

HEALTH HAZARD EVALUATION REPORT 72-92-93  
HAZARD EVALUATION SERVICES BRANCH  
DIVISION OF TECHNICAL SERVICES

Establishment : Sturm Machine Company, Inc.  
Barboursville, West Virginia

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE  
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
CINCINNATI, OHIO 45202

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HEALTH HAZARD EVALUATION REPORT 72-92  
STURM MACHINE COMPANY, INC.  
BARBOURVILLE, WEST VIRGINIA

I. SUMMARY DETERMINATION

Section 20(a) (6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from Sturm Machine Company, Inc., an employer, relative to exposure to toxic metal fumes encountered while flame-spraying pump shaft sleeves. These replacement sleeves, the sole product of Sturm Machine Company, either custom made or furnished as a stock item, are used in the paper, pulp, powder, chemical, mining, petrochemical, marine and petroleum industries.

The Occupational Health Standards promulgated by the U.S. Department of Labor (Title 29, Code of Federal Regulations, Chapter XVII, Part 1910.93 entitled, "Air Contaminants") applicable to the individual substances of this evaluation are as follows:

<u>Substance</u>	<u>Eight-Hour Time-Weighted Concentration</u>	
	p.p.m. <sup>a</sup>	mg/M <sup>3</sup>
Antimony and compounds (as Sb)		0.5
Boron oxide	15	
Cadmium fume (Z37.5-5-1970)		0.1 mg/M <sup>3</sup> (8 hrs) 0.3 mg/M <sup>3</sup> ceiling
Carbon monoxide	50	55
Chromium, metal and insol salts		1
Cobalt, metal fume and dust		0.1

<u>Substance</u>	<u>Eight-Hour Time-Weighted Concentration</u>	
	<u>p.p.m.<sup>a</sup></u>	<u>mg/M<sup>3b</sup></u>
Copper fume		0.1
Iron oxide fume		10.0
Manganese (ceiling value not to be exceeded)		5.0
Nickel, metal and sol cmpds. as Ni.		1
Nitric oxide	25	30
Nitrogen dioxide	5	9
Ozone	0.1	0.2

<sup>a</sup>p.p.m. - parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm Hg pressure.

<sup>b</sup>mg/M<sup>3</sup> - approximate milligrams of substance per cubic meter of air

Individual occupational health standards are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

In the case where employees are exposed to a mixture of air contaminants, the equivalent exposure is computed as follows:

$$E_m = \frac{C_1}{L_1} + \frac{C_2}{L_2} + \frac{C_3}{L_3} + \dots + \frac{C_n}{L_n}$$

Where:  $E_m$  is the equivalent exposure for the mixture  
 $C$  is the concentration of the particular contaminant  
 $L$  is the exposure limit for that contaminant

Additionally, the American Conference of Governmental Industrial Hygienists (ACGIH) has recommended changes in the Threshold Limit Values (TLV) or health standards based on recent evaluations to the following levels:

Silicon 10 mg/M<sup>3</sup>

NIOSH investigators conducted environmental and medical investigations of these operations on October 26-27, 1972.

Nine bulk samples of the metal powders commonly used were collected and submitted to the laboratory for analysis by emission spectroscopy to determine the most prominent elements present.

Four air samples for metal fumes taken in the breathing zone of employees while spraying metal powder were collected on membrane filters October 26 and 27, 1973. The samples were analyzed in the laboratory, using atomic absorption techniques, for antimony, boron, cadmium, cobalt, chromium, iron, nickel, manganese and silicon. Simultaneous samples for gaseous decomposition products were taken using detector tubes for carbon monoxide, oxides of nitrogen and ozone. Results indicate that concentrations of all metal fumes were less than twenty-five percent of OSHA Standards except for antimony and chromium which were approximately fifty percent.

One of the samples collected at the 13017 Comet showed a combined exposure to metal fumes equal to 1.7 times the OSHA Standard for equivalent mixed exposure, but the exposure was not of 8-hour duration.

Gaseous contaminant concentrations were low. No measurable amounts of nitrogen oxides could be found. Only faint traces of ozone were detected and the levels of carbon monoxide were less than fifty percent of Federal standards.

Employees are furnished with Bureau of Mines approved air supplied hoods which are equipped with vortex tubes for cooling the face and head while flame spraying. Use of this equipment was optional but it was used for protection from heat rather than from the fumes.

No local exhaust was provided and general ventilation was minimal. However, the shop was being enlarged and plans had been made to move the two lathes used for metal spraying and install local exhaust with a water wash collector (METCO), now on the premises ready for installation.

Medical evaluation of the metalizing employees showed that all five reported symptoms of upper respiratory tract irritation. In two workers, these symptoms had been constant and severe. Other symptoms of eye irritation, headache, abdominal cramps and diarrhea occurred occasionally. The two men with the most severe symptoms have worn new protective hoods provided for them, with a significant decrease in symptoms. The one worker of the two with remaining symptoms is also a welder and does not use the new hood for that work. Upper respiratory tract irritation also occurred in one worker while changing the steel grit in the grit blaster. He does not wear protective respiratory equipment for this job at the present time. The remaining two employees have not been wearing the new hoods because of discomfort caused by the extra weight.

The symptoms experienced by the exposed men are compatible with the symptomatology of exposure to the primary vapors of nitrogen dioxide, nitric oxide, and possibly copper. The symptoms do not suggest acute pulmonary irritation, and exposure to high concentrations of ozone, nitrogen dioxide and nitric oxide is unlikely. Since the symptoms of headaches were elicited, exposure to low concentrations of carbon monoxide may be occurring. However, no evidence of symptoms from higher concentrations was found.

Based upon the results of the environmental-medical investigation reported above, it is our determination that the subject substances, antimony, boron, cadmium, cobalt, chromium, iron, nickel, manganese, silicon as well as carbon monoxide, oxides of nitrogen and ozone have produced toxic effects in employees in the past. At the concentrations measured during this evaluation these substances are judged to be potentially toxic to employees due to the persistence of mild symptomatology and the potential for enhanced toxicity of substances found in combination.

It is recommended that the plant:

1. Provide local exhaust hoods on the lathes used for metallizing as contemplated. The effluent should be cleaned by appropriate means before discharge into the outside atmosphere. The unit on hand now being installed should be adequate.
2. Require the use of the Bureau of Mines approved air line respirators which are equipped with vortex tubes for cooling should be required until local exhaust systems have been installed. An oil-less air compressor supplying fresh air from an uncontaminated source is suggested.
3. Provide a welding booth or portable local exhaust is suggested for shop welding.
4. Repair the abrasive blasting cabinet. Respirators approved for toxic dust should be worn when changing the steel grit in the grit blaster.
5. Provide preplacement and periodic (every one or two years) chest X-rays for metallizing workers.

Copies of the Summary Determination as well as the Full Report of the evaluation are available from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies of both have been sent to:

- a) Sturm Machine Company, Inc.
- b) U. S. Department of Labor - Region III
- c) Bureau of Industrial Hygiene, West Virginia Department of Health
- d) NIOSH - Region III

For the purposes of informing the approximately 5 "affected employees" the employer will promptly "post" the Summary Determination in prominent places near where affected employees work for a period of 30 calendar days.

## II. INTRODUCTION

### A. Background Information

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the Sturm Machine Company, Inc., Barboursville, West Virginia. The primary hazard evaluated was the exposure of employees to metal fumes and gases while frame-spraying pump sleeves. These operations consist of preheating the sleeve, spraying or metallizing with one or more of sixteen metal powders, and fusing the built-up section to the base metal. This forms a tough, hard, corrosion-resistant bearing surface on the replacement pump sleeves.

This facility employs approximately 53 people, the majority being machinists. Most productive activity is on the day shift but a few operations are conducted on the swing shift. Five metallizers are employed, three on days, two on the evening shift.

### B. Description of Process

Pump sleeves are machined from stainless steel, cleaned by abrasive blasting and then placed on one of two lathes for flame-spraying (or metallizing). The bearing area is preheated by a hand held oxyacetylene torch, then the appropriate metal powder is flame-sprayed by the thermospray gun mounted on the tool rest of the lathe. Parts adjoining the bearing area are coated with a nitrocellulose lacquer to prevent overspray from adhering. The built-up area was immediately fused by heating to approximately 1900°F using a hand held methyl acetylene propadiene torch. Finally, the bearing is ground to close tolerances on silicon carbide wheels.

Metal spraying is done in an area 20' x 30' separated from the 60' x 150' one story shop by 10' walls. No local exhaust is provided but one window fan and open ceiling do provide some general ventilation. An addition to the shop is now under construction. Local exhaust for the metallizing lathes is planned; in fact, a "Metro" waterwash exhauster is now on the premises.

Bureau of Mines approved supplied air-hoods which were also equipped with vortex tubes for cooling were available. However, the metallizers used them while fusing, seldom while spraying.

III. BACKGROUND HAZARD INFORMATION

## A. Standards

The Occupational Health Standards promulgated by the U.S. Department of Labor (Title 29, Code of Federal Regulations, Chapter XVII, Part 1910.93 entitled, "Air Contaminants") applicable to the individual substances of this evaluation are as follows:

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Chromium, metal and insol salts		1
Cobalt, metal fume and dust		0.1
Copper fume		0.1
Iron oxide fume		10.0
Manganese (ceiling value not to be exceeded)		5.0
Nickel, metal and sol. cmpds. as Ni.		1
Nitric oxide	25	30
Nitrogen dioxide	5	9
Ozone	1	2

<sup>a</sup>p.p.m. - parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm Hg pressure.

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Where:  $E_m$  is the equivalent exposure for the mixture  
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Additionally, the American Conference of Governmental Industrial Hygienists (ACGIH) has recommended changes in the Threshold Limit Values (TLV) or health standards based on recent evaluations to the following levels:

Silicon 10 mg/M<sup>3</sup>

#### B. Toxic Effects

**Carbon Monoxide:** This odorless, colorless gas is produced by the incomplete combustion of carbon fuels. It has a high affinity for the hemoglobin molecule, 200 times greater than that of oxygen. For this reason, relatively small percentages of CO in the air are sufficient to build up high concentrations of carboxyhemoglobin in the blood over a given period of exposure, reducing oxygen carrying capability. A concentration of 0.5% CO for one hour during mild activity will give a 20% blood carboxyhemoglobin level and can cause headaches. Levels of 30 to 50% blood carboxyhemoglobin can result in headache, irritability, confusion, dizziness, nausea, vomiting, and fainting. Blood concentrations from 50 to 80% can cause convulsions, coma, respiratory failure, and death.

**Nitrogen dioxide:** This gas is produced by oxyacetylene and MAP torches burning in room air. Nitrogen dioxide is a primary irritant, and the current occupational health standard is 5 ppm. Acute exposures to concentrations of 10 to 20 ppm produce symptoms of eye, nose, and upper respiratory tract irritation. Exposure to potentially lethal concentrations (in the range of 50 ppm or greater) may produce no symptoms of eye, nose and upper respiratory tract irritation. Exposure to potentially lethal concentrations (in the range of 50 ppm or greater) may produce no symptoms for as long as 8 hours, at which time symptoms of acute pulmonary edema appear. Continuous chronic exposure to concentrations greater than 5 ppm may produce progressive and possibly fatal pulmonary edema and hemorrhage. The evaluation of nitrogen dioxide toxicity is easily confused because of the frequent simultaneous presence of nitric oxide and ozone. Chronic exposure may lead to build-up of methemoglobin in the blood, which can be an indicator of exposure.

Nitric oxide: This gas is also a product of oxyacetylene and MAP welding torches. It is converted spontaneously in the air to nitrogen dioxide, but this reaction is slow to occur at concentrations less than 50 ppm. It causes symptomatology similar to that of nitrogen dioxide, but is felt to be approximately one-fifth as toxic.

Ozone: This gas is produced by electrical arcs and by sources of ultra-violet radiation, and it is commonly associated with electric arc welding. Mild exposure produces symptoms of eye, nose, and throat irritation, as well as chest cramps, headaches, vertigo, and fatigue. Serious exposure can cause pulmonary edema and death (with exposure in the range of one part or greater per million).

Antimony: Little is known of human response to the exposure of antimony. Industrial experience is limited. Smelter workers exposed to antimony and its compounds were diagnosed as being symptomatic of antimony poisoning. Pathological conditions were dermatitis, rhinitis and inflammation of the upper and lower respiratory tract. A few cases of gastritis and conjunctivitis were also noted.

Boron oxide: This element has a low toxicity, and there are no reported cases of poisoning from "oxygen bonded" salts of boron. Experimentally, high exposures to boron oxide produced only mild nasal irritation.

Cadmium: Acute cadmium fume poisoning, with lung edema the outstanding symptom, has been reported relatively frequently. The average concentrations responsible for fatal cases have been estimated to be 50 mg/M<sup>3</sup> and 40 mg/M<sup>3</sup> both for exposure of one hour. Non-fatal pneumonitis has been reported from concentrations between 0.5 and 2.5 mg/M<sup>3</sup>. Chronic cadmium poisoning is characterized by emphysema and renal injury in which the urine contains a high molecular protein. The ACGIH recommended threshold limit value (TLV) of 0.2 mg/M<sup>3</sup> for cadmium dust is proposed to protect against the possibility of these systemic effects, while a limit of 0.1 mg/M<sup>3</sup> is recommended for the more hazardous cadmium oxide fume.

Cobalt: Contact with this metal and its compounds has been associated with an allergic dermatitis. Another serious manifestation reported is a chronic interstitial pneumonitis seen in workers using cobalt cemented tungsten carbide. Pulmonary symptoms of an allergic hypersensitivity nature have occurred with exposure to concentrations less than the current standard.

Copper: Inhalation of copper metal fumes have been associated with the development of "metal fume fever," a flu-like syndrome usually with onset 4 to 12 hours after exposure and not lasting longer than 24 hours. Specific symptoms attributed to copper fume inhalation are upper respiratory tract irritation, increased salivation, sweetish metallic taste, nausea, vomiting, diarrhea, gastric pain, and hemorrhagic gastritis. Discoloration of the skin and hair have been observed. Chronic inhalation of copper has produced pathologic lesions similar to dust diseases caused by steel and porcelain particles. Chronic exposure has also been linked with anemia. Metallic copper is considered less toxic than its salts.

Iron: The chronic inhalation of iron and iron oxide fumes produces siderosis, a characteristic mottling of X-ray picture of the lungs. This condition requires 6 to 10 years of exposure to develop, and it is not felt to occur with exposures less than 15 mg per cubic meter. This is a benign, non-proliferative pulmonary fibrosis. However, it may be confused with other X-ray diagnosis of lung disease.

Nickel: Industrial exposure to metallic nickel is of interest for two reasons: nickel sensitivity dermatitis and a possible carcinogenic effect. Other than nickel carbonyl, no well-authenticated reports of acute or chronic industrial intoxication are known for nickel and its compounds. Dermatitis, or "nickel itch," is an allergic sensitivity reaction seen among nickle platers. A significant increase in lung and sinus cancer has been reported among nickel refinery employees in England, Norway, and Canada. Nickel carbonyl has been implicated by some studies as the possible carcinogen, however, the exact etiology for this statistical increase is not now known. Experiments involving rats and guinea pigs exposed to 15 mg per cubic meter of powdered nickel produced malignant pulmonary neoplasms in those animals.

#### IV. HEALTH HAZARD EVALUATION

A. The hazard evaluation survey of the Sturm Machine Company, Inc., Barboursville, West Virginia was made by NIOSH representatives, A. A. Maier, Kenyon Rupnik and Phillip Polakoff, M.D. October 26-27, 1972.

The president of the corporation was interviewed by the NIOSH survey team. He gave a brief resume of the company's activities; included were the history of the company, products manufactured, manufacturing methods, problems related to health and safety, as well as reasons for the hazard evaluation request. The team was then escorted through the shops to observe the machining, shot or grit blasting, flame-spraying and silicon carbide grinding facilities. Following the observational tour, Mr. Maier proceeded with the collection of air

samples at the metal spraying operations and the medical support team - Mr. Kenyon Rupnik and Dr. Phillip Polakoff, interviewed privately the five metallizers and obtained their past medical history and present complaints. See "Medical Evaluation" for details.

#### B. Environmental Survey

A health hazard survey was made to determine the levels of contaminants to which the metallizers were exposed while spraying various metal powders on the pump sleeves. Breathing zone air samples for fumes were collected on cellulose membrane filters (0.8 $\mu$  pore size), while flame spraying operations were in progress. The air was sampled at a rate of 0.2 liters per minute by the use of MSA Model G battery operated personnel monitoring vacuum pump.

Air in the breathing zone of the metallizers was sampled (simultaneous with those mentioned above) for gaseous contaminants, carbon monoxide, oxides of nitrogen and ozone using a MSA Universal Hand Pump and appropriate detector tubes.

#### Results

1. Bulk samples of nine commonly used powders were submitted to the laboratory for analysis. Samples of the powders used while collecting air samples were analyzed for prominent metallic components by emission spectroscopy. Antimony, Boron, Cobalt, Chromium, Iron, Manganese, Nickel, and Silicon were present. Cadmium, Molybdenum, Tungsten, and Vanadium were not found. Emission spectroscopy proves the manufacturers statements that cadmium is not present in their metallizing powders used by Sturm Machine Company, unless in trace amounts.
2. Table I gives the results of air samples taken in the breathing zone of metallizers which were analyzed using atomic absorption techniques. (Note: Cadmium was found in the air samples.)
3. Carbon monoxide was the only gaseous contaminant present in significant quantity. Samples varied from 18 to 25 p.p.m., the highest value being only one-half of the OSHA Standard. Oxides of nitrogen were not found and only traces (not measurable) of ozone were detected.

#### Discussion

Two lathes are located in the shop and both are equipped for flame spraying. However, only one lathe was in operation during the survey. One sample (No. 3) was taken while two spray guns were used simultaneously on the single lathe spraying a single part.

This did not increase the concentration of the contaminants either metallic or gaseous.

It was also obvious that continuous flame-spraying is unlikely or impossible as considerable time is required to set up each job and remove it after application of the hard coat. Exposure is not likely to exceed 2 or 3 hours a day, standards are based on an eight-hour work day.

### C. Medical Evaluation

#### 1. Method

A walk-through inspection was made on October 26-27, 1972. Workers were questioned throughout the production process as to whether they suffered from any occupational ill-effects including occupational dermatoses, upper respiratory symptomatology, headaches, and nausea. No medical examinations, except personal histories were taken at this time.

#### 2. Findings

The two men whose symptoms prompted this hazard evaluation are 32 and 36 years old and they have been working as metallizers for seven and four years respectively. Both give a similar history of intermittent sore throats since they started work and until January/February 1972, when they developed continuous sore throats with cough. Both men sought medical help which resulted in chest X-rays and pulmonary function tests. These were normal for one worker and showed asthmatic changes in the other.

The other three metal spray workers are 23, 21, and 19 years of age, and they have been with the company 4, 18, and 6 months respectively. When questioned about symptoms, one of them reported an occasional sore throat related only to the job of changing the grit in the grit blaster; another related an occasional sore throat and cough while working with 450 and 451 Metco metal spray (an aluminum coated nickel powder) which reportedly produces an exothermic reaction and a particle temperature of 5000 degrees centigrade; while the third has had a continuous cough for the last five months since starting work. (He has smoked 1-1/2 packs per day for two years). The last two men do not wear their protective hoods because they claim the weight causes headaches.

A review of body systems revealed their additional complaints: both of the evening shift workers complained of decreased night vision from watching the metallizing flame; three of the five workers complained of frequent dry nose and throat while spraying and three complained of eye irritation with increased lacrimation. Two workers mentioned occasional headaches; all five reported occasional head-

aches; and all five reported occasional abdominal cramps or diarrhea. One worker's symptoms ceased with the introduction of the new protective hoods.

Since the onset of symptoms in the workers, the company has made changes in protective equipment and ventilation in the spray area. The company has acquired welding hoods with external air supply, and they have purchased a water wash dust collector which will be installed shortly. In the three months these hoods have been in use, one worker's symptomatology has cleared, although the other still complains of intermittent sore throats and wheezing. This man does welding for the company as well as metal spraying, for which he wears a welder's face shield without separate air supply. In addition, he has a past medical history of one episode of acute bronchitis and asthma in 1969. He did not report any earlier asthma history. Both men have smoked two packs of cigarettes per day for many years, but the first allegedly quit one and a half years ago, while the second allegedly quit two months ago.

In conclusion, all five workers involved in the metallizing operations reported symptoms of upper respiratory tract irritation. In two workers, these symptoms had been constant and severe. Other symptoms of eye irritation, headache, abdominal cramps and diarrhea occurred occasionally. The two men with the most severe symptoms have worn new protective hoods provided for them, with a significant decrease in symptoms. The one worker of the two with any remaining symptoms is also a welder and does not use the new hood for that work. Upper respiratory tract irritation also occurred in one worker while changing the steel grit in the grit blaster. He does not wear protective respiratory equipment for this job at the present time. The remaining two employees have not been wearing the new hoods because of discomfort caused by the extra weight. Further improvement in the ventilation of the metallizing area is planned with the installation of the water wash dust collector.

The symptoms experienced by the exposed men are compatible with the symptomatology of exposure to primary vapors of nitrogen dioxide, nitric oxide, amyl acetate, and possibly copper. The symptoms do not suggest acute pulmonary irritation, and exposure to high concentrations of ozone, nitrogen dioxide and nitric oxide is unlikely. Since the symptoms of headaches were elicited, exposure to low concentrations of carbon monoxide may be occurring. However, no evidence of symptoms from higher concentrations was found.

TABLE I: RESULTS OF ENVIRONMENTAL SAMPLING

Element	Exposure Standard mg/M <sup>3</sup>	Breathing Zone #1 Sample of Metco #16-e		Breathing Zone #2 Sample of Comet #13017		Breathing Zone #3 Sample at Metco #12-c #16-c		Breathing Zone #4 Sample at Metco #12-c #16-3	
		Concentration mg/M <sup>3</sup>	C/L	Concentration mg/M <sup>3</sup>	C/L	Concentration mg/M <sup>3</sup>	C/L	Concentration mg/M <sup>3</sup>	C/L
Iron	10	0.045	.0045	0.06	.006	0.026	.0026	0.36	.036
Nickel	1	0.009	.009	0.12	.12	0.053	.053	0.23	.23
Manganese	5	0.018	.0036	0.006	.0012	0.0014	.0003	0.007	.0014
Cadmium	0.1	0.013	.13	0.017	.17	0.015	.15	0.010	.10
Cobalt	0.1	0.013	.13	0.024	.24	0.011	.11	0.014	.14
Chromium	1.0	0.018	.018	0.51	.51	0.014	.014	0.061	.061
Silicon	1.0	0.36	.036	0.49	.049	0.21	.021	0.29	.029
Boron	15	1.8	.12	2.4	.16	1.05	.07	1.4	.093
Antimony	0.5	0.18	.36	0.24	.48	0.11	.22	0.14	.28
		$C_i/L_i = 0.81$		$C_i/L_i = 1.74$		$C_i/L_i = 0.64$		$C_i/L_i = 0.97$	
Gases	ppm	Average PPM		Average PPM		Average PPM		Average PPM	
Carbon Monoxide	50	20		20		20		20	
Nitrogen Oxides	5 & 25	0		0		0		0	
Ozone	0.1	Trace		Trace		Trace		Trace	