



# United States Department of the Interior

**Office of the Secretary**  
Occupational Health and Safety  
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## Memorandum

**Date:** March 30, 2009

**To:** Safety Manager, Yellowstone National Park

**From:** Industrial Hygienist, Office of Occupational Health and Safety,  
Department of the Interior

**Subject:** Personal Exposure Monitoring of Entrance Station Employees at West  
Yellowstone Entrance – President’s Weekend 2009

### Summary:

**Personal monitoring of employees was conducted at West Yellowstone entrance to evaluate exposure to components of engine exhaust using standard industrial hygiene techniques. These contaminants included carbon monoxide, aldehydes such as formaldehyde, acetaldehyde and acrolein, and common hydrocarbons. Noise monitoring was also performed. All results were below OSHA, ACGIH, and NIOSH occupational exposure limits. The new ventilation system in the entrance station booths was not operating during the survey. It is recommended that this system be utilized during the high traffic volume periods to maintain positive pressure in the booths to further limit exposures.**

Personal air monitoring for snow mobile exhaust was conducted at the west Yellowstone entrance station over President’s Day weekend 2009. This was the first evaluation of exposures in the new entrance station configuration. President’s Day weekend represents one of the highest traffic flow weekends for the winter season. Visitors on snowmobiles

and in snowcoaches are accompanied by a guide who was responsible for the transaction with the NPS entrance station employee. The local rental/guide companies use snowmobiles with 4-stroke engines that meet NPS best available technology requirements resulting in lower noise levels and lower emissions of unburned hydrocarbons than 2-stroke engines.

The total traffic volume for the weekend was 64 snow coaches and 635 snowmobiles which was slightly less than the 2008 season. During the 2008 President's weekend there were 71 snow coaches and 691 snowmobiles. The traffic was routed through two entrance station lanes. The transaction time at the booth ranged from 1-3 minutes. Some of the guides turned off their snowmobiles or snow coaches while at the booth if they expected a longer transaction at the window. Only the guides stop at the window. The period of exposure ranged from 1 ½ to 2 ½ hours. The first guided groups arrived around 0800 and the traffic dropped off dramatically by 1000.

**Traffic Volume**

<b>Date</b>	<b>Snow Coaches</b>	<b>Snowmobiles</b>
2/14	26	250
2/15	19	221
2/16	19	164

Weather conditions over the weekend ranged from -5° to -2° F at 0800 and by 1000 had warmed to 15° to 18° F. The air was still with no measurable wind in the vicinity of the entrance station during the exposure period. All three mornings were overcast with some snow falling in the morning of Feb 15. With these conditions the exhaust dissipated fairly rapidly (within one minute) as evidence by the short peaks on the CO meter.

At the time of the survey, the ventilation system was not operating. Airflow measurements showed turbulent flow at the window opening with cold air flowing in the bottom and warm air flowing out at the top. This was illustrated using smoke tubes to visualize the air movement. A hot wire anemometer was also used to measure the airflow into and out of the booth. Flow rates of 200 linear feet per minute were measured flowing

into the booth in the lower third of the opening with a larger area of 40 linear feet per minute flowing out at the upper half. Although contaminant concentrations were low, the direction of flow may bring exhaust contaminants into the breathing zone of the entrance station employees. Maintaining positive pressure inside the booth relative to the outdoor air should minimize the intrusion of exhaust and further reduce exposures. The entrance station employees were not familiar with the operation of the ventilation system and the safety manager was not included in the design review and was not aware that the ventilation system was not being utilized.

The sample results are reported for the duration of the sampling time and the 8-hour time-weighted average exposures were calculated for comparison to the occupational exposure limits. The occupational exposure limits such as the OSHA Permissible Exposure Limit (PELs) and the American Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit Values (TLVs) are referenced in the results table below.

## **Methods**

Personal monitoring was conducted using SKC pocket pumps calibrated before and after use to a flow rate of 200 cc/minute. Standard activated charcoal sorbent tubes were used as the collection media for the hydrocarbon scan. The samples were sent to the Wisconsin Occupational Health Laboratory and were desorbed using carbon disulfide then processed through a gas chromatograph equipped with a flame ionization detector.

Aldehydes were collected using SEPAC cartridges and Gilian 3500 high flow pumps calibrate to 500 cc/min using the Gilian low flow adapters. This method for aldehyde sampling was consistent with that used by the Centers for Disease Control and Prevention during the FEMA trailer formaldehyde study. The sampling media was stored in a freezer prior to and after sampling. These samples were desorbed using acetonitrile and analyzed using high performance liquid chromatography and UV detection.

Carbon monoxide was monitored using a data logging direct reading Biosystems ToxiPro personal monitor. Spot checks were also taken using the TSI Q-Trak. Peak readings and time-weighted average exposures were recorded.

Noise exposures of the entrance station workers were monitored using a Quest-300 noise dosimeter and sound levels were spot checked using a type 1 sound level meter.

## **Results**

Personal exposures to the organic solvent contaminants were well below the OSHA permissible exposure limits and the ACGIH threshold limit values. Most were below the detectable limits. The types of chemicals detected were slightly different than last year's samples which may be the result of slightly different fuel mixtures. For example ethyl and isopropyl alcohols were not detected on the 2009 samples. Petroleum distillates were detected in slightly higher concentrations than last year's results but several orders of magnitude below a level of concern.

Carbon monoxide concentrations were slightly higher this year with an average 8-hr exposure of 1.3 ppm compared to last year's average of 0.4 ppm for entrance station employees (the 8-hr TWA corrects for differences in sampling time and represents their full shift exposure). This difference may be due to the absence of ventilation in the booths. Although these concentrations are relatively low, utilizing the positive pressure ventilation system in the booths would likely lower the carbon monoxide exposures further.

The aldehyde samples were well below the OSHA, ACGIH, and NIOSH exposure limits. The detection limit for the SEP-PAK cassette sampler using the 500 cc/min flow rate was generally an order of magnitude lower than the XAD tube sampling in 2008. Acrolein was not measured above the limit of detection in any of the samples and acetaldehyde was present in just one of the samples.

The peak noise exposure was 91 A-weighted decibels (dBA) and the time weighted average exposures were 69.1 dBA and 67.3 dBA. These are well below the OSHA action level and are consistent with last years noise exposures. Inclusion in a hearing conservation program is not warranted for this level of exposure.

**Noise Exposure Results**

Personal Sample	Date	Decibels (dBA) Time-weighted Average	OSHA Action Level / PEL
Personal Sample Inside Kiosk A	2/14	69.1	85 / 90
Personal Sample Inside Kiosk B	2/14	67.3	85 / 90

**Discussion**

Under the current conditions and traffic volumes, these results indicate exposures are below all occupational exposure limits for the contaminants sampled. Carbon monoxide was slightly elevated from last year’s readings. Formaldehyde is classified as a proven carcinogen (group 1) by the International Agency for Research on Cancer. The National Institute for Occupational Safety and Health has a recommended exposure limit of 0.016 ppm (8-hr TWA) but also recommends that exposure to carcinogens be as low as technologically feasible. Because of this, the positive pressure ventilation system should be utilized during the periods of peak traffic volume.

On February 15 the snow coaches were separated from the snowmobiles to determine whether exposure levels would differ. Nineteen snow coaches entered via lane B and 241 snowmobiles entered lane A. The exposure results showed carbon monoxide was slightly higher over the sampling period for the snowmobile lane, however the peak reading for carbon monoxide was higher for the snow coaches. The CO monitor was set to alarm at 50 ppm and the monitors exceeded this level momentarily on three occasions, however the peak readings never reached the NIOSH ceiling of 200 ppm. The time-weighted averages and the peak readings for the exposure periods are shown in the table below.

There were no differences evident in the aldehyde or volatile organic compound results between the two lanes.

**Carbon Monoxide Results**

<b>Date/Kiosk</b>	<b>CO time-weighted average for time sampled, ppm</b>	<b>CO 8-hr time-weighted average, ppm</b>	<b>Peak Reading, ppm</b>
2/14 Kiosk A	2	1.6	48
2/14 Kiosk B	2	0.5	42
2/15 Kiosk A	10	2.3	91
2/15 Kiosk B	6	1.3	126
2/16 Kiosk A	4	1.3	48
2/16 Kiosk B	2	0.6	22
OSHA PEL / STEL		50	-
ACGIH TLV		25	-
NIOSH REL		35	200

The chemical deca, methyl, cyclo, pentasioxane was detected on all samples. This chemical is a component of consumer products found in lotions, shampoos, deodorants. There is no indication of any toxic effects from exposure to this compound.

Exposure conditions will differ depending on weather conditions, traffic volume, vehicle type, etc. Once the new ventilation system is operating, the Park should evaluate the effectiveness of the system to ensure positive pressure in the booths in relation to the outside air. You may also consider quantifying the entrance station employee’s exposure to vehicle exhaust during the high traffic volume during the summer months.

If you have questions about this report or need further assistance on occupational health issues, feel free to call me at (303)236-7130.

**Time-weighted Average for time sampled (calculated 8-hr TWA) Volatile Organic Compounds Sample Results in Parts Per Million**

Sample	Date (sample duration in minutes)	Acetone	Benzene	Ethyl Alcohol	Decamethyl Cyclo Pentasiloxane	Naptha	Petroleum Distillates	Toluene	Xylene	Carbon Monoxide
KE-1 Personal sample Inside Kiosk A	2/14 (391)	<0.009	<0.015	<0.045	0.0020(0.002)	<0.0049	0.047(0.038)	<0.0060	<0.0052	2 (1.6)
CG-1 Personal Sample Inside Kiosk B	2/14 (114)	<0.030	<0.0055	<0.15	<0.0055	<0.016	0.050(0.012)	<0.020	<0.017	2 (0.5)
A-1 Area Sample Outside Kiosk A	2/14 (138)	<0.027	<0.044	<0.13	<0.0050	<0.015	0.024(0.007)	<0.018	<0.016	
CG-2 Personal Sample Inside Kiosk B (snow coaches only)	2/15 (105)	<0.032	<0.052	<0.16	0.032(0.007)	<0.017	0.069(0.015)	<0.021	<0.018	6 (1.3)
DD-2 Personal Sample Inside Kiosk A (snow mobiles only)	2/15 (109)	<0.031	<0.051	<0.16	0.19(0.043)	<0.017	0.081(0.018)	<0.021	<0.018	10 (2.3)
A-2 Area Sample Outside Kiosk B	2/15 (94)	<0.039	<0.063	<0.19	<0.0072	<0.021	<0.021	<0.026	<0.023	
DD-3 Personal Sample Inside Kiosk A	2/16 (156)	<0.022	<0.036	<0.11	0.12(0.039)	<0.012	0.026(0.008)	<0.015	<0.013	4 (1.3)
CG-3 Personal Sample Inside Kiosk B	2/16 (150)	<0.025	<0.040	<0.12	0.085(0.027)	<0.013	0.022(0.007)	<0.016	<0.014	2 (0.6)
AB-1 blank		BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
OSHA Permissible Exposure Limit 8-hr		1000	1.0	1000	n/a	100	300	200	100	50
American Conference of Governmental Industrial Hygienist Threshold Limit Value		500	0.5	1000	n/a	n/a	n/a	50	100	25

BDL: below detection limit

**Aldehyde Sample Results in Parts Per Million for time sampled (calculated 8-hr TWA)**

Sample Number	Date (sample duration)	Formaldehyde ppm	Acetaldehyde ppm	Acrolein ppm
KE-1 Personal Sample Inside Kiosk A	2/14 (389)	0.012 (0.01)	0.0059(0.005)	<0.00032
CG-1 Personal Sample Inside Kiosk B	2/14 (114)	0.0075(0.0018)	<0.0060	<0.0012
A-1 Area Sample Outside Kiosk A (pump fault due to low temp)	2/14 (138)	0.0025(0.0007)	<0.0042	<0.00087
DD-2 Personal Sample Inside Kiosk A	2/15 (109)	0.011(0.002)	<0.0059	<0.0012
CG-2 Personal Sample Inside Kiosk B	2/15 (105)	0.0073(0.002)	<0.0058	<0.0012
DD-3 Personal Sample Inside Kiosk A	2/16 (156)	0.0080(0.003)	<0.0039	<0.00081
CG-3 Personal Sample Inside Kiosk B	2/16 (150)	0.0069(0.002)	<0.0044	<0.00091
OSHA Permissible Exposure Limit		0.75 / 2.0*	200	0.1
American Conference of Governmental Industrial Hygienist Threshold Limit Value (TLV)		0.3**	25**	0.1**
NIOSH Recommended Exposure Limit		0.016 / 0.1*		0.1 / 0.3*

BDL: below detection limit

\*Short Term Exposure Limit \*\* Ceiling Limits