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Gulf Science and Technology Company

MEDICAL AND HEALTH RESOURCES DIVISION

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April 11, 1978

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Mr. Bryan H. Gambrill
China Gulf Plastics Corporation
P. O. Box 22144
Taipei, Taiwan 105
Republic of China

Dear Bryan:

Enclosed are two copies of my report on evaluation of industrial hygiene programs at China Gulf Plastics Corporation conducted during November 1977. I apologize for the delay. A bizarre event occurred during shipping that caused desorption of every bit of vinyl chloride from all the charcoal tube air samples we brought back from CGPC. However, I believe the observations and the survey results based on organic vapor analyzer were mostly adequate in assessing occupational vinyl chloride and solvents exposures at Toufen factory.

All findings and recommendatons in this report were discussed with you in Taipei and with the factory management in Toufen. Please let me know if you have any questions or need further information.

Warm regards,

R. Cheng

Robert T. Cheng

RTC/aln
Enclosure

cc: Dr. F. D. Gassaway
Dr. R. L. Gibson (3)
Mr. C. R. Grimes
Dr. W. A. McClellan
~~Mr. H. E. Runion~~

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A DIVISION OF GULF OIL CORPORATION

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EVALUATION

OF

INDUSTRIAL HYGIENE PROGRAM

AT

CHINA GULF PLASTICS CORPORATION

November 1977

Robert T. Cheng, Ph.D., P.E.
Gulf Regional Industrial Hygiene Director

(0005) 0058. 0002

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I. SUMMARY

China Gulf Plastic Corporation's industrial hygiene program was re-evaluated in November 1977 following its initial set-up in February 1974, and a comprehensive review conducted in August 1976. Impressive progress has been achieved by CGPC in reducing workers' occupational exposures to vinyl chloride, solvent vapors, mercury, and dusts of lead, barium, cadmium and chromium. At this moment, CGPC's industrial hygiene program is by far the most advanced and comprehensive among all industries in Taiwan.

The time-weighted average exposure to vinyl chloride for workers at the Toufen polymer plant was over 200 ppm prior to 1974, reduced to about 50 ppm by August 1976, and further reduced to approximately 10 ppm as surveyed in November 1977. This is indeed an extraordinary achievement, considering that the Government of the Republic of China is still abiding by the old and obsolete 500 ppm permissible vinyl chloride exposure limit; and most of CGPC's local competitors have done very little to reduce occupational VC exposures in their factories.

CGPC has implemented a vinyl chloride leakage "search and secure" program. Successful identifying and controlling of leaks have resulted in significant reduction of VC emissions and occupational exposures in the Toufen monomer plant and polymer plant.

Nevertheless, reactor cleaners' VC exposures still exceeded CGPC's own exposure limit of 10 ppm. It appears that the only way to reduce their over-exposure is to eliminate routine manual cleaning of the reactors by adopting one of the several automatic reactor cleaning processes currently used by PVC manufacturers in the U. S. and some European countries. In fact, CGPC could meet the U.S. 1 ppm vinyl chloride exposure standard if manual reactor cleaning is eliminated and fugitive emissions reduced.

Occupational exposures to solvent vapors have been reduced over the years. However, there were still excessive airborne solvent vapor concentrations in the Printing Shop and in the new Polyurethane Plant. Additional exhaust ventilation is required to lower exposures to safe levels.

Mercury vapor exposures in the Chlor-Alkali Plant have been reduced to acceptable levels through measures of dilution ventilation and local exhaust ventilation. Exposures to dusts of lead, barium and chromium in the Extrusion Plant were mostly at safe levels, but occasionally over the permissible limits. It is recommended that a strong effort should be made to replace dyes and pigment containing lead chromate; otherwise, stringent control measures should be implemented to minimize employees' chromate exposures. CGPC's industrial hygiene laboratory should acquire field and laboratory equipment for measuring airborne concentrations of lead, chromium, barium and cadmium dusts.

Hygiene conditions in the plating Shop were below expectations. Local exhaust ventilation systems should be installed to control high concentrations of chromic acid and sulfuric acid fumes.

Preliminary results of this survey have been reported to Mr. B. H. Gambrill, CGPC President. Mr. K. Yü and other senior management personnel at Toufen Plant have also been appraised of the findings and recommendations during a debriefing session. The author wishes to thank Messrs. B. H. Gambrill, L. S. Ting, S. K. Yeh, K. Yü and other members of CGPC management for their courtesies and help during his stay in Taiwan. Special thanks to Ed Lu and O. H. Huang for their assistance in carrying out the survey work.

II. VINYL CHLORIDE EXPOSURES

A. POLYMER PLANT

In the November 1977 industrial hygiene survey, monitoring of workplace vinyl chloride concentrations was accomplished with a portable organic vapor analyzer which can give instantaneous display of parts per million concentration of total combustible hydrocarbon gases and vapors present in the air. Because vinly chloride gas was the only combustible gas present in significant quantities in the air inside the polymer plant, readings obtained with the organic vapor analyzer, after adjustment for the instrument's sensitivity factor for vinyl chloride, should give a fair indication of workplace vinly chloride concentrations.

The highest vinyl chloride concentration was encountered when the top manhole of the reactor vessel was opened to facilitate flushing down PVC resins from reactor walls with a large water hose. Airborne vinyl chloride concentrations easily exceeded 1,000 ppm (upper detection limit of the instrument) at places near the manhole. Vinyl chloride can also be sensed readily by its characteristic sweet odor at a few feet distance downwind from the manhole opening. (VC odor can be detected by a sensitive nose at 2000 ppm concentration.) This "flush-down" operation lasted only a couple of minutes. Then the manhole opening was covered up again, and the slurry of reacted PVC resin was withdrown completely from the reactor vessel.

Workers who are involved in the "flush-down" operation, and any other employees who are on the main floor of the polymer plant during that time period, shall be required to wear supplied-air respirators. No one should be exposed to vinyl chloride at concentrations above odor threshold for even a very brief time. This rule should be enfored with vigor.

The most hazardous job in terms of high workplace VC concentrations and lengthy exposure durations was the manual cleaning of the reactor vessel. After PVC resins and the un-reacted monomer were recovered and the reactor vessel air purged, three reactor cleaners were sent into the vessel through the bottom manhole to scrape PVC scales off the reactor walls with

hand tools consisting of hammer, knife and chisel. Although air purging was continued during the reactor cleaning time, permeation of monomer from PVC scales on the reactor walls created 50 ppm to 200 ppm VC concentrations within the reactor. It takes 30 to 40 minutes for the three cleaners to clean one reactor. They clean four reactors per shift. Therefore, it is estimated that a reactor cleaner's typical eight-hour time-weighted average exposure should be somewhere between 15 ppm to 50 ppm.

Other workers at the polymer plant were exposed to considerably less vinyl chloride than those experienced by the reactor cleaners. VC concentrations were found to vary between 5 to 20 ppm on the main floor (third floor) of the polymer plant during reactor "loading" time. Concentrations within the enclosed control room and office area were 0 to 2 ppm. When all reactor top and bottom manholes were closed, VC concentrations varied from 0 to 4 ppm on the first floor, 0 to 15 ppm on the second floor, and 0 to 15 ppm on the third floor of the Polymer Plant. Overall, the average vinyl chloride exposure for all jobs at the Polymer Plant was estimated at 10 ppm.

Although occupational VC exposures for polymer plant workers still exceed the 1 ppm U. S. standard, nevertheless, great advances have been made by CGPC in controlling occupational vinyl chloride exposures ever since the first industrial hygiene survey of February 1974. Prior to 1974, the time-weighted average VC exposure for polymer plant workers was put at 200 ppm, but could be well above 500 ppm. During the industrial hygiene survey of 1976, the time-weighted average VC exposure for polymer plant workers was reduced to 50 ppm. Now, we found that the average exposure was further reduced to about 10 ppm. This is indeed an extraordinary achievement considering that the government of the Republic of China is still abiding by the old and obsolete 500 ppm permissible VC exposure limit; and most of CGPC's local competitors have done very little to reduce occupational VC exposures in their factories.

It appears that the next step for CGPC to advance in VC exposure control is to adopt one of the several automatic reactor cleaning processes currently used by PVC manufacturers in the U. S. and several European countries. As of now, it is unlikely that the 10 ppm CGPC self-imposed vinyl chloride exposure standard can be achieved for reactor cleaners. On the other hand, if routine reactor cleaning is eliminated by adopting an automatic reactor cleaning process, CGPC should be able to meet the current U. S. 1 ppm vinyl chloride standard through extra efforts in maintaining good hygiene practices and controlling fugitive vinyl chloride emissions.

B. MONOMER PLANT

Total airborne organic vapor concentrations varied from 0 to 20 ppm at the low pressure distillation tower of the Monomer Plant. Measurements at other locations at the Monomer Plant showed 10 to 20 ppm at high boiling point material storage (#340B), approximately 10 ppm at the VCM transfer pumps, 5 to 15 ppm at Section #300, and 0 to 5 ppm at the methanol distillation area. No vinyl chloride was detected at the laboratory and office rooms, mainly because they are situated on north side (upwind side) of the Monomer Plant's process area. Also, no vinyl chloride was found at workers' resting booth after it was moved wisely to its present upwind location.

During the industrial hygiene survey of August 1976, three long-term air samples collected along the walkway near the high-boiling-point materials unloading station showed VC concentrations at 60, 87, and 14 ppm. This time, we found much lower VC concentrations at those locations. It is estimated that the average VC exposure for CGPC monomer plant workers might be around 2 ppm, considering that workers do spend a substantial amount of time within office, laboratory and other areas where VC concentrations were very low. Further reduction of occupational VC exposures can be achieved through vigorous implementation of the recommended "search and secure" program.

C. "SEARCH AND SECURE" PROGRAM

CGPC has implemented with success a vinyl chloride "Search and Secure" program as recommended in the 1976 Industrial Hygiene Survey Report. With the cooperation and assistance of process area workers, personnel from CGPC's Industrial Safety and Hygiene Department were able to search and locate VC leakage points and suggest maintenance and repair measures to secure those leaks. For example, in a VCM leakage search survey conducted between June 29 and July 1, 1977, a total of 64 leakage points were identified in the polymeratization plant. The #401 VCM measuring tank alone was found to contain 17 leakage points at various places such as pipe flanges, valves and level gauges.

After the leakage points were identified, the survey results were submitted to the Production Department and Engineering Department. Maintenance and repair measures were initiated to control and secure the vinyl chloride leaks. Subsequently, a re-survey of the leakage points was conducted to determine the success of the control measures. For example, a re-survey of the Polymer Plant leakage points was conducted during August 31 and September 1, 1978. Results of this second survey showed that 14 out of the original 17 leakage points on #401 VCM measuring tank were under control and the remaining three points needed further treatment. Table 1 summarizes activities and results of the "Search and Secure" effort for the #401 VCM measuring tank.

Experience at CGPC indicate that to search and locate the leakage points was relatively easy, but to repair and secure the leaks was sometimes rather difficult. What occurred at the fourth floor of the Low Pressure Distillation Tower of the Monomer Plant is summarized in Table 2. There one can see that among the 15 leakage points detected during the initial search survey, only six leaks had been repaired and secured by the re-survey time. The remaining nine leaks were either unable to be repaired, or not fully under control after repair.

It should be recognized that successful implementation of a "search and secure" program will not only result in great reduction of occupational and environmental vinyl chloride hazards, but produce savings through

feedstock and energy conservation. Therefore, it is recommended that this program be implemented with strong support from CGPC management. As of September 1, 1977, there were 86 leakage points at Monomer Plant and 43 leakage points at Polymer Plant waiting to be fixed.

TABLE 1

"SEARCH AND SECURE" OF VC LEAKS FOR #401 MEASURING TANK, CGPC POLYMER PLANT

Initial Search Survey Conducted: June 29 - July 1, 1977

Re-survey conducted: August 31 - September 1, 1977

Leakage Points Detected	Initial Survey VC Conc. (ppm) at Leak Point	Maintenance and Repair Measures Taken	Re-survey VC Conc. (ppm) at Leak Point
1. Front flange of reflux pipe at tank bottom	50	Packing replaced	20
2. Back flange of reflux pipe and tank bottom	90	Packing replaced	20
3. Valve gland of reflux pipe	> 1000	Screws tightened	30
4. Discharging valve gland	> 1000	Packing replaced	22
5. Bottom flange of level pipe	670	Packing replaced	0
6. Upper valve gland of second level gauge	740	Screws tightened	12
7. Bottom valve gland of second level gauge	50	Screws tightened	0
8. Bottom valve gland of third level gauge	> 1000	Screws tightened	320 *
9. Upper valve gland of third level gauge	70	Screws tightened	10
10. Sampling nozzle of third level gauge	> 1000	Nut sealed	14
11. Upper valve gland of fourth level gauge	60	Screws tightened	0
12. Safety valve gland at at tank top	> 1000	Screws tightened	140 *
13. Valve gland of charging pipe at tank top	> 1000	Packing replaced	25

continued next page

TABLE 1
(continued)

Leakage Points Detected	Initial Survey VC Conc. (ppm) at Leak Point	Maintanance and Repair Measures Taken	Re-survey VC Conc. (ppm) at Leak Point
14. Valve gland of balance pipe connected to monomer plant	> 1000	Screws tightened	30
15. Valve gland of main balance pipe	740	Screws tightened	0
16. Flange joint before automatic controller	320	Packing replaced	80 *
17. Valve gland of heat ing pipe	70	Screws tightened	12

* indicates further treatment is needed to secure the leak.

NOTE: Measurements were made with Century Organic Vapor Analyzer Model 118B

TABLE 2

UNSUCCESSFUL LEAKAGE CONTROL EFFORTS

AT FOURTH FLOOR OF LOW PRESSURE DISTILLATION TOWER, CGPC MONOMER PLANT

Initial Search Survey conducted: June 22 - June 28, 1977

Re-survey conducted: August 18 - August 20, 1977

Leakage Points Detected	Initial Survey VC Conc. (ppm) at Leak Point	Maintenance and Repair Measures Taken	Re-survey VC Conc. (ppm) at Leak Point
1. Valve gland for exhaust gases discharge at #329 separator	>1000	Unable to control	> 1000 *
2. Defreezing valve at #326 inlet	700	Unable to control	> 1000 *
3. Pressure gauge cock at #326 freezer inlet	>1000	Cock tightened	0
4. Safety valve gland of #325B freezer	>1000	Screws tightened	650 *
5. Gland & upper flange of nozzle valve at #325B freezer outlet	450	Screws tightened	100 *
6. Pressure gauge gland at 325B freezer	>1000	Screws tightened	700 *
7. Gland & bottom flange of inlet valve at #325B freezer	>1000	Screws tightened	30
8. Nozzle valve at #328 separator	>1000	Valve tightened	0
9. Pressure gauge adaptor at #325A freezer	800	Valve tightened	> 1000 *
10. Cock gland of pressure gauge at #325A freezer	850	Screws tightened	300 *
11. Nozzle valve at #325B freezer inlet	>1000	Valve tightened	0
12. Nozzle valve at 325A freezer outlet	>1000	Valve tightened	0

contined next page

Table 2
(continued)

Leakage Points Detected	Initial Survey VC Conc. (ppm) at Leak Point	Maintenance and Repair Measures Taken	Re-survey VC Conc. (ppm) at Leak Point
13. Nozzle valve at #319 freezer inlet	>1000	Unable to control	>1000 *
14. Valve gland of level gauge duct at #319 distillation tower	400	Packing replaced	0
15. Valve gland of level gauge duct at #320 distillation tower	250	Had not treated	>1000 *

* indicates further treatment is needed to secure the leak

NOTE: Measurements were made with Century Organic Vapor Analyzer model 118B

D. VINYL CHLORIDE SAMPLING BY CHARCOAL TUBE

Besides vinyl chloride measurement with portable organic vapor analyzer, extensive air sampling effort was made during this survey to evaluate workers' vinyl chloride exposures. A total of 56 long-term air samples were collected with charcoal adsorption tubes from various locations and from many workers (personal samples). We expected to see high VC concentrations (10 to 50 ppm) for a few selected air samples such as those collected from reactor cleaners. However, laboratory analysis showed that all 56 samples had virtually no vinyl chloride.

There does not appear to be a good answer to the absence of vinyl chloride on the charcoal tubes. Dr. James O. Jackson, Director of Industrial Hygiene Laboratory, suggested that aircraft partial depressurization in the cargo chamber could have caused desorption of the collected vinyl chloride from the charcoal tube during sample shipment. Had depressurization occurred, the reported organic solvent vapor concentrations could also be lower than the true concentrations. However, vinyl chloride, being a gas at standard temperature and pressure, would have desorbed faster and more completely than solvents such as MEK and toluene. A copy of Dr. Jackson's letter and raw data of laboratory analytical results are included in this report as Appendix 1. We are very sorry that this bizarre event has occurred.

It is recommended that CGPC's Industrial Safety and Hygiene Department should periodically send parallel charcoal tube air samples of vinyl chloride and solvent vapors to Gulf's Industrial Hygiene Laboratory for comparative analysis.

III. SOLVENT VAPOR EXPOSURES

A. PRINTING SHOP

The third printing machine, a five-color printer, has been added to the Printing Shop since the last survey of August 1976. Solvent vapors, mainly those of toluene and MEK evaporated from printing ink troughs and the PVC fabrics, were readily detectable by odor. Total organic vapor concentrations, as measured with an organic vapor analyzer, ranged from 50 ppm inside the enclosed office to over 1000 ppm at several work places beneath the six-color printer.

Occupational solvent vapor exposures were also evaluated with charcoal adsorption tubes and portable personal air samplers. Twenty-four air samples were collected from workers in the Printing Shop and Leather Shop. However, because of contamination and desorption that occurred during sample shipment, the laboratory analytical results are simply presented in Appendix 1 without interpretation.

Five-Color Printer. Slotted local exhausters have been installed below every ink trough of the new five-color printer. The exhausters are of the proper type and are cleverly designed for the tight space. However, they all have very inadequate air-moving capacities. As measured with Century Organic Vapor Analyzer, the total organic vapor concentrations often exceeded 500 ppm at spaces between ink troughs. The maximum allowable airborne concentrations for MEK and toluene are 200 ppm and 100 ppm, respectively, according to the Chinese Standards.

The Chinese Governmental regulation on industrial ventilation mentioned that ventilation hoods should have 0.5 meters per second (~100 ft/min) capture velocity. This is a simple, yet adequate, rule of thumb, but the catch word is "capture velocity." Capture velocity may not be equivalent to the hood face velocity. Capture velocity is the air-moving velocity at a point in front of the hood where one wishes to catch and control the air contaminants. Thus, for an ordinary laboratory hood,

the capture velocity is equivalent to the face velocity; for an overhead canopy hood, the capture velocity may be roughtly the same as the face velocity; but for a slotted exhausting hood, the capture velocity is not the face velocity at the slot opening. Judging by the distance between the slotted exhauster and the top of the ink trough, it is believed that the desired slot velocity (face velocity at the slot) should be at least 5 meters per second. Therefore, try to increase the present exhausting capacity by about ten times. Many slot openings of the slotted exhausters were plugged up by glue and ink. Routinely scheduled maintenance is needed to keep the slots clean.

Four-Color Printer. The airborne concentration of solvent vapors around and under the four-color printer varied between 100 ppm to 300 ppm as total organic vapors. But it should be noted that anywhere in the Printing Shop, the total organic vapor concentration may be 100 ppm and above. One reading in the center aisle between the four-color printer and the six-color printer showed 500 ppm.

The five wall-mounted exhaust fans were fairly effective in reducing solvent vapor concentrations at the four-color printer. In fact, it is believed that those five wall fans were mainly responsible for moving contaminated air out of the Printing Shop and providing needed dilution ventilation to this large room.

Six-Color Printer. The local exhaust ventilation system for the six-color printer was partially disassembled during the survey time. Concentrations of total organic vapors exceeded 500 ppm at spaces between ink troughs. Again, when slotted exhausters are installed here for controlling solvent vapors emitting from the ink troughs, the slot air velocity should be at least 5 meters per second.

Huge quantities of solvent vapors are emitted from the travelling PVC fabric, coated with wet ink on both sides of the cloth. It is physically impossible to design a local exhaust system to catch all solvent vapors before they disperse into the work-place air. The slotted hood

exhuasters, which are good for controlling solvent vapors emitting from the ink troughs can not effectively control solvent vapors evaporated from the travelling fabric. Additional fresh air should be supplied to the Printing Shop to dilute the solvent vapor concentrations.

Dilution ventilation in the form of roof exhausters, as suggested in the 1976 Industrial Hygiene Report, should be re-evaluated. Other ventilation design ideas, e.g., wall-mounted exhausters with ductwork extending to the adjacent Leather Shop, or fresh air supplied to the working zone through a blower and ductwork system, should also be considered.

Ink Preparation Room. The ventilation system for the ink mixers in the Ink Preparation Room was well designed. The system consisted of four ink mixer side-exhaust hoods connected by ductwork to a single blower. A damper was installed on each of the four branch ducts so that each hood can be controlled separately. The operator of the mixers has been instructed to shut a damper when its hood was not in use, thus increasing the exhaust capacity at the remaining ink mixer hoods.

There was almost no solvent odors in the Ink Preparation Room. The operator, Mr. Lin, was very health-and-safety conscious, and the room was in good housekeeping order. All ink and solvent containers were neatly stored. Containers were capped when not in use, thus avoiding unnecessary evaporation of the solvents.

B. LEATHER PLANT

Housekeeping conditions around the five surface treating machines in the leather plant were exactly the opposite of those in the ink preparation room. The worst was observed at #3 and #5 surface treating machines where dozens of ink and solvent containers were randomly placed, most of them with caps fully open. The floor around each of the machines was wet with ink, glue, and solvent spills.

Installation of local exhaust hoods at the surface treating machines have mostly been completed. Typical solvent vapor concentrations around a machine operator's breathing zone, measured as total organic vapors, have been reduced roughly five times from the old (prior to 1974) 200 ppm - 500 ppm level to the present 40 ppm - 150 ppm level.

Better solvent vapor control can be accomplished if the downdraft slotted hood on #3 surface treating machine could be moved closer to the ink trough. Vapor concentrations at #4 surface treating machine can be further reduced if a side-draft hood could be installed on this machine in addition to the existing downdraft hood.

C. POLYURETHANE PLANT

The Polyurethane Plant was not in operation during the time of this industrial hygiene survey. However, measurement of solvent vapor concentrations were conducted by CGPC's Industrial Safety and Hygiene Department on July 12, 1977. Results of that survey, presented in Table 3, clearly indicate excessive solvent vapor exposure.

Besides MEK and toluene, large quantities of dimethylformamide (DMF) were also consumed in the production of polyurethane leather. The maximum allowable concentration for DMF is 10 ppm, compared to 200 ppm for MEK and 100 ppm for toluene. DMF at excessive concentrations can cause gastric irritation and pain, nausea and headache, and liver and kidney damage. Prolonged skin contact will cause dermatitis.

The Polyurethane Plant is located upstairs of the Fabrication Plant.

During summer time, the temperature inside the PU Plant is unbearably hot. Ventilation system for the PU plant, therefore, should be designed for heat relief as well as for solvent vapor reduction. High capacity roof fans may be used for heat reduction and general dilution ventilation, while local exhausters should be installed near the major solvent vapor emission points to reduce workers' solvent exposures.

TABLE 3

TOTAL ORGANIC VAPOR CONCENTRATIONS

AT CGPC POLYURETHANE PLANT

Survey Date: July 12, 1977

Instrumentation: Century Organic Vapor Analyzer 1188

Surveyor: Mr. O. H. Huang, CGPC

Location of Measurement	Total Organic Vapor Concentration (ppm)
Office desk	2.6
Ink preparation area	30 - 42
No. 1 coater, ink trough	22 - 26
No. 1 coater, South side	100 - 160
No. 1 coater, North side	220 - 400
No. 2 coater, paste trough	20 - 28
No. 2 coater, South side	>1000
No. 2 coater, North side	>1000
Floating knife coater, paste trough	300 - 600
Laminator, South side	>1000
Laminator, North side	>1000

Isocyanates are often used to manufacture polyurethane foams. Two compounds have been incriminated as causes of occupational asthma. These are toluene diisocyanate (TDI) and diisocyanatodiphenyl methane (MDI). The permissible exposure limit for both is 0.02 ppm as ceiling value. Although CGPC reported none of the above isocyanates was used in its PU Plant, it is possible that they might be contained in one of the many types of additives purchased under trade names. Anyway, please keep alert.

IV. MERCURY EXPOSURES

Chlorine is manufactured by the electrolysis of salt brine in 36 mercury cells in the Chlor-Alkali Plant. Work-place mercury vapor concentrations have been in the decrease since the first industrial hygiene survey of 1974. Opening up of all windows on both sides of the mercury cell building and installation of local exhaust ventilation systems were effective in reducing occupational mercury exposures.

An air sampling survey of airborne mercury concentration was conducted on November 2, 1977 at CGPC's Chlor-Alkali Plant. The samples were collected by drawing air through an impinger containing a potassium permanganate ($KMnO_4$) solution acidified with H_2SO_4. Mercury vapor and inorganic mercury compounds were absorbed, and the quantity of mercury later determined by atomic absorption method in the laboratory.

Table 4 summarizes results of the mercury survey. All three air samples showed less than 0.002 mg/m^3 of mercury concentration. The permissible occupational mercury exposure limit is 0.05 mg/m^3 for eight-hour continuous exposure. (Chinese and U. S. have the same standard). Therefore, as sampled on November 2, 1977, the occupational mercury exposures at Chlor-Alkali Plant were well within the permissible level. It should be noted that all windows on both sides of the Chlor-Alkali Plant's main floor were opened, and the wind speed was fairly strong (4 meters/second) during the air sampling time.

The flake-caustic soda machines in the basement of the Chlor-Alkali Plant were out of service for many months and may not resume operation due to lack of market demand for flake soda. Previous hygiene surveys have shown that mercury vapor concentrations were excessively high around the flake soda machines. It is believed that occupational mercury exposures at CGPC will remain at safe levels as long as the two flake-soda machines remain inactive.

Should the flake soda machines resume production in the future, however, it is recommended that the manufacturing operation be moved out of the basement. The mercury vapor concentrations are simply too high in the

TABLE 4

AIRBORNE MERCURY CONCENTRATIONS AT CGPC's CHLOR-ALKALI PLANT

FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION Type / Location	SAMPLE VOLUME Liters	MERCURY CONCENTRATION mg/m^3
6	N. of #21 Mercury Cell	660	<0.002
7	N. of #5 Mercury Cell	666	<0.002
8	S. of #5 Mercury Cell	defective sample	-
9	S. of #21 Mercury Cell	670	<0.002
BLANK	--	0	-

Sampling Method: Wet absorption in $KMnO_4$ - H_2SO_4 solution with Midget Impinger

Analytical Method: Atomic Absorption

Detection Limit: One microgram of mercury

Results: All samples showed below detection limit mercury concentration

Occupational Exposure Standard = 0.05 mg/m^3

basement for effective ventilation control. In addition, the workers are exposed to excessive heat, humidity, and dusts of caustic soda.

For temporary, short-duration exposures to high mercury vapor concentrations such as during maintenance and clean-up of the mercury cells, it is suggested that proper types of respiratory protective equipment be worn by the workers. Substantial protection can be provided by disposable 3M brand Mercury Vapor Respirator #8707. A manufacturer's descriptive bulletin for this respirator is enclosed as Appendix 2 of this report. 3M has sales representatives in Taipei.

V. LEAD, BARIUM, CADMIUM AND CHROMIUM

Lead, barium and cadmium stearates are added to the PVC resin as stabilizers to avoid disintegration of PVC in later fabrication processes. Compounds of chromium, iron, titanium, lead, etc. are added to the PVC resin as dyes and pigments. Weighing and mixing of these compounding materials are handled in the Compounding Ingreadients Mixing Room located on the second floor of the Extrusion Plant.

Airborne suspended particulates samples were collected with Millipore-type AA membrane filters and analyzed for chromium, lead, barium, and cadmium. Table 5 presents results of the airborne concentrations of these toxic metals. The current OSHA permissible occupational exposure limits in the United States are 0.05 mg/m^3 for chromate compounds, 0.15 mg/m^3 for lead, 0.5 mg/m^3 for barium, and 0.05 mg/m^3 for cadmium. Except for lead, the airborne concentrations of chromium, barium and cadmium were, in general, within their respective permissible occupational exposure standards.

A. CHROMIUM

Air sample #808, collected at the master batch mixer, showed 0.39 mg/m^3 of chromium and 2.2 mg/m^3 of lead. It appears that the excessively high concentrations of both lead and chromium was due to the use of lead chromate pigments. According to information supplied by manufacturers, the following pigments in CGPC contain chromates:

CGPC Catalog Number	Product Trade Name	Chemical Components		CGPC Annual Consumption
6-21A	Molybdate Orange P-380	$PbCrO_4$, $PbMoO_4$	$PbSO_4$	25 short ton
6-81C	Chrome Yellow GL	$PbCrO_4$	(87% min)	34 short ton
6-83D	Chrome Yellow 10G	$PbCrO_4$ $PbSO_4$	(50% min) (43% min)	15 short ton

Table 5

OCCUPATIONAL EXPOSURES TO DUSTS OF CHROMIUM, LEAD, BARIUM AND CADMIUM

at

CGPC EXTRUSION PLANT AND TAOYUAN PLANT

FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION Type/Location	CHROMIUM mg/m^3	LEAD mg/m^3	BARIUM mg/m^3	CADMIUM mg/m^3
796	Blender #2 calendar of film plant	< 0.01	< 0.01	< 0.01	< 0.01
797	Blender #4 calendar of leather	< 0.01	< 0.01	< 0.01	< 0.01
798	Blender #6 calendar of tile floor	< 0.01	0.68*	< 0.01	< 0.01
799	Blender #1 calendar of film	< 0.01	< 0.01	< 0.01	< 0.01
801	Blender #3 calendar of film	< 0.01	< 0.01	< 0.01	< 0.01
802	Blender #8 calendar of leather	< 0.01	< 0.01	< 0.01	< 0.01
803	Blender #7 calendar of film	< 0.01	0.07	< 0.01	< 0.01
804	Blender #5 calendar of film	< 0.01	< 0.01	< 0.01	< 0.01
805	Blender of PVC compound machine	< 0.01	< 0.01	< 0.01	< 0.01
808	Mixers of Master Batch	0.39*	2.2*	< 0.01	< 0.01
810	Stabilizer preparing room, extrusion plant	0.03	5.5*	3.1*	0.03
811	Middle between 3102 ABC mixers	< 0.01	0.22*	< 0.01	< 0.01
812	Middle between 3102 DEF mixers	< 0.01	< 0.01	< 0.01	< 0.01
813	Middle between 3103 ABC blenders	< 0.01	0.23*	< 0.01	0.01
815	Middle between 3103 DEF blenders	< 0.01	0.93*	< 0.01	< 0.01
816	Operator of 3102A mixer, 3103A blender	< 0.01	0.73*	2.6*	< 0.01

TABLE 5 (continued)

FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION Type /Location	CHROMIUM mg/m^3	LEAD mg/m^3	BARIUM mg/m^3	CADMIUM mg/m^3
817	Worker of Stabilizer compounding room	<0.01	0.50*	<0.01	0.03
819	Operator of RC 100 extruder	<0.01	0.08	<0.01	<0.01
820	Operator of 310G Mixer	0.01	0.33*	<0.01	<0.01
821	Worker of PVC waste pipe crushing of reborn room	<0.01	<0.01	<0.01	<0.01
807	#15 500L Ribbon Blender operator employee 66973 Taoyuan Plant	<0.01	0.05	0.05	<0.01
809	#11 300L Super Mixer operator employee 66949 Taoyuan Plant	<0.01	0.05	0.05	0.03
814	N.W. of #11 Super Mixer Taoyuan Plant	<0.01	0.11	<0.01	0.02
818	1000L Ribbon Blender operator employee 62908 Taoyuan Plant	<0.01	0.05	<0.01	0.04
822	BLANK	-	-	-	-
805	BLANK	-	-	-	-

Sample Matrix: 0.8 μ Type AA filter

Analytical Method: Atomic absorption

* Concentration exceeds threshold limit value

In December 1975, the U. S. National Institute for Occupational Safety and Health (NIOSH) declared that certain forms of hexavalent chromium, including lead chromate, have been found to cause increased respiratory cancer mortality among workers. NIOSH recommends that exposure to those carcinogenic hexavalent chromium be not greater than one microgram per cubic meter of air (1 $\mu g/m^3$).

In the United States, the Dry Color Manufacturers Association has formed a Lead Chromate Task Force which has advised their employees and customers to prudently reduce chromate pigment exposure to the lowest practical level. In dealing with a proven human carcinogen such as lead chromate, an airborne concentration of 0.39 mg/m^3 (as Cr) is totally unacceptable.

It is recommended that CGPC should make a strong effort to replace dyes and pigments that contain lead and zinc chromate. If that is not feasible, then stringent control measures should be implemented to reduce occupational exposures to a minimum. Attached to the report as Appendix 3 is the NIOSH Recommended Standard for Occupational Exposure to Hexavalent chromium. Until a new OSHA chromate exposure standard is published, please use this NIOSH criteria document as a guideline for control.

B. LEAD

Results in Table 5 indicate approximately one-third of the air samples showed airborne lead concentrations exceeded U.S. OSHA's 0.15 mg/m^3 lead exposure standard. (It is believed that Chinese have the same lead standard.) Among personal air samples, the highest lead concentration was 0.73 mg/m^3 for sample #816, which was collected at the stabilizer preparation room of the Extrusion Plant.

The following comments and suggestions are based on observations at the Extrusion Plant and the air sampling results:

1. Employees in the Compounding Ingredients Mixing Room and other potential dust exposure areas wore dust respirators. Therefore, actual dust inhalations by employees in those areas were significantly below the exposures indicated by air sampling results.

2. Floors, walls, and other surfaces in the Extrusion Plant, especially inside the Compounding Ingredients Mixing Room, were covered with a coat of powdery material. No doubt, most of the powders were dusts of PVC resin. But there could be significant amounts of lead dust mixed with the PVC resin dusts. Re-entrainment of the settled lead dusts by foot traffic and air currents could have created high airborne lead concentrations.

3. Effective local exhaust hoods have been installed for all compounding ingredient mixers following suggestions made in the 1974 industrial hygiene survey report. These side-draft slotted hoods have reduced the work-place concentrations of dusts of toxic metals.

4. Weighing of compounding ingredients, including dyes and pigments, were conducted within a walk-in booth which was exhausted with a wall fan. This is a correct ventilation arrangement, although the position of the wall fan could be lowered and the capacity of the fan increased for even better dust control.

5. CGPC's industrial hygiene laboratory should have field and laboratory equipment for measuring airborne particulates concentrations of lead, cadmium, barium and chromium. High flow rate personal air sampling pumps and filters should be acquired for capturing the suspended particulates, and proper analytical instruments (e.g., atomic absorption) for determining trace metal concentrations.

6. Enclosed as Appendix 4 is U.S. NIOSH recommended standard for occupational exposure to inorganic lead. Please use this document as a guideline for control of lead exposures.

C. BARIUM AND CADMIUM

Review of results in Table 5 indicate that only two air samples showed airborne barium concentration exceeded threshold limit value of 0.5 mg/m^3. All air samples showed airborne cadmium concentrations within its threshold limit value of 0.05 mg/m^3. Barium and cadmium exposures would be further reduced when measures were taken to lower occupational lead exposure.

VI PLATING SHOP

Hygiene conditions in the Plating Shop were worse in November 1977 than August 1976. The side draft ventilation hood and the blower for the chrome plating tank were taken down for two months without replacement. A wall fan on the farther end of the room was broken down but not replaced either. Airborne concentration of acid fumes (chromic and sulfuric) were so strong that workers complained about eye, nose, and throat irritation. A few persons, including this author, coughed and chocked during the short time this walk-through survey was made.

Acid corrosion might be the main cause for the breaking down of the exhausting fans in the Plating Shop. The replacement blower and wall fan should have plastic fan blades or blades coated with inert material such as epoxy resin.

It was noticed that there were more activities and more workers (both men and women) inside the Plating Shop. A few of them were without proper eye and body protection. It is believed that the wearing of eye goggles, acid-proof gloves, boots, aprons or other appropriate protective clothing shall be made mandatory for Plating Room workers.

Next to the Plating Shop are the darkroom and the art design and engraving room. A solvent dipping tank (for washing the rollers) should be equipped with a slotted exhauster along the length of the tank to control solvent emissions. This has been discussed with the Plating Room supervisor.

APPENDIX 1

LABORATORY ANALYTICAL RESULTS OF CHARCOAL TUBE SAMPLES

OF VINYL CHLORIDE AND SOLVENT VAPORS

INTERNAL CORRESPONDENCE
L-360

FROM James O. Jackson — DATE January 23, 1978

TO R. T. Cheng, Ph.D. AT San Diego — REFERENCE F77-251 - IHL-77-270 & IHL-77-268

SUBJECT China Gulf Plastics Corporation Visit of November, 1977

The Industrial Hygiene Laboratory has reviewed the data generated from samples submitted by you from your November, 1977 visit to China Gulf Plastics Corporation. The absence of vinyl chloride on the charcoal tubes leads to the conclusion that an anomaly has occurred and unfortunately no good explanation is available.

At your request, the Industrial Hygiene Laboratory has reviewed the data from Sample No. F77-251. The following observations can be made:

1. Samples were received in a single wooden box. This wooden container contained both the bulk material and the charcoal tubes, although they were each packed in separate cardboard boxes. As we have discussed, the Shipping Department at General Atomic probably repacked your two cardboard boxes into the one wooden box.

2. Both bulk samples of toluene were empty when received and both polyethylene bottles were collapsed. The other bulk liquid materials were intact in their containers.

3. Both field blanks submitted by you had substantial amounts of toluene on both the front and the back layers. Laboratory blanks, which were added to the samples submitted upon arrival, contained no toluene or any other chemicals.

4. Toluene was observed to be contaminated on all submitted charcoal tubes. There appears to be a consistent contamination level on all tubes of 100-200 µg of toluene.

The above statements lead us to believe that toluene escaped from the containers and was deposited on the charcoal tubes. Because you stated that all bulk material bottles were intact when you packed them for delivery to the Industrial Hygiene Laboratory, and because the toluene bulk material bottles were collapsed when they arrived at the Industrial Hygiene Laboratory, it seems that an unexplained event occurred between shipment from San Diego and arrival in Harmarville. One probable cause of this could have been aircraft depressurization, although we have no way of evaluating this phenomenon. Had depressurization occurred, it is quite probable that vinyl chloride would have desorbed preferentially because it is a gas at STP.

As a further evaluation of this problem, the pumps you used in Taiwan were re-calibrated. The calibrations were unchanged and the sample volumes were confirmed.

The vinyl chloride methodology was analytically confirmed by gas chromatography and mass spectrometry by the Harmarville Research Laboratory. The lot of charcoal which you used in Taiwan was also re-evaluated and good recovery was again found.

Unfortunately, there does not appear to be a good answer to the absence of vinyl chloride on these charcoal tubes. The amount of toluene that was found on the charcoal, added to the other solvent amounts discovered, is probably not sufficient to have caused the displacement of vinyl chloride.

Please feel free to contact us any time and we would be most interested in your comments on this matter.

James O. Jackson

JOJ/gb

cc: R. L. Gibson, M.D.

SPONSOR: R. T. Cheng

UNIT/LOCATION: Personal/Area

FACILITY: Gulf China Plastics Corporation

SAMPLING DATE(S): November 2,3,4,5,7,8,9,10

IH LAB SAMPLE NUMBER	FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION TYPE/LOCATION	SAMPLE VOLUME LITERS	VINYL CHLORIDE PPM	METHYL ETHYL KETONE PPM	BENZENE PPM	METHYL ISOBUTYL KETONE PPM	TOLUENE[1] PPM	CYCLO-HEXANONE PPM
IHL-77-270A	Blank	Submitted	NA	TR	0.001 mg	TR	0.001 mg	0.091[2] mg	---
IHL-77-270B	Blank	Submitted	NA	--	--	TR	TR	0.165[2] mg	---
IHL-77-270C	--	Lab Blank	NA	--	--	--	TR	---	---
IHL-77-270D	--	O. C. Tube	NA	--	--	0.059 mg	TR	---	---
IHL-77-270E	1	Instrument Control Operator 59110	28	BDL	BDL	TR	TR	1.0[2]	BDL
IHL-77-270F	2	Operator of VCM Charging 58116	24	BDL	BDL	TR	TR	1.1[2]	BDL
IHL-77-270G	3	PVC slurry discharging operator 59019	25	BDL	BDL	TR	TR	1.3[2]	BDL
IHL-77-270H	4	Worker, PVC scale Cleaning 66124	28	BDL	BDL	TR	TR	1.4[2]	BDL
IHL-77-270I	5	Worker, PVC scale Cleaning 59113	28	TR	BDL	TR	TR	1.1[2]	BDL
IHL-77-270J	10	Operator, VCM Charging, 58116	46	BDL	BDL	TR	TR	0.60[2]	BDL
IHL-77-270K	11	Operator, PVC slurry discharging 59019	45	BDL	BDL	TR	TR	0.82[2]	BDL
IHL-77-270L	12	Operator, Instrument Control 59110	45	BDL	BDL	TR	TR	0.82[2]	BDL

SAMPLE MATRIX: Charcoal tubes

ANALYTICAL METHOD: NIOSH P&CAM 127

ANALYST: [signature]

LAB DIR/SUPVR: [signature] DATE: 12/15/77

cc: HTM/file

BDL=Below Detection Limit; NA=Not Applicable; TR=Trace

COMMENTS: [1] There appears to be a Toluene contaminant on the front and backup sections of all submitted charcoal tubes ranging from 0.025-0.2 mg. The values reported include this contaminant.

[2] Breakthrough occurred.

Gulf

0036 0058. (0005)

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SPONSOR: R. T. Cheng UNIT/LOCATION: Personal/Area

IH LAB SAMPLE NUMBER	FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION TYPE/LOCATION	SAMPLE VOLUME LITERS	VINYL CHLORIDE PPM	METHYL ETHYL KETONE PPM	BENZENE PPM	METHYL ISOBUTYL KETONE PPM	TOLUENE PPM	CYCLO-HEXANONE PPM
IHL-77-270M	13[3]	PVC Scale Cleaning 66124	---	BDL	BDL	TR	TR	0.152[2]=8	BDL
IHL-77-270N	14	PVC Scale Cleaning 59113	43	BDL	BDL	TR	TR	0.96[2]	BDL
IHL-77-270Ø	15	VCM charging operator 61276	26	BDL	BDL	TR	TR	1.1[2]	BDL
IHL-77-270P	16	PVC Scale Cleaning 64348	24	BDL	BDL	TR	TR	0.34[2]	0.90
IHL-77-270Q	17	PVC Scale Cleaning 58109	26	BDL	BDL	TR	TR	1.4[2]	BDL
IHL-77-270R	18	PVC Slurry discharging 65297	23	BDL	BDL	TR	TR	0.96[2]	BDL
IHL-77-270S	19	Laboratory of General Plant	870	BDL	2.2	TR	0.21	0.61	0.01
IHL-77-270T	20	Ink stirring #2 surface TM,56160	25	BDL	0.01	0.05	0.07	5.1[2]	BDL
IHL-77-270U	21	Ink stirring #3 surface TM,61270	24	BDL	98	0.12	17	19	0.74
IHL-77-270V	22	Ink stirring #4 STM 60222	24	BDL	18	0.05	4.2	6.4	0.23
IHL-77-270W	23	Ink stirring #5 STM 58213	23	TR	BDL	TR	TR	1.8[2]	BDL
IHL-77-270X	24	Ink stirring #5 STM 58260	22	BDL	5.0	0.03	1.5	5.1	0.09
IHL-77-270Y	26	Ink stirring of color printer,64221	11[4]	BDL	5.7	0.03	1.1	22	BDL
IHL-77-270Z	27	Ink stirring of 5 color printer,64125	11	BDL	23	0.12	3.9	62	0.05
IHL-77-270A2	28	Foreman of 6,4,5 color printers, 57132	7.9	BDL	25	0.07	3.8	63	0.05

COMMENTS: [3] Field data sheet reports this as a "defective sample."

0037 0058. (0005)

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SENSOR: R. T. Cheng UNIT/LOCATION: Personal/Area

IH LAB SAMPLE NUMBER	FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION TYPE/LOCATION	SAMPLE VOLUME LITERS	VINYL CHLORIDE PPM	METHYL ETHYL KETONE PPM	BENZENE PPM	METHYL ISOBURYL KETONE PPM	TOLUENE PPM	CYCLO-HEXANONE PPM
IHL-77-270B$_2$	29	Printed Ware Parking Workman 65360	8.8	BDL	2.2	TR	0.72	17	BDL
IHL-77-270C$_2$	30	Laboratory of Monomer Plant	610	BDL	BDL	TR	TR	0.10[2]	BDL
IHL-77-270D$_2$	31	S. of VCM Distillation Tower, Monomer Plant	610	BDL	BDL	TR	TR	0.29[2]	BDL
IHL-77-270E$_2$	32	S. of #300 R division of Monomer Plant	610	BDL	BDL	TR	TR	0.11[2]	BDL
IHL-77-270F$_2$	33	Ink stirring #2 STM 56160	45	BDL	14[2]	0.05	23[2]	130[2]	1.3
IHL-77-270G$_2$	34	Ink stirring #3 STM 61270	45	BDL	78[2]	0.07	4.4	1.6	1.0
IHL-77-270H$_2$	35	Ink stirring #4 STM 60222	45	BDL	160[2]	TR	13	36	2.0
IHL-77-270I$_2$	36	Ink stirring #5 STM 58213	45	TR	BDL	0.01	0.01	0.95[2]	BDL
IHL-77-270J$_2$	37	Ink stirring #5 STM 58260	45	BDL	8.2	0.03	1.8	4.4	0.25
IHL-77-270K$_2$	38	Ink stirring of 6 color printer, 57133	23	BDL	68[2]	0.14	7.3	99	0.15
IHL-77-270L$_2$	39	Ink stirring of 4 color printer, 64211	13	BDL	67	0.19	6.1	100	0.12
IHL-77-270M$_2$	40	Ink stirring of 5 color printer, 64125	22	BDL	50[2]	0.14	4.3	85	0.08
IHL-77-270N$_2$	41	Foreman of 6,4,5 color printer, 57132	16	BDL	80	0.16	3.3	50	0.10
IHL-77-270Ø$_2$	42	Printed film ware packing 65360	22	BDL	2.1	0.01	0.51	13	BDL
IHL-77-270P$_2$	43	Guarding Booth, beside Main Office	850	BDL	BDL	TR	TR	0.08[2]	BDL

COMMENTS:

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0038 0058. (0005)

SPONSOR: R. T. Cheng UNIT/LOCATION: Personal/Area

IH LAB SAMPLE NUMBER	FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION TYPE/LOCATION	SAMPLE VOLUME LITERS	VINYL CHLORIDE PPM	METHYL ETHYL KETONE PPM	BENZENE PPM	METHYL ISOBUTYL KETONE PPM	TOLUENE PPM	CYCLO-HEXANONE PPM
IHL-77-270Q2	44	NE 1ST. Class Dormitory	830	BDL	BDL	TR	TR	0.08[2]	BDL
IHL-77-270R2	45	NW 4th. Class Dormitory	800	BDL	0.01	TR	TR	0.14[2]	BDL
IH 77-270S2	46	S. fence Carpenter Shop	810	BDL	BDL	TR	TR	TR[2]	BDL
IHL-77-270T2	47	VCM Tank Cars	840	BDL	BDL	TR	TR	0.07[2]	BDL
IHL-77-270U2	48	Instrument Control Operator 59110	13	BDL	BDL	TR	TR	4.7[2]	BDL
IHL-77-270V2	49	PVC Slurry discharge 59019	12	BDL	BDL	0.03	TR	5.8[2]	BDL
IHL-77-270W2	50	PVC Scale Cleaning 66124	9	BDL	BDL	TR	TR	5.4[2]	BDL
IHL-77-270X2	51	PVC Scale Cleaning 59113	12	BDL	BDL	TR	TR	5.9[2]	BDL
IHL-77-270Y2	52	Office of Polymerization	58	BDL	BDL	0.01	TR	0.58[2]	BDL
IHL-77-270Z2	53	3rd. Floor Polymerization Bldg.	50	BDL	BDL	TR	TR	0.77[2]	BDL
IH 77-270A3	54	Polymerizer 2nd. floor of P.P.	50	BDL	BDL	TR	TR	0.81[2]	BDL
IHL-77-270B3	55	1st. floor of Polymerizer Plant	50	BDL	BDL	TR	TR	0.94[2]	BDL
IHL-77-270C3	56	Workmen rest area of PP	49	BDL	BDL	0.01	TR	0.84[2]	BDL
IHL-77-270D3	57	Instrument Control 59110	23	BDL	BDL	TR	0.01	2.6[2]	BDL
IHL-77-270E3	58	Operator, PVC Discharging 59019	22	BDL	BDL	TR	0.01	2.7[2]	BDL

COMMENTS:

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SPONSOR: R. T. Cheng UNIT/LOCATION: Personal/ Area

IH LAB SAMPLE NUMBER	FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION TYPE/LOCATION	SAMPLE VOLUME LITERS	VINYL CHLORIDE PPM	METHYL ETHYL KETONE PPM	BENZENE PPM	METHYL ISOBUTYL KETONE PPM	TOLUENE PPM	CYCLO-HEXANONE PPM
IHL-77-270F3	59	PVC Scale Cleaning 66124	16	BDL	BDL	TR	TR	2.9[2]	BDL
IHL-77-270G3	60	PVC Scale Cleaning 59113	21	BDL	BDL	TR	TR	2.1[2]	BDL
IH 7-270H3	61	Office of Monomer Plant	330	BDL	BDL	TR	TR	0.13[2]	BDL
IHL-77-270I3	62	Booth of Monomer Plant	330	BDL	TR	TR	TR	0.14[2]	TR
IHL-77-270J3	63	CH_3OH distillation area, Monomer Plant	330	BDL	BDL	TR	TR	0.12[2]	BDL
IHL-77-270K3	64	2500 ℔ VCM Sphere	310	BDL	BDL	TR	TR	0.15[2]	BDL
IHL-77-270L3	65	500 ℔ VCM Sphere	310	BDL	BDL	TR	TR	0.19[2]	BDL
IHL-77-270M3	66	4th floor, low P distillation tower	13	BDL	BDL	0.02	TR	3.3[2]	BDL
IHL-77-270N3	67	3rd. floor, low P distillation tower	13	BDL	BDL	TR	TR	2.7[2]	BDL
IHL-77-270Ø3	68	2nd. floor, low P distillation tower	9	BDL	BDL	TR	TR	3.5[2]	BDL
IH 7-270P3	69	1st. floor, low P distillation tower	12	0.01	BDL	TR	TR	2.5[2]	BDL
IHL-77-270Q3	70	VCM transfer pumps	21	BDL	BDL	TR	0.01	1.5[2]	BDL
IHL-77-270R3	71	Control Room refrigeration Plant	20	BDL	BDL	TR	TR	2.2[2]	BDL
IHL-77-270S3	72	S. fence by Poly-merization pilot plant	480	BDL	TR	TR	TR	0.08[2]	BDL
IHL-77-270T3	73	S. fence beside Carpenter Shop	520	BDL	BDL	TR	TR	0.09[2]	BDL

COMMENTS:

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SPONSOR: R. T. Cheng UNIT/LOCATION: Personal/Area

IH LAB SAMPLE NUMBER	FIELD SAMPLE NUMBER	SAMPLE DESCRIPTION TYPE/LOCATION	SAMPLE VOLUME LITERS	VINYL CHLORIDE PPM	METHYL ETHYL KETONE PPM	BENZENE PPM	METHYL ISOBUTYL KETONE PPM	TOLUENE PPM	CYCLO-HEXANONE PPM
IHL-77-270U$_3$	74	SW guard booth by ink prep. rm.	480	BDL	0.04	TR	0.01	0.33	TR
IHL-77-270V$_3$	75	W. fence by wastewater res.	490	TR	0.03	TR	0.01	0.24	BDL
IHL-77-270W$_3$	76	Polymerization Plant Control Room	22	BDL	BDL	TR	TR	1.9[2]	BDL
IHL-77-270X$_3$	77	Bottom VCM measuring tank	22	BDL	BDL	TR	TR	2.4[2]	BDL
IHL-77-270Y$_3$	78	Center aisle, 3rd. floor poly. plant	22	BDL	BDL	TR	TR	1.6[2]	BDL
IHL-77-270Z$_3$	79	2nd. floor, Polymerization Plant	22	TR	BDL	TR	TR	1.6[2]	BDL
IHL-77-270A$_4$	80	#421 VCM gas holder, poly. Pl	22	BDL	BDL	TR	TR	1.7[2]	BDL
IHL-77-270B$_4$	81	N. doorway, printing plant	11	BDL	8.5	0.03	1.1	20	0.03
IHL-77-270C$_4$	82	Office, printing plant	11	BDL	0.09	TR	0.04	3.8[2]	BDL
IHL-77-270D$_4$	83	Center aisle, printing plant	7.8	BDL	450[2]	0.49[2]	1.8	730	0.11
IHL-77-270E$_4$	84	S. Doorway, printing plant	9.8	BDL	BDL	TR	0.05	4.2[2]	BDL

COMMENTS:

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APPENDIX 2

3M BRAND MERCURY VAPOR RESPIRATOR

3M Brand Mercury Vapor Respirator #8707

#8707 3M Brand Mercury Vapor Respirator

Substantial protection. The 3M Brand Mercury Vapor Respirator protects workers up to eight hours against five times the threshold limit value. A worker can depend on effective protection for the length of a normal work shift.

Low cost for this vital protection. You can furnish the 3M Brand Mercury Vapor Respirator for about 95 cents.* A low price to pay for protection against potentially damaging mercury vapor. At such reasonable cost, the respirator becomes a disposable item. So you can issue a fresh respirator for proper protection every day.

Protects against particulate matter. Because the 3M Brand Mercury Vapor Respirator is composed of two layers of filtration material, it performs two important protection functions. It protects against mercury vapor, of course. But it also filters 98 percent of particulate matter with a mean particle diameter of 0.4 to 0.6 microns.

Comfortable—workers will wear it. Naturally, any respirator must be worn to be effective. The 3M Brand Mercury Vapor Respirator encourages regular use because it is unusually comfortable. It's lightweight at just 0.3 ounces. The straps keep it snug without excessive pressure on the face or head.

Doesn't interfere with normal functions. A worker can breathe easily with the 3M Brand Mercury Vapor Respirator on. And he feels practically no interference with speech or vision. So he can conduct his normal work activities, almost forgetting that the respirator is there protecting him while he works.

Weight: 8.4 grams. (very lightweight.)

Vision: Respirators were fitted to test subjects, heads were held straight, and subjects were asked to point out all areas of a numbered grid on the floor which were not obscured from view. Results are shown below. Units indicate distance in feet which was obscured from view.

Respirator	Angle from center line			
	0° (straight ahead)	30°	60°	90°
None	2.0	2.0	2.5	3.5
3M #8707	3.0	2.5	3.0	3.5

For more information about the 3M Brand Mercury Vapor Respirator and other 3M Brand Occupational Health and Safety Products, write: 3M Company, 3M Center, Bldg. 527-110, St. Paul, Minnesota 55101. In Canada contact Box 5757, London, Ont., phone (519) 451-2500.

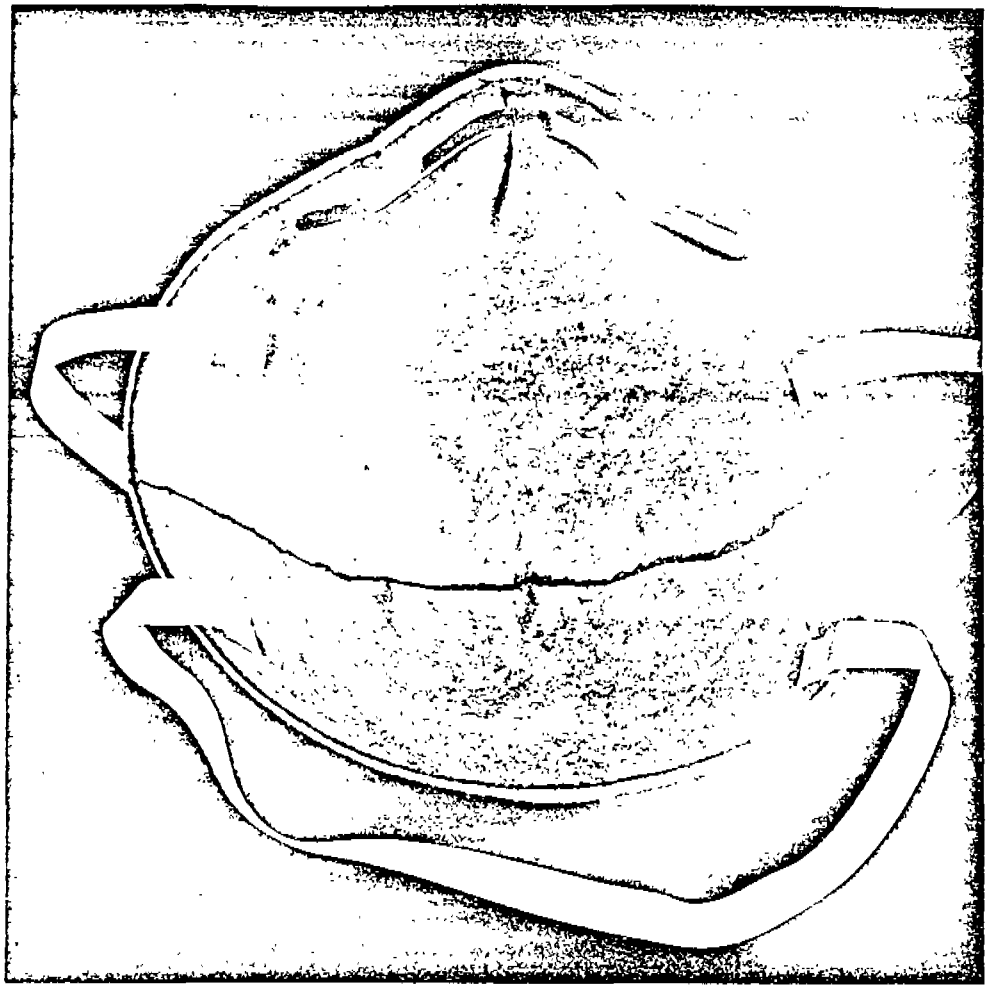
*Manufacturer's suggested list price.

R-MVR (942) (0005) 0058. 0043

Litho in U.S.A. with 3M BRAND Photo Offset Plates, Film and Chem

3M Brand Mercury Vapor Respirator #8707

3M Brand Mercury Vapor Respirator #8707



Mercury Vapor protection at a price you can live with.

(0005) 0058. 0044

APPENDIX 3

GUIDELINE FOR CHROMIUM (VI) EXPOSURE

NIOSH Recommended Standard for Occupational Exposure To Chromium (VI)

A complete criteria document for occupational exposure to chromium (VI), also called hexavalent chromium or Cr(VI), has been prepared by the National Institute for Occupational Safety and Health (NIOSH). Certain forms of chromium(VI) have been found to cause increased respiratory cancer mortality among workers. NIOSH has found that certain other forms of chromium (VI) are noncarcinogenic; they are the monochromates and bichromates (dichromates) of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium and chromium(VI) oxide (chromic acid anhydride).

The recommended standard is part of a continuing series of criteria documents developed by NIOSH in accordance with the Occupational Safety and Health Act of 1970. The document was transmitted to the Occupational Safety and Health Administration in the Department of Labor on Dec. 1, 1975, for review and consideration in the standard setting process.

NIOSH recommends that chromium(VI) in the workplace be considered to be carcinogenic unless an employer can demonstrate that only the noncarcinogenic chromium(VI) compounds mentioned above are present. If this can be demonstrated, NIOSH has less restrictive recommendations appropriate for noncarcinogenic materials.

In those instances where the recommendations for carcinogenic chromium(VI) apply, NIOSH recommends that exposure to chromium(VI) be not greater than 1 μg Cr(VI)/cu m. If only the noncarcinogenic chromium(VI) materials described above are present in the workplace, NIOSH recommends workplace environmental limits of 50μg chromium(VI)/cu m as a 15-minute ceiling and a TWA of 25 μg chromium(VI)/cu m for up to a 10-hour workday, 40-hour workweek. The present Federal workplace environmental limit for chromium(VI) materials is a ceiling of 52 μg chromium(VI)/cu m or 100 μg chromium(VI) oxide/cu m.

In 1973, NIOSH provided recommendations for occupational exposure to chromic acid. These 1975 recommendations for chromium(VI) supersede the recommendations for chromic acid in several instances.

Exposure to any form of chromium(VI) may result in disorders of the skin, and liver and kidney damage. Compliance with all sections of the NIOSH recommended standard should prevent noncarcinogenic adverse effects of exposure to chromium(VI) in the workplace air and by skin exposure.

NIOSH estimates that 175,000 workers are potentially exposed to chromium(VI) which is produced principally from chromite ore. It is used in such diverse operations as pigment production, plating and anodizing, match manufacturing, battery manufacturing, and as an antioxidant. The proposed standard would apply to the processing, manufacturing, and use of chromium(VI) products and byproducts covered by the Occupational Safety and Health Act.

The following is the first chapter of the criteria document. It contains the NIOSH recommendations for controlling worker exposure to chromium(VI).

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

Single copies of complete criteria document are available from:
Office of Technical Publications
National Institute for Occupational Safety and Health
Post Office Building
Cincinnati, Ohio 45202

Please include a self-addressed mailing label to assist in answering your request.

NIOSH Recommended Standard

I. RECOMMENDATIONS FOR A CHROMIUM(VI) STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to chromium(VI), ie, hexavalent chromium or Cr(VI), in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and safety of workers for up to a 10-hour workday, 40-hour workweek over a working lifetime. Compliance with all sections of the standard should prevent all noncarcinogenic adverse effects of exposure to chromium(VI) in the workplace air and through skin exposure and should reduce materially the risk of lung cancer from occupational exposure to carcinogenic chromium(VI). The standard is measurable by techniques that are valid, reproducible, and available. Sufficient technology exists to permit compliance with the recommended standard. The standard will be subject to review and revision as necessary.

For the purpose of this standard, "chromium(VI)" is defined as the chromium in all materials in the +6 (hexavalent) state.

There are 2 recommended standards for chromium (VI). One addresses occupational exposure to a group of noncarcinogenic, but otherwise hazardous materials, while the other pertains to occupations and workplaces where there is exposure to other chromium(VI) materials associated with an increased incidence of lung cancer.

On the basis of the chemical analysis of airborne chromium(VI) materials, there is no practical means of distinguishing between these 2 groups of chromium (VI) materials. Until the airborne chromium(VI) in a particular workplace is demonstrated by the employer to be of the type considered to be noncarcinogenic, all airborne chromium(VI) shall be considered to comprise carcinogenic materials.

Based on current evidence, "noncarcinogenic chromium(VI)" is the chromium(VI) in monochromates and bichromates (dichromates) of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, and chromium(VI) oxide (chromic acid anhydride). "Carcinogenic chromium(VI)" comprises any and all chromium (VI) materials not included in the noncarcinogenic group above. "Occupational exposure to carcinogenic chromium(VI)" is defined as exposure to airborne chromium(VI) at concentrations greater than one-half of the workplace environmental limit for carcinogenic chromium(VI). "Occupational exposure to noncarcinogenic chromium(VI)" is defined as exposure to airborne chromium(VI) at concentrations greater than one-half of the workplace environmental limit for noncarcinogenic chromium(VI). Exposure to chromium(VI) at concentrations less than one-half of the workplace environmental limit will not require adherence to the following sections, except for 3(a,b,c,d), 4a, 5, 6(b,c,e,f), and 7.

Section 1 — Environmental (Workplace Air)

(a) Concentration of Carcinogenic Chromium(VI)

Carcinogenic chromium(VI) shall be controlled in the workplace so that the airborne workplace concentration of chromium(VI), sampled and analyzed according to the procedures in Appendices I and II, is not greater than 1 μg Cr(VI)/cu m of breathing zone air.

(b) Concentration of Noncarcinogenic Chromium(VI)

Noncarcinogenic chromium(VI) shall be controlled in the workplace so that the airborne workplace concentration is not greater than 25 μg Cr(VI)/cu m of breathing zone air determined as a time-weighted average (TWA) exposure for up to a 10-hour workday, 40-hour workweek, and is not greater than 50 μg Cr(VI)/cu m of breathing zone air as determined by any 15-minute sample.

Procedures for sampling and analysis of chromium (VI) in air shall be as provided in Appendices I and II, or by any method shown to be equivalent in precision, accuracy, and sensitivity to the methods specified.

Section 2 — Medical

Medical surveillance shall be made available as outlined below for all workers with occupational exposure to carcinogenic or noncarcinogenic chromium(VI), including maintenance personnel periodically exposed during routine maintenance or emergency repair operations.

(a) Preplacement and annual medical examinations shall include:

(1) A comprehensive or interim work history.

(2) A detailed medical history including information on conditions indicating the inadvisability of further exposure to chromium(VI), eg, potential skin or pulmonary sensitization, a skin or mucous membrane condition that may be exacerbated by chromium(VI), smoking habits, and history of liver or kidney disease.

(3) Examination of the skin for evidence of dermatitis or chrome ulcers, and of the membranes of the upper respiratory tract for irritation, bleeding, ulcerations, or perforations.

(4) An evaluation of the worker's ability to use negative or positive pressure respirators.

(5) Urinalysis.

(b) For workers with occupational exposure to carcinogenic chromium(VI), preplacement and annual medical examinations shall include 14" × 17" chest X-rays. Other tests, including sputum cytology and liver function studies, shall be considered by the responsible physician.

(c) For workers with occupational exposure to noncarcinogenic chromium(VI) and not to carcinogenic chromium(VI), preplacement medical examinations shall include 14" × 17" chest X-rays. Thereafter, X-ray examinations shall be offered at 5-year intervals and annually after age 40. Other tests, such as liver function studies, may be considered by the responsible physician.

(d) Medical examinations shall be made available to all workers with signs or symptoms of skin or upper respiratory tract irritation likely to have been the result of exposure to chromium(VI).

(e) If clinical evidence of adverse effects due to chromium(VI) is developed from these medical examinations, the worker shall be kept under a physician's care until the worker has completely recovered or maximal improvement has occurred.

(f) Initial annual examinations for presently employed workers shall be offered within 6 months of the promulgation of a standard incorporating these recommendations.

(g) The medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, and of the employer shall have access to all medical records. Physicians designated and authorized by any employee or former employee shall have access to that worker's medical records.

(h) Medical records shall be maintained for all employees with occupational exposure to carcinogenic or noncarcinogenic chromium(VI) and for maintenance personnel with periodic exposure. Preplacement X-rays and X-rays for the 5 years preceding termination of employment and all medical records with pertinent supporting documents shall be retained at least 30 years after the individual's employment is terminated.

Section 3 — Labeling (Posting)

(a) Except for shipping and storage containers for lithium chromate, lithium bichromate, sodium chromate, sodium bichromate, potassium chromate, potassium bichromate, rubidium chromate, rubidium bichromate, cesium chromate, cesium bichromate, ammonium chromate, ammonium bichromate, and chromium(VI) oxide (chromic acid anhydride), as dry solids or concentrated solutions, all shipping and storage containers for chromium(VI) shall bear the following label in addition to, or in combination with, labels required by other statutes, regulations, or ordinances:

(Chemical name)
(Synonyms)

DANGER! EXTREME HEALTH HAZARD
MAY CAUSE IRRITATION, RASH, OR EXTERNAL ULCERS
INHALATION MAY CAUSE CANCER

Keep container closed.
Avoid contact with skin and eyes.

Avoid breathing dust or solution spray.

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician. Flush skin with water.

Wash clothing before reuse.

(b) All shipping and storage containers for lithium chromate, lithium bichromate, sodium chromate, sodium bichromate, potassium chromate, potassium bichromate, rubidium chromate, rubidium bichromate, cesium chromate, cesium bichromate, and ammonium chromate, the hydrates of these compounds, high purity aqueous solutions of these compounds, and dry mixtures containing only these materials shall bear the same label except that "Inhalation may cause cancer" shall be deleted and "Extreme Health Hazard" shall be replaced by "Moderate Health Hazard."

(c) Because of the flammable characteristics of ammonium bichromate (dichromate), shipping and storage containers for dry forms of this compound shall bear the following label in addition to, or in combination with, labels required by other statutes, regulations, or ordinances:

AMMONIUM BICHROMATE
DANGER! HIGHLY FLAMMABLE
MODERATE HEALTH HAZARD
MAY CAUSE IRRITATION, RASH, OR EXTERNAL ULCERS.

Keep away from heat, sparks, and open flame.

Keep container closed.

Avoid contact with skin and eyes.

Avoid breathing dust or solution spray.

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician. Flush skin with water.

Wash clothing before reuse.

(d) All storage containers of chromic acid, or chromium(VI) oxide (chromic acid anhydride) shall bear the following label in addition to, or in combination with, labels required by other statutes, regulations, or ordinances.

CHROMIUM TRIOXIDE
(CHROMIC ACID)
DANGER! POWERFUL OXIDIZER
CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE
MAY CAUSE DELAYED BURNS OR EXTERNAL ULCERS

Keep container closed.

Do not get in eyes, on skin, on clothing.

Do not breathe dust or mist from solutions.

In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes.

For eyes, get medical attention immediately.

Wash clothing before reuse.

Use fresh clothing daily. Take showers after work, using plenty of soap.

(e) In areas where there is occupational exposure to carcinogenic chromium(VI), the following warning sign shall be posted in readily visible locations, particularly at the entrances to the area.

WARNING
CANCER-SUSPECT AGENT
USED IN THIS AREA
UNAUTHORIZED PERSONS KEEP OUT

The sign shall be printed both in English and in the predominant language of non-English-speaking workers, if any, unless they are otherwise trained and informed of the hazardous areas. All illiterate workers shall receive such training.

(f) In areas where airborne chromium(VI) comprises only lithium chromate, lithium bichromate, sodium chromate, sodium bichromate, potassium chromate, potassium bichromate, rubidium chromate, rubidium bichromate, cesium chromate, cesium bichromate, ammonium chromate, or chromium(VI) oxide (chromic acid anhydride), their hydrates, or mixtures containing only these chromium(VI) materials, the warning sign shall read as follows:

WARNING
CHROMATES, BICHROMATES OR CHROMIC ACID ANHYDRIDE USED IN THIS AREA
UNAUTHORIZED PERSONS KEEP OUT

The sign shall be posted in readily visible locations, particularly at the entrances to the area. The sign shall be printed both in English and in the predominant language of non-English-speaking workers, if any, unless they are otherwise trained and informed of the hazardous areas. All illiterate workers shall receive such training.

(g) In areas where airborne chromium(VI) contains ammonium bichromate, or where ammonium bichromate is stored, manufactured, or used, the following shall be added to the warning sign in (e) or (f) above:

FLAMMABLE SUBSTANCE

Section 4 — Personal Protective Equipment and Protective Clothing

(a) Protective Clothing

(1) Coveralls or other full-body protective clothing shall be worn in areas where there is occupational exposure to chromium(VI). Protective clothing shall be changed at least daily at the end of the shift and more frequently if it should become grossly contaminated.

(2) Impervious gloves, aprons, and footwear shall be worn at operations where solutions of chromium(VI) may contact the skin. Protective gloves shall be worn at operations where dry compounds of chromium(VI) are handled and may contact the skin.

(3) Eye protection shall be provided by the employer and used by the employees where eye contact with chromium(VI) is likely. Selection, use, and maintenance of eye protective equipment shall be in accordance with the provisions of the American National Standard Practice for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1968. Unless eye protection is afforded by a respirator hood or face piece, protective goggles or a face shield shall be worn at operations where there is danger of contact of the eye with dry or wet compounds of chromium(VI) because of spills, splashes, or excessive dust or mists in the air.

(4) The employer shall ensure that all personal protective devices are inspected regularly and maintained in clean and satisfactory working condition.

(5) Work clothing shall not be taken home by employees. The employer shall provide for maintenance and laundering of protective clothing.

(6) The employer shall ensure that precautions necessary to protect laundry personnel are taken when soiled protective clothing is laundered.

(b) Respiratory Protection from Carcinogenic Chromium(VI)

Engineering controls shall be used wherever feasible to maintain airborne carcinogenic and noncarcinogenic chromium(VI) concentrations below those recommended in Section 1 above. Compliance with the permissible exposure limits by the use of respirators is only allowed when airborne chromium(VI) concentrations are in excess of the workplace environmental limit because required engineering controls are being installed or tested, when nonroutine maintenance or repair is being accomplished, or during emergencies. When a respirator is thus permitted, it shall be selected and used in accordance with the following requirements:

(1) For the purpose of determining the type of respirator to be used, the employer shall measure the airborne concentration of chromium(VI) in the workplace initially and thereafter whenever process, worksite, climate, or control changes occur which are likely to increase the airborne concentration of chromium(VI); this requirement does not apply when carcinogenic chromium(VI) is present.

(2) The employer shall ensure that no worker is occupationally exposed to chromium(VI) because of improper respirator selection, fit, use, or maintenance.

(3) A respiratory protection program meeting the requirements of 29 CFR 1910.134 and 30 CFR 11 which incorporates the American National Standard Practices for Respiratory Protection Z88.2-1969 shall be established and enforced by the employer.

(4) The employer shall provide respirators in accordance with Table I-1, or Table I-2 when appropriate, and shall ensure that the employee uses the respirator provided.

(5) Respirators described in Tables I-1 and I-2 shall be those approved under the provisions of 29 CFR 1910.134 and 30 CFR 11.

(6) The employer shall ensure that respirators are adequately cleaned, and that employees are instructed on the use of respirators assigned to them and on how to test for leakage.

(7) Respirators specified for use in higher concentrations of airborne chromium(VI) may be used in workplaces with lower concentrations of airborne chromium(VI).

(8) When an emergency may develop which could result in employee injury from chromium(VI), the employer shall provide an escape device as listed in Table I-1, or in Table I-2 where appropriate.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR PROTECTION AGAINST CARCINOGENIC CHROMIUM(VI)

Self-contained breathing apparatus with positive pressure in full facepiece
Combination supplied air respirator, pressure-demand type, with auxiliary self-contained air supply.

Section 5 — Informing Employees of Hazards from Chromium(VI)

At the beginning of employment or assignment for work in a chromium(VI) area, employees with occupational exposure to chromium(VI) shall be informed of the hazards, relevant signs and symptoms of overexposure, appropriate emergency procedures, and proper conditions and precautions for the safe use of chromium(VI).

Instruction shall include, as a minimum, all information in Appendix III which is applicable to the specific chromium(VI) product or material to which there is exposure. This information shall be posted in the work area and kept on file, readily accessible to the worker at all places of employment where chromium(VI) is involved in unit processes and operations.

A continuing educational program shall be instituted to ensure that all workers have current knowledge of job hazards, proper maintenance procedures, and clean-up methods, and that they know how to use respiratory protective equipment and protective clothing correctly.

Information as specified in Appendix III shall be recorded on US Department of Labor Form OSHA-20 "Material Safety Data Sheet" or a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

TABLE I-2

RESPIRATOR SELECTION GUIDE FOR PROTECTION AGAINST NONCARCINOGENIC CHROMIUM(VI)

Multiples of TWA Limit	Respirator Type
Less than or equal to 10X	Half-mask respirator with replaceable high efficiency filter(s). or Type C supplied-air respirator, demand type (negative pressure), with half-mask facepiece.
Less than or equal to 100X	Full facepiece respirator with replaceable high efficiency filter(s). or Type C supplied-air respirator, demand type (negative pressure), with full facepiece. or Self-contained breathing apparatus in demand mode (negative pressure), with full facepiece.
Less than or equal to 200X	Powered air-purifying (positive pressure) respirator with high efficiency filter(s).
Greater than 200X	Self-contained breathing apparatus with positive pressure in full facepiece. or Combination supplied-air respirator, pressure-demand type, with auxiliary self-contained air supply.
Emergency (no concentration limit)	Self-contained breathing apparatus with positive pressure in full facepiece. or Combination supplied-air respirator, pressure-demand type, with auxiliary self-contained air supply.
Evacuation or Escape (no concentration limit)	Self-contained breathing apparatus in demand or pressure-demand mode (negative or positive pressure). or Gas mask, Type N, with high efficiency filter, and mouthpiece respirator with high efficiency filter(s).

Note: A high efficiency filter is defined as a filter having an efficiency of at least 99.97% against 0.3 μm DOP (Dioctyl Phthalate)

Section 6 — Work Practices

(a) Control of Airborne Contamination:

Emission of airborne particulates (dust, mist, spray, etc) of chromium(VI) shall be controlled at the sources of dispersion by means of effective and properly maintained methods such as fully enclosed operations and local exhaust ventilation. Other methods may be used if they are shown to effectively control airborne concentrations of chromium(VI) within the limits of the recommended standard.

(b) Control of Contact with Skin and Eye:

(1) Employees working in areas of possible contact of skin or eyes with chromium(VI), dry or wet, shall wear full-body protective clothing, including neck and head coverings, and gloves, in accord with Section 4(a).

(2) Clean protective clothing shall be put on before each work shift.

(3) If, during the shift, the clothing becomes wetted with a solution, slurry, or paste of a chromium (VI) material, or grossly contaminated with a dry form of such material, it shall be removed promptly and placed in a special container for garments for decontamination or disposal. The employee shall wash the contaminated skin area thoroughly with soap and a copious amount of water. A complete shower is preferred after anything but limited, minor contact. Then, clean, protective clothing shall be put on before resuming work. When working directly with chromium (VI) oxide, with unsealed containers of chromium(VI) oxide, or with chromium(VI) oxide in other than fully enclosed operations, protective devices and clothing shall be removed and the arms, hands, and face thoroughly washed after working with chromium(VI) oxide, and at 30-minute intervals when working with chromium(VI) oxide for extended periods of time.

(4) Minor areas of skin (principally the hands) contaminated by contact with chromium(VI) shall be washed immediately and thoroughly with an abundance of water. Water shall be easily accessible in the work areas as low-pressure, free-running hose lines or showers.

(5) If chromium(VI) comes into contact with the eyes, the eyes should be flushed with a large volume of low-pressure flowing water for at least 15 minutes. Medical attention shall be obtained without delay but not at the expense of thoroughly flushing the eyes.

(c) Procedure for emergencies, including firefighting, shall be established to meet foreseeable events. Necessary emergency equipment, including appropriate respiratory protective devices, shall be kept in readily accessible locations. Only self-contained breathing apparatus with positive pressure in the facepiece shall be used in firefighting. Appropriate respirators shall be available for use during evacuation.

(d) Special supervision and care shall be exercised to ensure that the exposures of repair and maintenance personnel to chromium(VI) shall be within the limits prescribed by this standard.

(e) Prompt cleaning of spills of chromium(VI):

(1) No dry sweeping shall be performed. Wet methods or dry vacuuming shall be used as appropriate.

(2) Wet spills and flushing of wet or dry spills shall be channeled for appropriate treatment or collection for disposal. They shall not be channeled directly into the sanitary sewer system.

(f) General requirements:

(1) Good practices of housekeeping shall be observed to prevent or minimize contamination of areas and equipment and to prevent build-up of such contamination.

(2) Good personal hygiene practices shall be encouraged.

(3) Equipment shall be kept in good repair and free of leaks.

(4) Containers of dry chromium(VI) shall be kept covered insofar as is practical.

Section 7 — Sanitation

(a) Washing Facilities

Emergency showers and eye-flushing fountains with adequate pressure of cool water shall be provided and be quickly accessible in areas where there is potential of skin or eye contact with chromium(VI). This equipment shall be frequently inspected and maintained in good working condition.

Showers and washbasins shall be provided in the employees' locker areas. Employees exposed to chromium(VI) shall wash before eating or smoking during the work shift.

(b) Food Facilities

Food storage, preparation, and eating shall be prohibited in areas where chromium(VI) is handled, processed, or stored.

Eating facilities provided for employees shall be located in nonexposure areas. Washing facilities should be accessible nearby.

(c) Employees shall not smoke in areas where chromium(VI) is handled, processed, or stored.

(d) Clothing and Locker Room Facilities

Locker room facilities shall be provided in a nonexposure area for employees required to change clothing before and after work. The facilities shall provide for the separate storage of street clothing and clean work clothing from soiled work clothing. Showers and wash basins should be located in the locker area to encourage good personal hygiene.

Covered containers should be provided for work clothing discarded at the end of the shift or after a contamination incident. The clothing will be held in these containers until removed for decontamination or disposal.

Section 8 — Monitoring and Recordkeeping Requirements

Workers are not considered to have occupational

exposure to chromium(VI) if, on the basis of a professional industrial hygiene survey, (a) the airborne concentration of carcinogenic chromium(VI) is sufficiently low that a sampling volume greater than 1.0 cu m is necessary in order to collect 0.5 μg of carcinogenic chromium(VI) and (b) the airborne concentration of noncarcinogenic chromium(VI) is not greater than half the recommended limit of 25 μg Cr(VI)/cu m. All samples of airborne chromium(VI) shall be analyzed by the chemical analytical method in Appendix II; if samples can be demonstrated to contain only noncarcinogenic chromium(VI), other methods of chemical analysis equivalent to the method in Appendix II may be used. Records of these surveys, including the basis for concluding that there is no occupational exposure to chromium(VI) shall be maintained until a new survey is conducted.

In workplaces where chromium(VI) is handled or processed, surveys shall be repeated annually and when any process change indicates a need for reevaluation. Requirements set forth below apply to areas in which there is occupational exposure to chromium (VI).

Employers shall maintain records of workplace environmental exposures to chromium(VI) based upon the following sampling, analytical, and recording schedules:

(a) In all monitoring, samples representative of the exposure in the breathing zone of employees shall be collected by personal samplers.

(b) An adequate number of samples shall be taken in order to permit construction of TWA exposures for every operation or process. Except as otherwise determined by a professional industrial hygienist, the minimum number of representative TWA determinations for an operation or process shall be based on the number of workers exposed as provided in Table I-3.

(c) The first determination of the workers' exposures to airborne chromium(VI) shall be completed within 6 months after the promulgation of a standard incorporating these recommendations.

(d) A reevaluation of the exposures of workers to airborne chromium(VI) shall be made within 30 days after installation of a new process or process changes.

(e) Samples of airborne chromium(VI) shall be collected and analyzed at least every 2 months for those work areas with occupational exposure to carcinogenic chromium(VI) and at least every 3 months if the airborne chromium(VI) is noncarcinogenic.

(f) A reevaluation of the workers' exposures to airborne chromium(VI) shall be repeated at 1-week intervals when the airborne concentration has been found to exceed the recommended workplace environmental limit. In such cases, suitable controls shall be instituted and monitoring shall continue at 1-week intervals until 3 consecutive surveys indicate the adequacy of controls.

(g) Records of all sampling and analysis of airborne chromium(VI) and of medical examinations shall be maintained for at least 30 years after the individual's employment is terminated. Records shall indicate the details of (1) type of personal protective devices, if any, in use at the time of sampling, and (2) methods of sampling and analysis used. Each employee shall be able to obtain information on his own exposure. In the event that the employer who has employees with occupational exposure to carcinogenic chromium(VI) ceases business without a successor, records shall be forwarded by registered mail to the Director, National Institute for Occupational Safety and Health.

TABLE I-3
SAMPLING SCHEDULE

Number of Employees Exposed	Minimum Number of Employees Whose Individual Exposures Shall Be Determined
1–20	50% of the total number of exposed employees
21–100	10 plus 25% of the excess over 20 exposed employees
over 100	30 plus 5% of the excess over 100 exposed employees

(h) A regulated area shall be established and maintained where:

(1) Carcinogenic chromium(VI) is manufactured, reacted, repackaged, stored, handled, or used; and

(2) Airborne concentrations of carcinogenic chromium(VI) are in excess of the permissible exposure limit in Section 1.

(i) Access to the regulated areas designated by Section 8h shall be limited to authorized persons. A daily roster shall be made of authorized persons who enter; these rosters shall be maintained for 30 years.

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APPENDIX 4

GUIDELINE FOR LEAD EXPOSURE

NIOSH

A Recommended Standard for Occupational Exposure to.....

Inorganic Lead

A criteria document for protection against exposure to inorganic lead has been prepared in accordance with sections 6(b)(7) and 20(a)(3) of the Occupational Safety and Health Act and was transmitted to the Occupational Safety and Health Administration, U.S. Department of Labor, for review and consideration in the standard setting process.

The standard is based upon criteria developed from the results of numerous investigations of the effects of inorganic lead on the worker. The environmental limit proposed is lower than the present standard established by the Occupational Safety and Health Administration (published in Part 1910.93 of the *Federal Register*, Volume 35, Number 157, pages 15101-15107, dated August 13, 1971) of 0.2 mg/m^3 and based upon American National Standards Institute recommendations that provided no basis for their conclusions. In addition to recommending a lower environmental level, provisions for biological monitoring and medical examinations were recommended to be made available to certain workers. Biological monitoring will allow for a more precise evaluation of exposures to inorganic lead, which come from many sources. The diversity of occupations where lead exposure occurs is referenced in the document, where over 100 different occupations are listed. Primary exposure to inorganic lead occurs in the manufacture of batteries and electronic devices, foundry operations, lead burning, automotive manufacture, galvanizing, manufacture of paint, and in the printing industry. It is estimated that approximately 783,000 industrial workers are potentially exposed to lead products.

The recommendations for an occupational exposure standard for inorganic lead take into consideration available information on health effects and limited data on the technical feasibility of achieving various levels of exposure.

The criteria document was reviewed by six knowledgeable consultants, a professional society, and government agencies with interest and responsibility in occupational safety and health. Eight responses were received from the solicitation in the *Federal Register*.

It was the feeling of the reviewers that the inorganic lead standard as proposed in this document is appropriate and that no additional information that would affect the standard is available at this time.

Substantial changes in the criteria document were made in the program for environmental and biological monitoring as a result of the reviewers comments.

The following is the first chapter of the criteria document. It contains the NIOSH recommendations for controlling worker exposure to Inorganic Lead.

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

I. RECOMMENDATIONS FOR AN INORGANIC LEAD STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to inorganic lead in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and safety of workers for an 8-hour day, 40-hour week over a working lifetime; compliance with the standard should therefore prevent adverse effects of lead on the health and safety of workers. The standard is measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. The criteria and standard will be subject to review and revision as necessary.

"Inorganic lead" means lead oxides, metallic lead, and lead salts (including organic salts such as lead soaps but excluding lead arsenate). "Exposure to inorganic lead" is defined as exposure above half the recommended workroom environmental standard. Exposures at lower environmental concentrations will not require adherence to the following sections, except for Section 7(a).

Section 1 — Environmental (workplace air)

(a) Concentration

Occupational exposure to inorganic lead shall be controlled so that workers shall not be exposed to inorganic lead at a concentration greater than 0.15 mg Pb/m^3 determined as a time-weighted average (TWA) exposure for an 8-hour workday.

(b) Sampling, Collection, and Analysis

Procedures for collection of environmental samples shall be as provided in Appendix I, or by an equivalent method. Analysis of samples shall be as provided in Appendix II, or by any method shown to be equivalent in precision and accuracy to the method specified in Appendix II.

Section 2 — Medical

Medical monitoring (biologic monitoring and medical examinations) shall be made available to workers as outlined below.

(a) Biologic monitoring

Biologic monitoring shall be made available to all workers subject to "exposure to inorganic lead." It consists of sampling and analysis of whole blood, or alternatively, of urine for lead content. Such monitoring shall be performed to ensure that no worker absorbs an unacceptable amount of lead. Unacceptable absorption of lead posing a risk of lead poisoning is demonstrated at levels of 0.080 mg Pb/100 g of whole blood or greater, or at levels of 0.20 mg Pb/liter of urine (with urine specific gravity corrected to 1.024) or greater.

Procedures for sampling and analysis of blood or urine for lead shall be as described in Appendix II, or by any method shown to be equivalent in precision and accuracy. In the case of urine, "spot" urine specimens of about 100 ml shall be collected during a workday, and urine specimens with a specific gravity less than 1.010 shall be discarded and another sample obtained.

Half of all workers subject to "exposure to inorganic lead" shall be offered biologic monitoring every 6 months, so that each worker shall have blood sampling and analysis made available to him yearly. If urine sampling and analysis are chosen instead of blood lead sampling and analysis to satisfy the biologic monitoring requirement, every worker shall have urine sampling and analysis made available to him at 6 month intervals. The schedule of biologic monitoring, above, may be altered if indicated by a professional industrial hygiene survey. If environmental sampling and analysis show that environmental levels are at or greater than the environmental limit, the interval of biologic monitoring shall be halved, i.e. blood analysis shall be conducted quarterly, with each worker sampled semi-annually, or urinalysis shall be conducted quarterly on every worker. This increased frequency shall be continued for at least 6 months after the high environmental level has been shown.

If a worker's urine lead level is found to be 0.20 mg/liter or greater, calculated to a specific gravity of 1.024, a blood sample shall be obtained and analyzed within two weeks. If a blood lead level of 0.080 mg Pb/100 g or greater is found, and confirmed by a second sample to be taken within two weeks, steps to reduce his absorption of lead shall be taken as soon as the high levels are confirmed. Steps to be considered should include improvement of environmental controls, of personal protection or personal hygiene, and use of administrative controls. A medical examination for possible lead poisoning shall be made available, and the OSHA area industrial hygienist shall be informed of the results of the biologic sampling of those workers with confirmed, high biologic levels of lead.

Biologic monitoring shall also be made available where the OSHA area industrial hygienist has reason to believe operations produce unusual exposure excursions or that environmental samples do not adequately describe worker exposure.

(b) Medical examination

Medical examinations shall be available when a variance has been granted permitting administrative controls or use of respiratory protection, for workers with unacceptable absorption of lead as judged by biologic monitoring, or when environmental levels are at or above the environmental standard.

These examinations should be made available prior to employee placement and annually thereafter. They should include a physical examination, complete blood counts, blood lead determinations, routine urinalysis (specific gravity, sugar and protein determinations, and microscopic examination), and should record any signs or symptoms of plumbism, if present. Where urine is selected instead of blood for biologic monitoring, the preplacement examination should also include a urinary lead determination. Each employee who absorbs unacceptable amounts of lead as indicated by biologic monitoring shall be examined as soon as practicable after such absorption is demonstrated and confirmed, and at least every 3 months thereafter until his blood or urine lead levels have returned to normal, i.e. below 0.080 mg/100 g of blood or 0.20 mg/liter of urine. If clinical evidence of plumbism is developed from these medical examinations, the worker shall be kept under a physician's care, in accordance with applicable Workman's Compensation provisions, until the worker has completely recovered or maximal improvement has occurred.

Medical records shall include information on all biologic determinations and on all required medical examinations. These records shall be available to the medical representatives of the employer, of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, and, at the employee's request, to the employee's physician. These records shall be kept for at least five years after the last occupational exposure to inorganic lead.

Section 3 — Labeling (Posting)

Areas where exposure to lead at levels over one-half the workroom air standard is likely to occur shall be posted with a sign reading:

LEAD (Pb)

DANGER!

High concentrations of fume or dust may be hazardous to health.
Provide adequate ventilation.

If environmental levels are at or greater than the environmental limit, or if a variance permitting use of respiratory controls has been granted, add information to the label or placard describing the location of the respirators.

Section 4 — Personal Protective Equipment and Work Clothing

Subsection (a) shall apply whenever a variance from the standard recommended in Section 1 is granted under provisions of the Occupational Safety and Health Act, or in the interim period during the application for a variance. When the limits of exposure to lead prescribed in paragraph (a) of Section 1 cannot be met by limiting the concentration of lead in the work environment, an employer must utilize, as provided in subsection (a) of this Section, a program of respiratory protection to effect the required protection of every worker exposed.

(a) Respiratory Protection

Engineering controls shall be used wherever feasible to maintain lead dust and fume concentrations below the prescribed limits.

Appropriate respirators shall be provided and used when a variance has been granted to allow respirators as a means of control of exposure to routine operations and while the application is pending. Administrative controls should also be used to reduce exposure. Respirators shall also be provided and used for nonroutine operations (occasional brief exposures above the TWA of 0.15 mg/m^3 and for emergencies); however, for these instances a variance is not required but the requirements set forth below continue to apply. Appropriate respirators as described in Table I-1 shall only be used pursuant to the following requirements:

(1) For the purpose of determining the class of respirator to be used, the employer shall measure the atmospheric concentration of inorganic lead in the workplace when the initial application for variance is made and thereafter whenever process, worksite, climate or control changes occur which are likely to affect the lead concentration. The employer shall test for respirator fit and/or make lead measurements within the respiratory inlet covering to ensure that no worker is being exposed to inorganic lead in excess of the standard either because of improper respirator selection or fit.

(2) Employees experiencing breathing difficulty while using respirators shall be referred to a physician for evaluation. This evaluation should investigate if the employee has adequate ventilatory capacity and any evidence of obstructive lung disease. Employees with inadequate ventilatory capacity or evidence of obstructive lung disease shall not wear types A, B, and E respirators.

(3) A respiratory protective program meeting the general requirements outlined in section 3.5 of American National Standard for Respiratory Protection Z88.2-1969 shall be established and enforced by the employer.

(4) The employer shall provide respirators in accordance with the Table below and shall assure that the employee uses the respirator provided.

(5) If both fume and dust are present, the recommended usage is that for fume.

(6) Respiratory protective devices described in the following Table I-1 shall be either those approved under the following listed regulation or those approved under 30 CFR 11, published March 25, 1972. The termination date of currently approved respirators described in 30 CFR 11 shall apply.

(i) Reusable or replaceable filter-type air-purifying respirator — 30 CFR 14 (Bureau of Mines Schedule 21B)

(ii) Powered air-purifying positive-pressure respirator — 30 CFR 14 (Bureau of Mines Schedule 21 B)

(iii) Type C positive-pressure supplied air respirator — 30 CFR 12 (Bureau of Mines Schedule 19 B)

(7) Usage of a respirator specified for use in higher concentrations of lead is permitted in atmospheres of lower concentrations.

(8) Employees shall be given instruction on the use of respirators assigned to them, cleaning of the respirators, and how to test for leakage.

(b) Work Clothing

(1) Each employee subject to exposure above the environmental standard of Section 1 should wear coveralls or similar full body work clothing and hat, which should be worn during the working hours in areas where there is exposure to lead. Workers subject to "exposure to inorganic lead" at or below the recommended standard should change into work clothing before starting work, and should remove work clothing before leaving work. This work clothing need not afford full body coverage.

(2) Work clothing should be vacuumed before removal. Clothes shall not be cleaned by blowing or shaking.

(3) Work clothing should be changed at least twice a week and more frequent changes, especially in high exposure areas, are suggested.

(4) Adequate shower facilities should be available and used.

(5) When in the judgment of the OSHA area industrial hygienist contamination of clothing or exposed body surfaces can produce significant secondary exposures, items (1), (2), (3), and (4) above shall be mandatory.

Section 5 — Apprisal of Employees of Hazards from Lead

(a) Each employee exposed to lead shall be apprised at the beginning of his employment or assignment to a lead area of all hazards, relevant symptoms, appropriate emergency procedures,

TABLE I-1

Requirements for Respirator Usage
at Concentrations Above the Standard

Exposure	8 Hr TWA mg/m³		*Respirator type
Inorganic lead dust	less than	1.5	A,B
	less than	15.0	C
	greater than	15.0	D
Inorganic lead fume	less than	1.5	E
	less than	15.0	F
	greater than	15.0	D

*A - Reusable or replaceable filter-type air-purifying dust respirator
B - Single-use dust respirator
C - Powered air-purifying positive-pressure dust respirator
D - Type C positive-pressure supplied air respirator
E - Replaceable filter-type air-purifying fume respirator
F - Powered air-purifying positive-pressure fume respirator

and proper conditions and precautions for safe use or exposure and shall be instructed as to availability of such information which shall be kept on file including that prescribed in (b) below and shall be accessible to the worker at each place of employment where lead is involved in unit processes and operations.

(b) Information as specified in Appendix III shall be recorded on U. S. Department of Labor Form OSHA-20, "Material Safety Data Sheet", (see page IX-4 and IX-5), or on a similar form approved by the Occupational Safety and Health Administration, U. S. Department of Labor.

Section 6 — Work Practices

(a) Emergency Procedures

(1) Procedures including fire fighting procedures shall be established and implemented to meet foreseeable emergency events.

(2) Respirators shall be available for wearing during evacuation procedures if long distances need to be traversed; supplied air respirators shall be available for employee use where equipment or operations cannot be abandoned.

(b) Exhaust Systems

Where a local exhaust ventilation and collection system is used, it shall be designed and maintained to prevent the accumulation of lead dust and fume.

(1) Hazardous types of exposure should not be scattered throughout a plant but, rather, concentrated in a single area where special control procedures can be utilized.

(2) Air from the exhaust ventilation systems shall not be recirculated into the workroom, and should not be discharged outside the plant so as to create an air pollution problem.

(c) General Housekeeping

(1) Vacuuming shall be used wherever practicable and no dry sweeping or blowing shall be performed.

(2) Emphasis shall be placed upon cleanup of spills, periodic repair of equipment and leaks, proper storage of materials, and collection of lead-containing dust.

Section 7 — Sanitation Practices

(a) Food Facilities

Food preparation, dispensing (including vending machines), and eating shall be prohibited in lead work areas.

(b) Locker Facilities

Work and street clothing should not be stored in the same locker.

Section 8 — Monitoring, Recordkeeping, and Reporting Requirements

Workroom areas where it has been determined, on the basis of an industrial hygiene survey or the judgment of a compliance officer, that environmental levels do not exceed half the environmental standard shall not be considered to have inorganic lead exposure. Records of these surveys, including the basis for concluding that air levels are below half the environmental standard, shall be kept.

Requirements set forth below apply to inorganic lead exposures.

(a) Employers shall monitor environmental levels of lead at least every 6 months, except as otherwise indicated by a professional industrial hygiene survey. If environmental levels are at or above the standard, environmental levels shall be monitored every 3 months. This increased frequency of monitoring shall be continued at least 6 months (i.e. two more quarterly monitoring periods) after the last sampling that demonstrated levels at or above the environmental limit.

Periodic environmental sampling shall be performed to coincide with periodic biologic sampling, i.e. shall be performed within 2 weeks of biologic sampling.

Breathing zone samples shall be collected to permit construction of a time-weighted average exposure for every operation. The following number of samples shall be collected and analyzed, as a minimum, based on the number of workers exposed in any given work area:

Number of Employees Exposed	Number of Samples
1-20	50% of the number of workers
20-100	10 samples plus 25% of the excess over 20 workers
over 100	25 samples plus 5% of the excess over 100 workers

(b) When any time-weighted average exposure is at or above the environmental standard, the OSHA area industrial hygienist shall be notified.

(c) Records shall be maintained for all sampling schedules to include the sampling methods, analytical methods, type of respiratory protection in use (if applicable), and the concentrations of lead in each work area. Records shall be maintained so that they can be classified by employee. Each employee shall be able to obtain information on his own environmental exposure.

(d) Medical records shall include information on all biologic determinations and of all required medical examinations. These records shall be kept for at least five years following the last occupational exposure to inorganic lead.

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XX: TOJ, RLG

INTERNAL CORRESPONDENCE
GA 1076

FROM R. T. Cheng

IN REPLY REFER TO RTC:78-15

TO J. O. Jackson, Ph.D.

DATE February 14, 1978

SUBJECT Laboratory Reagents for China Gulf Plastics Corp., Ed Lu

AK80-09

Attached is a list of laboratory reagents that Mr. Ed Lu of China Gulf Plastics Corporation needed for his laboratory (GC Analysis). Please arrange to have these chemical reagents shipped to CGPC's Taipei Headquarters.

For easy clearing of the Chinese customs, the invoice for the items should be written as less than $150 per shipment. We may want to ship the materials in two shipments at different times. The actual costs of these chemical reagents can be billed to CGPC in a separate invoice.

Bob

R. T. Cheng

RTC/aln
attachment

cc: H. T. Miller, Ph.D.
R. L. Gibson, M.D.

RECEIVED

Required Reagents for the Analysis of Gas Chromatograph

Chemical Name	Specification	Quantity Required
1. n-Butane	chromatoquality grade	1 bottle
2. Butene-2	"	1 bottle
3. Ethyl chloride	"	1 bottle
4. Chloroprene	"	1 bottle
5. Chloroform	"	1 bottle
6. Ethylene dichloride	"	1 bottle
7. Hydrogen chloride	"	1 bottle
8. 1.3 Butadiene	"	1 bottle
9. Ethyne	"	1 bottle
10. Ethylene	"	1 bottle
11. Vinyl chloride, lecture bottle,	99.9% minimum purity	5 bottles
12. Acetone	chromatoquality grade	1 bottle
13. Benzene	"	1 bottle
14. Cyclohexanone	"	1 bottle
15. Dimethyl formamide	"	1 bottle
16. Methyl ethyl ketone	"	1 bottle
17. Toluene	"	1 bottle
18. Trichloroethylene	"	1 bottle
19. Carbon disulfide	spectroquality grade	10 bottles
20. Tetrahydrofuran	chromatoquality grade	1 bottle