TORONTO

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To: **Gord Webber, Manager, EMS Operations, Northeast District**

From: **Ana Mijailovic Elms, Senior Occupational Hygiene Consultant**
Occupational Health, Safety and Worker's Compensation

Date: **November 29, 2004**

Subject: **Exposure to Vehicle Emissions in Northeast Hub –**
2430 Lawrence Ave. E.

Please find attached a copy of the air monitoring results for indicators of vehicle exhaust carried out at the above location on November 19, 2004. Should you require further information, need assistance with the interpretation of the data, or have any questions regarding this report, please contact me at 392-5181 or via e-mail.

Sincerely,

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Ana Mijailovic Elms, M.H.Sc., C.I.H.
Senior Occupational Hygiene Consultant
OHSWC

cc. Chris Dixon, Supervisor, EMS Operations, Northeast District
Wayne Vibert, Deputy Chief/Director, EMS Operational Support
Bruce Janes, JHSC worker rep., EMS
Rory O'Neill, JHSC worker co-chair, EMS
Gord Webster, JHSC mgt. co-chair, EMS
Chandra Spence, HR Health & Safety Consultant, EMS
Cindy O'Brien, Mgr, OHSWC

BACKGROUND

As a result of a referral from Chandra Spence, Health and Safety Consultant, EMS, and, in response to a request made by Gord Webber, Manager, EMS Operations, Northeast District, an occupational hygiene assessment was conducted at 2430 Lawrence Avenue East.

As 2430 Lawrence Avenue East is a hub, the vehicles in this station do not respond directly to emergency calls but are available as a backup to replace any active vehicles that are experiencing mechanical problems. These requests can not be predicted and as a result, several simulations were enacted for the purposes of evaluating potential worker exposure to vehicle emissions. In some cases these simulations were representative of routine conditions (e.g. vehicle started up and left station within one minute), while in other cases they were not representative of routine conditions (e.g. vehicle left idling inside the station) but would be indicative of a worst case scenario.

A system of air cleaning filters was recently installed at this site. Four ceiling mounted AirMATION units were installed, each reportedly with the capacity of moving and filtering **3000 cubic feet per minute (CFM)** of air. According to a supplier representative, each unit has a first stage pre-filter (that captures particles of a size range of 10 microns or greater) followed by a more efficient pre-filter (that removes particles of a size range of 4 microns or greater). The next filter is a high efficiency particulate air (HEPA) filter (that removes particles of a size range of 0.3 microns or greater). The final stage in this air cleaning system is an activated charcoal filter that removes organic vapours and gases. These units can be left running continuously or are activated either by the opening of a bay door or movement detected by the motion sensor. At this site, the units are activated and remain on for approximately 10 minutes. In addition to the AirMATION units, there are also three ceiling fans that are manually turned on and are left continuously running.

At the time of this testing there were a total of six vehicles parked inside the station. There were four ambulances (one of which was diesel, the remaining three were gasoline) and two supervisor vans (both gasoline). Instantaneous testing (for nitrous oxide, sulphur dioxide, airborne dust) was carried out at the back of the bay area behind the vehicle being started up or backing up into the station. Ongoing monitoring (e.g. for carbon monoxide and airborne dust) was carried out in the corner work area in the station where the workbench and Cidex disinfection area are located. This location was selected for ongoing monitoring as it is the area where ambulance staff (excepting those who are inside the vehicle leaving the station) are most likely to be present during vehicle activity in the station.

The purpose of this test was to evaluate worker exposure to components of vehicle emissions by comparison to relevant occupational standards. Neither the testing equipment nor the sampling methods were suitable for evaluating the performance of the AirMATION units.

Vehicle engine exhaust, and in particular, diesel exhaust, is a highly complex mixture, containing a wide range of organic and inorganic compounds in both gaseous and particulate phases. The U.S. National Institute of Occupational Safety and Health recognizes diesel exhaust as a probable human carcinogen. Research has shown that the induction of tumours in animals is associated with exposure to unfiltered (i.e. particulate portion of) diesel exhaust. Therefore, all unnecessary worker exposure to diesel exhaust should be avoided/minimized.

No single constituent of vehicle exhaust serves as a unique marker of exposure, however, carbon monoxide and oxides of nitrogen and sulphur, aldehydes, polycyclic aromatic hydrocarbons, total particles, fine particles, and, most recently, elemental carbon, have been used in past monitoring

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conducted within the City. Most of these measures have limitations as indicators of vehicle exhaust, including measurement of only the gaseous components of vehicle exhaust and/or being non-specific for vehicle exhaust.

In this assessment, given the short-term nature of worker exposure to vehicle exhaust, it was decided that occupational hygiene testing would include testing for short-term concentrations of carbon monoxide, nitrous oxides, sulphur dioxide and airborne (respirable) dust. Each of these compounds has an applicable occupational exposure limit (including, in some cases, a short-term exposure limit) to facilitate comparison with test results. In the case of carbon monoxide, instantaneous concentrations were data-logged over the entire sampling period. Testing was carried out over the sampling period of approximately 7 a.m. to 12:30 p.m. The worker joint health and safety committee representative for this site was informed of the testing but was not available to be present at the start of testing.

SAMPLING METHODOLOGY

Instantaneous area concentrations of carbon monoxide were measured and data-logged using a TSI Q-TRAK. The Q-TRAK was calibrated prior to testing and is maintained regularly.

Instantaneous concentrations of nitrous fume levels were measured using Drager Tubes CH29401 and a Drager Multi-gas Detector Pump. The Drager tubes determine the concentration of nitric oxide (NO) and nitrogen dioxide (NO_2) in air using 5 strokes, in the range of 0.5 to 10 ppm indicated as a colour change (from grey/green to blue/green). Similarly, instantaneous measurements of sulphur dioxide levels were measured using Drager Tubes 6728491 and a Drager Multi-gas Detector Pump. The Drager tubes measure the concentration of sulphur dioxide (SO_2) in air using 20 strokes, in the range of 0.5 to 5 ppm indicated as a colour change (from grey/blue to white).

Instantaneous measurements of airborne dust were measured using a MIE MiniRam particulate monitor. This direct reading instrument measures both respirable and inhalable particles in the size range of 0.1 to 10 microns based on light scattering. The concentration of airborne dust is displayed in milligrams per cubic meter (mg/m3) and is updated every 10 seconds.

EXPOSURE STANDARDS

In Ontario, the occupational exposure limits are defined in regulations made under the Occupational Health and Safety Act. The Regulation respecting Control of Exposure to Biological or Chemical Agents lists exposure limits for over seven hundred chemicals. The TWAEV refers to the airborne concentration of substances over an 8-hour day, 40-hour workweek and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. The STEV is the maximum concentration to which a worker can be exposed to in any 15-minute period.

Carbon monoxide currently has a time-weighted average value (TWAEV) of 35 ppm and a short-term exposure value (STEV) of 400 ppm. However, more protective limits have been introduced, i.e. a TWAEV of 25 ppm and a STEV of 100 ppm, and are to become effective December 31, 2005. Nitrous fumes, including nitrogen dioxide (NO_2) and nitric oxide (NO) have a TWAEV of 3 ppm

and 25 ppm, respectively. In addition, NO_2 has a STEV of 5 ppm. Sulphur dioxide has a TWAEV of 2 ppm and a STEV of 5 ppm.

In addition to the Ontario occupational exposure limits, the American Conference of Governmental Industrial Hygienists (ACGIH), an internationally recognized organization that sets occupational hygiene standards, has also established exposure limits. In the occupational hygiene field, ACGIH threshold limit values (TLVs) are considered the accepted standard and best practice for occupational exposure limits. TLVs are annually assessed and revised as required based on current scientific and technical research. For carbon monoxide, the 2004 ACGIH TLV is 25 ppm with no STEL. For nitrogen dioxide, nitric oxide and sulphur dioxide the 2004 ACGIH TLVs are comparable to the established Ontario limits.

RESULTS AND DISCUSSION

Results of instantaneous testing carried out at the back of the bay during vehicle activity are presented in Table 1. Results of instantaneous testing conducted in the corner work area where staff are most likely to be located during vehicle activity in the station are presented in Table 2. Figure 1 graphically shows carbon monoxide concentrations measured in the corner work area throughout the test period.

Table 1. **Instantaneous Test Results for Indicators of Vehicle Exhaust Bay Area, Northeast Hub, 2430 Lawrence Ave. E. November 19, 2004**

Time and Description of Conditions at Time of Testing	Instantaneous NO_x concentration (ppm)	Instantaneous SO_2 concentration (ppm)	Instantaneous airborne dust concentration (mg/m3)
Occupational Exposure Limits **TWAEV:**	**3 ppm (NO_2)** **25 ppm (NO)**	**2 ppm**	**3 mg/m3 (respirable dust)** **10 mg/m3 (inhalable dust)**
STEV:	**5 ppm (NO_2)**	**5 ppm**	**-**
7:35-7:45 a.m. **At back of bay with all bay doors closed;** **Diesel ambulance left idling **** **AirMATION units on and ceiling fans on**	**1**	**BDL ***	**0.00-0.01**
9:15 a.m. **At back of bay with one bay door open;** **Gas ambulance started up and driven out;** **AirMATION units activated by opening of bay door:** **AirMATION units remain on for approx. 10 min**	**0.5**	**-**	**0.00-0.01**
10:00 a.m. **At back of bay;** **One bay door opens for one gas ambulance to return to station and subsequently closes;** **A second gas ambulance started up momentarily and moved forward:** **AirMATION units activated by opening of bay door and remain on for approx. 10 minutes.**	**0.5**	**-**	**0.00-0.03**

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10:25-10:40 a.m. **At back of bay with all bay doors closed;** **diesel ambulance left idling **** **AirMATION units off and ceiling fans off.**	**<0.5** **2.5-3**	**BDL ***	**0.00-0.05**

***** **= Below Detection Limit (i.e. < 0.5 ppm)**

****** **= Non-routine conditions**

Table 2. **Test Results for Indicators of Vehicle Exhaust**
Corner Work Area, Northeast Hub, 2430 Lawrence Ave. E.
November 19, 2004

Time and Description of Conditions at Time of Testing	Instantaneous CO concentration (ppm)	Instantaneous airborne dust concentration (mg/m3)
Occupational Exposure Limits **TWAEV:**	**35 ppm** **25 ppm (as of Dec 31/05)**	**3 mg/m3 (respirable dust)** **10 mg/m3 (inhalable dust)**
STEV:	**400 ppm** **100 ppm (as of Dec 31/05)**	**-**
7:10 a.m. **Background conditions;** **No vehicle activity;** **One bay door open**	**0**	**0.01-0.05**
7:35-7:45 a.m. **Diesel ambulance left idling inside station;**** **AirMATION units on for approx. 10 min.**		
8:25 a.m. **AirMATION units now off;** **No current vehicle activity;** **All bay doors closed**	**5**	**0.00**
9:15 a.m. **Gas ambulance started up and driven out;** **AirMATION units on for approx. 10 min.**		
9:25 a.m. **AirMATION units now off;** **No current vehicle activity;** **All bay doors closed**	**11**	**0.00**
10:00 a.m. **One gas ambulance started up and driven out;** **Second gas ambulance started up momentarily and then turned off;** **AirMATION units on for approx. 10 min.**		
10:10 a.m. **One bay door opens for one supervisor's vehicle to back out and subsequently closes;** **AirMATION units on.**	**9**	**0.00**
10:15 a.m. **No current vehicle activity;** **AirMATION units still on;** **All bay doors closed.**	**13**	**0.00**

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Time and Description of Conditions at Time of Testing	Instantaneous CO concentration (ppm)	Instantaneous airborne dust concentration (mg/m3)
10:25 a.m. No current vehicle activity; AirMATION units now off; All bay doors closed.	**13**	**0.00**
10:25-10:40 a.m. Diesel ambulance left idling inside station; AirMATION units and ceiling fans off.**		
10:40 a.m. No current vehicle activity; AirMATION units off; All bay doors closed.	**17**	**0.07**
10:43 a.m. No current vehicle activity; AirMATION units off; All bay doors closed.	**18**	**0.14**
10:49 a.m. No vehicle activity; AirMATION units off; All bay doors closed.	**15**	**0.07**
10:50 a.m. AirMATION units turned on		
10:55 a.m. No vehicle activity; AirMATION units on; All bay doors closed.	**14**	**0.05**
11:00 a.m. No vehicle activity; AirMATION units on; All bay doors closed.	**13**	**0.00-0.01**
11:05 a.m. No vehicle activity; AirMATION units on; All bay doors closed.	**12**	**0.00**
11:10 a.m. No vehicle activity; AirMATION units on; All bay doors closed.	**11**	**0.00**
11:15 a.m. No vehicle activity; AirMATION units on; All bay doors closed.	**11**	**0.00**
11:45 a.m. No vehicle activity; AirMATION units on; All bay doors closed.	**8**	**0.00**
12:20 p.m. No vehicle activity; AirMATION units on; All bay doors closed.	**5**	**-**

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TEST RESULTS MAY VARY IN OTHER FIRE STATIONS

Time and Description of Conditions at Time of Testing	Instantaneous CO concentration (ppm)	Instantaneous airborne dust concentration (mg/m3)
	Average CO concentration during test period (7:10-12:20) was 8 ppm	**Average airborne dust concentration during test period (7:10-11:46) was 0.00 mg/m3**

**** non-routine conditions**

Figure 1. **Carbon Monoxide Concentrations, Corner Work Area**

DISCUSSION

Carbon monoxide:

The carbon monoxide concentration measured during the test period 7:15 -11:45 a.m. in the corner work area ranged from 0-20 ppm (see Figure 1). The average carbon monoxide concentration over this same test period was 8 ppm. The highest concentration of 20 ppm was measured shortly after the test simulation in which the diesel ambulance was left idling inside the station with all the bay doors closed and without the AirMATION system running. Thereafter the carbon monoxide

concentrations started to decline (this decline was further continued with the activation of the AirMATION system) (see Table 2 and Figure 1). All of the concentrations measured are below established occupational exposure limits.

Nitrous oxides:
The instantaneous nitrous oxide fumes measured in the back of the bay during vehicle activity ranged from <0.5-3 ppm (see Table 1). The highest instantaneous concentration of 3 ppm was measured with the diesel ambulance idling inside the station with all the bay doors closed and without the AirMATION system running. All of the nitrous oxide fumes measured were below established occupational exposure limits for nitric oxide and nitrogen dioxide.

Sulphur Dioxide:
The instantaneous sulphur dioxide levels measured in the back of the bay during vehicle activity were below the detection of the sampling method (i.e. < 0.5 ppm). This is also below the established occupational exposure limits.

Airborne dust:
The instantaneous airborne dust concentrations measured in the back of the bay area during vehicle activity ranged from 0.00-0.05 mg/m^3 (see Table 1). Furthermore, instantaneous airborne dust concentrations measured in the corner work area throughout the sampling period of 7:15 to 11:45 a.m. ranged from 0.00-0.14 mg/m^3. The highest airborne dust concentration of 0.14 mg/m^3 was measured in the corner work area shortly after the test simulation in which the diesel ambulance was left idling inside the station with all the bay doors closed and without the AirMATION system running (see Table 2). Thereafter the airborne dust concentrations started to decline (this decline was further continued with the activation of the AirMATION system (see Table 2)). Furthermore, the average respirable dust concentration measured over the entire sampling period was 0.00 mg/m^3 (see Table 2). All of the airborne dust concentrations measured were below established occupational exposure limits.

CONCLUSIONS

- The results of this assessment indicate that concentrations of carbon monoxide, nitrous oxides, sulphur dioxide and airborne (respirable) dust as indicators of vehicle exhaust, are all below established occupational exposure limits both under routine conditions as well as non-routine conditions considered as a worst case scenario (vehicle left idling inside the station).

- In order to continue to minimize occupational exposure to vehicle exhaust, the AirMATION filtration units should continue to be used during vehicle activity in the station.

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