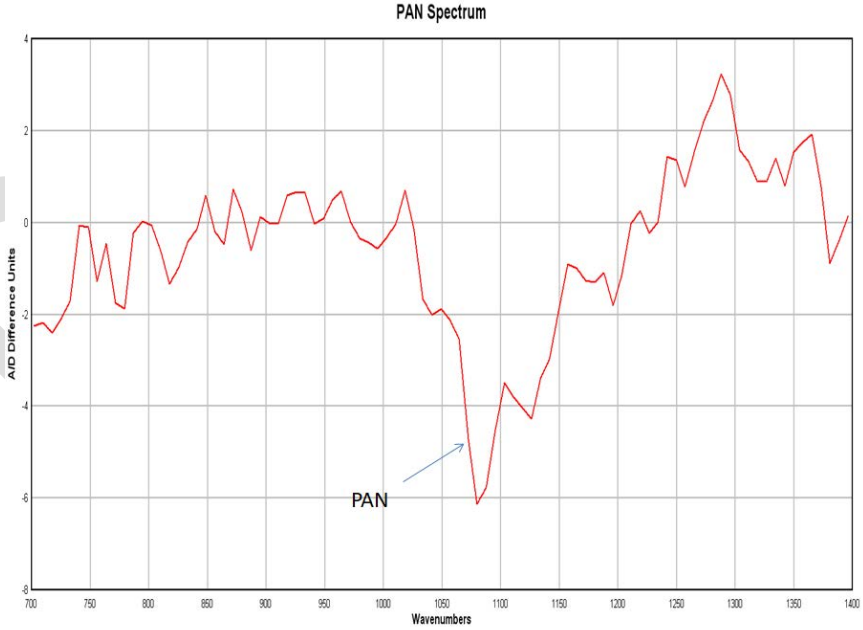


*Figure 9: Passive (remotely detected at 2,800 ft AGL) FTIR spectra showing PAN (Peroxyacytyl nitrate), a commonly occurring air pollutant. This confirms that the instrument was operating properly.*

0930 hrs: ASPECT landed at its base of operations, Addison Airport.

1330 hrs. ASPECT continues to monitor the site with no significant detections. Additional imagery continue to be collected and some are included in this report.

1415 hrs. ASPECT begins to detect anomalies over the site and the team informed the R6 OSC of potential emissions (Figure 10).

1430 hrs. ASPECT flew over the site again and confirmed significant anomalous detections. The reach back team continues to have poor transmission rates via satellite and is attempting to switch to a backup cellular service. During these activities, the team continues to attempt to pull data from the aircraft for spectral analysis of the detections.

*Figure 10: Location of "weak" peroxide detections during ASPECT passes conducted between 1415 hrs and 1700 hrs. All detections are within the symbols shown in the image. Our collection frequency (70 measurements per second) caused many of the symbols to overlap. White dots collected during Flight 4. Yellow dots collected during Flight 5.*

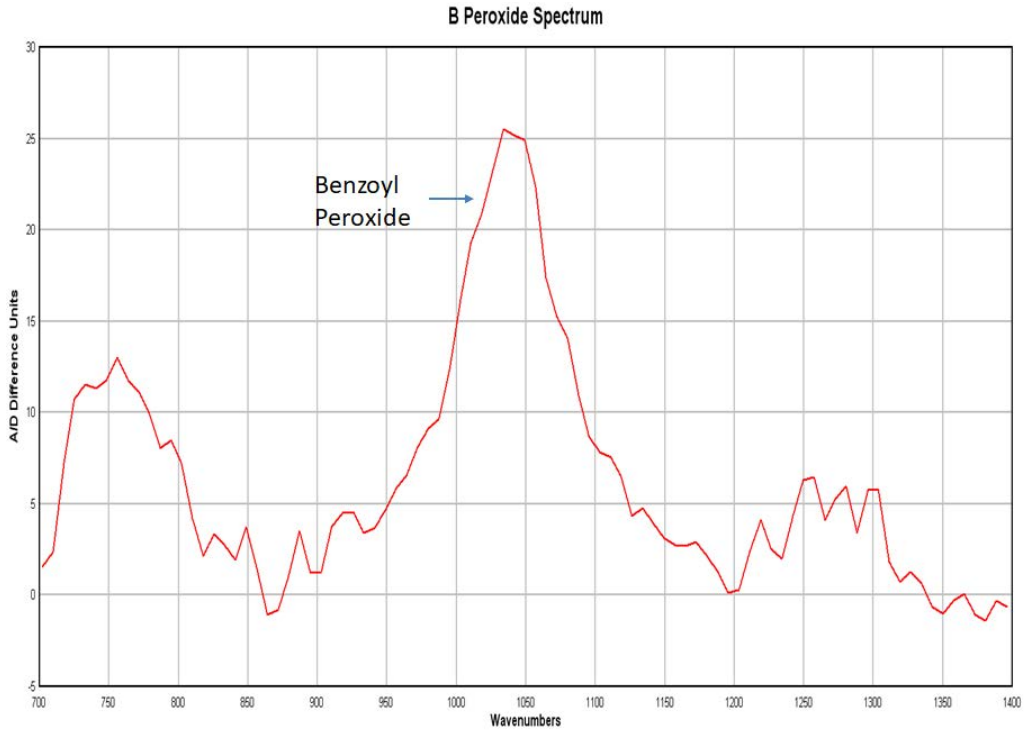


*Figure 11: FTIR spectra showing signature consistent with benzoyl peroxide vapors. The signature represents a typical spectra that exceeded our detection limit of about 5 ppm.*

1445 hrs. ASPECT is headed to Hobby Airfield to refuel. The ASPECT aircrew used this time to upload photos and chemical data to a secure FTP site. The technical reach back team will process these data ASAP.

The afternoon flight (#4) collected 67 aerial photos, 117 oblique photos, and about 37,500 FTIR specta.

1615 hrs ASPECT departs Hobby Airfield to initiate its third flight of the day. Troubleshooting satellite issues continues.

1635 hrs ASPECT reports no significant detections over Arkema facility after two passes. They will continue to monitor the site about every 20 minutes.

1710 hrs and 1730 hrs ASPECT reported detections consistent with benzoyl peroxide over the site at approximately the same location shown in Figure 10.

1820 hrs ASPECT is returning to base. The late afternoon flight (#5) collected 17 aerial photos, about 15 oblique photos, and about 30,000 FTIR specta. These will be processed tomorrow.

ASPECT aircrew will be moving their base of operations from Addison Airfield to Hobby Airfield. Pending any maintenance issues, this will position the aircraft closer to the target areas and reduce the transit time by more than one hour. The ASPECT technical reach-back team will remain in Addison, TX.

Figure 12 provides snap shots taken from an infrared video collected during the afternoon flight. Dark areas indicate lower temperatures. Eight tanks are identified in these images.

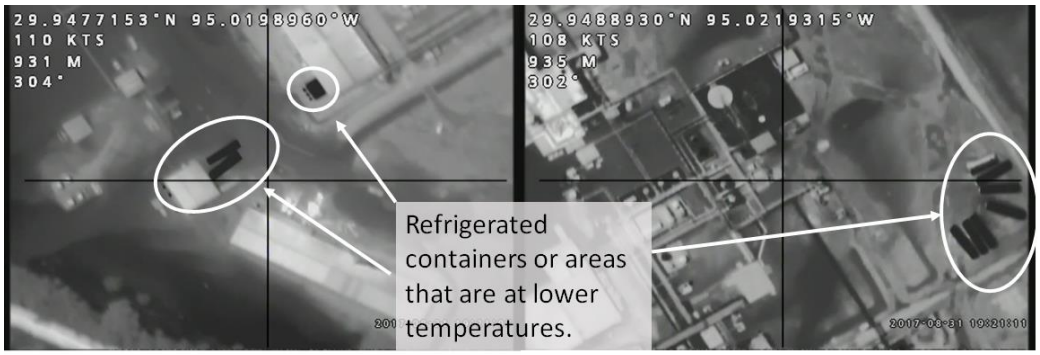


*Figure 12: Infrared images obtained from an infrared video (1320 hrs CST) clearly showing heat signatures which identifies which containers are cooled (black colors) at the Arkema facility. Note the northernmost tank in the image to the right. It is painted blue which may affect its heat signature. These photos show eight tanks that are being refrigerated.*

# 4 Observations

Operational Challenges

1. Satellite communications continue to limit the amount of data that can be pulled from the aircraft. Aerial photos create the largest demand on the system. Another demand on the system is multiple users. The team reduced the number of users accessing the system. We worked with the Satellite vendor and continue to assess potential solutions (e.g., software and hardware) to improve the speed. By 1830 hrs, it appears the transmission rates are improving. We continue to monitor this situation.

2. Actively addressing recording issues with the IR system. It appears that the recording computer is failing in the aircraft. The team will work to replace the parts this evening. The crew go into rest mode and is planned to depart for the Houston area at 0530 hrs tomorrow. In the event that a response is required during the night, the crew and team will respond. Immediately upon landing from the emergency, the crew will land for a rest period.

3. ASPECT detected anomalies, consistent with benzoyl peroxide, shortly after 1400 hrs but due to a slow satellite connection, they landed at Hobby Airfield to refuel and upload the data to a secure FTP site. The technical reach back team continues to resolve issues with the aircraft and process data from Flights 4 & 5.

4. Safety observation and clarification: ASPECT continues to fly in the TFR area (Temporary Flight Restriction) under an assigned squawk code in close coordination with the U.S. Coast Guard. The aircraft does not fly through known chemical plumes or take air samples. It uses a passive remote sensing technology that can detection vapors at distances of over 5,000 ft away. It flies at about 3,000 ft above the hazard.

# 5 ASPECT Team and Crew

Dr. Mark Thomas, ASPECT Program Manager
Dr. John Cardarelli II, ASPECT Radiological / Tech Lead
Mr. Timothy Curry, ASPECT Logistics/Finance Lead
Dr. Robert Kroutil, Kalman Co Inc.ASPECT Chemical / GIS Lead (contractor)
Dr. Brian Dess, Kalman Co Inc. ASPECT Chemical / IT support (contractor)

Sam Fritcher, Airborne ASPECT Inc., CEO
Beorn Leger, Airborne ASPECT Inc., Chief Pilot
Ned Conner, Airborne ASPECT Inc., Pilot
Tom Cruise, Airborne ASPECT Inc., ATP/Operator
Dallas Sley, Airborne ASPECT Inc., Equipment Operator
Robert Kirby, Airborne ASPECT Inc., Engineer
Bruce Dingman, Airborne ASPECT Engineering Tech.

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