

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 DETERMINATION
REPORT NO. 73-93-105

RCA GRIMES LANE WAREHOUSE
BLOOMINGTON, INDIANA
JANUARY 1974

I. TOXICITY DETERMINATION

It has been determined that employees working at the north loading dock of the Grimes Lane Warehouse in Bloomington, Indiana, are exposed to potentially toxic concentrations of carbon monoxide (CO). This conclusion is based upon; (1) worker exposure to 8-hour time-weighted-average (TWA) concentrations of CO which exceeded 35 parts per million (ppm), the exposure standard recommended in the NIOSH criteria document "Occupational Exposure to Carbon Monoxide"; (2) the significant rise and high level of carboxyhemoglobin (CO-Hb) found in the blood of non-smoking industrial truck operators.

It is suspected that exposures to CO in excess of 50 ppm (the current occupational health standard for 8-hour exposure promulgated by the U.S. Department of Labor) may occur when loading doors remain closed when not in use during winter months.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202.

Copies have been sent to:

- a) RCA Consumer Electronics, Bloomington, Indiana (Manager and Safety Officer)
- b) Authorized Representative of Employees
- c) U.S. Department of Labor - Region V
- d) NIOSH - Region V

For the purposes of informing the approximately 18 "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S. Code 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 a representative of employees regarding exposure to the exhaust gases (specifically carbon monoxide) from the liquified propane (LP) powered industrial trucks in use at the RCA Grimes Lane Warehouse, Bloomington, Indiana.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

The activity of this RCA facility deals primarily with final assembly of television receivers from components shipped in from many geographic locations. In the Grimes Lane Warehouse, which is about one block from the assembly plant, most of the bulky components as well as the cardboard cartons for the finished product are stored. When needed these items are taken by truck to the assembly facility.

Carbon monoxide measurements made on September 20, 1973 established the area of most concern to be the north half of the warehouse in the general loading area where four six-cylinder LP industrial trucks distribute the items at nine loading doors. It was suspected that toxic levels of CO from the trucks could build up over the course of a work shift. It was also suspected that these industrial truck operators (ITO's) could be breathing toxic levels of CO as they frequently drive forward and reverse in rapid succession inhaling their own truck engine exhaust.

Except for the effect of the open doors on the two ends of the building, there is no ventilation. Approximately 18 employees are exposed to the LP truck exhaust gases.

B. Design

Both environmental and medical sampling techniques were utilized in accessing the alleged CO hazard.

Environmental Evaluation Methods

In order to ascertain the environmental levels of CO, an Ecolyzer[®] was used at various points around the north end dock and aisle area to continuously monitor CO levels in the general working environment. The preliminary survey indicated low CO levels (5-10ppm) in the south end of the building which were judged not to warrant further investigation. The CO levels at points in the north dock area were recorded at 10 minute intervals. In addition, personal breathing zone samples were taken from three (of four) industrial truck operators (ITO's) and one (of two) receivers. None of the seven storekeepers were sampled. Sampling was done with a low volume MSA vacuum pump modified to pump air into a mylar bag of approximately 0.5 cubic foot volume connected to the pump discharge. A tygon tube leading from the person's breathing zone to the pump sampled the air at the rate of

0.5 cubic feet per hour. At the end of each hour the bag sample was fed directly into the Ecolyzer[®] and the CO concentration recorded.

Medical Evaluation Methods

(1) Sampling Methods

The emphasis of the medical evaluation was on workers at the north end of the warehouse since the majority of worker complaints arose from this area and because low CO environmental levels were measured at the south end of the warehouse. The medical evaluation involved: (1) examination of the OSHA 102 forms, as well as the logs from the plant's dispensaries, (2) the interview by questionnaire of the involved employees, and (3) obtaining the blood samples for CO-Hb analysis from the men exposed to exhaust fumes. The sample group included three (of four) ITO's, two (of two) receivers, and four (of seven) storekeepers all from the north end of the warehouse. Two ITO's from the south end were interviewed as well. A copy of the questionnaire accompanies this report.

With regard to industrial truck exhaust, all groups of men (ITO's, Receivers, Storekeepers) were considered exposed to the CO-containing exhaust gases. An exception was one of the storekeepers who spends nearly all of his day within the office adjacent to the warehouse dock. Blood was drawn for carboxyhemoglobin (CO-Hb) analysis from the exposed workers and from non-exposed controls. Additionally four of the exposed employees had pre-work samples, as well as, post-work blood samples drawn on the same day.

(2) Analytical Methods

Carboxyhemoglobin analysis was carried out in the manner described by Dubowski and Luke.¹ Blood samples were drawn in 10 ml. heparinized vacutainer tubes. They were then hand-carried to the NIOSH laboratories in Cincinnati via a refrigerated container and subsequently were split in a sterile manner with approximately 5 ml. being sent to Dr. K. M. Duboskwi of Toxicology Labs, University of Oklahoma, and the remainder being analyzed at the NIOSH laboratory.

C. Evaluation Criteria

The Occupational Health Standard promulgated by the U.S. Department of Labor for occupational exposure to carbon monoxide (CO) is an 8-hour time-weighted-average (TWA) concentration of 50 parts per million (ppm). This standard is based upon air concentrations that should result in CO-Hb levels not greater than 10% (just below the level where signs of exposure and borderline effects occur).

The function of the recommended standard of 35 ppm described in the 1972 NIOSH criteria document for "Occupational Exposure to Carbon Monoxide" is to (1) "prevent acute poisoning, (2) protect the worker from deleterious

myocardial alterations associated with levels of carboxyhemoglobin (CO-Hb) in excess of 5 per cent and (3) provide the employee protection from adverse behavioral manifestations resulting from exposure to low levels of CO."

It should be emphasized that the standard may not provide the same degree of protection for smokers as for non-smokers and for individuals with compromised oxygen delivery to body tissues (e.g., coronary heart disease, emphysema, anemia).

D. Environmental Evaluation Results and Discussion

Results of environmental samples taken at the north end of the RCA Grimes Lane Warehouse 22 October 1973 are shown in the following tables.

TABLE I
RCA GRIMES LANE WAREHOUSE (22 OCTOBER 1973)
GENERAL AREA ENVIRONMENTAL SAMPLES FOR EXPOSURE TO CARBON MONOXIDE

| Location | Time Period of Sample | Average Concentration for Period Sampled (Parts Per Million) |
|----------|-----------------------|--|
| a | 30 minutes | 38-42 ppm |
| b | 2 hours 25 minutes | 47-51 ppm |
| c | 2 hours 10 minutes | 53-57 ppm |
| d | 30 minutes | 58-60 ppm |

Sample Locations:

- (a) On heater enclosure at the beginning of the right aisle.
- (b) On top of a short stack of boxes in front of a loading door between the beginning of the center and right aisles.
- (c) Between loading doors 4 and 5.
- (d) In center aisle.

TABLE II
RCA GRIMES LANE WAREHOUSE (22 October 1973)
PERSONAL SAMPLES FOR EXPOSURE TO CARBON MONOXIDE

| Person Sampled | Time Period of Sample | Average Over Period Sampled | Eight-Hour-Time Weighted-Average (Parts Per Million) |
|----------------|-----------------------|-----------------------------|--|
| ITO* I | 4 hours 35 minutes | 52-55 ppm | 31-33 ppm |
| ITO* II | 3 hours 30 minutes | 59-62 ppm | 34-37 ppm |
| ITO* III | 3 hours 30 minutes | 62-66 ppm | 40-43 ppm |
| Receiver | 2 hours 35 minutes | 65-68 ppm | 38-41 ppm |

* Industrial Truck Operator

Table I gives a very general indication of environmental levels of CO in the north loading dock area. The "Average Concentration" in the table represents an average of several samples taken for a short period of time throughout the shift. Moreover, the "Time Period of Sample" is a summation of the short time lengths. Samples were collected longer and more often at locations "b" and "c" since a great deal of meter fluctuation occurred there which was caused by a great amount of truck movement in this area. At location "a" and "d" the air seemed to be stagnant; at no time was much meter fluctuation indicated. Table II presents personal samples of three ITO's and one receiver. Samples were collected from the ITO's during nearly all of the time they were in the loading dock area. In estimating the 8-hour TWA for the personal samples the time periods away from the work area were also taken into consideration. These times included lunch and other breaks. In the lunch and break areas CO levels were not above 8-10 ppm. Unfortunately the men were away from the building for an extended period to have blood samples drawn. If they had both morning and afternoon samples drawn, time away from the building was more than 2 hours in many instances. During this time the men were exposed to virtually no CO. For this reason the TWA is somewhat lower than it would have been on a truly average day. It was interesting to note the relatively high personal sample of the receiver. This is probably due to the greater time spent in the trailers checking material. This fact led to the conclusion that exposure of other dock area workers may be at times as great or greater than the exposure of ITO's.

In conclusion the established federal standard for carbon monoxide on an 8-hour time weighted-average of 50 ppm was not exceeded at the time of this evaluation. However, the NIOSH recommended standard of 35 ppm was generally exceeded at all locations. In addition it can be seen that the potential is definitely present for being exposed to much higher levels of CO such as in winter when loading doors would more likely be closed when not in use.

E. Medical Results and Discussion

A. Dispensary logs and OSHA 102 form. These reflect the injury/illness status of the entire plant's work force (6000+ workers). The logs from the plant's two dispensaries as well as the OSHA 102 form indicate mostly lacerations, contusions, sprains and strains, with a smaller number of abrasions, infections, eye injuries, etc. Comparison of the OSHA 102 form for 1971 and 1972 shows a significant decrease in the number of work-related injuries. No notable injury/illness pattern was recorded for the employees in the area of the health hazard evaluation request.

B. Questionnaire - interview. Eleven of the men working in the area of the alleged hazard were interviewed. Complaints of occasional headache and sinus problems (nasal stuffiness and drainage) while at work were most common. Other work-related complaints include eye burning and tearing, chest tightness, and lightheadedness. None of the men ever experienced nausea or vomiting which they felt might be work-related.

C. Carbonxyhemoglobin Analyses

Table III presents the CO-Hb results which were obtained by the NIOSH laboratory analysis. Split samples were sent to Dr. K. M. Dubowski for his analysis using the CO-oximeter. The differences in the two techniques were minimal; it was elected to use the NIOSH laboratory data because it was felt to be more accurate.

TABLE III

| <u>Specimen ID #</u> | <u>Smoker Exposure Before Sample</u> | <u>Work Exposure</u> | <u>CO-Hb (%)</u> |
|----------------------|--------------------------------------|------------------------------|----------------------|
| 1 AM* | None | Receiver | 2.2 |
| 2 AM* PM** | None | IT0 ¹ - North end | 2.8 8.1 |
| 3 AM* PM** | None | IT0 ¹ - North end | 2.3 8.7 |
| 4 AM* | None | Storekeeper | 2.0 |
| 5 AM* PM** | None | IT0 ¹ - North end | 2.2 8.2 |
| 6 AM* PM** | 3-4 cigarettes 15-20 cigarettes | Storekeeper | 7.6 11.2 |
| 7 AM* | None | Storekeeper | 2.0 |
| 8 AM* | 5 cigarettes | Receiver | 8.4 |
| 9 PM** | None | Storekeeper | 6.8 |
| 10 PM** | 15-20 cigarettes | IT0 ¹ - South end | 10.8 |
| 11 PM** | None | Inv. ² | 4.0 |
| 12 AM* | None | Control | 1.5 |
| 13 AM* | 2 cigarettes | Control | Inadequate Sample |
| 14 AM* | 10-12 cigarettes | Control | 5.0 |

* Samples collected between 8:00 and 9:00 AM

** Samples collected between 2:54 and 3:15 PM

1 - Industrial Truck Operator

2 - Investigator

3 - Insufficient sample was available for CO-Hb analysis by the NIOSH laboratory.

Before the results of the questionnaire interviews of the workers are discussed comment will be made on the significance of the workers' carboxy-hemoglobins and their relationship to the environmental levels of carbon monoxide. Several important inferences can be made from the information in Table III. As expected, there is a considerable difference in the AM CO-Hb of smoking and non-smoking workers -- average = 7.5% in the smokers and average = 2.3% in the non-smokers. An abnormal PM CO-Hb of 6.8% was found in worker 9. Because no AM sample was obtained, no specific conclusions can be drawn except that this value for a non-smoker exceeds the 5% CO-Hb level associated with an 8-hour time-weighted exposure of 35 ppm of CO. All individuals (smokers and non-smokers) who had PM samples drawn showed CO-Hbs well above the 5% level with two individuals (smokers) with values about 10%.

The chart below lists the increment in CO-Hb during the working day exposure of three of the ITO's and one of the storekeepers; only the storekeeper is a smoker.

TABLE IV

| <u>Specimen ID #</u> | <u>Work Exposure</u> | <u>Change in CO-Hb from AM to PM</u> |
|----------------------|----------------------|--------------------------------------|
| 2 | ITO | 5.3*] |
| 3 | ITO | 6.4*] Mean increase = 5.9* |
| 5 | ITO | 6.0*] |
| 6 | Storekeeper | 4.5 |

*Paired to test evaluation shows significance of average CO-Hb rise to be $p < 0.01$.

Table IV points out the significant rise ($p < 0.01$) in the CO-Hb of the industrial truck operators, all of whom were not cigarette smokers. Worker 6, a storekeeper, likewise showed increase in his CO-Hb but he had smoked a considerable amount throughout the day. The rise in CO-Hb in workers 2, 3 and 5 points to warehouse exposure to CO as the chief agent in bringing about such an increment. Environmental monitoring of these individuals revealed CO concentrations as listed in Table II. These concentrations appear lower than one would expect to produce the relatively high CO-Hb levels in the men; charts on the absorption of CO indicate an 8-hour time-weighted average of 75-80 ppm will produce a CO-Hb of 8.9% in a sedentary, non-smoking individual.² One explanation for the apparent discrepancy relates to the prolonged period of time required for CO disassociation from the blood once the worker has been exposed.³ Thus one peak exposure could result in an unusually high level of CO-Hb which would not reflect the low levels of CO during the remainder of the work day. Another explanation is that the rate and depth of inhalation affect the amount of inspired CO; the collection of personal air samples by the method previously described was carried out under a constant flow rate. This assumes that work is carried out at a constant respiratory rate. An increased respiratory rate and depth would tend to cause more CO-Hb to accumulate than in periods of less vigorous breathing, while the environmental monitoring equipment would record the same concentration of CO exposure regardless of the rate of inspiration in the worker.

Interview of the men revealed a considerable number of minor complaints. A number of the complaints could be attributed to several factors in the working atmosphere which are irritating but not potentially toxic. For example, complaints of burning and tearing of the eyes, nasal stuffiness and drainage, and headaches could result from the inhalation and exposure to unburnt or partially burned fuel hydrocarbons in the exhaust. Also the movement of the industrial trucks through the warehouse tends to stir up settled dust on the floor, which can serve as a mucous membrane irritant. Finally, the complaints of headache which several of the men occasionally experience could be caused by elevated carboxyhemoglobin levels. Although the presence of headache is usually associated with CO-Hb in the range of 10-15%, it is certainly conceivable that comparable CO-Hb blood levels might be reached on days of increased fork lift truck activity coupled with diminished ventilation in the plant.

In summary, there appears to be excessive exposure of the workers to carbon monoxide from industrial truck emissions. This conclusion is made in light of the NIOSH "evaluation criteria" which were stated earlier.

MEDICAL QUESTIONNAIRE
RCA GRIMES LANE WAREHOUSE

NAME _____

JOB DESCRIPTION _____

Duration at present work _____

PAST MEDICAL HISTORY

SIGNIFICANT PROBLEMS _____

SMOKING HISTORY _____

PROBLEMS IN THE WORK ENVIRONMENT _____

Eye Irritation-burning-tearing _____

Nose-throat-irritation _____

Chest irritation-tightness _____

Headaches _____

Dizziness-lightheadedness _____

Nausea _____

Other _____

V. REFERENCES

1. Dubowski, K.M. and Luke, J.L. "Measurement of Carboxyhemoglobin and Carbon Monoxide in Blood," Annals of Clinical Laboratory Science, 3, No. 1 (1973).
2. National Institute for Occupational Safety and Health. "Occupational Exposure to Carbon Monoxide," (1972).
3. Goldsmith, J.R., "Carbon Monoxide and Human Health," Science, 62:1352.
4. Steward, R.D. "Experimental Human Exposure to Carbon Monoxide," Archives of Envir. Health, 21:154-164 (1970).
5. Federal Register, 37, 202; Part II:22140 (Oct. 18, 1972).
6. "The Industrial Lift Trucks", Michigan Occ. H. Bulletin, 12, No. 1 (1966).
7. Pfbender, R.E., "Chronic Carbon Monoxide Poisoning," Industrial Medicine and Surgery, (March 1962).
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VI. AUTHORSHIP AND ACKNOWLEDGMENTS

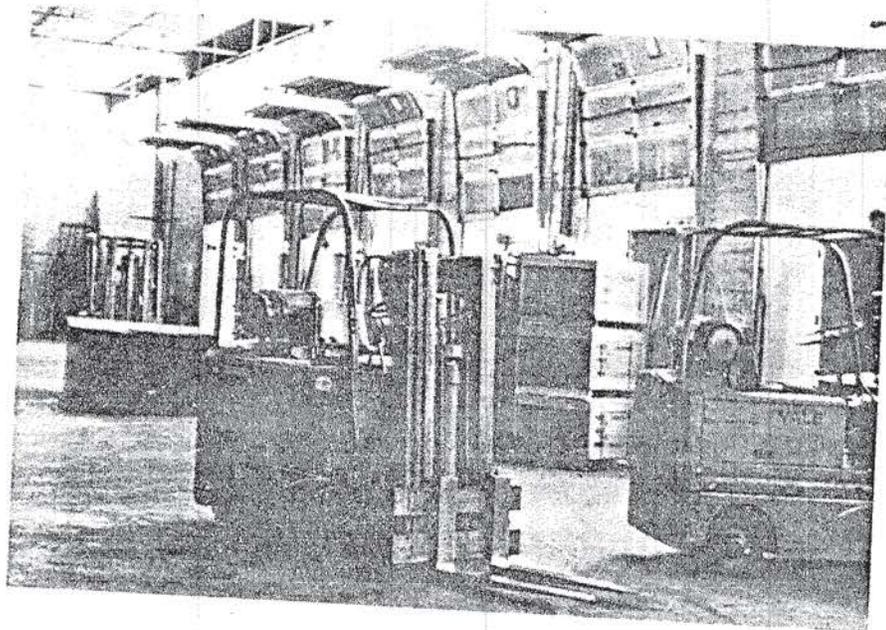
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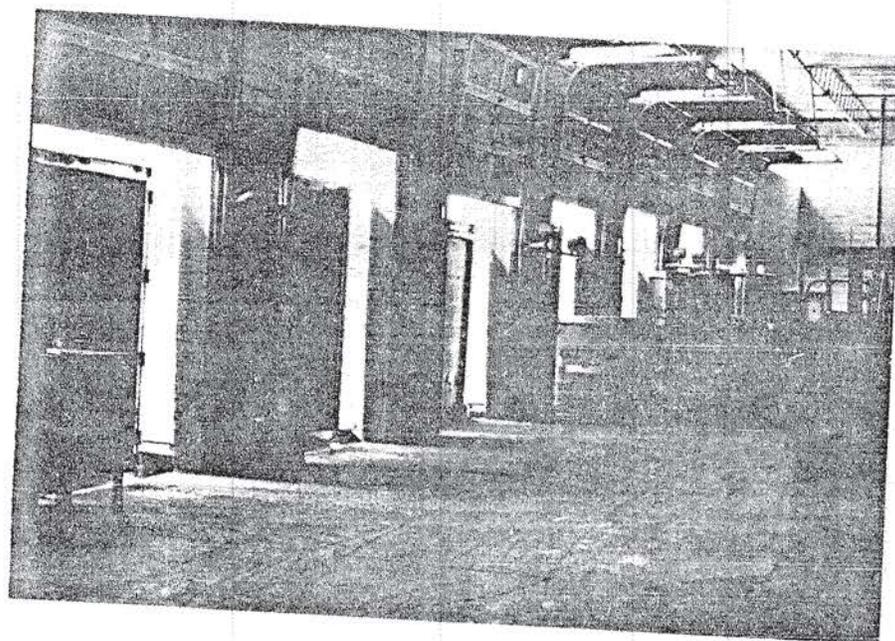
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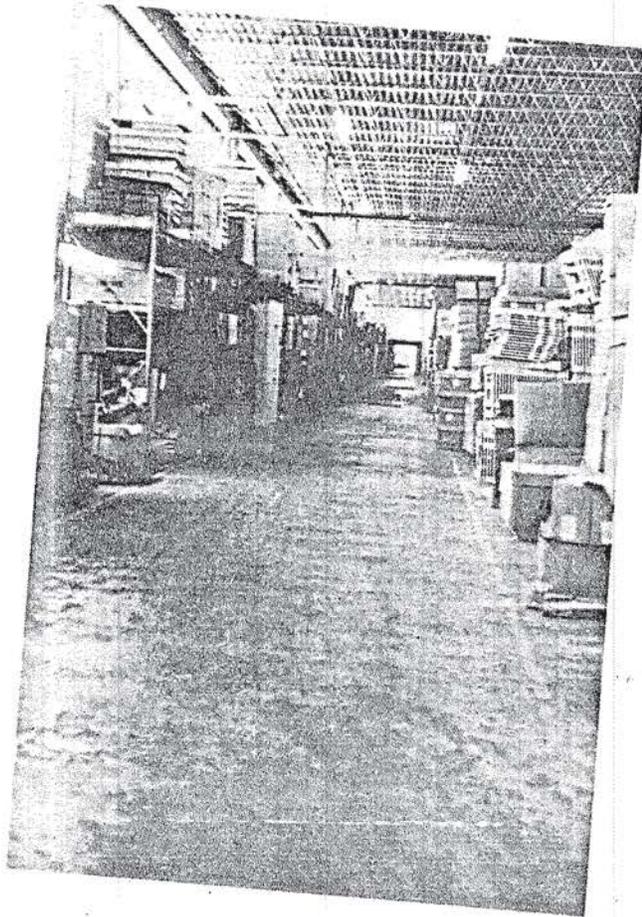
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LOADING AREA AT NORTH END OF GRIMES LANE WAREHOUSE





RIGHT AISLE
NORTH END OF WAREHOUSE

CENTER AISLE
NORTH END OF WAREHOUSE

