

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 80-27-704

AIRCO WELDING PRODUCTS
CHESTER, WEST VIRGINIA 26034

June 1980

I. SUMMARY

On November 6, 1979, NIOSH received a request to evaluate worker exposure to air contaminants during the manufacture of welding wire at Airco Welding Products, Chester, West Virginia (SIC 3480). To evaluate the request, environmental samples were taken during normal operating conditions for methylene chloride, carbon monoxide, iron oxide, copper, nickel, chromium, manganese, zirconium, molybdenum, silica, fluorides, hydrochloric acid and sulfuric acid among the 85 workers. Eleven day-shift employees were interviewed to determine work related health problems.

Methylene Chloride concentrations ranged from 33 to 630 ppm and in 14 of 15 personal breathing-zone air samples exceeded the NIOSH recommended standard of 45 ppm as computed when considering the additive toxic effects of the concurrent carbon monoxide exposure of 15 ppm. Iron oxide concentrations in two of three personal breathing-zone samples exceeded the ACGIH threshold limit value of 5 mg/M³. Airborne concentrations of manganese, fluoride, copper, hydrochloric acid and sulfuric acid were all within NIOSH and OSHA standards. Personal breathing zone samples taken for free crystalline silica, chromium, nickel, molybdenum and zirconium were below the limits of detection.

The employee interviews revealed complaints compatible with methylene chloride exposure. Four out of eight exposed employees reported dry skin conditions and three workers reported dizziness, drowsiness, headaches, and nausea.

On the basis of the data obtained in this investigation, NIOSH determined that a hazard to the health of workers exposed to methylene chloride/carbon monoxide and iron oxide existed in degreasing and descaling operations at Airco Welding Products. Other potential hazards were noted and recommendations for improved work practices, engineering controls and personal protective equipment are provided in the report on page 6.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970*, NIOSH investigates the toxic effects of substances found in the workplace. An authorized representative of two employees of Airco Welding Products requested such an investigation from NIOSH to determine the hazards presented by the manufacture of welding wire (SIC 3480). The scope of the study included the evaluation of exposures to: (1) methylene chloride in degreasing operations, (2) carbon monoxide from fork lift exhausts, (3) iron oxide dust from mechanical descaling of wire, (4) copper dust and mist and sulfuric acid mist in the copper coating of wire, (5) hydrochloric acid mist in a pickling process, and (6) particulates of nickel, chromium, manganese, zirconium, molybdenum, silica, and fluorides in the weighing, mixing and pouring of flux core in welding wire. Industrial hygiene sampling was conducted on December 18, 1979, and March 4-5, 1980. An interim report describing the methods, preliminary results, and future actions of the health hazard evaluation was sent to employer and employee representatives in December, 1979.

III. BACKGROUND

There are approximately 125 employees at the plant of whom approximately 85 are production workers. There are two major manufacturing operations where potential health hazards exist. The "loopro" operation begins with rust-coated wire that is mechanically descaled and then undergoes a pickling operation in hydrochloric acid. The wire is copper coated by dipping it into a solution of copper salts and sulfuric acid and is finally reduced to the desired diameter through drawing machines. One employee per shift is exposed to iron oxide and two workers/shift are exposed to copper dust and mist and acid mists.

The "flux-core" operation begins with flat strips of metal that are degreased by sliding through tanks of methylene chloride. After degreasing, the strips are mechanically formed to a "U" shape and the flux powders are poured into the core. The "U" shaped strip is mechanically closed to form a round wire which is then drawn to the desired diameter. Seven to ten workers per shift are exposed to methylene chloride/carbon monoxide at the degreasing station where propane-operated forklifts occasionally operate. One worker is exposed to the flux core powders at the weighing and mixing areas.

*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 and Human Services 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.

IV. EVALUATION DESIGN AND METHODS

1. Personal breathing zone samples for iron oxide, copper, nickel, chromium, manganese, zirconium, and molybdenum were collected on mixed cellulose-ester filters using battery powered sampling pumps operated at 1.5 liters per minute. The samples were analyzed by atomic absorption spectroscopy (NIOSH Method P&CAM 173).
2. Personal breathing zone samples for fluorides were collected on sodium formate-treated membrane filters at 1.5 liters per minute and analyzed by fluoride ion selective electrode (NIOSH Method P&CAM 212).
3. Respirable personal breathing zone samples for silica were drawn through a cyclone at 1.7 liters per minute and collected on membrane filters. Bulk and air samples were analyzed by X-ray diffraction (NIOSH Method P&CAM 259).
4. Methylene chloride personal breathing zone samples were collected in standard activated charcoal tubes at 0.02 liters per minute and analyzed by flame ionization detection on a Hewlett-Packard 5731A gas chromatograph (NIOSH Method S-329).
5. Carbon monoxide was sampled using both direct-reading Drager tubes and Ecolyzer Model 2400 with strip chart recorder.
6. Hydrogen chloride area samples were collected in midget impingers containing 0.5 M sodium acetate at a sampling rate of 1.0 liter per minute and analyzed by chloride ion-specific electrode (NIOSH Method S-246).
7. Sulfuric acid area samples were collected on mixed cellulose ester filters at 1.5 liters per minute and analyzed for sulfate ion by ion chromatography.
8. Acid mist samples were also collected by an experimental method using silica gel tubes. Silica gel was washed in deionized water to remove inorganics before sampling. Samples were collected at a rate of 0.2 liters per minute and analyzed by ion chromatography.

Eleven, day shift employees were interviewed by NIOSH on December 17, 1979 in a non-directed manner to determine work-related health problems. Eight of the employees working closest to methylene chloride, and employees near the mechanical descaler, the weighing and mixing rooms, and the pickling and copper coating areas were interviewed.

V. EVALUATION CRITERIA

Methylene chloride is a mild narcotic. Effects from intoxication include headache, stupor, giddiness and irritability. Repeated skin contact with methylene chloride may cause a dry, scaly dermatitis. Exposure to this agent may cause elevated carboxyhemoglobin levels which may be physiologically significant in smokers, workers with anemia or heart disease, and for those with other carbon monoxide (CO) exposures. NIOSH has recommended a time-weighted average limit of 75 ppm in the absence of occupational exposure to CO greater than 9 ppm (TWA). For CO exposures greater than 9 ppm, a reduced exposure limit is calculated. Evaluation criteria for the other substances investigated in this study can be found in Table I.

The inhalation of iron oxide dust may cause a benign pneumoconiosis (siderosis). Chronic exposure to iron oxide and other welding fumes has been known to cause lung disease (bronchitis). The ACGIH threshold limit value is 5 mg/M³ and the OSHA permissible exposure limit is 10 mg/M³.

VI. RESULTS

A. Interviews

The employee interviews revealed complaints compatible with methylene chloride exposure. Four out of eight reported dry skin on their hands and arms that they believed was caused by methylene chloride. Three workers reported occasional instances of dizziness, drowsiness, headaches, and nausea, and one of these stated that he was once nearly "overcome" while handling methylene chloride. He was ill for about three hours with chest pains, dizziness, and headaches but no medical services were sought. Five out of eight of the workers were smokers. All three of the employees that reported dizziness, drowsiness, and headaches were smokers.

B. Environmental

Methylene chloride exposures ranged from 33 - 630 ppm with a mean of 163 ppm (Table II). The degreasing tanks are well enclosed and much of the solvent is automatically removed from the metal strips as they leave the tanks. The primary source of exposure occurs during the periodic filling of the tanks. Carbon monoxide levels measured by direct-reading indicator tubes ranged from 20-30 ppm. The continuous direct-reading measurements taken by the Ecolyzer showed 20-35 ppm whenever propane-operated forklifts passed by the area and 5-10 ppm otherwise. The time weighted average was estimated to be about 15 ppm.

The mechanical descaler operator was exposed to iron oxide at a concentration of 7.4 mg/M^3 on December 17, 1979 (Table III). Before more samples were taken in March a new descaler was installed with new local exhaust ventilation. Most of the rust is captured in a closed box and periodically emptied by removing the rust tray at the bottom. On occasion it was observed that the door to the rust tray was left open; this negated the local exhaust ventilation. One sample taken with the door occasionally open had an iron oxide concentration of 6.7 mg/M^3 . With the door closed throughout the sampling period the concentration was 1.4 mg/M^3 .

The copper coating employee was exposed to copper dust and/or mist at concentrations of 0.02 and 0.04 mg/M^3 . Two area samples taken for sulfuric acid close to the dip tank showed non-detectable and 0.1 mg/M^3 concentrations. The hydrochloric acid pickling tanks were well ventilated with local exhaust canopy hoods enclosed on three sides over the tops of the tanks; horizontal capture velocities were measured at 250-300 feet per minute.

Two area samples taken close to the tanks detected hydrogen chloride levels of 0.1 and 0.2 mg/M^3 . Complaints of acid mist exposure were noted, however, during monthly maintenance of the local exhaust system. MSA Dustfoe 66 respirators with MSA dust and mist filters were reported to be used during such maintenance.

The weighing and mixing rooms contain potentially dusty operations during the weighing and mixing of the various flux core powders. Total particulates were present at concentrations of 0.4 and 1.9 mg/M^3 , and respirable particulates at 0.7 and 1.4 mg/M^3 . Although bulk samples for silica were analyzed as containing 100% quartz, no free crystalline silica was detected in any respirable breathing zone sample or total area sample. Chromium, nickel, molybdenum and zirconium in personal breathing zone samples were all below the limits of detection. Manganese was present at a concentration of 0.09 mg/M^3 . Fluorides were present at 0.1 and 0.4 mg/M^3 . The person working in that area was observed to be wearing a Dustfoe 66 respirator during weighing and mixing of the flux core powders and during sweeping of the work area. The local exhaust vents near the weighing barrel and hoppers had capture velocities of 20-50 feet per minute.

VII. CONCLUSIONS

The exposures of primary concern at this plant are the combined effects of methylene chloride and carbon monoxide. The observed health complaints of drowsiness, headaches, dizziness and dry skin are compatible with the documented overexposures. Smokers and workers with anemia or heart disease should be considered particularly susceptible. Adherence to the following recommendations should help to ameliorate the adverse effects of methylene chloride/carbon monoxide.

VIII. RECOMMENDATIONS

A. Degreasing

1. Suitable engineering controls designed to limit exposure to methylene chloride should be utilized. Management has informed NIOSH that such controls have been planned. The new system would essentially be totally enclosed and eliminate the need for manually filling the degreasing tanks.
2. More careful work practices are needed when filling the tanks. Spills cause a dramatic increase in airborne concentrations because of the high volatility of methylene chloride.
3. Methylene chloride containers should stay capped when not in use.
4. Skin contact should be avoided at all times.
5. Written operating instructions and emergency medical procedures should be posted in conspicuous locations where accidental exposure to high concentrations of methylene chloride may occur.

B. Weighing and Mixing

1. Although no overexposure to hazardous substances was found by NIOSH in these areas, the irritation caused by dust is causing the operator to use a respirator during weighing, mixing, and sweeping. To alleviate these problems, a more efficient local exhaust ventilation system could be used. Figure I illustrates a local exhaust procedure for barrel filling as recommended in the Industrial Ventilation Manual by the American Conference of Governmental Industrial Hygienists.
2. Some of the dust generated in the mixing room could be alleviated by shortening the distance from the bottom of the mixer to the hopper during pouring. The use of a cone shaped lid on top of the hopper is another possibility.
3. The doors to the mixing room should be kept closed, and the operator should stay out of the room except when necessary.
4. Sweeping of the work areas should be replaced by vacuum cleaning methods.
5. Protective aprons, long shirt sleeves, and cotton gloves should be used for preventing skin contact with toxic dusts.

- C. The local exhaust system on the mechanical descaler appears to be adequate in controlling iron oxide dust. However, the system is only effective when kept intact by keeping the rust tray door closed when descaling.

- D. Due to the presence of highly toxic substances such as chromium and nickel dusts, no eating or drinking should be permitted outside the designated lunchroom area. No smoking should be permitted in the weighing and mixing rooms.
- E. Standard written operating procedures should be developed for respirator use. The procedures should specify exactly when a respirator is to be used (e.g. pickling tank maintenance). They should describe NIOSH/OSHA approved respirator selection, training, fitting, inspection, cleaning, and maintenance. NIOSH publication 76-189, A Guide to Industrial Respiratory Protection should be consulted for developing standard operating procedures.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and Report
Prepared By:

Steven A. Lee
Project Officer
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

Assisted By:

Richard Patnode
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

William A. Evans
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

Originating Office:

Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies
Cincinnati, Ohio

Report Typed By:

Leesa Berling
Clerk Typist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

- a. Airco Welding Products
- b. Representative of employees
- c. U.S. Department of Labor, Region III
- d. NIOSH, Region III

For the purpose of informing the 85 "affected employees", the employer shall promptly "post" the Determination Report for a period of 30 days in a prominent place near where exposed employees work.

TABLE I
EVALUATION CRITERIA FOR HAZARDOUS SUBSTANCES

<u>CONTAMINANT</u>	<u>OSHA PERMISSIBLE EXPOSURE LIMIT</u>	<u>ACGIH THRESHOLD LIMIT VALUE</u>	<u>NIOSH RECOMMENDED STANDARD</u>	<u>HEALTH EFFECTS</u>
Methylene Chloride	500 ppm	200 ppm	75 ppm	Mild narcotic, fatigue, headache, limbs numb, dermatitis, elevated carboxy-hemoglobin
Carbon Monoxide	50 ppm	50 ppm	35 ppm	Headache, weakness, elevated carboxy-hemoglobin, electrocardiogram changes
Iron Oxide	10 mg/M ³	5 mg/M ³	--	Benign pneumoconiosis, X-ray shadows that are indistinguishable from fibrotic pneumoconiosis
Copper dusts/mists	1 mg/M ³	1 mg/M ³	--	Irritation of mucous membranes, dermatitis eye irritation, nasal septum perforation
Fluoride dust	2.5 mg/M ³	2.5 mg/M ³	2.5 mg/M ³	Eye and respiratory irritant, abdominal pain, diarrhea, increased bone density
Manganese	5 mg/M ³	5 mg/M ³	--	Metal fume fever, dry throat, cough, Parkinson's tremor
Hydrogen Chloride	5 ppm (7 mg/M ³)	5 ppm (7 mg/M ³)	--	Inflammation of nose and throat, choking, burning eyes, dermatitis
Sulfuric Acid	1 mg/M ³	1 mg/M ³	1 mg/M ³	Eye, skin, nose, and throat irritation; dental erosion
Nuisance Particulate	15 mg/M ³	10 mg/M ³ 5 mg/M ³ (respirable)	--	Reduced visibility, unpleasant deposits in eyes, ears, and nasal passages
Crystalline Silica	$\frac{10 \text{ mg/M}^3}{8 \text{ respirable SiO}_2 + 2}$ (Quartz) 1/2 quartz formula (Cristobalite) 1/2 quartz formula (Tridymite)	$\frac{10 \text{ mg/M}^3}{8 \text{ respirable SiO}_2 + 2}$ (Quartz) 1/2 quartz formula (Cristobalite) 1/2 quartz formula (Tridymite)	.05 mg/M ³ (respirable)	Silicotic nodules severely affect the lung bases; upper lobes and hilar lymph nodes, favors growth of tubercle bacilli; causes pulmonary hypertension and abnormal blood gas tensions leading to vasoconstriction

TABLE II
RESULTS OF PERSONAL BREATHING ZONE SAMPLES
FOR
METHYLENE CHLORIDE

Location	Sampling Time	Sampling Volume (liters)	Parts Per Million of Methylene Chloride in Air (ppm)*
<u>12/17/79</u>			
Flux line 1	8:20 am - 3:40 pm	8.74	55
Flux line 2	8:10 am - 3:40 pm	8.55	83
Flux line 3	8:25 am - 3:40 pm	8.89	95
Flux line 4	8:15 am - 3:40 pm	8.11	95
Flux line 5	8:30 am - 3:40 pm	8.69	630**
Methylene Chloride Distiller	11:06 am - 12:06 pm	12.0	83
<u>3/4/80</u>			
Flux line 1	8:10 am - 2:55 pm	8.81	52
Flux line 2	8:20 am - 3:00 pm	8.03	79
Flux line 3	8:25 am - 3:00 pm	5.27	316
Flux line 4	8:25 am - 3:05 pm	8.01	610**
<u>3/5/80</u>			
Flux line 1	8:00 am - 3:00 pm	8.89	33
Flux line 2	8:05 am - 3:00 pm	8.25	63
Flux line 3	8:10 am - 3:00 pm	5.33	59
Flux line 6	8:17 am - 3:00 pm	7.43	101
Flux line 7	8:20 am - 3:00 pm	6.78	85

* NIOSH Recommended Standard 75 (without CO exposure)

** Samples contained an amount of methylene chloride on the B section of the tube which was greater than 1/3 the total for that tube. Therefore, reported values may be too low.

Carbon Monoxide (CO) levels from indicator tubes = 20-30 ppm

CO levels from Ecolyzer Model 2400 range from 5-35 ppm

Estimated TWA Exposure = 15 ppm

$$\frac{C(\text{CO})}{L(\text{CO})} + \frac{C(\text{CH}_2\text{Cl}_2)}{L(\text{CH}_2\text{Cl}_2)} < 1$$

Where:

C(CO) = TWA exposure concentration of CO, ppm

L(CO) = the recommended TWA exposure of CO = 35 ppm

C(CH₂Cl₂) = TWA exposure concentration of methylene chloride, ppm

L(CH₂Cl₂) = the recommended TWA exposure limit of methylene chloride = 75ppm

Therefore, methylene chloride TWA exposure should be limited to 45 ppm.

TABLE III
RESULTS OF ENVIRONMENTAL AIR SAMPLES FOR
TOTAL PARTICULATE, RESPIRABLE PARTICULATE, FLUORIDES, MANGANESE,
IRON OXIDE, COPPER, HYDROGEN CHLORIDE, AND SULFURIC ACID

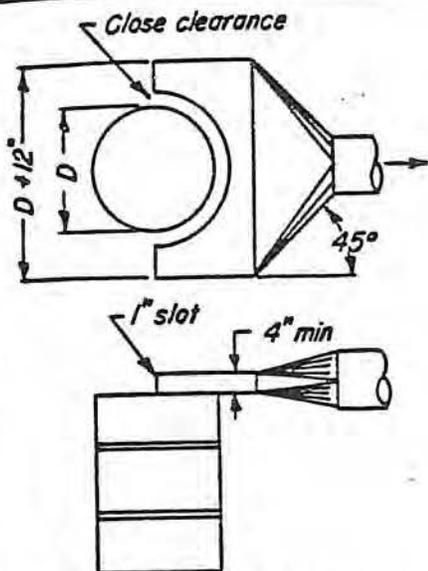
LOCATION	CONTAMINANT	SAMPLE TYPE	SAMPLING TIME	CONTAMINANT CONCENTRATION* MILLIGRAMS PER CUBIC METER OF AIR (mg/M^3)
<u>MARCH 4, 1980</u>				
Weighing Room	Respirable particulate	Personal breathing zone	8:38 a.m.-2:57 p.m.	1.4
Weighing Room	Total particulate	Area	8:38 a.m.-2:57 p.m.	0.4
<u>MARCH 5, 1980</u>				
Weighing Room	Respirable particulate	Personal breathing zone	8:24 a.m.-2:55 p.m.	0.7
Weighing Room	Total particulate	Area	8:25 a.m.-2:55 p.m.	1.9
<u>MARCH 4, 1980</u>				
Weighing Room	Fluorides	Personal breathing zone	8:38 a.m.-2:57 p.m.	0.4
<u>MARCH 5, 1980</u>				
Weighing Room	Fluorides	Personal breathing zone	8:24 a.m.-2:55 p.m.	0.1
<u>DECEMBER 17, 1979</u>				
Weighing Room	Manganese	Personal breathing zone	8:45 a.m.-3:40 p.m.	0.09
Flux Core	Manganese	Personal breathing zone	8:10 a.m.-3:40 p.m.	0.06
Flux Core	Manganese	Personal breathing zone	8:25 a.m.-3:40 p.m.	0.05
Mechanical descaler	Iron oxide	Personal breathing zone	8:50 a.m.-3:15 p.m.	7.4
<u>MARCH 4, 1980</u>				
Mechanical descaler	Iron oxide	Personal breathing zone	4:02 p.m.-7:55 p.m.	6.7

TABLE III
RESULTS OF ENVIRONMENTAL AIR SAMPLES FOR
TOTAL PARTICULATE, RESPIRABLE PARTICULATE, FLUORIDES, MANGANESE,
IRON OXIDE, COPPER, HYDROGEN CHLORIDE, AND SULFURIC ACID
(CONTINUED)

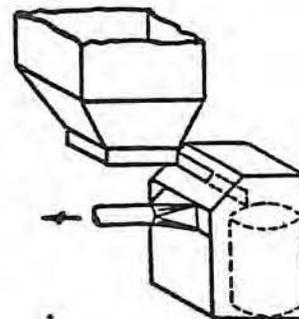
LOCATION	CONTAMINANT	SAMPLE TYPE	SAMPLING TIME	CONTAMINANT CONCENTRATION* MILLIGRAMS PER CUBIC METER OF AIR (mg/M ³)
Mechanical descaler	Iron oxide	Personal breathing zone	<u>MARCH 5, 1980</u> 8:40 a.m.-3:00 p.m.	1.4
Copper Coating	Copper	Personal Breathing zone	<u>DECEMBER 17, 1979</u> 8:52 a.m.-3:40 p.m.	0.04
Copper Coating	Copper	Personal Breathing zone	<u>MARCH 4, 1980</u> 8:47 a.m.-3:05 p.m.	0.02
Pickling	Hydrogen Chloride	Area impinger	<u>DECEMBER 17, 1979</u> 10:42 a.m.-2:52 p.m.	0.2
Pickling	Hydrogen Chloride	Area silica gel	10:54 a.m.-2:55 p.m.	0.1
Copper Coating	Sulfuric Acid	Area filter	10:47 a.m.-2:55 p.m.	non-detectable
Copper Coating	Sulfuric Acid	Area silica gel	10:47 a.m.-2:55 p.m.	0.1

* See Table III for Evaluation Criteria

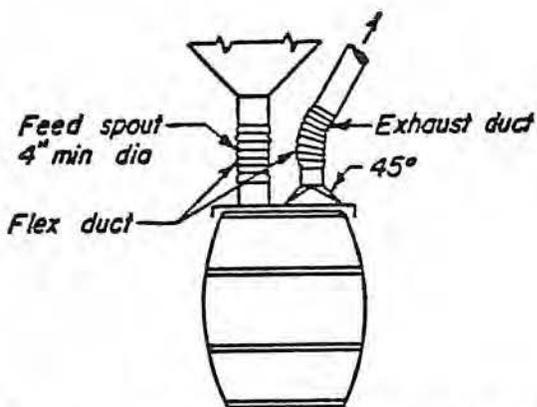
FIGURE 1



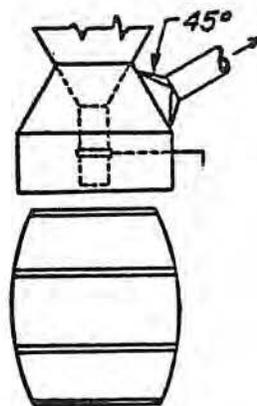
$Q = 100 \text{ cfm/sq ft barrel top min}$
 Duct velocity = 3500 minimum
 Entry loss = $0.25 VP + 1.78 \text{ slot VP}$
 Manual loading.



$Q = 150 \text{ cfm/sq ft open face area}$
 Duct velocity = 3500 fpm minimum
 Entry loss = $0.25 VP$ for 45° taper



$Q = 50 \text{ cfm} \times \text{drum dia (ft)}$ for weighted lid
 $150 \text{ cfm} \times \text{drum dia (ft)}$ for loose lid
 Duct velocity = 3500 fpm minimum
 Entry loss = $0.25 VP$



$Q = 300-400 \text{ cfm}$
 Duct velocity = 3500 fpm min
 Entry loss = $0.25 VP$

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 GOVERNMENTAL INDUSTRIAL HYGIENISTS

BARREL FILLING

DATE 1-64

VS-303