

Report
San Antonio Chlorine Derailment Response Using the ASPECT Aircraft
28 June 2004
San Antonio, Texas

Background

At 1630 UTC Region 7 US EPA contacted the Emergency Operations Center at the US EPA Region 6 concerning a train derailment located southwest of San Antonio, TX and the possible deployment of the EPA ASPECT system. Region 6 elected to deploy the system. ASPECT was reported in the air at 1800 UTC after thunderstorms cleared Midway Airport in Midlothian, TX.

The Preliminary site description and situation report indicated that train derailment had occurred and chlorine was releasing from a damaged rail car. The geographical location of the site provided by EPA Region 6 was 29° 20.341' N Latitude/98° 41.220' W Longitude. Reports from the Region 6 operations center indicated that a fire was in progress. Media reports (MSNBC and CNN) indicated that quantities of ammonia might have also been released as part of the derailment.

Chlorine does not possess an infrared signature since it exists as a diatomic gas. Chlorine will, however, form very active infrared compounds once it has combined to form various oxides, organics and inorganics. Based on this information, the ASPECT crew was instructed to look for hydrogen chloride and ammonia due to the active fire associated with the derailment.



Location of San Antonio Chlorine Derailment Response.

Data collected for this mission was done using the EPA ASPECT airborne sensor suite. This suite consists of an infrared spectrometer (Bomem MR-254) and a wide-angle infrared line scanner. The spectrometer is operated at either 4 or 16-wavenumber (cm^{-1}) resolution, which permits a scan rate of 40 (4 cm^{-1}) or 87 (16 cm^{-1}) Hz. This translates into a scan being collected every 1.5 (4 cm^{-1}) or 0.75 (16 cm^{-1}) meters depending on airspeed. The spectrometer has individual 3 to 5 and 8 to 12 micron detectors. Aerial images were collected using an Olympus E-20 digital camera with a spatial resolution of 0.48 meters.

ASPECT reported in prior to the first pass at 1852 UTC. A series of data collection passes was flown using the following mission profile:

Altitude:	2700 Ft MSL
Air Speed:	108 Kts
Direction:	Generally up the plume
Duration:	Block 1 – 4 Passes (16 cm^{-1} Resolution)
	Block 2 – 3 Passes (4 cm^{-1} Resolution)

The initial block of data was collected immediately after the aircraft was on station. Reports from the crew indicated that no visible plume was observed from the derailment (Figure 2). Note: Due to a fault in the line scanner GPS system, images are not geo-rectified.

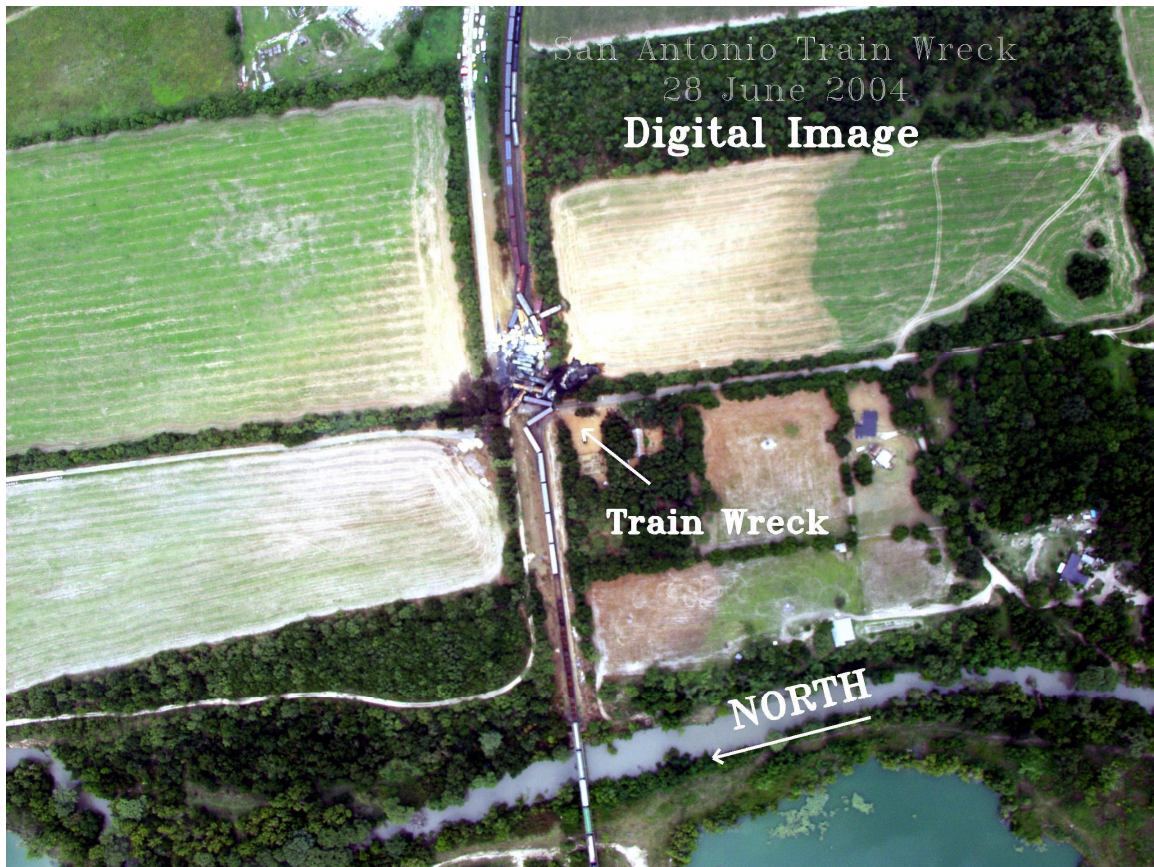


Figure 2. Aerial View Train Derailment, 3000 MSL

The 8 to 12 micron region is an atmospheric window to detect many organic vapors since the area is not masked by water vapor or carbon dioxide. A set of discrimination filters for selected compounds was processed for this run including:

Ethanol	Series 1
Ammonia	Series 2
Isopropanol	Series 3
Acetone	Series 4
Methyl Ethyl Ketone	Series 5
Methanol	Series 6

Filter results show a number of triggers along the data run (Figure 3). These possible hits were compared to the spectra collected. Figure 4 represents every 50th scan selected from the 8 to 12 micron detector (roughly every 37 meters). This data shows no significant features including an absence of peaks near 950 cm⁻¹ indicating that ammonia is not present above detection limits (approx 10 ppm*M). The slight deviation in the baseline centered near 1030 cm⁻¹ appears to be background influenced. All other runs collected showed similar results.

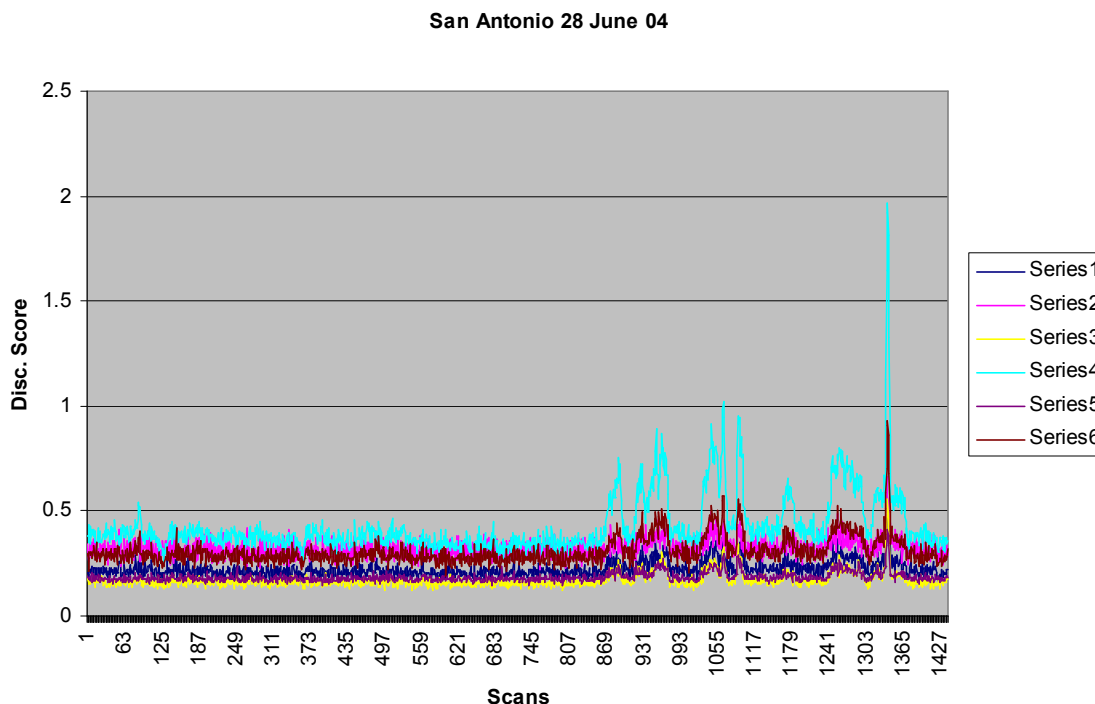


Figure 3. Discrimination Results – 6-Compound Scan

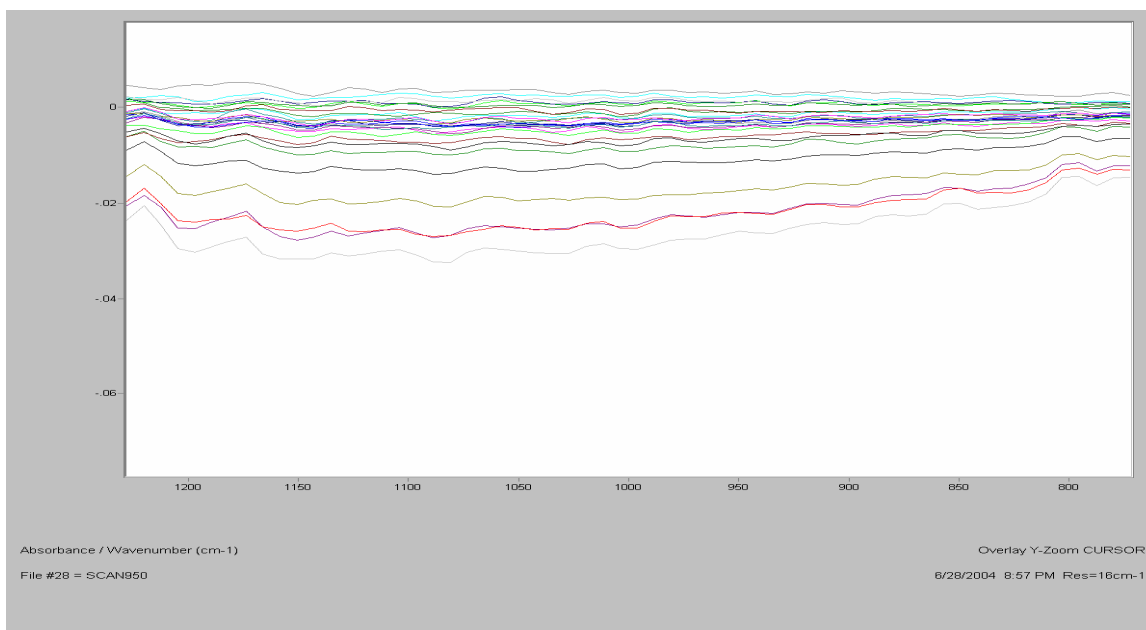


Figure 4. Run 2 Over the Derailment

Intermediate processing products generated late on 28 June implied that HCl might be present. This was investigated by examining the 3 to 5 micron data collected by the spectrometer. Figure 5 shows every 50th scan collected with the 3 to 5 micron detector for run 1. Little content is present other than CO₂ (2250 to 2400 cm⁻¹).

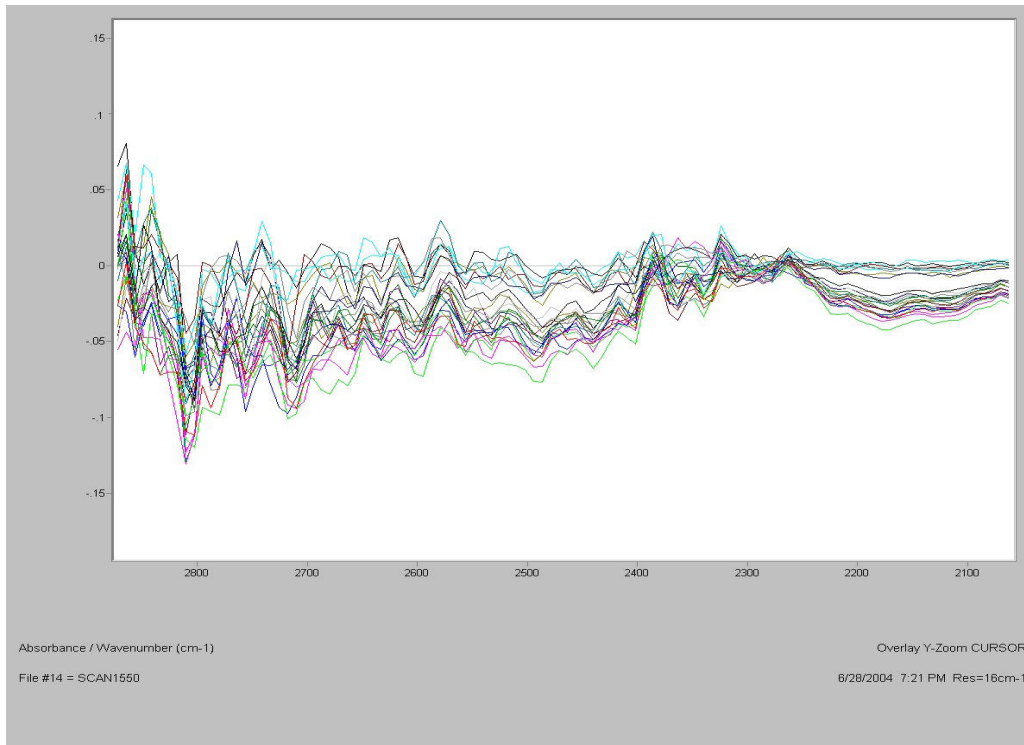


Figure 5 50-Scan Interval Overlay for Run 1 -- 37 Meter Effective Spacing

Table 1 represents detection results for the entire collection. This table also represents the method detection limits since all results were below detectable quantities. If measurable quantities had been detected, the corresponding scan number and geolocation would have been indicated.

Compound	Run 1 (ppm*M)	Run 2 (ppm*M)	Run 3 (ppm*M)	Run 4 (ppm*M)	Run 5 (ppm*M)	Run 6 (ppm*M)
Ethanol	25u	25u	25u	25u	25u	25u
Ammonia	10u	10u	10u	10u	10u	10u
Isopropanol	30u	30u	30u	30u	30u	30u
Acetone	40u	40u	40u	40u	40u	40u
MEK	35u	35u	35u	35u	35u	35u
Methanol	20u	20u	20u	20u	20u	20u

Note: u – At or below method detection limit

Table 1. Monitoring Results

Figures 6 and 7 represent multispectral images of the derailment. This data was collected using a RS800 line scanner imager having an array of 16 cold filters. The image is about 1300 meters wide. Two band pass filters have been optimized for the primary peak of ammonia. Three bands were combined to provide color for the image

and include a broad longwave band, and the two ammonia bands. Figure 7 is an enlargement of Figure 6. Results clearly show the elevated temperature (white areas) corresponding to the area of the fire but no indication of ammonia is present. No other chemical channels showed detections.



Figure 6. IR Image of Plume.

A thermal contour of the scene is represented in Figure 8. This image was generated by utilizing the internal calibration blackbodies of the RS800. These blackbodies are used to radiometrically calibrate each scan of the line scanner unit. While the aircraft was setting up for the first pass, an absence of a plume indicated that the active fire was out. Accordingly, the crew set the blackbody unit to 30° and 35° C, respectively. This was done to enhance the dynamic range of the scanner A/D converters. The image shows that the immediate area of elevated temperature corresponds to the area of the fire. Isolated areas of higher temperature are also noted and most likely correspond to dark colored surfaces heated by solar radiation.



Figure 7 IR Detail

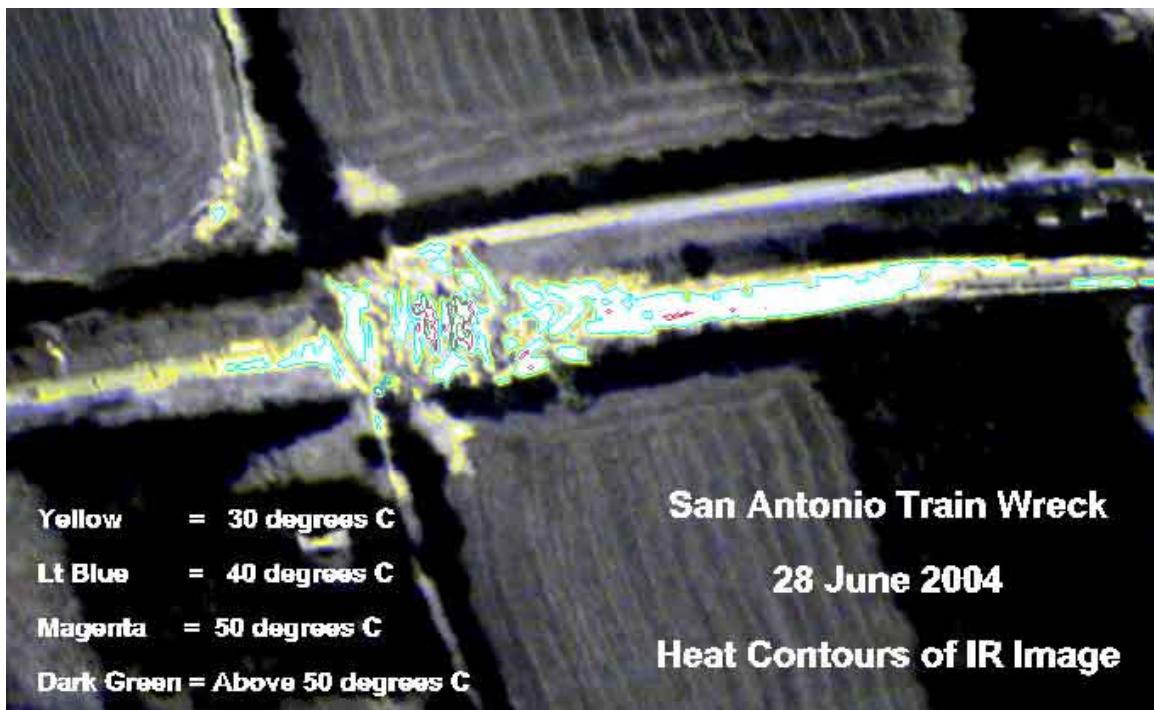


Figure 8 Thermal Contour

Conclusion

Based on the IR data collected for the San Antonio Derailment concentrations of selected compounds were below detection limits of the ASPECT system. Data including both 3 to 5 and 8 to 12 micron spectra was examined over and downwind of the scene. No significant detections were noted other than small quantities of CO₂. A review of chemical imagery for the site shows no significant content. A thermal contour of the scene showed evidence of elevated temperature within the cluster of rail cars corresponding to latent heat from the fire.