

07 February 2013  
EE36049

Palliser Airshed Society  
3271 Dunmore Road SE, Unit 3  
Suite 208  
Medicine Hat, Alberta T1B 3R2

**Attention: Russ Golonowski, Chairman**

**Reference: Fire Hall Canister Sampling Report – Collected on January 31, 2013.**

## **EXECUTIVE SUMMARY**

A canister sample was collected at the City of Medicine Hat Fire Hall at 06:22 am January 31, 2013. At the time of sampling, environmental conditions were characterized by low wind speeds (3 to 4 km/hr) from the southwest direction. The Fire Hall was downwind of the CPR Rail yard and the downtown business area. SO<sub>2</sub> concentration (3 ppb) at the Crescent Heights Station was higher than the typical ambient background concentration (<1 ppb), indicating existence of combustion sources using sulphur-containing fuels. The canister sample was analyzed for reduced sulphur compounds (RSCs) and volatile organic compounds (VOCs). Among the analyzed RSCs, carbonyl sulphide (COS) was the only species above the instrument detection limit. The measured COS concentration of 0.7 ppb was slightly higher than the typical background concentration in the natural environment. A total of 28 VOC species were detected in the sample; the total VOCs concentration was 7.3 ppb. The major VOC species include benzene, toluene, Freon-11 and four alkanes. Their concentrations ranged from 0.4 to 2 ppb. In comparison with a study for the rail yard at Mirror, Alberta, the concentration of benzene (2 ppb) was apparently higher than the Mirror study samples (0.1 to 0.3 ppb). This could be due to a greater traffic emissions or other fuel combustion sources in the City of Medicine Hat than in the hamlet of Mirror. For toluene, Freon-11 and the four alkanes, other emission sources in addition to the CPR Rail yard could be existent. The concentrations of the remaining minor VOC species were less than 0.2 ppb. These VOCs were detected in the three samples which were collected downwind of the respective rail yards, most of them were not detected in the remaining samples. The evidence might indicate an association with rail yard operations. The above inferences are tentative due to a small sample size; future investigation with more samples is required.

## **ENVIRONMENTAL CONDITIONS DURING SAMPLING**

A grab sample of ambient air was collected using a SILCO canister at the City of Medicine Hat Fire Hall at 06:22 am January 31, 2013. According to the Crescent Heights Station monitoring data, wind was from the southwest direction and the wind speed was low (3 to 4 km/hr). At this time, the Fire Hall was downwind of the CPR Rail yard and the downtown business area. The ambient temperature was -17°C and relative humidity was 66%.

SO<sub>2</sub> concentration was 3 ppb at the Crescent Heights air monitoring station. The concentration was higher than the typical baseline concentration of <1 ppb. It suggests existence of combustion sources using sulphur-containing fuels in the area. On the other hand, the concentrations for the other pollutants (NO/NO<sub>2</sub>/NO<sub>x</sub>, CO, THC, O<sub>3</sub>, and PM<sub>2.5</sub>) were at the normal range of the Crescent Heights station.

## **CANISTER SAMPLING RESULTS**

### *Reduced Sulphur Compound*

A total of 22 RSC species were analyzed for the canister sample. Only carbonyl sulphide was above the instrument detection limit. The measured concentration was 0.7 ppb, which was slightly higher than typical background concentration of 0.5 ppb in the natural environment. COS is one of the most abundant sulfur compounds naturally present in the atmosphere. A number of anthropogenic sources emit COS, e.g. flue gas desulfurization, automobiles, coal-fired power plants, biomass combustion, fish processing, petroleum manufacture, and grain fumigation. COS is a colourless flammable gas with an unpleasant sulphide odour, like a rotten egg smell.

### *Volatile Organic Compounds*

To assist in data analysis, the VOC analytical results were compared to a study at the hamlet of Mirror, Alberta (Alberta Environment, 2011). Table 1 summarizes sample information for the Fire Hall sample and the Mirror study samples. For the Mirror rail yard study, Sample A was collected downwind of the hamlet of Mirror. Sample B and Sample C were collected downwind of the Mirror rail yard. Sample D and Sample E were collected downwind of the southern section of rail yard; however there were no apparent activities during sampling. The similarity and differences among these samples provide evidences for source investigation.

Figure 1 compares the concentrations of 28 VOC species, which were identified in the Fire Hall sample. The major VOC species include benzene, toluene, Freon-11, and four alkanes (isobutene, butane, isopentane, and pentane). These major species were detected in all samples, with the exception of isobutane, butane, and Freon-11, which were not detected in the Mirror Sample A. Because these species were detected in all samples generally, there may be other emission sources in addition to the CPR Rail yard.

The Fire Hall sample detected a higher concentration of benzene (2 ppb) than the Mirror samples (<0.3 ppb). Benzene is found in crude oil and is also formed in petrochemical operations. In Canada, vehicle emissions are the largest anthropogenic emission source of benzene. In an urban area, vehicle emissions can contribute over 80% of benzene. The higher benzene concentration in the Fire Hall sample could be due to its location within the downtown of the City of Medicine Hat.

The concentration of toluene was comparable among the six samples. The concentration ranged from 0.2 ppb to 0.4 ppb. Since it was measured in all samples, rail yard operation may not be the sole contribution source of toluene. Toluene is a naturally occurring component of

crude oil and petroleum. The major anthropogenic emission sources in Alberta are oil and gas operation and cement manufacturing. Toluene is also formed during the combustion of organic materials. Fugitive emissions comprise the largest portion of the emissions. Toluene is a clear, colourless liquid under standard conditions. It has a sweet and pungent odour.

Freon-11 (trichlorofluoromethane) was detected in all samples, with the exception of the Mirror Sample A. The concentration was approximately 0.2 ppb. Freon-11 was widely used for refrigerant and aerosol propellant in the past, but it has been banned due to its contribution to the depletion of the ozone layer.

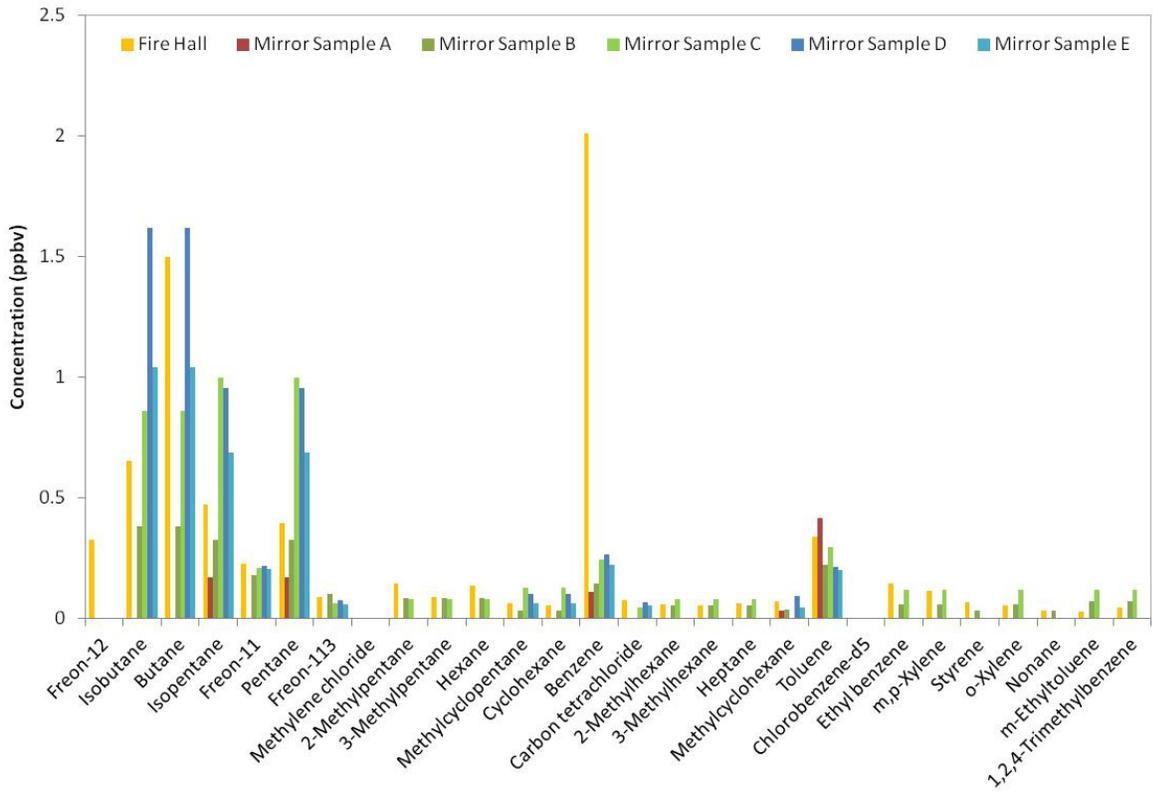
The concentration of the four alkanes varied among the six samples, but none exceeded 1.6 ppb. Alkanes are saturated hydrocarbons. They consist only of hydrogen and carbon atoms. The major anthropogenic source of alkanes is production, transportation, use, and disposal of petroleum product and natural gas.

For the remaining VOC species, the concentration was low (<0.2 ppb). However there was a consistent trend between the samples collected upwind and downwind of the rail yards. These minor VOC species were commonly detected in the Fire Hall sample and the Mirror Samples B and C. These samples were collected downwind of the rail yards. On the other hand, the remaining three Mirror Samples (collected upwind of the rail yard or were collected downwind of the rail yard when no apparent operation activities were existent) did not detect most of these species. The difference between these two groups of samples indicates a potential link with rail yard activities for the minor VOC species.

**Table 1. Sample information for the Fire Hall and Mirror Rail yard studies**

Parameter	Medicine Hat	Mirror Rail Yard Study				
	Fire Hall	Sample A	Sample B	Sample C	Sample D	Sample E
Date	Jan 31, 2013	May 28, 2010	June 5, 2010	Jan 1, 2011	Jan 2, 2011	Jan 3, 2011
Sample type	Grab sample	1-hr average	1-hr average	1-hr average	1-hr average	1-hr average
Wind speed	3 to 4 km/hr	3 to 4 km/hr	15 km/hr	10to20 km/hr	5 to 15 km/hr	5 to 15 km/hr
Wind direction	SW	E	NNW	NNW	W and SW	W and SW
Total VOC conc.	7.3 ppb	5.6 ppb	26.7 ppb	12.1 ppb	13.0 ppb	18.9 ppb
No. of species	28	13	38	35	23	27
Sampling site orientation	Downwind of CPR Rail yard and downtown business area	Downwind of hamlet of Mirror	Downwind of Mirror Rail yard	Downwind of Mirror Rail yard	Downwind of Mirror Rail yard, but no apparent activity in rail yard	Downwind of Mirror Rail yard, but no apparent activity in rail yard

**Figure 1. VOC concentrations for the Fire Hall and Mirror Rail yard studies**



If you have any questions, please do not hesitate to contact Robert Scotten at (780) 436-2152.

Respectfully submitted,

**AMEC Environment & Infrastructure**

James Jeng, Ph.D.  
Senior Environmental Scientist

Reviewed by

Robert Scotten, EHT  
Group Leader, Air Quality  
Environmental Division