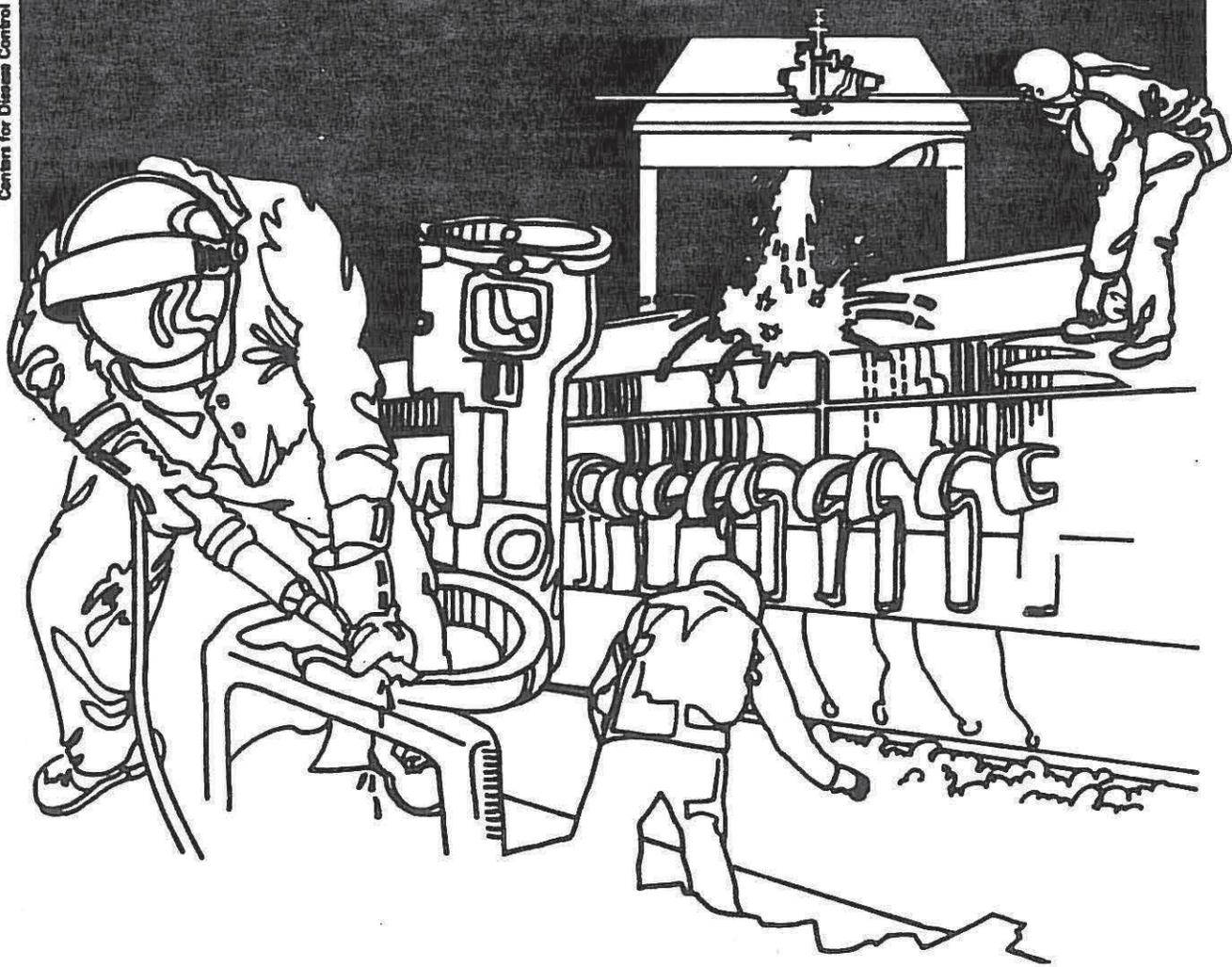


U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 82-186-1203
PERRY NUCLEAR POWER PLANT
PERRY, 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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

I. SUMMARY

In March 1982, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate airborne contaminants being generated during welding, arc gouging, painting, and sand blasting at the Perry Nuclear Power Plant construction project, Perry, Ohio. At the time of the study, about 300 construction workers of various crafts were employed in the reactor containment building.

On March 25, 1982, NIOSH investigators conducted industrial hygiene sampling at the construction project. Personal breathing-zone air samples for metal contaminants were collected on filters and analyzed by atomic absorption spectroscopy. Organic vapors were collected on charcoal and analyzed by gas chromatography. NIOSH also obtained and evaluated industrial hygiene data that had been recently collected by consultants for the construction project.

NIOSH collected three personal breathing-zone air samples for metal contaminants during welding, arc gouging and grinding. Iron oxide concentrations (measured as iron) ranged from 5400 to 9900 $\mu\text{g}/\text{M}^3$. Nickel concentrations ranged from 720 to 850 $\mu\text{g}/\text{M}^3$, and chromium concentrations ranged from 650 to 1100 $\mu\text{g}/\text{M}^3$. All three samples exceeded the evaluation criteria for iron oxide (5000 $\mu\text{g}/\text{M}^3$), nickel (15 $\mu\text{g}/\text{M}^3$), and chromium (25 $\mu\text{g}/\text{M}^3$).

NIOSH collected two personal breathing-zone air samples for xylene, methyl isobutyl ketone (MIBK), cellosolve, ethanol, and isopropanol during spray painting with an epoxy paint. Assuming additivity, combined exposures were 88% and 93% of the evaluation criteria.

Twenty-two personal breathing-zone air samples were taken by the consultants and analyzed specifically for chromium (VI). Concentrations ranged from less than 1 $\mu\text{g}/\text{M}^3$ to 270 $\mu\text{g}/\text{M}^3$ with a mean of 37 $\mu\text{g}/\text{M}^3$. Seven samples exceeded the evaluation criterion of 25 $\mu\text{g}/\text{M}^3$.

Nine personal breathing-zone air samples were taken by the consultants during spray painting with "CZ-11" (a zinc-based paint containing 1% lead chromate). Zinc concentrations ranged from 700 to 17000 $\mu\text{g}/\text{M}^3$ with a mean of 5500 $\mu\text{g}/\text{M}^3$. Four samples exceeded the evaluation criterion of 5000 $\mu\text{g}/\text{M}^3$. Lead concentrations ranged from 6 to 170 $\mu\text{g}/\text{M}^3$ with a mean of 66 $\mu\text{g}/\text{M}^3$. The evaluation criterion is 50 $\mu\text{g}/\text{M}^3$. Chromium concentrations ranged from less than 3 $\mu\text{g}/\text{M}^3$ to 53 $\mu\text{g}/\text{M}^3$ with a mean of 25 $\mu\text{g}/\text{M}^3$. The evaluation criterion is 1 $\mu\text{g}/\text{M}^3$. Five samples exceeded the evaluation criteria for lead and seven samples exceeded the evaluation criteria for chromium.

The consultants collected two personal breathing-zone air samples for respirable free crystalline silica during sandblasting. The two workers were exposed to concentrations of 85 and 87 $\mu\text{g}/\text{M}^3$. The evaluation criterion is 50 $\mu\text{g}/\text{M}^3$.

Respirator programs were an important aspect of worker protection during these construction processes. Most workers were wearing half-mask respirators with either standard dust filters or high-efficiency particulate filters for metal contaminants and organic vapor cartridges for painting. Combination cartridges were worn when exposed to both (such as "CZ-11" painting).

NIOSH found potential hazards from overexposure to iron oxide dust and fume, zinc oxide dust, lead, nickel, crystalline silica, chromium, chromium (VI) oxide, and carcinogenic chromium (VI) at the time of these surveys.

Recommendations for controlling these hazards are presented in Section VII of this report.

KEYWORDS: SIC 1629 (Heavy Construction) construction, welding, arc gouging, grinding, stainless steel, sandblasting, painting, iron oxide, zinc oxide, inorganic lead, inorganic nickel, lead chromate, chromium, chromium (VI), organic vapors, solvents, crystalline silica.

II. INTRODUCTION

In March 1982, NIOSH received a request for a health hazard evaluation at the Perry Nuclear Power Plant construction project in Perry, Ohio. The request was submitted by the United Brotherhood of Carpenters and Joiners of America who asked NIOSH to evaluate the air quality in the reactor containment building during welding, sand blasting, painting, and arc gouging operations.

Preliminary recommendations were distributed in April 1982, following the plant visit.

III. BACKGROUND

Kaiser Engineers, Inc. began construction of the Perry Nuclear containment building about five years ago. About 300 construction workers of various crafts were employed in the containment building at the time of the NIOSH investigation. Work operations in the building included welding, grinding, and arc gouging of stainless steel; abrasive blasting with silica sand; spray painting with a zinc-based paint containing 1% lead chromate ("CZ-11"); and spray painting with epoxy paint ("C-191").

IV. EVALUATION DESIGN AND METHODS

On March 25, 1982, NIOSH collected three personal breathing-zone air samples for zinc, iron oxide, lead, nickel and chromium from workers who were arc gouging, welding, and grinding stainless steel. Two personal breathing-zone air samples for zinc, lead, and chromium were collected during spray painting with "CZ-11". Two personal breathing-zone air samples for xylene, methyl isobutyl ketone, cellosolve, ethanol, and isopropanol were also collected from painters using "C-191". Sand blasting was not being conducted at the time of the NIOSH investigation.

The particulate samples were collected on cellulose-ester filters using battery-powered sampling pumps operating at 1.7 liters per minute. Metals were analyzed by atomic absorption spectroscopy according to NIOSH Method P&CAM 173. The organic vapor samples were collected on activated charcoal using personal sampling pumps operating at 20 cubic centimeters per minute. Analysis was by gas chromatography using NIOSH Method 127.

The respiratory protection programs at the project were also evaluated by NIOSH.

In addition to this study, a more extensive industrial hygiene survey of the containment building was conducted by consultants (Environmental Research Group, Inc.) for Kaiser Engineers in November 1981 through January 1982. The data were obtained and evaluated by NIOSH.

V. EVALUATION CRITERIA

Environmental evaluation criteria and the principle health effects of the substances sampled in this study are summarized in Table I. The more important compounds of this investigation are discussed here.

Nickel¹

Airborne exposure to inorganic nickel compounds can cause erosion and perforation of the nose and impairment of the sense of smell. Skin exposure can cause allergic contact dermatitis and those workers who become sensitive to nickel may also develop asthma.

Epidemiology studies have shown that nickel refinery workers have an increased risk of lung, nasal, and kidney cancer. The nickel compounds most commonly found during refining are nickel sulfate, nickel sulfide, and nickel oxide but prudence dictates that all nickel compounds should be considered carcinogenic until further studies are conducted. NIOSH recommends a TWA exposure limit of 15 ug/M³. The OSHA permissible exposure limit is 1 mg/M³ for an 8-hour TWA exposure.

Chromium²

Chromium compounds in the +6 oxidation state are the most toxic. Exposure to the skin can cause allergic contact dermatitis and skin ulcers. Airborne exposures to chromium (VI) compounds can cause irritation and ulceration of the nasal lining, and perforation of the nasal septum. Chromium (VI) exposure has also caused kidney damage, liver damage, pulmonary congestion and edema, and erosion and discoloration of the teeth.

Some of the chromium (VI) compounds have been associated with lung cancer while other commonly used compounds in this class have not been associated with the disease. Therefore, NIOSH has adopted two recommended exposure limits for chromium (VI) compounds. "Noncarcinogenic" chromium (VI) [such as chromium (VI) oxide] should be limited to 25 ug/M³ as a time-weighted average (TWA) exposure for up to a 10-hour workday, 40-hour workweek. "Carcinogenic" chromium (VI) [such as lead chromate] has a recommended TWA standard of 1 ug/M³. The American Conference of Governmental Industrial Hygienist (ACGIH) has recommended a threshold limit value of 500 ug/M³ for chromium metal and those chromium compounds in the +2 and +3 oxidation states. The OSHA permissible exposure limit is 500 ug/M³ for soluble chromic and chromous salts and 1000 ug/M³ for chromium metal and its insoluble salts.

Lead³

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. Absorbed lead can damage the kidney, peripheral and central nervous systems, and the blood forming organs. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 ug/deciliter whole blood are considered to be normal levels which may result from daily environmental exposure. The Occupational Safety and Health Administration (OSHA) standard for lead in air is 50 ug/M³ calculated as an 8-hour time-weighted average for daily exposure. The standard also dictates that workers with blood lead levels greater than 60 ug/deciliter must be immediately removed from further lead exposure and, in some circumstances, workers with lead levels of less than 60 ug/deciliter must also be removed. Removed workers have protection for wage, benefits, and seniority for up to 18 months until blood levels decline to below 50 ug/deciliter and they can return to lead exposure areas.

VI. RESULTS AND DISCUSSIONA. NIOSH, Sampling Results

Table II shows that airborne iron oxide, nickel and chromium concentrations exceeded the evaluation criteria in all three of the samples taken during welding, grinding and arc gouging. One sample collected 70 ug/M³ of lead during a one-hour painting task using CZ-11.

Table II - Personal Air Samples For Metal Contaminants (ug/M³)

<u>Job</u>	<u>Sampling Time</u>	<u>Zinc</u>	<u>Iron</u>	<u>Lead</u>	<u>Nickel</u>	<u>Chromium</u>
Arc gouging	9:20-14:56	81	5400	N.D.*	720	650
Welding	9:40-15:00	260	7900	17	850	1100
Grinding	9:50-15:00	99	9900	N.D.	760	910
CZ-11 painting	13:30-14:37	3500	-**	70	-	N.D.
CZ-11 painting	13:30-14:37	3200	-	N.D.	-	N.D.
<u>Evaluation Criteria</u>		5000	5000	50	15	1 (painting) 25 (welding, arc gouging) 500 (grinding)

*N.D. = no contaminant detected
** - = not analysed

Table III shows that painters using C-191 were exposed to a mixture of organic vapors at concentrations reaching 88% and 93% of the evaluation criteria.

Table III - Personal Air Samples For Organic Vapors (mg/M³)

<u>Job</u>	<u>Sampling Time</u>	<u>Xylene</u>	<u>MIBK</u>	<u>Cellosolve</u>	<u>Ethanol</u>	<u>Isopropanol</u>	<u>Combined Exposure Ratio</u>
C-191 painting	8:55-14:50	67	48	91	N.D.*	N.D.	0.88
C-191 painting	8:57-14:50	70	52	91	N.D.	20	0.93
Evaluation Criteria		435	200	185	1900	980	1.0

*N.D. = no contaminant detected

Respiratory Protection

Half-mask respirators were being used among the various construction crafts during the NIOSH visit. However, none of the construction contractors had standard written operating procedures for their respirator programs. Thus, the quality of certain aspects (selection, use, training, fitting, inspection, cleaning, maintenance, and storage) of the programs was unclear.

The aspect of respirator selection was investigated by NIOSH during the walkthrough inspection. Generally, the correct respirator cartridges were being used for the given situation. Some workers who were exposed to metal dusts and fumes displayed some confusion and annoyance over the fact that they were assigned different cartridge types despite the fact that they were working in the same areas with the same materials. Apparently, some contractors had selected standard dust filters while others had selected high-efficiency particulate filters. This is one area of respirator selection where the correct choice is not always readily apparent. This issue is discussed in Section VII - Recommendations.

Quantitative fit-testing was not being conducted by any of the contractors.

B. Environmental Research Group (ERG), Sampling Results

Welding/Arc Gouging/Grinding

Eleven personal breathing-zone air samples were taken for iron oxide, zinc, nickel, and chromium.

1. Iron oxide concentrations ranged from 40 to 4100 ug/M³ with a mean of 2500 ug/M³. The evaluation criterion is 5000 ug/M³.

2. Zinc concentrations ranged from 20 to 570 ug/M³ with a mean of 150 ug/M³. The evaluation criterion is 5000 ug/M³.
3. Nickel concentrations ranged from 5 to 590 ug/M³ with a mean of 200 ug/M³. Nine samples exceeded the evaluation criterion of 15 ug/M³.
4. Total chromium concentrations ranged from 5 to 770 ug/M³ with a mean of 210 ug/M³. Five samples exceeded the evaluation criterion of 500 ug/M³.

Twenty-two personal breathing-zone, air samples were taken and analysed specifically for chromium (VI). Concentrations ranged from less than 1 ug/M³ to 270 ug/M³ with a mean of 37 ug/M³. Seven samples exceeded the evaluation criterion of 25 ug/M³.

Six personal breathing-zone samples for lead ranged from less than 5 ug/M³ to 12 ug/M³ with a mean of 6 ug/M³. The evaluation criterion is 50 ug/M³.

Painting

Nine personal breathing-zone air samples were taken during spray painting with "CZ-11".

1. Zinc concentrations ranged from 700 to 17000 ug/M³ with a mean of 5500 ug/M³.
2. Lead concentrations ranged from 6 to 170 ug/M³ with a mean of 66 ug/M³.
3. Chromium concentrations ranged from less than 3 ug/M³ to 53 ug/M³ with a mean of 25 ug/M³. The evaluation criterion for "carcinogenic" chromium (VI) is 1 ug/M³.

Nine personal breathing-zone samples were taken for xylene, MIBK, cellosolve, butyl cellosolve, ethanol, and toluene during various painting operations using "C-191" and "CZ-11". Combined exposures were well below the evaluation criteria.

Sand Blasting

Personal breathing-zone samples taken inside the sandblasting workers' airline respirators showed that two workers were exposed to respirable free crystalline silica at concentrations of 85 and 87 ug/M³. This indicates that the air supply was somehow being contaminated with silica. The evaluation criterion is 50 ug/M³.

VII. CONCLUSIONS/RECOMMENDATIONS

In terms of the evaluation criteria used for this study, potential hazards from overexposure to iron oxide dust and fume, zinc oxide dust, lead, nickel, crystalline silica, chromium, chromium (VI) oxide, and carcinogenic chromium (VI) occurred at the time of the NIOSH and ERG surveys. In contrast, it is interesting to note that almost all of these exposures are below the current OSHA standards. However, this should not be interpreted, especially by workers, as meaning that such exposures are completely "safe". Such assumptions could only be made by ignoring most of the more recent health hazard data and NIOSH recommendations concerning these substances. In the case of lead, the current OSHA standard of 200 ug/M³ for the construction industry is mostly indicative of problems with the technical feasibility of using engineering controls for controlling airborne contaminants at construction sites.

Since communication could be somewhat difficult among the several distinct contractors and labor unions working at this site, it should be the responsibility of each contractor to inform their workers of any health hazard information concerning the materials with which they work. Information pertaining to newly introduced products should be disseminated before work proceeds with those products. Knowledge about occupational health hazards will help maintain better cooperation and understanding of the use of personal protective equipment, improved work practices, personal hygiene, and the following recommendations:

1. Conventional engineering controls, such as local exhaust ventilation, would be difficult to employ in most construction projects. However, some of the portable local exhaust systems that are available should be investigated for their possible utility. The improvements that have been made in general (or dilution) ventilation should also be continued to avoid a buildup of background contaminant concentrations.
2. Administrative controls and product substitution should be used, whenever feasible. For instance, attempts should be made to replace CZ-11 with a zinc paint that does not contain lead chromate. It is also feasible to replace silica sand with other types of blasting abrasives. Steel shot or grit, silicon carbide, and aluminum oxide have been some of the more common substitutes, particularly in many of the European countries that have forbidden the use of silica sand for abrasive blasting.
3. Due to the presence of toxic metal fumes and dusts, no eating, drinking, or smoking should be allowed in areas where CZ-11 painting, welding, arc gouging, or grinding are conducted.

4. Respiratory protection programs at the Perry construction project are a crucial part of worker protection. These programs must be of high quality to be effective. Since each construction contractor is responsible for their respirator program, NIOSH recommends that each contractor be required to have a designated respirator program administrator who can be held accountable for the quality of the program. Each administrator should have the knowledge and authority to ensure that the established respirator program is effective and that all aspects of the written program are enforced through continual monitoring. The administrators should have overall responsibility for the selection, use (based on NIOSH recommended standards), training, fitting, inspection, cleaning, maintenance, and proper storage of respirators. NIOSH publication no. 76-189, "A Guide to Industrial Respiratory Protection," should be consulted when developing these programs.
5. Confusion about respirator selection was evident in some areas of the construction project. One argument was whether to use standard dust filters or high efficiency particulate filters in cases of exposure to metal contaminants. Theoretically, high efficiency particulate filters should be used to protect against particulates which have NIOSH recommended time-weighted average standards at or below 50 ug/M³ (such as lead, nickel, hexavalent chromium, etc.). Realistically, however, the filtration efficiency difference between the two cartridges can be somewhat insignificant when compared to the importance of facepiece fit. In fairly dusty areas, in fact, the rapid dust loading and resulting increase in breathing resistance through high efficiency filters can actually cause facepiece leaks which greatly reduce the effectiveness of the respirator. This problem should be taken into consideration when relatively low levels of lead, nickel, or chromium are accompanied by relatively high concentrations of iron oxide, zinc, or nuisance dusts. In such cases the standard dust filter would generally be the correct choice.
6. Facepiece fit is one of the most important aspects of respiratory protection which needs to be improved at the construction project. During the NIOSH visit, for example, several workers were seen with half-mask respirators "fitted" over full beards. When questioned, some of the men displayed confidence in the respirator because they had "passed" the fit test. This is clearly an indication that some of the contractors have failed to properly fit test their workers. It has been the experience of most investigators that respirators will not properly seal when any facial hair is present beneath the edges of the facepiece. Quantitative fit-testing should be required in areas where exposures to toxic heavy metals exceed NIOSH recommended standards. Positive pressure air-supplied respirators would be a more protective alternative.

VIII. REFERENCES

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Kaiser Engineering, Inc., Perry, Ohio
2. Carpenters Union, Cleveland and Vicinity District Council
3. NIOSH, Region V
4. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I
EVALUATION CRITERIA FOR HAZARDOUS SUBSTANCES
PERRY NUCLEAR POWER PLANT
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Contaminant	OSHA Permissible Exposure Limit	ACGIH Threshold Limit Value	NIOSH Recommended Standard	Principle Health Effects
Nickel	1 mg/M ³	metal-1 mg/M ³ soluble compounds-0.1 mg/M ³	15 ug/M ³	allergic contact dermatitis; erosion and perforation of the nose; loss of sense of smell; lung, nasal, and kidney cancer.
Chromium	0.5 mg/M ³	0.5 mg/M ³ chromium (VI)-50 ug/M ³	noncarcinogenic chromium (VI)-25 ug/M ³ carcinogenic chromium (VI)-1 ug/M ³	allergic contact dermatitis; ulceration and perforation of the nose; some of the chromium (VI) compounds may cause lung cancer.
Lead	50 ug/M ³	150 ug/M ³	50 ug/M ³	damage to the kidneys, peripheral and central nervous systems, and the blood forming organs; infertility; fetal damage.
Respirable Crystalline Silica	10 mg/M ³ ; %SiO ₂ +2	10 mg/M ³ ; %SiO ₂ +2	50 ug/M ³	chronic exposure may cause a fibrotic lung disease known as silicosis which may further develop into tuberculosis or pulmonary hypertension.
Iron Oxide Fume	10 mg/M ³	5 mg/M ³	-	chronic exposure may cause a fibrotic lung disease known as siderosis.
Zinc Oxide	5 mg/M ³ fume only	5 mg/M ³ fume only	5 mg/M ³ dust or fume	exposure to freshly formed fumes may cause fever and shaking chills, elevation of leukocyte count, and gastrointestinal disturbance.
Xylene	435 mg/M ³	435 mg/M ³	435 mg/M ³	irritation of the eyes, mucous membranes and skin; in high concentration, dizziness, drowsiness, incoordination, nausea, and vomiting.
MIBK	410 mg/M ³	200 mg/M ³	200 mg/M ³	dermatitis; irritation of the eyes, nose, and throat; nausea; headache; in high concentrations weakness, drowsiness, and dizziness.
Cellosolve	740 mg/M ³	185 mg/M ³	-	irritation of the eyes, mucous membrane, and skin; in high concentrations dizziness, drowsiness, incoordination, headache, nausea, and vomiting.
Ethanol	1900 mg/M ³	1900 mg/M ³	-	in very high concentrations irritation of the eyes and respiratory tract, headache, drowsiness.
Isopropanol	980 mg/M ³	980 mg/M ³	-	irritation of the eyes, nose, and throat; in high concentrations dizziness, drowsiness and incoordination.

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