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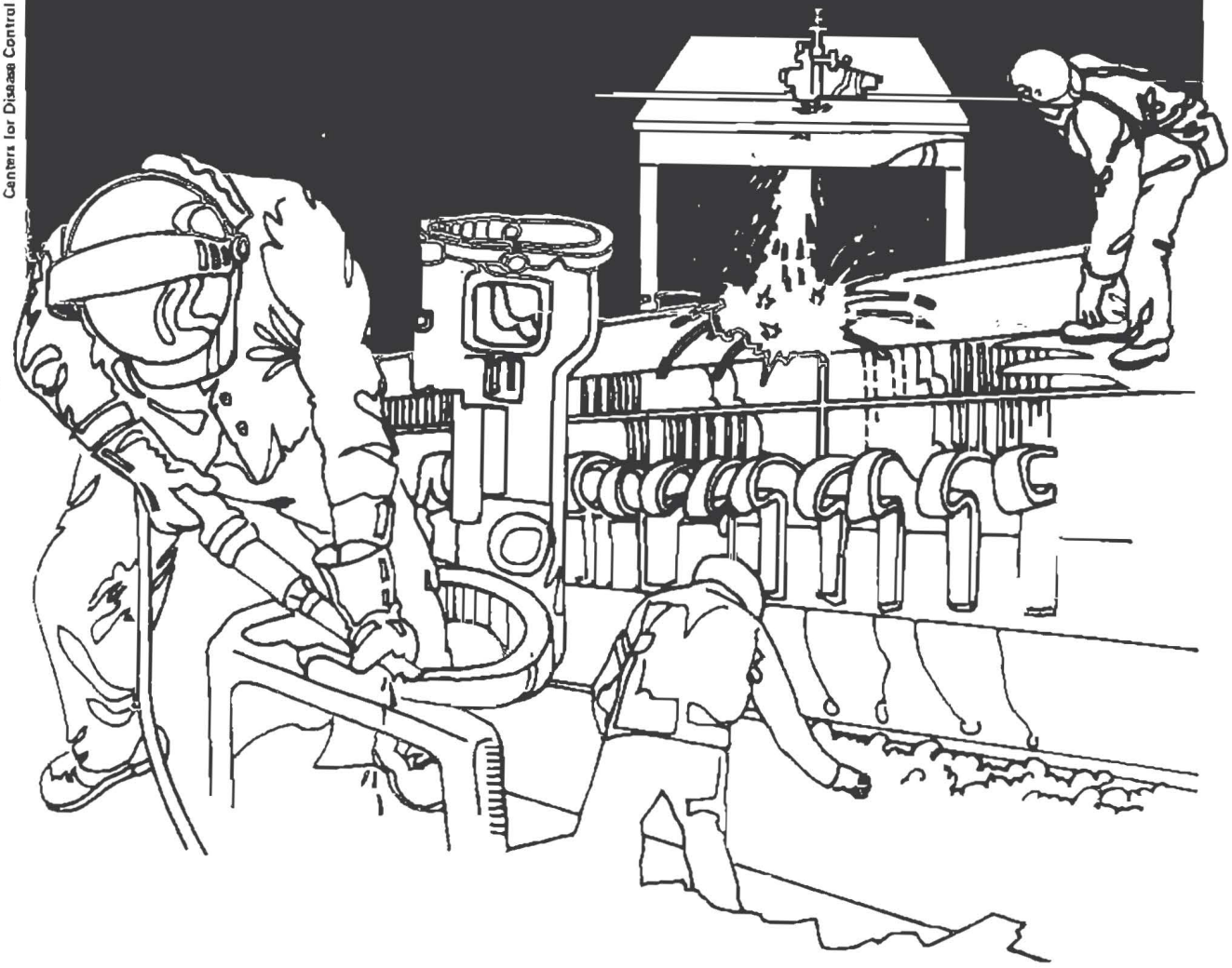

Health Hazard Evaluation Report

HETA 82-106-1366
HONDA MOTOR COMPANY
OF AMERICA
MARYSVILLE, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 82-106-1366
SEPTEMBER 1983
HONDA MOTOR COMPANY OF AMERICA
MARYSVILLE, OHIO

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I. SUMMARY

In January 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate exposures to carbon monoxide and to particulates from welding operations and diesel engine emissions at the construction site of the Honda Motor Company of America plant in Marysville, Ohio.

On February 18-19, 1982, a NIOSH survey team conducted an environmental and medical evaluation at the facility. Personal and area air samples were collected to measure worker exposure to total particulates, metals, and carbon monoxide (CO). NIOSH investigators interviewed 65 workers representing six different trades and collected pre- and post-shift blood samples for determination of carboxyhemoglobin (COHB) concentrations and pre- and post-shift expired breath for CO and COHB concentrations.

The total particulate concentrations ranged from 0.22 milligrams per cubic meter (mg/m^3) to 8.53 mg/m^3 (geometric mean: 1.75 mg/m^3) for personal air samples, and from 0.55 mg/m^3 to 1.29 mg/m^3 (geometric mean: 0.82 mg/m^3) for area air samples. The American Conference of Governmental Industrial Hygienists' (ACGIH) environmental exposure limit for total particulates is 10 mg/m^3. Concentrations of iron ranged from 20 micrograms per cubic meter (ug/m^3) to 2,580 ug/m^3 (ACGIH environmental limit - 5,000 ug/m^3) while other metals, including lead, nickel, zinc, beryllium, and copper, were not detected. The carbon monoxide concentrations ranged from 0 parts per million (ppm) to 33 ppm (arithmetic mean: 19 ppm) for personal air samples and 5 ppm to 42 ppm (arithmetic mean: 26 ppm) for area air samples. The NIOSH environmental exposure limit for carbon monoxide is 35 ppm.

The medical interviews revealed no current or past episodes of metal fume fever. Four of the six most frequently reported symptoms - headaches, reported by 43 (66%) of the 65 participants, fatigue by 29 (45%), nausea by 24 (37%) and chest tightness by 20 (31%) - were compatible with mild carbon monoxide intoxication. There were no significant differences in symptom reporting between smokers and nonsmokers. As a result of the changes in environmental condition at the time of the NIOSH visit, results of current blood and breath tests could not be related to past symptoms. The mean COHB concentration showed small but significant increases over the shift, by both blood and expired breath determinations, in both smokers and nonsmokers. In nonsmokers, mean ($\pm$ standard deviation) COHB in blood increased from 0.3 ($\pm$ 0.4) % pre-shift to 2.9 $\pm$ (2.1) % post-shift ($p<0.0001$, paired t-test).

The NIOSH survey has determined that workers' symptoms with onset since working at the construction site were compatible with mild CO intoxication and that a small, but statistically significant pre- to post-shift increase in COHB occurred at the time of the survey. Although elevated environmental CO and blood COHB concentrations were documented in the past, no hazard from CO and welding and diesel fumes was documented at the time of the survey. Recommendations are contained in Section VII of this report.

KEYWORDS: SIC 1541 (General Contractors - Industrial Buildings and Warehouses); carbon monoxide, welding fumes, blood carboxyhemoglobin.

II. INTRODUCTION

In January 1982, NIOSH received a confidential request to evaluate employee exposures to carbon monoxide and particulates resulting from welding operations and diesel engine emissions inside the building at the construction site of the Honda Motor Company of America plant in Marysville, Ohio. After the NIOSH study team was refused permission to perform the hazard evaluation, a warrant was secured to gain access to the facility. NIOSH then conducted an opening conference and subsequent environmental/medical evaluation at the plant on February 18-19, 1982.

Notification letters of individual results of carboxyhemoglobin determination in blood and expired breath were distributed in June 1982.

III. BACKGROUND

The construction of the Honda automobile manufacturing plant in Marysville, Ohio was begun in January 1981. During the fall of 1981, after the walls and roof were completed, several workers received medical treatment for nausea and headaches, which possibly resulted from exposure to carbon monoxide gas, welding fumes, and diesel emission fumes. In December 1981, several ceiling fans were installed to help reduce the levels of these contaminants. During February 1982, when this hazard evaluation was performed, a significant amount of arc welding and diesel vehicular traffic still existed within the building. However, the subjective impression of the workers was that the level of contaminants was lower in February than in December 1981, when the initial health problems occurred. A total of about 250 workers, representing ten trade unions, worked at the construction site. A majority of them worked during the day shift.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

Environmental sampling was conducted at the Marysville, Ohio construction site on Feburary 18-19, 1982. A total of 47 personal breathing zone and area air samples for total particulate weight and metals were collected on pre-weighed polyvinyl chloride (PVC) filters at a flow rate of 1.5 liters per minute (lpm). Twenty-eight of these particulate samples were analyzed for iron, lead, nickel, zinc, beryllium, and copper.

Thirty-five personal breathing zone and five area air samples for carbon monoxide gas were collected using Draeger™ long-term detector tubes at a flow rate of 50 to 100 cubic centimeters per minute (cc/min).

B. Medical

Employees working for a representative spectrum of subcontractors at the construction site were invited to participate in the medical evaluation. A total of 65 workers belonging to six different trades were evaluated.

With the weather at the time of the NIOSH visit warmer than at the time the request had been submitted, some of the doors of the factory were opened. Thus, NIOSH personnel designed the questionnaire to elicit information on symptoms compatible with CO and metal fume exposure reported previously while working at the construction site (in addition to demographic data, work history and smoking history). Informal questioning revealed that similar symptoms on the days of interviewing were not reported.

Biological monitoring consisted of (1) determining pre- and post-shift carbon monoxide concentrations in exhaled breath by Ecolyzer and (2) analyzing pre- and post-shift blood for carboxyhemoglobin. This allowed an examination of whether significant COHB changes occurred during the shift. For the expired breath samples, the workers held their breath for 10 seconds and then exhaled into an Ecolyzer™ bag, the contents of which were then drawn through the Ecolyzer™ and the CO concentration recorded. The purpose of this indirect determination of COHB was to see if the method was a useful substitute for the blood analysis.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse

health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Listed below are the evaluation criteria for the sampled substances in this evaluation.

Substance	ACGIH TLV	OSHA Standard	NIOSH Recommended Standard
Particulate			
Total nuisance dust	10 mg/m^3	15 mg/m^3	-
Welding fumes*	5 mg/m^3	-	-
Iron Oxide	5 mg/m^3	10 mg/m^3	-
Gas			
Carbon monoxide	50 ppm	50 ppm	35 ppm

* According to the ACGIH TLV document[1], "Conclusions based on total fume concentration are generally adequate if no toxic elements present in welding rod, metal, or metal coating and conditions are not conducive to the formation of toxic gases".

B. Toxicology

Carbon Monoxide[2,3]

Carbon monoxide interferes with the oxygen-carrying capacity of the blood in two ways. It combines with hemoglobin (forming carboxyhemoglobin, COHB) with about 210 times the affinity of oxygen, thus inhibiting oxyhemoblobin formation. Second, once partial combination of hemoglobin with CO has occurred, the oxyhemoglobin dissociation curve is shifted, making the remaining hemoglobin bind oxygen with increased affinity, thereby decreasing tissue unloading.

Symptoms and signs of acute carbon monoxide poisoning can include headache, dilation of cutaneous blood vessels, weakness, dizziness, nausea, vomiting, difficulty concentrating, confusion and loss of consciousness, the latter symptoms usually occurring with higher levels (greather than 10% carboxyhemoglobin). In persons with existing coronary artery disease, exposure to carbon monoxide may aggravate angina pectoris if carboxyhemoglobin levels exceed 5 percent. The effects of chronic daily exposure to lower COHB levels (5-10%) in health individuals is not well known at this time.

The generally accepted "normal" range for COHB in non-smokers, without occupational exposure is up to 2.0 percent. The usual levels in cigarette smokers are higher and vary with such factors as frequency of smoking, time since last cigarette and degree of inhalation of cigarette smoke. While COHB levels in smokers are commonly 4-5 percent, levels of up to 9-10 percent have been found. Elevation in both smokers and nonsmokers can also result from exposure to carbon monoxide in the workplace, home or car. The OSHA permissible exposure limit of 50 ppm should limit COHB levels to about 7.5 percent. The NIOSH recommended standard of 35 ppm as an eight hour time-weighted average is designed to limit COHB to 5 percent.

Welding[3-5]

Inhalation of freshly formed welding fume of zinc oxide and other metals can result in the syndrome of metal fume fever, a self-limiting acute illness. Other metals producing the syndrome include copper, magnesium and less commonly aluminum, antimony,

manganese, iron and silver. Symptoms are "flu-like", including fever, chills, headache, sweat or metallic taste in the mouth, nausea, thirst, cough and pain in the muscles and joints, often occurring four to twelve hours after exposure to fresh fumes. Typically it is reported on Mondays and after holidays. Repeated exposures may cause no effects. The fever and leukocytosis that can result have suggested an immune mechanism, but the pathophysiology has not been established. Recovery is usually complete in 24 hours. No permanent damage has been reported.

VI. RESULTS

A. Environmental

The total particulate concentrations ranged from 0.91 mg/m^3 to 8.53 mg/m^3 (geometric mean: 1.83 mg/m^3) for 51 personal air samples (Table I) and 0.55 mg/m^3 to 1.29 mg/m^3 (geometric mean: 0.82 mg/m^3) for 10 area air samples (Table II). These concentration values are all below the 10 mg/m^3 ACGIH TLV for total nuisance dust. However, three personal air samples exceeded the 5 mg/m^3 ACGIH TLV for welding fumes. The geometric mean total particulate concentration for the area and personal samples was 1.46 mg/m^3 on 2/18/82 and 1.70 mg/m^3 on 2/19/82. Concentrations of iron ranged from 20 ug/m^3 to 2,580 ug/m^3 (environmental limit - 5,000 ug/m^3) while other metals, including lead, nickel, zinc, beryllium, and copper, were not detected.

The carbon monoxide concentrations ranged from 0 ppm to 33 ppm (arithmetic mean: 19 ppm) for personal air samples and 5 ppm to 42 ppm (arithmetic mean: 26 ppm) for area air samples (Table I). With the exception of one value (42 ppm), all carbon monoxide concentrations were below the ACGIH, OSHA, and NIOSH recommended standards. The arithmetic mean carbon monoxide concentration for the area and personal samples was 23 ppm for 2/18/82 and 17 ppm for 2/19/82.

B. Medical

Demographic data

All 55 employees seen were males; by race, 59 were white, 5 were black and one was another racial group. There were 26 smokers and 39 nonsmokers. The mean age of smokers was 42 yr (range 22-66) and of nonsmokers 39 yr (range 20-59). The job categories (unions) are listed in Table III.

Symptoms

There was no evidence from formal or informal questioning of episodes of metal fume fever. The overall prevalence of various symptoms since working at the construction site (two to four months prior to the evaluation for most employees), for those symptoms with greater than 20% prevalence are listed in Table IV. Most symptoms were slightly more common in non-smokers, but, none of the individual differences was statistically significant.

Four of the six most frequently reported symptoms, (headache, nausea, fatigue, dizziness) were compatible with mild CO intoxication. We defined a case of CO intoxication as the presence of headache plus two of the other three symptoms. Twenty-four workers met this case definition. These 24 epidemiologically defined cases were compared to other respondents for age, smoking status, and total number of symptoms. The age and smoking status of the two groups were similar (Table V). As a result of the change in worksite conditions at the time of the NIOSH visit, current blood/breath tests could not be related to past symptoms. Past blood tests taken on December 30 and 31, 1982, at (the "peak" of the carbon monoxide problem) showed that the highest COHB concentrations (greater than 10%) were found in electricians and plumbers/fitters. Therefore the distribution of cases in these two jobs vs all others was compared; no significant difference was found (Table V).

Blood and breath tests

By smoking status

A number of COHB blood samples were inadvertently opened at the laboratory prior to being tested, invalidating some results; these are not included in the analysis. Table VI shows the results of expired breath and blood tests for COHB concentration (pre-shift, post-shift and pre- to post-shift difference, where available), by smoking status.

The mean COHB concentrations increased significantly over the shift (paired t-test significantly different from zero), by both measurement techniques, regardless of smoking status (for COHB change [blood], $p = 0.0028$ in smokers and $p<0.0001$ in nonsmokers). The blood COHB values increased over the shift in all individuals except one, a nonsmoker.

By location and trade

The mean environmental CO levels by vertical location in the plant varied from a low of 16.4 ppm on the ground to 26 ppm on the mezzanine (Table VII). The mean post-shift blood COHB levels in nonsmokers by vertical location appeared to bear little relation to environmental levels, with those on the ground having the highest mean level (Table VII). These differences by location among mean post-shift COHB level were not significant ($F= 0.84$, $p= 0.48$, by analysis of variance). The mean pre- to post-shift difference followed the environmental levels more closely (Table VII).

Table VIII shows the mean post-shift COHB levels by job category in nonsmokers.

Individual elevated levels

Among the 32 nonsmokers with post-shift blood COHB determinations, four were above 5 percent (an electrician, a plumber/fitter and two sheetmetal workers), the same trades having the highest COHB determinations in December 1981. Two were above 7.5% (7.8% and 10.4%). For the latter individual the breath analysis determination was much lower (2.90%).

VII. DISCUSSION AND RECOMMENDATIONS

Elevated environmental CO and blood COHB concentrations were documented prior to the NIOSH study. Symptoms compatible with mild CO intoxication were reported by workers since working at the construction site. Small but significant increases in COHB in blood (by direct measurement and by calculation from breath CO concentrations) were observed over the shift at the time of the present survey. However, these determinations were lower than those observed in December 1981, when 12.5% of post-shift COHB determination exceeded 5.0%.

The changes in building ventilation such as the addition of several roof fans in December 1981, and the open doors and windows likely accounted for the lower COHB blood determinations observed during our study.

Although the correlation was weak, the pre- to post-shift change in COHB in blood test reflected environmental CO exposure by personal breathing zone monitoring.

The following recommendations should help minimize workers exposure to carbon monoxide and welding fumes.

1. Whenever possible, ventilation should be used to reduce the airborne levels of the aforementioned contaminants. The addition of roof fans and opening all doors and windows will help lower contaminant concentrations.

2. Several respirator manufacturers produce helmeted powered air-purifying respirators specifically for welders. In addition to protecting welders from the visual hazards of non-ionizing radiation, these respirators provide a continuous flow of filtered air past the worker's face. These respirators provide protection against particalates but not against CO.

VIII. REFERENCES

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3. NIOSH, Region V
4. OSHA, Region V

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Total Particulate, Iron, and Carbon Monoxide Concentration
for Area Samples

Honda Motor Company of America
Marysville, Ohio
HETA 82-106

February 18-19, 1982

Job Title (Union)	Date	Particulate Concentration			Carbon Monoxide Concentration (ppm)
		Duration	Total (mg/m^3)	Iron (ug/m^3)	
Carpenter	2-18-82	8:10-14:55	1.10	-	9
Electrician	2-18-82	8:13-14:32	1.51	-	30
Electrician	2-18-82	8:15-14:31	1.79	-	7
Sheet-Metal	2-18-82	8:10-14:40	1.11	-	28
Electrician	2-18-82	8:04-14:55	-	-	16
Electrician	2-18-82	8:06-14:55	1.14	-	27
Carpenter	2-18-82	8:08-14:58	2.21	-	18
Electrician	2-18-82	7:30-14:29	1.15	-	28
Electrician	2-18-82	7:35-14:26	1.17	-	27
Electrician	2-18-82	7:37-14:17	1.42	-	29
Electrician	2-18-82	7:42-14:27	1.12	-	16
Iron Worker	2-18-82	7:56-14:53	3.12	-	13
Electrician	2-18-82	7:59-14:40	0.91	-	7
Electrician	2-18-82	8:01-14:48	-	-	17
Electrician	2-18-82	7:45-14:25	1.17	-	33
Electrician	2-18-82	7:49-14:55	1.02	-	20
Electrician	2-18-82	7:52-14:55	1.84	-	32
Electrician	2-18-82	7:55-14:30	-	-	29
Sheet Metal	2-18-82	8:40-15:03	1.74	-	-
Sheet Metal	2-18-82	8:43-15:07	2.29	-	
Sheet Metal	2-18-82	8:45-14:43	1.23	-	-
Sheet Metal	2-18-82	8:19-15:01	1.34	-	28
Laborer	2-18-82	8:22-15:30	7.10	-	-
Laborer	2-18-82	8:25-14:55	8.53	-	-
Sheet Metal	2-18-82	8:33-15:00	2.79	-	-
Sheet Metal	2-19-82	7:50-15:14	-	-	23
Electrician	2-19-82	7:52-15:02	1.91	62.3	14

(Continued)

TABLE I
(Continued)

Job Title (Union)	Date	Particulate Concentration			Carbon Monoxide Concentration (ppm)
		Duration	Total (mg/m^3)	Iron (ug/m^3)	
Electrician	2-19-82	7:55-15:28	2.38	112	-
Plumber	2-19-82	7:57-12:07	1.28	64	-
Plumber	2-19-82	7:10-14:52	2.57	98	0
Plumber	2-19-82	7:19-14:32	1.86	63	11
Plumber	2-19-82	7:27-11:19	1.41	95	26
Plumber	2-19-82	7:58-12:07	1.52	80	-
Plumber	2-19-82	8:01-15:16	1.49	46	-
Plumber	2-19-82	8:03-15:17	3.27	70	-
Carpenter	2-19-82	8:11-14:25	1.41	45	-
Iron Worker	2-19-82	8:13-14:21	2.39	139	21
Iron Worker	2-19-82	8:15-11:20 11:30-15:13	2.61	63	-
Sheet Metal	2-19-82	7:35-14:37	2.93	237	9
Iron Worker	2-19-82	7:37-14:18	2.67	415	25
Plumber	2-19-82	7:40-14:36	1.39	47	18
Plumber	2-19-82	7:15-14:40	1.96	160	-
Plumber	2-19-82	7:28-14:47	6.45	2,580	12
Plumber	2-19-82	7:32-11:10	2.11	116	22
Plumber	2-19-82	7:42-15:07	1.72	189	30
Electrician	2-19-82	7:44-15:11	1.45	45	21
Electrician	2-19-82	7:47-15:02	2.22	55	3
Sheet Metal	2-19-82	8:16-15:12	1.65	67	7
Plumber	2-19-82	8:20-14:29	2.08	148	-
Electrician	2-19-82	8:22-15:22	1.17	49	-
Electrician	2-19-82	8:51-15:16	1.11	35	12

Evaluation Criteria

Substance	ACGIH TLV	OSHA Standard	NIOSH Recommended Standard
Particulate			
Total nuisance dust	10 mg/m^3	15 mg/m^3	-
Welding fumes	5 mg/m^3	-	-
Iron oxide	5 mg/m^3	10 mg/m^3	-
Gas			
Carbon monoxide	50 ppm	50 ppm	35 ppm

TABLE II

Total Particulate, Iron, and Carbon Monoxide Concentration
for Area Samples

Honda Motor Company of America
Marysville, Ohio
HETA 82-106

February 18-19, 1982

Sample Location	Date	Particulate Concentration			Carbon Monoxide Concentration (ppm)
		Duration	Total (mg/m^3)	Iron (mg/m^3)	
Ground Floor (Col.#7E)	2/18/82	9:25-15:31	0.36	-	-
Ground Floor (Col.#19E)	2/18/82	9:29-15:32	0.94	-	-
Mezzanine (Col.#40C)	2/18/82	9:37-15:39	0.98	-	42
Penthouse	2/18/82	9:55-15:37	1.01	-	-
Ground Floor (Col.#45D)	2-18-82	9:50-15:42	0.72	-	-
Ground Floor (Col.#13F)	2-19-82	8:43-15:29	1.29	-	-
Ground Floor (Col.#37E)	2-19-82	8:53-15:25	0.95	-	27
Mezzanine (Col.#37E)	2-19-82	8:59-15:32	0.92	-	33

(Continued)

TABLE 11
(Continued)

Sample Location	Date	Particulate Concentration			Carbon Monoxide Concentration (ppm)
		Duration	Total (mg/m^3)	Iron (mg/m^3)	
Mezzanine (Col.#41E)	2-19-82	9:22-15:35	0.86	-	23
Penthouse	2-19-82	9:46-15:27	0.55	-	5

Evaluation Criteria

Substance	ACGIH TLV	OSHA Standard	NIOSH Recommended Standard
Particulate			
Total nuisance dust	10 mg/m^3	15 mg/m^3	-
Welding fumes	5 mg/m^3	-	-
Iron oxide	5 mg/m^3	10 mg/m^3	-
Gas			
Carbon monoxide	50 ppm	50 ppm	35 ppm

TABLE III

Number of Employees by Job Category

Honda Motor Company of America
Marysville, Ohio
HETA 82-106

February 18-19, 1982

Electricians	24
Iron Workers	6
Carpenters	4
Sheet metal workers	12
Laborers	2
Plumbers/fitters	17
Total	65

TABLE IV

Prevalence of Reported Symptoms, Overall
and by Smoking Status

Honda Motor Company of America
Marysville, Ohio
HETA 82-106

February 18-19, 1982

Symptoms	Overall (N=65)		Smokers (N=26)		Nonsmokers (N=39)		p * Value
	No.	%	No.	%	No.	%	
Headache	43	66	16	62	27	69	0.5208
Phlegm	31	48	12	46	19	49	0.8393
Cough	30	46	13	50	17	44	0.6115
Fatigue	29	45	8	31	21	54	0.0667
Nausea	24	37	8	31	16	41	0.4012
Chest tightness	20	31	6	23	14	36	0.2726
Shortness of breath	16	25	6	23	10	26	0.8141
Chest pain	14	22	3	12	11	28	0.1093

* chi-square test (smokers vs nonsmokers)

TABLE V

Distribution of Age, Smoking Status, Job Category
in Cases and Non-cases

Honda Motor Company of America
Marysville, Ohio
HETA 82-106

February 18-19, 1982

Case definition: An employee seen at the construction site, by NIOSH, who reported having had headache and at least two of dizziness, fatigue and nausea since working at the construction site.

Factor	Cases (N =24)	Non cases (N=41)	Statistical Test	P value
Age (mean)	38.25	41.22	t = 1.00	p > 0.05 (N.S)
Smoking status (% smokers)	7/24 (29%)	19/41 (46%)	chi-square = 1.21	p > 0.05 (N.S)
Trade= Electricans and Plumbers/ Fitters	14/24 (58%)	27/41 (66%)	chi-square =0.09	p > 0.05 (N.S)
Average Number of Symptoms	6.7	2.8	t = 6.09	p < 0.001

TABLE VI

Carboxyhemoglobin Levels in Construction Workers, by Smoking Status

Honda Motor Company of America
Marysville, Ohio
HETA 82-106

February 18-19, 1982

	BREATH *			BLOOD		
	COHB%, mean ± S.D. (#)			COHB%, mean ± S.D. (#)		
	Pre-shift	Post-shift	Difference	Pre-shift	Post-shift	Difference
Smokers	5.1 + 1.7 (26)	7.8 + 1.8 (25)	2.7 + 1.6 (25)	4.6 + 2.8 (21)	7.6 + 2.7 (23)	3.1 + 3.7 (18)
			t = 8.31** p < 0.0001 df = 24			t = 3.50 p = 0.0028 df = 17
Nonsmokers	2.2 + 0.8 (39)	4.5 + 1.1 (38)	2.4 + 1.1 (38)	0.3 + 0.4 (31)	2.9 + 21 (32)	2.4 + 17 (25)
			t = 13.59 p < 0.0001 df = 37			t = 7.26 p < 0.0001 df = 24

COHb = Carboxyhemoglobin

*COHB Breath derived from Ecolyzer (ppm, carbon monoxide)

by COHB = CO (breath + 0.5
(Ringold Equation) (reference 5)

** = paired t-test, 2-tailed
df= degrees of freedon

TABLE VII

Personal Environmental CO and COHB Levels,
in Non-smokers by Vertical Location

Honda Motor Company of America
Marysville, Ohio
HETA 82-106

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Location	CO ppm air		post-shift* COHB %		pre- to post shift COHB change	
	#	mean ± SD	#	mean ± SD	#	mean
Ground	14	16.4 ± 8.7	8	3.9 ± 3.2	6	2.5
Mezzanine	5	26.0 ± 6.1	7	3.0 ± 2.8	3	2.9
Ceiling/JLG	11	18.2 ± 9.6	9	2.2 ± 1.1	9	2.0
Penthouse	8	23.1 ± 8.1	8	2.8 ± 0.7	7	2.7

*Analysis of variance F = 0.84, p = 0.48

TABLE VIII

Mean Post-shift COHB Levels by
Job Category, in Non-smokers

Honda Motor Company of America
Marysville, Ohio
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Job Category	#	COHB % mean ± S.D.
Electricians	11	3.0 ± 0.9
Iron workers	1	2.3
Carpenters	2	1.6 ± 1.1
Sheet metal workers	7	3.2 ± 3.1
Laborers	2	1.7 ± 2.3
Plumbers/Fitters	9	3.3 ± 2.8

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