

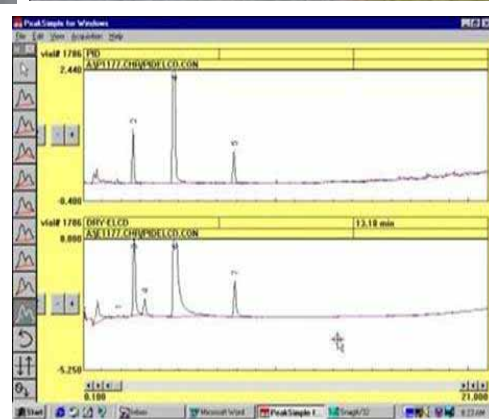
MassDEP Field Assessment and Support Team (FAST)

After Incident Report

DEP RTN 4-22,140

WESTPORT – 81 Robert Street

August 22, 2009



BACKGROUND

On August 19, 2009, plumbers were at 81 Robert Street, a one story residential ranch, installing a combined (gas) heating and central air conditioning system. A carbon monoxide (CO) detector was also installed at this time, which activated, and was thought to be defective. On August 20, 2009, another CO detector was installed, and it too activated.

On August 21, a third detector was installed. The AC system was turned on, and the third CO detector reportedly alarmed. The Westport Fire Department (WFD) was notified and responded to the site. CO meters carried by WFD personnel read 200 ppm at the front door of the home, and “pegged” at > 500 ppm in the basement. The basement was then actively vented for 2 hours, which reduced CO readings to 200 ppm. Reportedly, the highest CO readings were above a drainage sump in the basement. Although a natural gas service was recently piped to the house, it was not yet tied in. The home had no combustion appliances, and there had been no reported activities that would have generated CO (e.g., lawn mower, generators). The home did not have CO detectors in place before the incident.

WFD personnel checked the household resident as well as the on-site workers for CO exposure using a Masimo RAD-57 instrument, a non-invasive meter that measures CO in the bloodstream. Elevated levels were not observed.

MassDEP (SERO) was notified of the incident by the WFD at 3:15 PM. At Tier I HazMat status was declared at 4:25, prompting SERO/ER staff to respond to the site. By that time, active venting measures in the basement had reduced CO levels to less than 40 ppm. However, gas company workers using slam-bars to test the shallow soil gas along the recently installed gas service observed high readings (hundreds of ppm) on their CO meter (though there were reportedly no significant concentrations of explosive gases).

WFD personnel surveyed the other homes proximate to #81 Robert Street. Low levels (< 50 ppm) of CO were identified at #87 Robert Street, located to the south of the subject site. As a precautionary measure, both homes were evacuated, and were closed up for the night (i.e., no HVAC operations or open windows).

FAST assistance was requested by SERO/ER at about 9 PM on 8/21/09. Two FAST members were dispatched to the site on Saturday morning, 8/22/09, arriving at approximately 10:30 AM.



FAST ACTIVATION AND DEPLOYMENT

The FAST Mobile Laboratory Vehicle and two team members (Fitzgerald, Clark) deployed to the site. Chief FAST Chemist Larry Immerman set up and calibrated the GC/PID/ELCD and GC/FID instruments within the vehicle, prior to leaving the Wilmington office, and provided technical assistance throughout the day via cell phone.

Indoor Air Quality at #81 Robert Street

At approximate 12:00 noon, after surveying the site, gathering information, and bump-testing FAST instrumentation and meters, Team Member Clark made an entry into #81 Robert Street wearing a SCBA, accompanied by Deputy Chief Manley of the WFD, also wearing an SCBA. Two additional WFD firefighters stood by in case an emergency rescue was needed.

Team Member Clark carried an M-40 multi-gas meter, an MSA Sirius PID/multigas meter (both of which included a CO sensor), and Drager Simultaneous Test Sets I, II, and III (15 colorimetric tubes, including CO). Deputy Chief Manley carried a CO meter, as well as an air sampling pump with two 40 mL VOA vials (supplied by FAST). A later entry also included a Canberra UltraRadiac radiation (gamma) meter.

All results were negative (i.e., there were not significant detections of any contaminant):

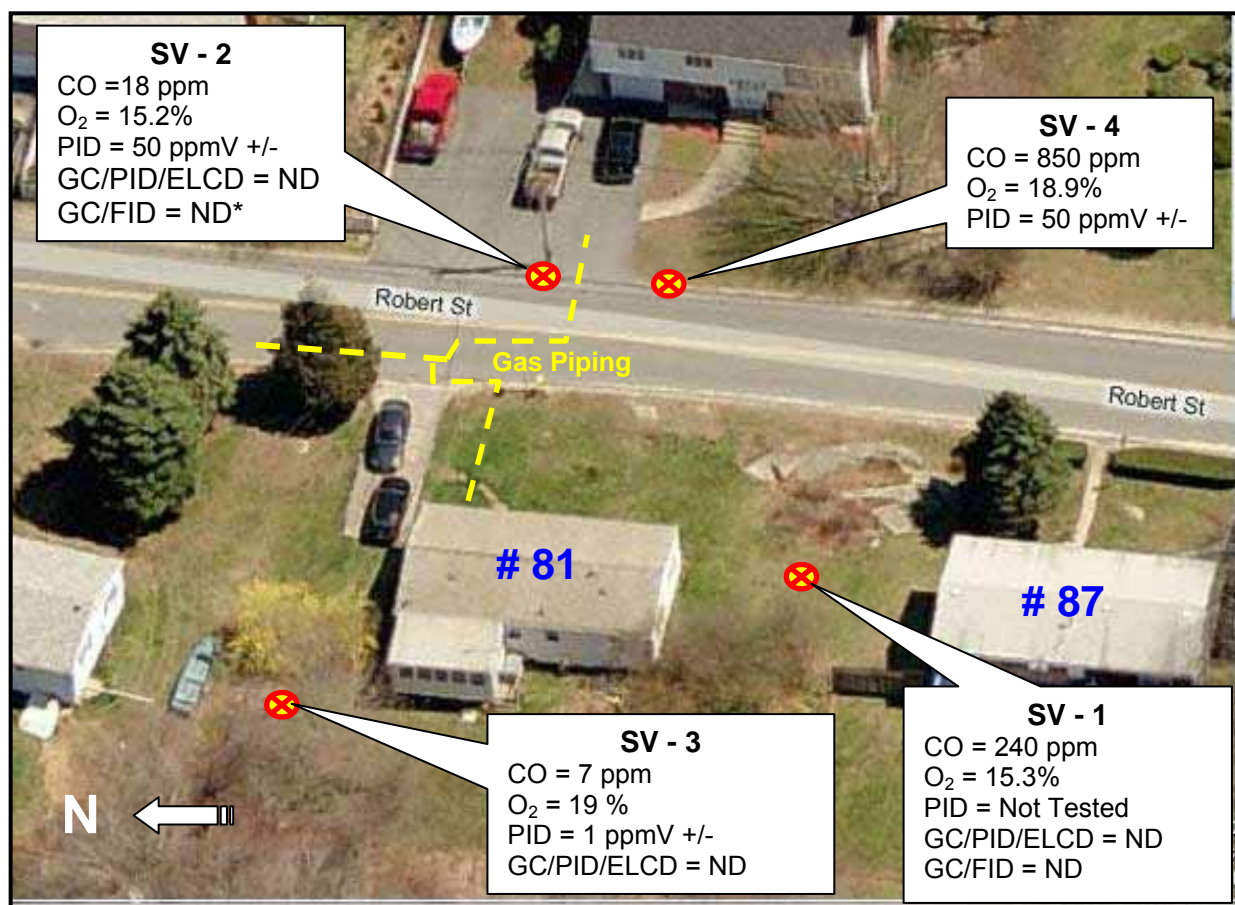
Contaminant	Device(s)	Result	Detection Limit
CO	M-40, Sirius	N.D.	1 ppm
Oxygen	M-40, Sirius	21%	0.1
Hydrogen Sulfide	M-40, Sirius	N.D.	1 ppm
Lower Explosive Limit (LEL)	M-40, Sirius	N.D.	1 - 10%
Ionizable Gases (10.6 eV PID)	Sirius	N.D.	0.1 ppm
Acid gases	Drager Set I	N.D.	5 ppm
Hydrocyanic Acid	Drager Set I	N.D.	10 ppm
Carbon Monoxide	Drager Set I	N.D.	30 ppm
Basic Gas	Drager Set I	N.D.	50 ppm
Nitrous Gas	Drager Set I	N.D.	5 ppm
Sulfur Dioxide	Drager Set II	N.D.	10 ppm
Chlorine	Drager Set II	N.D.	2.5 ppm
Hydrogen Sulfide	Drager Set II	N.D.	10 ppm
Phosphine	Drager Set II	N.D.	0.3 ppm
Phosgene	Drager Set II	N.D.	0.5 ppm
Ketones	Drager Set III	N.D.	50 ppm
Aromatics	Drager Set III	N.D.	50 ppm
Alcohols	Drager Set III	N.D.	100 ppm
Aliphatics	Drager Set III	N.D.	200 ppm
Chlorinated Hydrocarbons	Drager Set III	N.D.	1000 ppm
Gamma Radiation	UltraRadiac Meter	< 20 µR/hour	

N.D. = Not Detected

During this entry, two 40 mL air samples were obtained by Deputy Chief Manley from the basement area, #1 from just above a drainage/groundwater sump, and #2 near the water tank. Sample #1 was analyzed on the GC/FID unit (Lab ID # F361), and Sample #2 was analyzed on the GC/PID/ELCD unit (Lab ID #P5531). Neither sample contained significant concentrations of contaminants (i.e., > 10 ppbV), with the exception of what appears to be a benzene peak (#P5531), at about 35 ppbV (somewhat above typical residential levels). An unidentified low-concentration early-eluting peak was observed on the GC/ELCD chromatogram for Sample #2, which was also observed in all samples, including a syringe blank and ambient air sample. This may be a syringe or system contaminant, or a chlorofluorocarbon compound. Similarly, an unidentified low-concentration early-eluting (< C₅) peak was observed on the GC/FID chromatogram for Sample #1; this may be some type of alkane (e.g., butane). None of the peaks noted above appear to be significant, with respect to this incident.

Soil Vapor Data

To further explore the reported high levels of CO identified in the subsurface by gas company personnel, following an emergency Dig Safe notification, FAST personnel installed and sampled 4 soil vapor probes (KVA Temporary Probe apparatus). All probes were advanced approximately 2-3 feet below grade, in the locations indicated on the map below. Except for SV-1, the probes were sampled with a VX 500 PID unit, with measured (and metered) flowrates of less than 300 cc/minute. 40 mL soil gas samples obtained from SV-1, 2, and 3 were also analyzed on the GC/PID/ELCD and/or GC/FID units in the FAST vehicle. The results are depicted below:



Similar to the results for the basement air sample in #81 Robert Street, an unidentified early-eluting ($< C_5$) peak was observed on the GC/FID chromatogram for SV-1 and SV-2. This peak was much larger (i.e., $>> 20$ ppmV) on the sample from SV-2, which was near the gas piping. It is possible that this peak is a component of natural gas (e.g., butane).

Indoor Air Quality at #87 Robert Street

While focusing on #81 Robert Street, FAST personnel also tested the basement and first floor levels of #87 Robert Street, with an M-40 Multigas meter and MSA Sirius PID/Multigas meter. Both meters included a CO sensor. No CO readings were identified in the basement or first floor areas. Low levels of PID response (up to 0.6 ppm) were observed in the basement, in and near a workshop area containing paints and cleaning products.

DISCUSSION

This is a very unusual case; there are still a number of unknowns, as well as some conditions that appear anomalous.

Here is what is known:

- ☞ *There appears to be a gas present in the subsurface at this location that may or may not be carbon monoxide. It appears to have infiltrated #81 Robert Street for an unknown period of time, prior to its discovery on 8/21/09. Its origin, extent, and migration characteristics are not known.*
- ☞ *Following a venting effort on 8/21/09, no trace of the gas remained in the home on 8/22/09, even though the home was sealed up for a 12 hours period, to gage the level of an anticipated "rebound" (which did not occur).*
- ☞ *High levels of the gas remain in soil gas proximate to the home. This gas is not at explosive levels, and is not a common petroleum or commercial environmental contaminant (e.g., chlorinated solvent).*

Carbon Monoxide?

It is not clear whether this gas is carbon monoxide. The lines of evidence in favor of this conclusion are as follows:

- Similar CO readings were obtained on a number of meters containing electrochemical sensor from a number of manufacturers; and
- Reportedly, a Dräger Tube test on 8/21/09 indicated the presence of low levels of CO (5-10 ppm) in the basement, when meter readings were indicating levels in the range of 30 – 50 ppm).

The lines of evidence suggesting that this gas is not CO are as follows:

- There were no reports of CO poisoning symptoms by the resident or workers in the home, even though basement meter levels were above 500 ppm, which would likely have affected workers (e.g., headaches);
- The resident and workers did not have elevated levels of CO in their blood;

- A number of known (and presumably unknown) gases can cause an electrochemical CO sensor to falsely report a CO detection (see table); and
- It would appear unlikely that CO could be a natural (or even anthropogenic) contaminant at the site at these levels, or otherwise be present or “injected” into the ground via a commercial/industrial and/or combustion source.

Of the known gases that produce a false response on a CO meter (table to right), the most relevant compounds would be:

- Acetylene (has same response as CO);
- Hydrogen (a 40% response);
- Ethylene (a 24% response); and
- TCE (25% response).

All other listed compounds have a relatively low response factor.

Of the 4 compounds listed above, TCE can be ruled out, since it would have been detected in the soil vapor samples on the GC/PID/ELCD.

While some of the other gases may be detectable by PID and/or FID detectors, they may not have been discernable on the FAST gas chromatographs, given their elution time and/or the properties of the chromatographic columns.

On 8/25/09, FAST was informed that acetylene was used in the basement on 8/21/09. While this could explain the CO readings on 8/21/09, it would not explain the CO detector activations in the home on 8/19 and 8/20, nor would it explain the readings on the CO meters in the soil gas some distance from the home.

Of the known interfering compounds, Ethylene is probably the most likely candidate for further evaluation:

- ❖ Ethylene is produced by plants, and may be a breakdown product from plant waste and/or other organic materials. Reportedly, the area around #81 was once a wetland, that was filled in years ago;
- ❖ Unlike Hydrogen (I.E. = 15.4) and Acetylene (I.E. = 11/4), Ethylene (I.E. = 10.5) would be detected on a PID meter with a 10.6 eV lamp. As previously disclosed, based upon limited soil vapor data obtained by FAST, there is evidence of elevated PID readings in locations registering high CO meter concentrations. There was also some suggestion of decreased levels of O₂ in some of the soil

Response of Other Gases on CO Meters RAE Systems, Technical Note TN-114, 2008			
Gas	Conc.	Response w/o Filter#	Response w/ Filter*
H ₂ S	10 ppm	0 ppm	
SO ₂	5 ppm	0 ppm	
Cl ₂	10 ppm	0-1 ppm	
HCl	10 ppm	0 ppm	
NO	35 ppm	1 ppm	1 ppm
NO ₂	5 ppm	0 ppm	0 ppm
NH ₃	100 ppm	0 ppm	0 ppm
H ₂	100 ppm	40 ppm	40 ppm
Ethylene	100 ppm	24 ppm	20 ppm
Acetylene	250 ppm	250 ppm	
Ethanol	200 ppm	0 ppm	0 ppm
Ethylene oxide	125 ppm	≥40 ppm	
Propane	100 ppm	0 ppm	0 ppm
Butane	100 ppm	1 ppm	1 ppm
Isobutylene	100 ppm	9 ppm	4 ppm
Isobutylene	1000 ppm	30 ppm	22 ppm
Hexane	500 ppm	0 ppm	0 ppm
MEK	100 ppm	0 ppm	0 ppm
TCE	100 ppm	25 ppm	15 ppm
Nitrogen	100 %	0-4 ppm	

vapor wells, suggesting the possibility of subsurface biogenic activity.

- ❖ While Hydrogen, Acetylene, and Ethylene are all explosive gases, 500 – 800 ppm readings on the CO meters (which translate to somewhat higher concentration of these gases, given CO response factor) is still less than 10% of their respective LELs, which could explain why they were not eliciting a significant response on LEL meters.
- ❖ At least one web source has indicated that Ethylene has set off CO detectors (<http://www.aerias.org/DesktopModules/ArticleDetail.aspx?articleId=148&spaceid=1&subid=8>)

There is also a possibility that this gas is Hydrogen or Acetylene (e.g., from leaking buried cylinders), a completely different gas (i.e., not listed by CO detector manufacturers), or, CO. It is also possible that the gas in the basement on 8/21/09 was acetylene (from the use of this gas by plumbers), and the gas in the subsurface soils is something else (e.g., Ethylene).

RECOMMENDATIONS

1. Characterize the extent of the subsurface gas plume by advancing shallow soil gas probes around and outward from #81 Robert Street. Monitor for CO, O₂, LEL, and VOCs (via 10.6 eV PID).
2. Consider obtaining a soil gas sample (e.g., Teldar Bag; Summa Canister) from the soil vapor probe producing the highest CO reading, and analyze this sample for CO (via laboratory GC methods such as OSHA Method ID-210 or EPA Method 10B), to try to definitively determine whether this gas is CO.
3. Consider the possibility and feasibility of testing the soil gas sample for Hydrogen, Acetylene, and/or Ethylene, especially if CO is ruled out.
4. Strongly advise that at least two working CO detectors be installed at #81 Robert Street; one in the basement and one in or near the bedroom. Although the infiltrating gas may not be CO, these sensors appear to provide a reliable means to detect its presence.