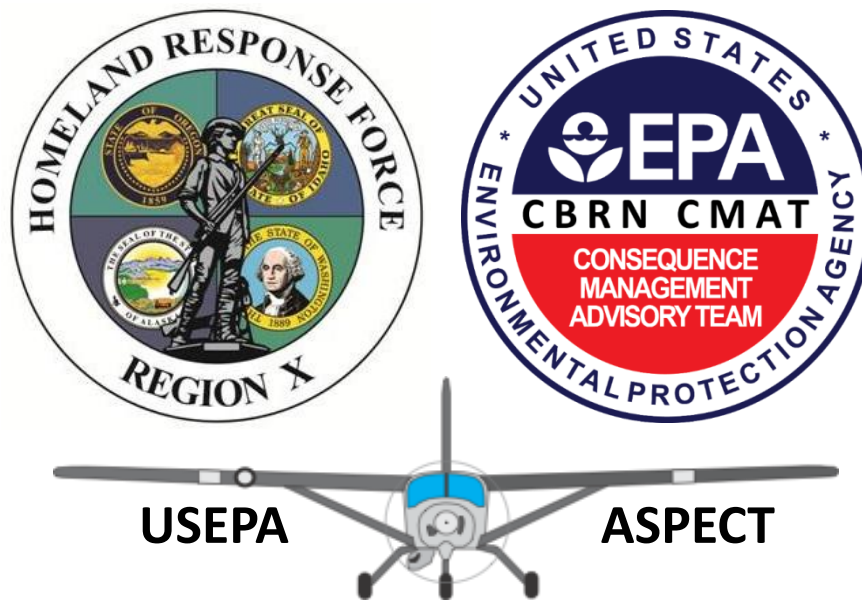


US EPA ASPECT  
Region X Homeland Response Force &  
10<sup>th</sup> Civil Support Team  
Radiological Field Exercise

November 1, 2014



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*Deployment in Support of:*  
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## Executive Summary

The US Environmental Protection Agency (EPA) CBRN Consequence Management Advisory Team (CMAT) Field Operations Branch (FOB) Airborne Spectral Photometric Environmental Collection Technology (ASPECT) Program participated with the Washington National Guard Region X Homeland Response Force (HRF) in a joint radiological field training exercise to simulate operational responses to lost industrial radiological sources. The ASPECT aircraft was used to survey an area in Spokane, WA and transmit that data back to the Seattle-based Tactical Operations Center (TOC) for product development and distribution. Maj Andrew Hill (Region X HRF), was the primary point of contact for the exercise planning and during exercise play and Capt Wesley Watson, 10<sup>th</sup> Weapons of Mass Destruction Civil Support Team (CST), served as a science/liaison officer between HRF, CST, and ASPECT.

The overall exercise objectives were:

1. Conduct a full integration of the ASPECT scientific reach back team with the HRF and 10<sup>th</sup> CST field structure.
2. Test the use of the HRF Defense Connect Online (DCO) communication system to transmit a live feed of the ASPECT computer monitor to HRF and CST officials.
3. Ensure the ASPECT Products provide usable information for the HRF Command to make informed decisions
4. Determine format of products (Google Earth, ESRI)
5. To learn about each program (HRF and ASPECT)

The exercise consisted of three lost industrial radiological sources and consisted of two Cs-137 (5 mCi and 10 mCi) and one Co-60 (5 mCi) source. They were hidden within a two square mile area in Spokane, WA. On 1 November 2014, the ASPECT aircraft was activated in Seattle, WA, flew to Spokane and conducted an environmental survey in the target area. Once on site, the aerial survey took about 20 minutes to complete. All three sources were detected, identified, and products were delivered to the HRF and CST officials within minutes of initial detection.

In general, all objectives outlined in the exercise were accomplished. It is worth noting that the HRF and CST support and use Google Earth products. These are available at the following URL:

[http://www.epaaspect3.net/googleearth/Washington\\_NG\\_rad\\_Nov2014/main/kml/Washington\\_NG\\_rad\\_Nov2014\\_main.kml](http://www.epaaspect3.net/googleearth/Washington_NG_rad_Nov2014/main/kml/Washington_NG_rad_Nov2014_main.kml).

This report details the technical approaches used to develop the products during the exercise and contains an after-action assessment in the conclusions.



## Acknowledgements

The team would like acknowledge the following members of the ASPECT Team that supported this effort:

- Craig McGee, Airborne ASPECT Inc.
- Beorn Leger, Chief Pilot, Airborne ASPECT Inc.
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- Gerry Boyles, Operator, Airborne ASPECT Inc.
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- Doug Draper, Source Authorized User and Health Physicist, Dade Moeller and Associates.
- Christopher Royce, Source Sentinel and Health Physicist, EPA Radiological Emergency Response Team
- Robert Kroutil, Scientist, Kalman Co, Inc.



## 1 ASPECT System Summary

The U.S. Environmental Protection Agency (EPA), CBRN Consequence Management Advisory Team (CMAT) fields a fixed-wing aircraft known as the Airborne Spectral Photometric Environmental Collection Technology (ASPECT). ASPECT is a 24/7/365 response-ready asset that can be airborne within an hour and collecting chemical, radiological and photographic data anywhere in the continental United States within nine hours of notification from its home base near Dallas, TX. A primary goal of the program is to provide actionable intelligence to decision makers within minutes of data collection via the aircraft satellite communication system. More information is available at <http://www2.epa.gov/emergency-response/aspect>.

The ASPECT sensor suite is installed into a Cessna 208B Caravan (Figure 1). The system uses two chemical sensors and three radiological sensors to detect and map chemical plumes and radiological deposition patterns and point sources. The ASPECT chemical sensors include a high resolution (0.5 meter pixels) multi-spectral infrared line scanner that produces a two dimensional image and a point detection Fourier transform infrared spectrometer (FTIR) that can be used to obtain detailed chemical information of points in the plume.



Figure 1. ASPECT Aircraft: Cessna 208B Caravan

Radiological detections are made using sodium iodide (NaI; 25 L), lanthanum bromide (LaBr; 1 L) gamma detectors and a helium-based neutron (He3; 4 L) sensor using full geospatial registration.

Visible imagery is collected using a high resolution digital camera system. All data are georeferenced with embedded geographical coordinates and can be used in a variety of GIS systems. Collected data are processed using onboard algorithms while the aircraft is in flight and preliminary data results are sent using a satellite system to the ASPECT scientific reach back team for QA/QC analysis.



## 2 Radioactive Sources

CBRN CMAT is licensed by the Nuclear Regulatory Commission (NRC) to maintain a series of radioactive sources (gamma and neutron emitters) for field exercises, demonstrations, and training individuals in civil defense activities. CBRN CMAT provides access to these sources to state and Federal partners for training purposes and handles all the field logistics regarding health and safety, transportation and storage. For more information about the CBRN CMAT source inventory and how to request their use for civil defense training purposes contact the CBRN CMAT Radiation Safety Officer, John Cardarelli at [cardarelli.john@epa.gov](mailto:cardarelli.john@epa.gov).

## 3 Open House

On 31 October 2014, the ASPECT Team held an Open House for members of the Washington State National Guard Region X Homeland Response Force (HRF), 10<sup>th</sup> Weapons of Mass Destruction Civil Support Team (CST), and EPA Region 10 (Figure 2). These events are typically scheduled during pre-deployments and exercises to increase awareness of the program. Team members briefly described the instrumentation on the aircraft and answered questions from the attendees. This activity also gave them an opportunity to see the aircraft and engage with the team, pilots and crew.



Figure 2. Region X HRF, 10<sup>th</sup> CST, and Region 10 EPA attending the ASPECT Open House on 31 October 2014



## 4 Radiological Exercise

The radiological exercise was conducted on 1 November 2014 and represented a lost industrial source scenario. It consisted of hiding two Cesium-137 sources (5 mCi and 10 mCi) and a Cobalt-60 (5 mCi) source in various locations within an area in Spokane, WA. ASPECT team members co-located with the Region X HRF in Seattle, WA at the National Guard Tactical Operations Center (TOC). A Science Officer from the 10<sup>th</sup> CST joined the ASPECT Team as a science/liaison officer for the HRF and 10<sup>th</sup> CST.

Per exercise play, at 0940, the HRF requested ASPECT support to conduct a radiological survey over a two square mile area near the Spokane County Raceway. By 1000, the ASPECT Team developed and delivered a mission assignment (Appendix A) to the crew which called for a series of 8 flight lines 600 ft apart at an altitude of about 300 ft AGL (Figure 3). A pre-flight briefing was conducted via conference call and the aircraft was airborne at 1050 for a 90 minute flight to Spokane.

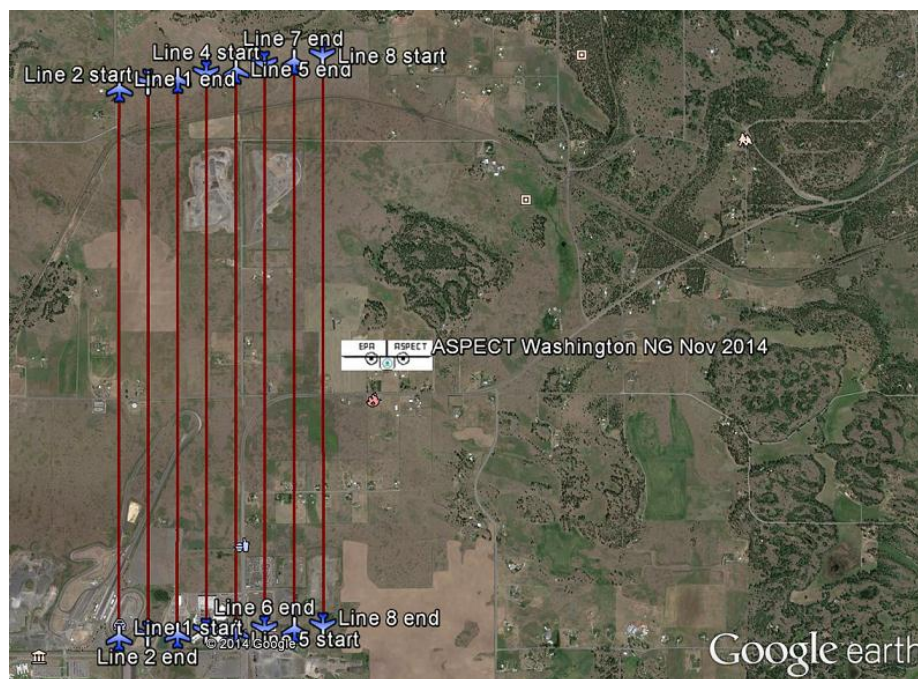


Figure 3. Flight line coverage (two square miles) for the radiological survey. Each flight line is about two miles long separated by 600 ft line spacing.

While the aircraft was en route, an EPA support team stationed in Spokane placed and managed the radioactive sources within designated areas on the Spokane County Raceway property. Local weather conditions caused the aircraft to land at the Spokane airport until air traffic control authorized its release. At 1245, the aircraft was allowed to take off, returned to exercise play, and began collecting radiological data.



A significant objective of this joint exercise was to develop a method to distribute and view products generated by the ASPECT Program. Due to the nature of the Region X HRF and 10th CST programs and the associated DOD requirements on network security, all data were transferred from the ASPECT Team to the Region X HRF using either email or Defense Connect Online (DCO). Email served to transmit static images and products to specific individuals (Figure 4).

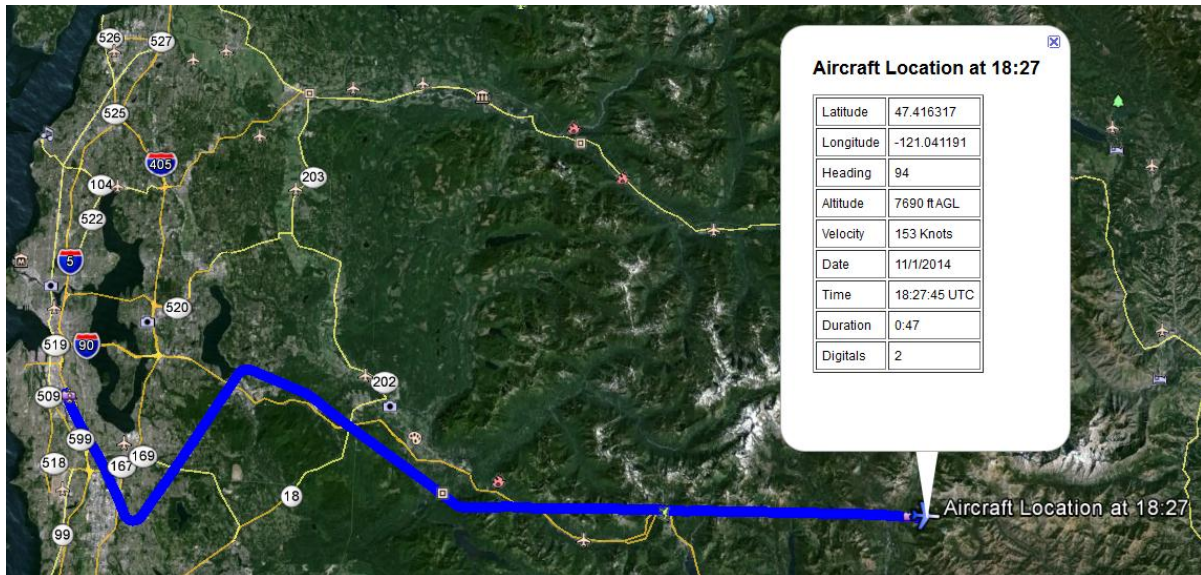


Figure 4. Status report of ASPECT aircraft while en route to Spokane. This product is used to inform the customer where the aircraft is located and the estimated time of arrival.

The DCO served as a more stable means to transmit near real-time data to anyone within the Region X HRF TOC who had the security access to view this information. The ASPECT scientific reach back team established a direct connection to the aircraft from which they communicated with the operators and made adjustments to the detectors when necessary. To prevent this level of access to Region X HRF observers, the DCO account was opened and the Region X HRF IT staff gave the ASPECT controller host rights to share their computer screen. This setup (1) permits the ASPECT Team to control what is distributed to the DCO, (2) prevents unauthorized access to the aircraft computers, and (3) provides flexibility for Region X HRF to determine who they wish to share this information. This is a very powerful tool for Region X HRF in that they can choose to share this near real-time information with anyone in the world.

The advantages of using the DCO is its speed and transparency of observing and delivering data to TOC decision makers. These attributes can also serve as disadvantages if these data are used to make field decisions without first confirming the preliminary results with the ASPECT scientific reach back team. Therefore, it is critically important that access to these data be limited to only those who have a need-to-know and are closely embedded with the ASPECT scientific reach back team.



During this exercise, Region X HRF was able to observe three significant radioactive detections within the first three flight lines (Figure 5).

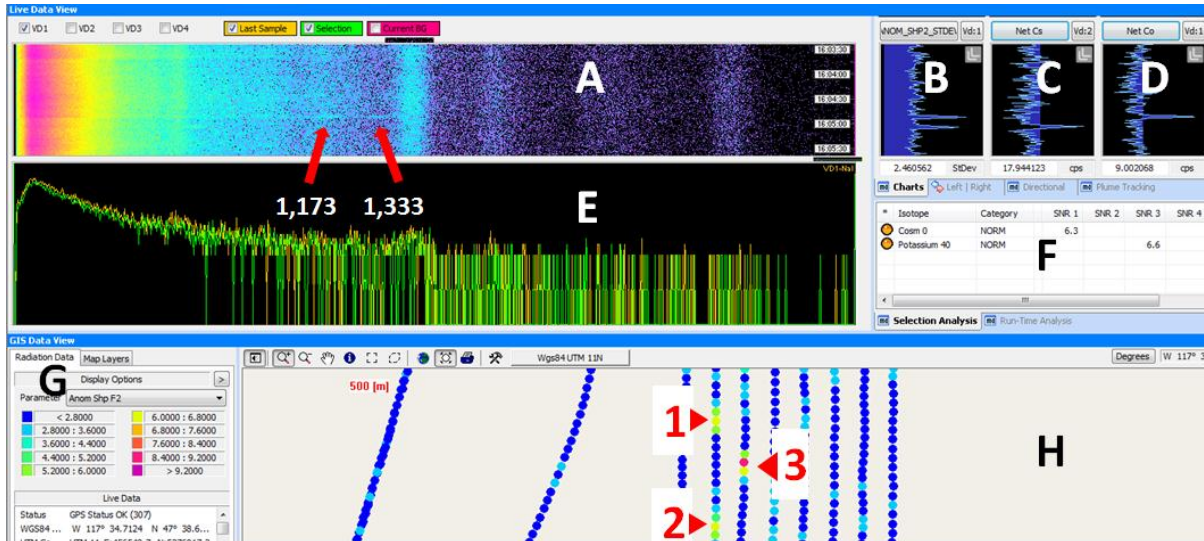


Figure 5. Screen shot of the aircraft computer screen showing the RadAssist application that is monitored by the ASPECT scientific reach back team. It clearly shows the two Co-60 gamma emissions and three distinct radiological sources which were transmitted via satellite to the ASPECT scientific reach back team for QA/QC and confirmation.

The RadAssist software provides a suite of information that permits near real-time detection and identification of radiological data. As labeled in Figure 5, Area A shows several minutes of spectral data in a “waterfall” display color coded by intensity. The Co-60 emissions (1,173 MeV and 1,333 MeV) are clearly visible in the image above. Areas B, C, and D display results from specific algorithms used by the ASPECT scientists to analyze data. Area B shows any anomalous detection during the survey. Two peaks are clearly visible indicating that two sources were detected within a few seconds. Areas C and D are algorithms specific to Cs-137 and Co-60 detections respectively. From these results, it was clear that the first peak in Area B (from the top) occurs at the same time the Co-60 algorithm is triggered in Area D. The second peak occurs simultaneously with Cs-137. Area F provides isotope identification using the built-in algorithms provided by the software vendor, Radiation Solutions, Inc. It would provide another identification method by highlighting the peaks in the Areas A, B, C or D; but it was not used in this figure. Area G shows the legend associated with the breadcrumb display in Area H. Dark blue dots indicate no significant deviations from natural background spectral patterns. As these color change from blue to purple, the confidence of a positive detection increases as does the level of public health threat.

Figures 6 and 7 show a close-up of the locations of two of three sources overlaid on two georectified aerial photos taken by the ASPECT aircraft. The colored dots in this image represent a preliminary product called a Sigma Plot. Each dot in the Sigma Plot represents a

one second measurement that is geospatially positioned in the mid-point between the distance flown by the aircraft during that second integration period (about 200 ft).

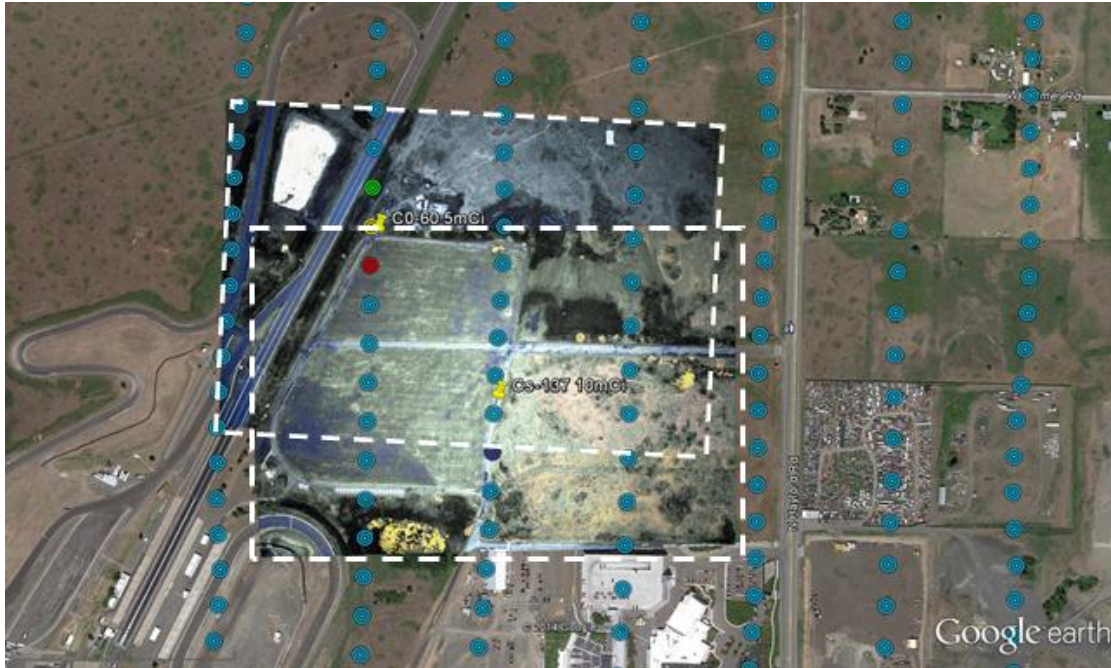


Figure 6. Co-60 (5 mCi) Sigma Plot product on aerial photo.

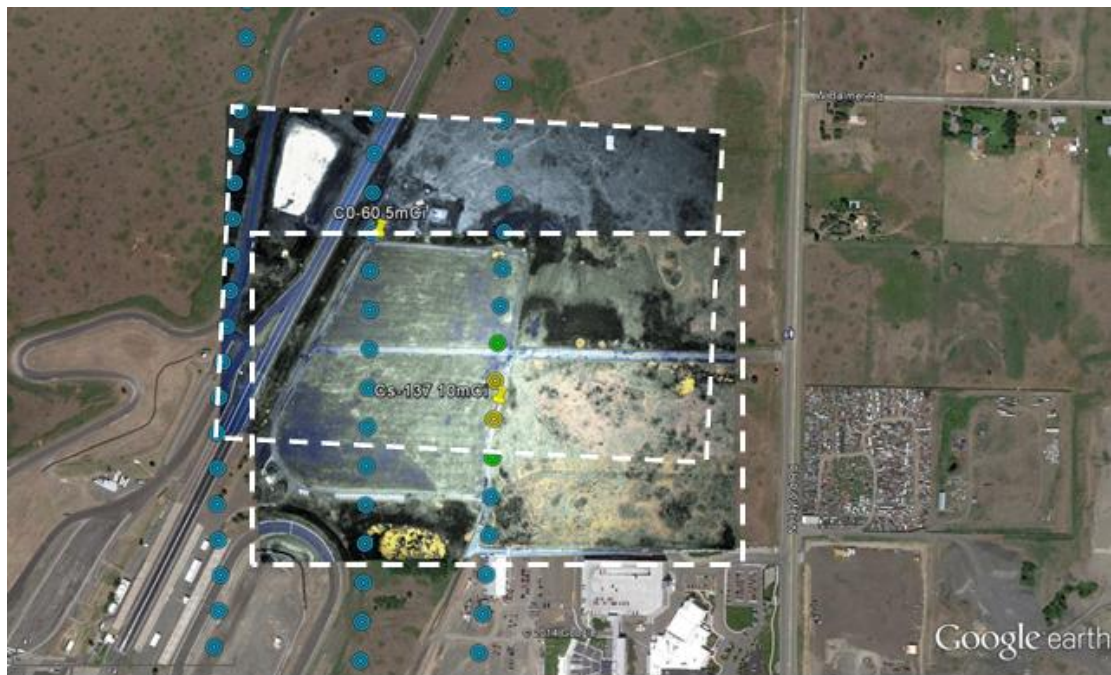


Figure 7. Cs-137 (10 mCi) Sigma Plot product on aerial photo.



The Sigma Plot provides a statistical comparison of every data point relative to a background location which is known not to contain any radiological contamination. For this exercise, the background location was about one mile west of the survey area. Light blue dots are within 2 standard deviations (e.g. sigma) when compared with the background location, green dots are  $>2$  and  $<4$  sigma; yellow is  $>4$  and  $<6$  sigma; and red is  $>6$  sigma. Any deviation from background greater than 4 sigma (e.g., yellow) is usually an initial indicator that the area may warrant a more detailed ground assessment. Any areas greater than 6 sigma (e.g., red) almost certainly warrant further ground investigation and initiate a more intense assessment of the spectral data to identify the isotope(s). In this case, the isotopes were known to be Co-60 and Cs-137.

The Sigma Plot is an adequate tool to quickly screen data values for further investigation. However, based on this exercise and through discussions with the 10<sup>th</sup> CST Science Officer and Region X HRF officials, the ASPECT scientific reach back team determined that additional products were necessary to further isolate the approximate locations and estimate recommended stand-off distances from the sources. A contour of the “anomaly” results met their needs (Figure 8).

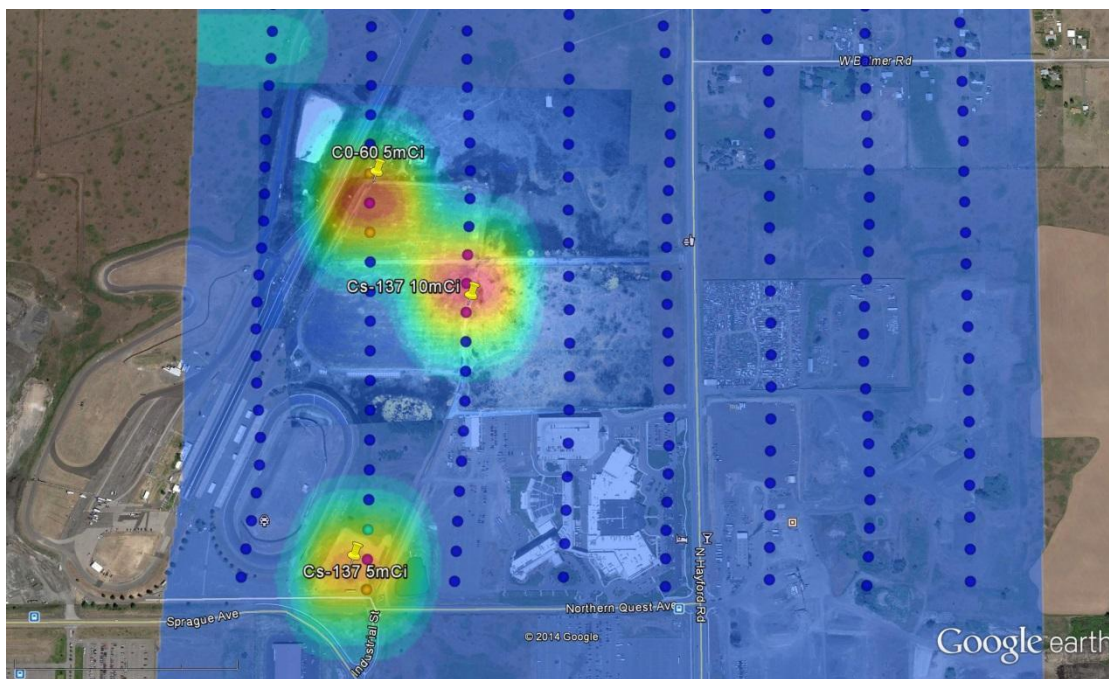


Figure 8. Contour image of the anomaly results clearly show three source locations and relative intensity.



## 5 Post Exercise Assessment

At the conclusion of the joint exercise, the ASPECT Team participated in the after action assessment to determine if the exercise objectives were met, what operational and/or technical gaps were identified, and how these gaps can be closed to better work with the Region X HRF and 10<sup>th</sup> CST in future exercise or deployments. The exercise objectives were:

1. Conduct a full integration of the ASPECT scientific reach back team with the HRF and 10<sup>th</sup> CST field structure.
2. Test the use of the HRF Defense Connect Online (DCO) communication system to transmit a live feed of the ASPECT computer monitor to HRF and CST officials.
3. Ensure the ASPECT Products provide usable information for the HRF Command to make informed decisions
4. Determine format of products (Google Earth, ESRI)
5. To learn about each program (HRF and ASPECT)

From the HRF and CST perspective, we believe these objectives were met. The team was able to successfully integrate into their structure and deliver usable data products in a timely manner (within minutes) to help guide their field operations. The ASPECT scientific reach back team was also able to transfer the live feed from the aircraft through the Region X HRF DCO webinar system, allowing many other scientific observers to participate in the review process as the data were being collected.

The Region X HRF and 10<sup>th</sup> CST requested data products in the Google Earth format. All data products are available at:

[http://www.epaspect3.net/googleearth/Washington\\_NG\\_rad\\_Nov2014/main/kml/Washington\\_NG\\_rad\\_Nov2014\\_main.kml](http://www.epaspect3.net/googleearth/Washington_NG_rad_Nov2014/main/kml/Washington_NG_rad_Nov2014_main.kml).





## 6 Additional ASPECT Products

The ASPECT Program provides additional products that were not used in this exercise but are worth noting. These usually take more time (up to several hours) to produce than allowed for most exercises but provide valuable situational awareness and historical documentation during actual events. An example is the georeferenced oblique photograph (Figure 9).



Figure 9. Georeference oblique photo taken from the ASPECT aircraft of the Spokane County Raceway. The sources were located in the field between the racetrack and the building.

These images are taken by the co-pilot and uploaded to a secure FTP site upon landing. After being processed by the ASPECT scientific reach back team, they are accessible via the Google Earth nlink. Clicking “Oblique Photography” in the nlink will open a new dataset in Google Earth showing white arrows positioned where the photo was taken and pointing in the general direction at the time it was taken (Figure 10).



Figure 10. Screenshot of the Oblique Photo dataset displayed in Google Earth.

A lot of situational awareness is provided in these photos. For example, one can determine weather conditions (e.g., overcast skies vs sun; dry vs. wet), presence of temporary structures, and ground activity at the time of the survey. Oblique photos have been successfully used to identify oil contamination on beaches during the BP Oil Spill response. Combining these photos with georectified aerial photos (See Figures 6 & 7) proved invaluable toward assessing 100s of miles of potentially contaminated beach fronts without having to deploy ground crews.

Additional information on these product and many others are also provided in Appendix B.





Gamma Backgrounds:

- 300 AGL, Cosmic Test Line
- 300 AGL, Survey and Test Line 1
- 300 AGL, Survey and Test Line 2
- Other:

1. Collect a 3000 AGL cosmic line. Use line 9  
 2. Collect a 300 AGL test line. Use line 9  
 3. Collect all data lines at a 300 ft AGL (Lines 1 – 8)

C. Data to Process

<input type="checkbox"/> Photo Thumbs (F3)	
<input checked="" type="checkbox"/> IRLS (F4)	Automated
<input checked="" type="checkbox"/> FTIR (F5)	Automated
<input type="checkbox"/> PHOTO (F8)	Automated
<input checked="" type="checkbox"/> GAMMA (F7)	Automated
<input type="checkbox"/> Shutter By Name (F8)	
<input type="checkbox"/> INS Binary (F9)	
<input checked="" type="checkbox"/> GPL File (F10)	Automated and when requested

Notes: Provide active feedback to the ground concerning the mission  
  
 Use the automated software to process all data.

- Google Talk Communication





**D. Data to Send**

**Note: Number in Box indicates the Priority to Send**

- Digitals Folder
- FTIR Folder
- Processed FTIR Folder
- IRLS Folder
- Processed IRLS Folder
- GPS Folder
- Gamma Folder
- Processed Gamma Folder (\_CMD.Zip)
- Run Sheets

Site:

Folder:

**E. Flight Design and Objectives**

Flight # 1

All navigation coordinates must be in DEGREE DECIMAL MINUTES (i.e., 32N 27.26, 96W 54.95)

Notes:

Fly "Spokane\_NG" for all rad lines  
 Fly "Spokane\_NG\_Photo" for chem/photo lines

Line Type	Chem/Photo		
Block	Line Range	Number of Lines	Length (Miles)
1	1 - 2	2	1.98

Line Type	Rad		
Block	Line Range	Number of Lines	Length (Miles)
Cosmic	9	1	1.08
Test	9	1	1.08
Survey	1 - 8	8	1.84




**Response Flight Lines**

- ER SOP
- 150 Meter Downwind
- 500 Meter Downwind
- 1000 Meter Downwind
- Up Plume
- Other:

**Targets**

Lost sources near/around race track

**Special Instructions**

Maintain contact with Google Talk. Provide a F10 update after each line is completed.



## Appendix B: How to use Google Earth

### Google Earth nlink for the Region X HRF Exercise:

[http://www.epaspect3.net/googleearth/Washington\\_NG\\_rad\\_Nov2014/main/kml/Washington\\_NG\\_rad\\_Nov2014\\_main.kml](http://www.epaspect3.net/googleearth/Washington_NG_rad_Nov2014/main/kml/Washington_NG_rad_Nov2014_main.kml).

The ASPECT Program processes all data into a format that can be accessed through Google Earth using an “nlink” script. This small file permits full access to all data associated with a particular mission and/or deployment and greatly aids in near real-time situational awareness (Figure 11). This script can be obtained directly as an email or pulled from the deployment specific website. The following instructions detail how to install the script and use the system:

1. Download the provided KML file to your desktop if you received it through email. If provided on a memory stick, simply copy the KML file to your desktop.
2. To open the kml, double click the file located on your desktop. This will automatically bring up your Google Earth Program, and the ASPECT airplane icon will appear and zoom to the geographic area of the mission. The ASPECT airplane icon provides total access to all of the data available for the mission.
3. Double Click the airplane and a balloon will expand listing all of the relevant information for the particular ASPECT mission. The relevant information available may vary from mission to mission. All of the sections depicted in blue are links to data on the ASPECT mission servers. The following is a brief description of each section:
  - a. **Brief Mission Description.** This section contains details of the overall mission and specific details of the current mission which will open up in a separate browser window.
  - b. **Sensor suite capabilities.** This browser window contains a description of the sensors used on ASPECT aircraft. When finished with this section, close the browser window.
  - c. **Color aerial photography.** Clicking the color aerial photography section permits georectified NADAR images to be displayed and/or downloaded using the Google Earth. Once selected, available images from the last mission will be displayed as transparent outlines on the main screen. *Note: By default, only outlines from the last mission are displayed. Additional images collected on prior missions can be selected under the places menu on the left side of the Google Earth tool.*



To load the actual imagery into Google Earth, click on a camera icon in one of the polygons. A photo balloon will open and a thumb nail of the non-georectified photograph will be displayed. Two options are given at the bottom of the image:

Download Image Overlay into Google Earth

Download High Resolution Image into Web Browser

By clicking on the “Download Image Overlay into Google Earth” the image will be imported into the Google Earth imagery database and the georegistered image will be shown on the screen. Repeat this process for as many images as you are interested in. *Note: each time you execute this procedure the referenced aerial photograph frame will appear in blue in your temporary places pane on the left hand side of the Google Earth window. Should you want to view a full resolution image of this frame, click on the option “Download High Resolution Image into Web Browser”. The full resolution image will be displayed in a separate browser window.*

- d. **Mosaic Aerial Photography (By Date).** Selection of a color mosaic will load a georectified color mosaic into Google Earth. The selected image is referenced to the date of collection. Due to the large size of these files, several minutes may be required to fully download the file.
- e. **Oblique Photography.** Viewing of oblique color aerial photography is accomplished by selecting the oblique photography item. Once selected, available oblique images for the last flight will be displayed as a collection of arrows. These arrows represent the location that the aircraft was positioned and the direction the camera was pointed when the frame was collected (about 2 o’clock of the heading looking about 45 degrees down). As the cursor is moved over the respective arrows, the frame number will be highlighted. If an arrow is double clicked, a thumbnail of the image will be displayed. The user has the option of downloading the image in a browser.
- f. **Infrared Color Imagery.** Multi-channel color infrared imagery is selected using this option. Once selected, transparent outlines of available images from the last flight will be displayed. Operation and manipulation of IR imagery is identical to procedures used to view color aerial photography.
- g. **FTS Confirmed Detection.** This section contains the locations of confirmed remote sensed chemical detections for the last mission. Detections will be displayed as an icon. Each detected compound will be displayed as a unique icon. As with other data, data from prior missions can be selected under the places menu.





- h. **Chemical Report Retrieval.** Chemical data associated with FTS confirmed detections is contained in this section. Each report shows a listing of compounds which are automatically scanned by ASPECT. The number of detections, maximum concentration, and the coordinates of the collection line are given in the report.
- i. **Aircraft Flight Tracks (By Date).** Flight track information for the last mission is available using this selection. Once selected, a color flight path will be displayed. Multiple tracks can be displayed by selecting additional paths from other missions.
- j. **New Data Additions.** As new data are added to the mission website, the provided Google Earth link will permit full access to the new data. You must periodically close the Google Earth program and re-open it using the Google Earth icon on your desktop. When you exit the program, Google Earth will prompt whether to save your “temporary places”. Select discard. Depending on the amount of data being collected and uploaded to the mission server, restarting the Google Earth program once each hour will permit access to the new data.
- k. **Troubleshooting.** If you are having problems with multiple ASPECT airplane icons appearing on the screen do the following:
  - 1. Locate the Places Box on the upper left hand side of Google Earth.
  - 2. Locate the line labeled as My Places.
  - 3. Right click on My Places and select Delete Contents
  - 4. Close Google Earth and reopen using the Google Earth Icon on your desktop

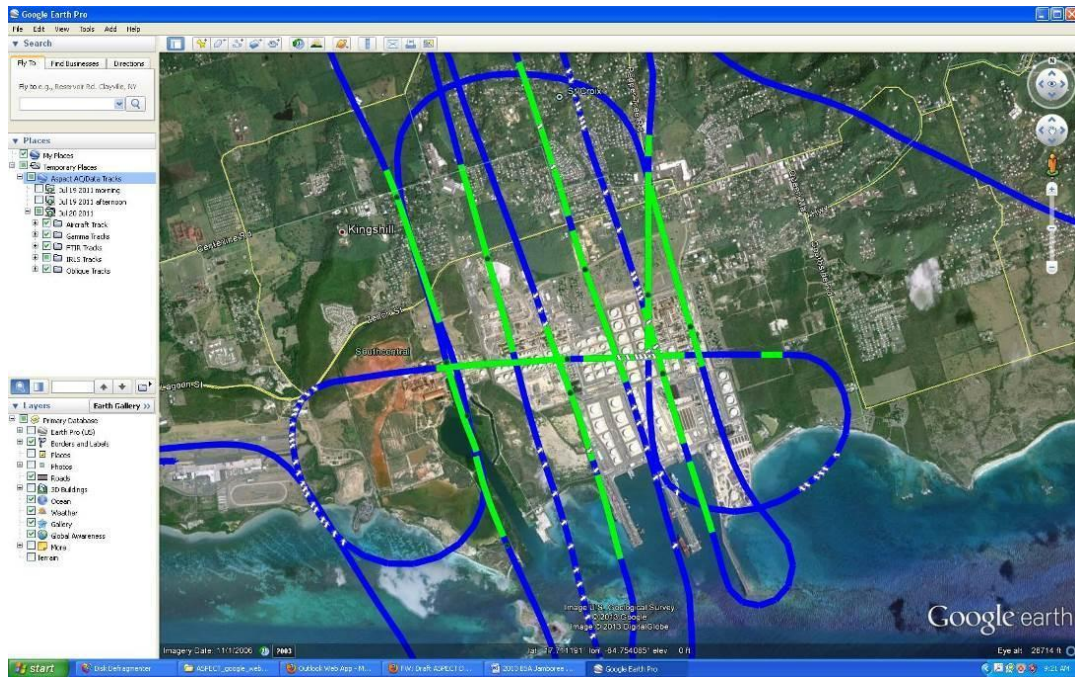


Figure 11. Google Earth Display of ASPECT Aircraft Tracks. The green tracks indicate when a chemical sensor was actively taking measurements.