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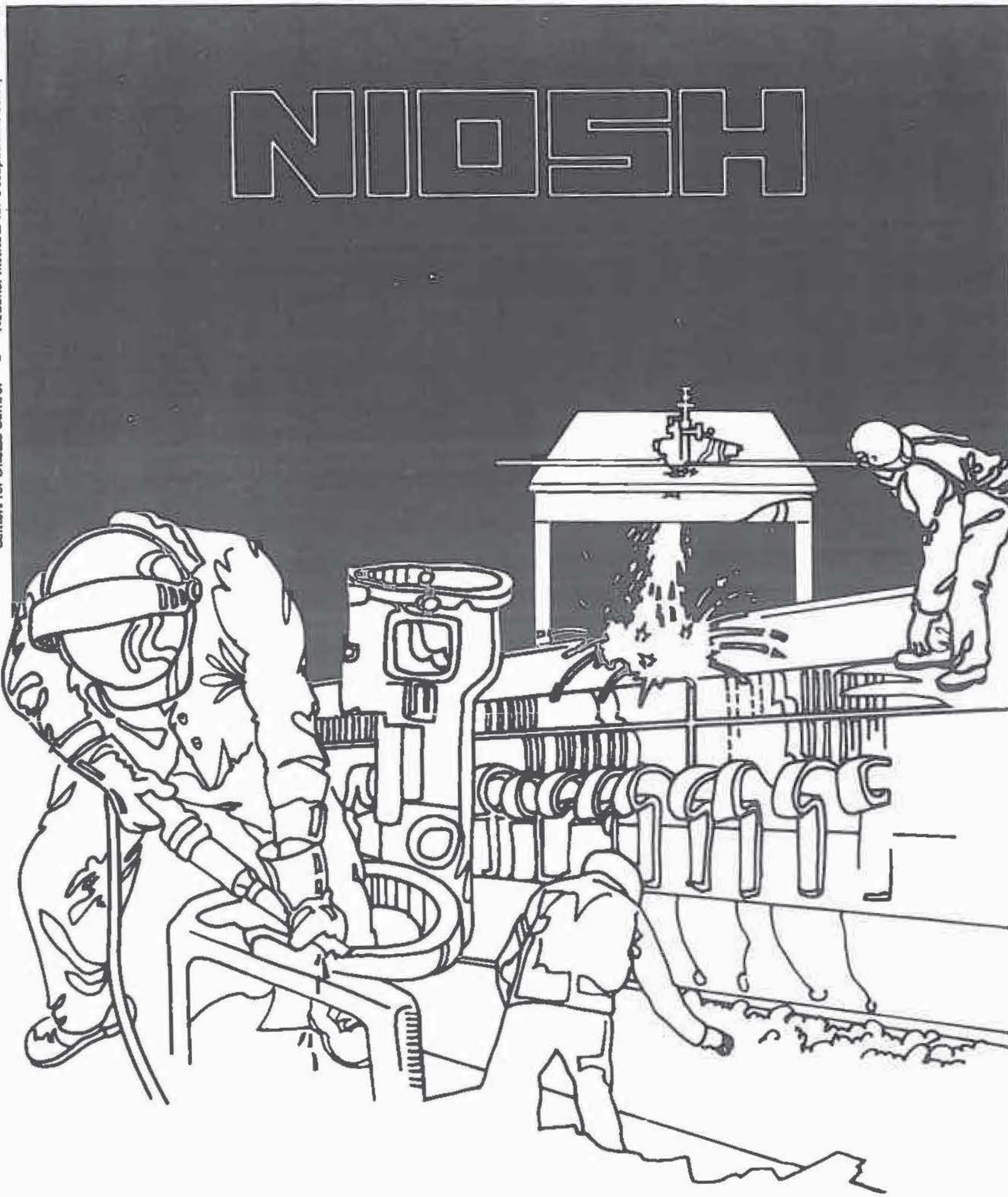

Health Hazard Evaluation Report

HHE 79-84-1072
GOULD INCORPORATED
CALDWELL, OHIO

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I. SUMMARY

In April 1979, the National Institute for Occupational Safety and Health (NIOSH), received a request for a health hazard evaluation from an authorized representative of employees at Gould Incorporated, Caldwell, Ohio, regarding possible health hazards associated with contaminants present in the work environment. Additionally, there was concern that the illnesses of four employees, diagnosed as multiple sclerosis (MS) may have been the result of occupational exposure.

Four-hundred workers manufacture bushings and bearings used primarily in the automobile industry. The major feedstock for the four production lines is a two-layered metal strip formed in the "clevite" area where a molten mixture composed primarily of lead and copper is layered onto a mild steel strip as it passes beneath a furnace spout.

Environmental samples were collected to estimate airborne exposure to lead, copper, organic vapors, polynuclear-aromatic hydrocarbons (PAH's) and oil mist. Bulk samples of Stoddard solvent and 4 synthethic oils were analyzed. The local exhaust system servicing the ajax furnaces in the clevite area was qualitatively evaluated using a smoke tube technique.

Airborne lead concentrations measured in 25 breathing zone (BZ) samples ranged from 3 to 217 micrograms per cubic meter (ug/M^3) with a mean of 22.4 ug/M^3. Three samples exceeded the 50 ug/M^3 OSHA lead standard. These samples were obtained from clevite operators who were wearing half-mask respirators for part of the day. Three area air samples for lead ranged from 64 ug/M^3 (clevite) to 1217 ug/M^3 (above Ajax furnace in clevite area) mg/M^3. No other excessive exposures were found in 28 air samples analyzed for copper, 21 for organic vapor or 22 for oil mist. There were no PAH's detected in five area air samples. One synthetic oil was found to contain 670 ppm nitroso-diethanol amine and 80 ppb nitrosomorphiline. The exhaust system servicing the furnace in the clevite area was found to be marginally effective.

The medical evaluation included consultation with the plant medical staff concerning medical surveillance programs, review of medical records of the 4 employees diagnosed as having MS, neurological review of the four MS cases and a blood lead screening program for 191 production workers.

Ten of the 12 (83%) clevite area workers had blood lead levels greater than 40 ug/dl (mean 57.7 ug/dl) compared to 11 of 179 other workers (mean 24.4 ug/dl). Review of the records of the four employees with multiple sclerosis did not indicate any association with exposures at the plant.

There is no evidence that exposures at Gould, Caldwell, Ohio, have resulted in the development of multiple sclerosis in any of the plant employees. Results of both NIOSH and company blood-lead screening studies indicate that employees, primarily clevite workers, are experiencing increased absorption of lead. Recommendations are provided to minimize exposure to lead in Section VII.

KEYWORDS: SIC 3325, 3568 (Bushings, Bearings), Lead, Multiple Sclerosis, Oil Mist

II. INTRODUCTION

In April 1979, the subdistrict director of the United Steelworkers of America requested a health hazard evaluation at Gould Incorporated, Caldwell, Ohio. The purpose of the study was to determine whether or not the illnesses of four Gould employees, diagnosed as multiple sclerosis, had resulted from exposure to contaminants in the work environment and if other employees' health may be at risk from exposure to these contaminants. There was concern that fumes from an adjoining plant that uses large amount of methyl-butyl-ketone (MBK) may be infiltrating the plant causing health problems for Gould employees.

Environmental/medical surveys were conducted on May 14-15, 1979, and October 13 - November 1, 1979. A follow-up environmental survey to re-sample oil mist was accomplished November 19-20, 1980. In view of the difficulty in confirming the diagnosis of MS and in relating occupational exposure to the development of this disease, assistance was requested from the Harvard Occupational Health Program to clarify these issues. Their evaluation consisted of review of hospital, physician and work records of the 4 individuals. The plant was visited on November 1, 1979, to identify relevant job exposures and 2 of the 4 (case 1 and 2) were interviewed in person.

The following reports were forwarded during the course of the study:

1. A letter was forwarded to union and management, dated June 26, 1979, concerning deficiencies noted on the initial visit (May 1979). Remarks were directed at the lead screening program, worker education, respirator program, and environmental sampling and hygiene facilities with reference to the OSHA standard on lead (1).

2. A letter, dated January 18, 1980, was forwarded reporting that the blood lead analysis for the specimens obtained on November 1, 1979, had been delayed due to an excessive backlog of this type of sample. Two enclosures provided information useful in minimizing employee exposure to lead. One was the NIOSH Technical Report "A Guide to Respiratory Protection", and the other was the current OSHA lead standard with appendices.

3. Interim Report #1 (May 1980) was forwarded to summarize actions to date, and report results of the first follow-up field study. Anticipated future actions as well as recommendations regarding the ventilation in the clevite area and the recommendation to discontinue use of the synthetic oil that was found to contain nitrosamines were also included. Blood lead results of the NIOSH testing were summarized.

4. Interim Report #2 (August 1980) was forwarded summarizing the results of the Harvard neurological evaluation of the four MS cases.

III. BACKGROUND

Gould Incorporated at Caldwell, Ohio, has been operating for approximately 26 years. A major facility expansion occurred in 1973. The primary products are bushings and bearings which are used in the automobile industry. Rolled steel is fed under a furnace spout where a molten alloy, made up of lead, tin, copper and small amounts of bronze and zinc, is layered and fused onto the surface forming a bi-metal (clevite) stock. The composition of the molten, metal mixture varies but routinely contains lead. This stock is further prepared for production by milling, ball-indenting, annealling, slitting and scarfing operations. The prepared stock is fed to the 4 major production lines; regular method, G-dies, progressive and washer and wear plates where the clevite stack is blanked, stamped and formed into bushing and bearings. All 4 production lines feed into the finishing area where the product is bored, ground and chamfered to within specified tolerances. Another operation performed on a portion of the product is burnishing and broaching. Burnishing is a method of ironing out the back of the bushing for more contact when pushed into the housing. Broaching is a method of putting spiral grooves into formed bushings. Parts are then inspected and packed. A complete tool room operates to make the various dies and other machine parts.

Feed stock is used at the rate of 140,000# per day. Half of this total ends up as product and the other half scrap which is recycled.

IV. METHODS

1. Environmental

Exposure to airborne contaminants was accomplished using both breathing zone and area sampling techniques. Breathing zone samples were obtained by attaching collection media such as filters or charcoal tubes to the collars of the worker. Battery-operated pumps, connected to the collection media by tubing, were clipped to the waist belt of the worker and allowed for a known volume of air to be sampled. Area samples were strategically placed to sample particular operations or areas. Twenty-eight lead and copper, five polynuclear aromatic hydrocarbons and twenty-four oil mist were sampled using filters in accordance with the NIOSH standard methods[2,3,4]. After review of oil mist results, it was evident that the fluorescence analytical method used was not well suited for evaluation of multi-oil exposures. Additionally, cigarette smoke caused a positive interference. Since the data was not interpretable, NIOSH lab personnel were asked to develop a method that could more accurately measure the oil mist exposure. A combination of methods which included total weight, fluorescence, infra-red and extracted weight were used on a second follow-up visit to the plant. Twenty-three duplicate samples were obtained on preweighed PVC filters. After re-weighing to get total weight, one duplicate was analyzed by the fluorescence method [4]. and the other by the IR method [5]. Extract weights were obtained on 5 of the IR samples.

Organic vapors were collected on charcoal tubes using the breathing zone and area techniques described above and analyzed by a NIOSH standard method [6].

Bulk samples of the Stoddard solvent used to mop the floor was analyzed to insure that toxic impurities such as benzene, a suspected carcinogen, were not present. Four synthetic oils were analyzed for nitrites and, if found, further analyzed for nitrosamines.

The capture efficiency of the ventilation system servicing the two furnaces in the clevite area was evaluated by generating smoke from a smoke tube at a level equal to the top of the furnaces. The path of the smoke was observed to determine how efficiently the smoke was captured and removed from the work environment by the existing local exhaust system.

2. Medical

Gould medical staff was consulted on the initial visit concerning medical problems at the plant and the medical surveillance program.

Medical records of the 4 employees diagnosed as having MS were reviewed. Further review of the MS cases was accomplished via a medical service contract with Harvard Medical School. This contract included a review of hospital, physician, and work records of the 4 employees to establish the diagnosis and to determine the temporal relationship between the onset of initial symptoms and job exposures. Two physicians from Harvard visited the plant on November 1, 1979, to observe work conditions and interview 2 of the 4 employees.

Blood samples were obtained on 191 employees and analyzed for lead content.

V. EVALUATION CRITERIA

Lead

Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion of lead dust contamination on food, cigarettes, or other objects. Once absorbed lead is excreted from the body very slowly. The absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reaction times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 ug/100ml whole blood are considered to be normal levels which may result from daily environmental exposure. However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/100 ml. Lead levels between 40-60 ug/100 ml in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60 to 100 ug/100 ml represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/100 ml are considered dangerous and often require hospitalization and medical treatment.

The new OSHA standard for lead in air is 50 ug/M^3 on an eight hour time-weighted average for daily exposure. For this particular industry the current standard is 100 with reduction by March 1, 1984, to a level of 50. The standard also dictates that in four years workers with blood lead levels greater than 50 ug/100 ml must be immediately removed from further lead exposure and in some circumstances workers with lead levels less than 50 ug/100 ml must also be removed. At present, medical removal of workers is necessary at blood lead levels of 70 ug/100 ml or greater. Removed workers have protection for wage, benefits, and seniority for up to eighteen months until their blood levels adequately decline and they can return to lead exposure areas.

Copper

There are few reports of toxic effects following chronic exposure to copper in the workplace, and most authors agree that copper is a relatively nontoxic substance. Acute poisoning with gastrointestinal symptoms and multi-system involvement may occur following ingestion of copper in the salt form [7], and symptoms similar to metal fume fever have been reported in workers inhaling copper fume and dust [8]. Contact dermatitis and eye irritation have also been reported. The OSHA standard for copper dust and copper fume is 1000 and 100 ug/M^3 respectively. The fume standard is lower due to the much smaller (respirable) particle size.

Stoddard Solvent

Stoddard solvent is typically made up of 15-20% aromatic hydrocarbons and 80-85% paraffin and naphthenic hydrocarbons. It is a mild central nervous system depressant and a mucous membrane irritant. Prolonged skin contact with this solvent may cause dryness and cracking due to defatting action. The OSHA standard is 2950 mg/M^3. NIOSH has a recommended exposure limit of 350 mg/M^3 with a 1800 mg/M^3 15 minute ceiling limit.

Toluene

Overexposure to toluene causes central nervous system depression. Repeated or prolonged skin contact may cause drying and cracking due to defatting action. Liver and kidney damage has been associated with exposure to toluene; however, there was no clinical or laboratory evidence of liver dysfunction in workers exposed for many years to concentrations as high as 300 ppm(9). The OSHA standard for toluene is 200 ppm. NIOSH has recommended a 100 ppm exposure limit.

Oil Mist

When evaluating exposure to oil mist, it is necessary to first determine whether the oil is mineral oil based or water based (synthetic). A review of exposure to mineral oil mist averaging below 15 mg/M^3 in several industries disclosed very few reported cases of illness(10). A study of oil mist exposure in machine shops at mean concentrations of 3.7 to 110 mg/M^3 showed no increase in respiratory symptoms or decrement in respiratory performance attributable to oil mist inhalation among men employed for many years(10). There was no evidence to suggest any relationship between inhalation of mineral oil mist and lung cancer. However, there are some reported cases of dermatitis with certain oils(11). One study(12) links skin cancer with cutting oils and suggests that it is probably due to the presence of a mixture of PAH's. This was deduced because it has been found that cancer is not a significant risk among large numbers of garage workers who work with solvent refined oils(12). Nonrefined mineral oils have been associated with scrotal cancer since the early 1900's. Most oils manufactured in the U.S. today have been extensively refined and therefore should not contain appreciable amounts of PAH's. Additionally, synthetic oils are now used as substitutes in many situations. There is essentially no data to indicate that exposure to airborne synthetic oil mist poses a health threat. However, the fact that many have been shown to contain nitrosamines is of concern; since these compounds have been linked with cancer in several animal species(13). Use of synthetic oils is currently being studied by several agencies including NIOSH.

The current OSHA standard for oil mist (mineral oil based) is 5 mg/M^3. Since there is a potential for exposure to PAH's if the oils are not properly refined, complete evaluation usually includes sampling for PAH's. Any detectable airborne concentration of PAH's is cause for concern since these poly-cyclic hydrocarbons are suspected carcinogens.

There is no environmental criteria for exposure to synthetic oils. Evaluation usually consists of determining if nitrosamines have been added. Since these substances are potent animal carcinogens any synthetic oil containing them should be replaced by one of the many available that are free of nitrosamines.

Multiple Sclerosis

Multiple Sclerosis is a chronic disorder of the central nervous system. It is termed a demyelinating disease because its main pathologic process consists of zones of plaques involving the myelin sheath (covering) of nerve fibers. Symptoms depend upon the areas of the nervous system affected. The symptoms of multiple sclerosis may include loss of sensation, speech disorders, temporary paralyses, or blindness. The disease is usually characterized by epidosdes of neurological impairment which remit and recur.

No clear cause has been determined for multiple sclerosis, however, many theories have been proposed including viral infections, genetics, allergic or immune factors, and metabolic factors. It is possible that demyelination may have several different causes and may be a common pathologic result of different diseases[14].

Population studies of people have revealed a relationship between geographical latitude and the risk of developing multiple sclerosis. The disease has been shown to be rare in the tropics, becoming more prevalent with increasing latitude. Studies of migrant populations have shown that individuals who migrate before the age of 15 assume the risk of their new environment, whereas those who migrate after the age of 15 retain the risk of their place of origin. These factors have been used to support the theory of a viral etiology of the disease (during childhood) and some studies have pointed to an association of M.S. with measles.[15]

Family members are at increased risk of developing M.S. This fact has been used to implicate a genetic predisposition for the disease; however, a viral or environmental factor could also produce this effect. Clusters of cases have been reported among family members and the risk increases with closer relationships. Studies of twins have failed to show a high risk in both members of the pair, and thus a simple genetic explanation is not likely. Clusters of non-familial cases have also been reported suggesting an environmental (including viral) exposure[15].

The age of onset of the disease is normally distributed with a mean between 30 and 35, thus the disease is rare in the very young and the very old. Women have a higher prevalence and incidence than men.

The incidence of M.S. has been shown to be greater in people who live in urban environments, however, one study showed an excess of risk among farmers and agricultural workers[15]. Also, a greater incidence has been found among members of more affluent socioeconomic groups.

Various events occurring immediately before the onset of illness have been termed precipitating factors associated with M.S. These include infections, emotional trauma, injury and pregnancy[14].

Lead exposure has been thought to be associated with the development of multiple sclerosis. However, the few studies evaluating this possible association have not provided any convincing evidence of this relationship.(16)

VI. RESULTS AND DISCUSSION

1. Environmental

a. Lead

Results of analysis of the 28 air samples obtained on November 15, 1979 are presented in Table 1. (These results were also reported in Interim Report #1.) Breathing zone samples ranged from 3-217 ug/M^3. Clevite operator samples ranged from 23-217 while non-clevite employees were exposed in the range of 3-24 ug/M^3. Clevite operators were wearing respirators part of the time (while they were tending the Ajax furnaces). Results indicate that, on the day of the survey, significant airborne lead contamination was confined to the clevite area. Samples from non-clevite operators were all less than half of the current OSHA standard of 50 ug/M^3.

Three area samples ranged from <4 (clinic) to 1217 (above Ajax furnace) ug/M^3. The 1217 value approximates the level of exposure for a clevite operator working up on the Ajax furnace platform without respirator protection.

b. Copper

Exposure to airborne copper was estimated by analysis of the same filter samples used in the airborne lead analysis. The highest airborne level of copper was 41 ug/M^3, directly above the Ajax furnace. The highest breathing zone sample was 25 ug/M^3 (clevite operator) and was 25% of the OSHA standard. Sixty percent (17/28) of the copper samples had no detectable concentrations of copper. The clevite area was determined to be the primary source of the metal fume.

c. Organic Vapor

Analysis of the bulk sample of Stoddard solvent showed that it was free of toxic impurities such as benzene.

Results of the air sampling conducted to estimate exposure to organic vapors are presented in Table 2.

The only organic vapors present in high enough concentrations to be detected were toluene and stoddard solvent. Both were significantly below current health criteria. Toluene values range from 0.1 - 0.7 ppm (NIOSH standard - 100 ppm) and stoddard solvent value ranged from 0.5 - 13.3 mg/M^3, (NIOSH standard - 350 mg/M^3, 15 minute ceiling).

Due to the fact that 4 employees were suffering from a neurologic disorder, an attempt was made to detect methyl-butyl-ketone (MBK) and n-hexane. Both have been associated with neurologic abnormalities. Neither solvent vapor was detected.

The barrels obtained from a neighboring plant, which had contained MBK products, will not cause a problem if cleaned properly to remove residual amounts of MBK. There were no barrels available for testing on the day of the survey; however, it is unlikely that brief exposures to the vapors emitting from these barrels during the time when they were not properly cleaned, would have resulted in anything more serious than short-term discomfort from upper respiratory irritation and possibly some nausea. This is assuming that a person did not purposely breathe the concentrated vapors in the barrels.

The possibility that MBK vapors may be contaminating the Gould plant by traveling with air currents from the direction of the neighboring plant to the southwest was evaluated and found not to be a problem on the day of the survey. Winds were from that direction. A review of an Airport Climatology Summary[4] revealed that, on an annual basis (10 years of data), winds are from the SW, SSW (direction of the plant using MBK products) 11.4% of the time at an average speed of 11 knots. Although it is possible that MBK vapors may infiltrate the Gould Plant by this method, if they are being emitted by the neighboring plant, it is unlikely, due to factors such as distance (200-300 yards), dilution, and infrequency of occurrence that such episodes would result in anything more serious than slight discomfort.

d. Oil Mist

(1) Mineral-based Oils

Oil mist results obtained on the first follow-up survey are not presented since interferences such as cigarette smoke invalidated the data. Additionally, the standard fluorescence method used for evaluation of oil mist exposure was not well suited for evaluation of a multiple oil environment. Components of "A" oil may be highly fluorescent compared to "B" oil and even though "A" is actually present in a lesser concentration, the analysis may indicate otherwise.

Results of the second follow-up survey are presented in Table 3. The column on the far right lists the airborne concentrations of oil mist using the results from the IR analysis method. This method was determined to give the best estimation of exposure for this sample set. Exposures were found to be less than 1 mg/M^3 except for two chamfer operators whose estimated exposures were 2.2 and 3.0 mg/M^3. Twelve personal breathing zone samples ranged from 0.2 - 3.0 mg/M^3

with a mean of 0.7 mg/M^3. Ten area samples ranged from 0.2-0.9 mg/M^3 with a mean of 0.4 mg/M^3. The fact that two chamfer operators had higher exposure levels than other chamfer operators is unexplained.

(2) Synthetic Oils

One synthetic oil, Bio-cool 500, was found to contain 670 ppm nitroso-diethanol-amine and 80 ppb nitrosomorphiline.. Use of this oil was discontinued shortly after the company was notified.

e. Polynuclear-Aromatic-Hydrocarbons (PAH's)

Specific PAH's such as: fluoranthene, pyrene, benzo(a)anthracene, chrysene and benzo(a)pyrene were analyzed in this investigation. There were no detectable (1.0-5.0 ug/sample) levels found in 5 area samples obtained in the chamfer (2), scarfing (1), clevite (1) or progressive (1) areas.

f. Ventilation

The capture efficiency of the hood above the furnaces in the clevite area was found to be marginal. Crossdrafts competed with the draw of the hood and the natural tendency of the hot, fume-laden air to rise up into the hood to the degree that smoke from the smoke tube could be seen out in the work area.

2. Medical

a. Multiple Sclerosis

Four cases of multiple sclerosis were identified in the facility. In view of the background incidence rate of five to ten cases per 100,000 persons per year, the occurrence of four cases over a 10-year period among the 500 employees at this plant raises concern over a common etiology. Nevertheless, detailed evaluation of these cases and their medical occupational histories did not reveal any evidence that would support the hypothesis that occupational exposure to toxic materials causes these cases of multiple sclerosis. The diagnosis of multiple sclerosis is well established in all four cases, but the onset of the disease occurred after employment at the plant in only two of these (cases 1 and 2). These two individuals were never exposed to a known neurotoxin and shared exposure only to burnish oil, a hydrocarbon-based material with no known toxicity. Industrial hygiene studies of the work environments of these two workers revealed no evidence of contamination by the known neurotoxins, n-hexane and methyl butyl ketone. Their exposure to lead was probably less than 25 ug/M^3 based on the data collected during the course of this evaluation. Neither had worked in the clevite area.

Most epidemiologic studies of multiple sclerosis have pointed to an unidentified exposure occuring in childhood as a possible etiology in multiple sclerosis. Although no common association was identified in these cases, cases 1 and 2 had extensive exposure to farm animals during their early year. In view of the small number of cases in this cluster, no meaningful statements can be made in regard to other potential risk factors.

b. Blood Lead

(1) Review of Company blood-lead data (1977, 78, 79)

The following blood lead screening results of testing of clevite workers were provided by the company.

Date	# Workers Tested	Range (ug/dl)	# >40 ug/dl and (% of those tested)
3/11/77	10	23-72	8 (80%)
9/20/77	12	20-54	4 (33%)
3/10/78	10	27-61	7 (70%)
9/15/78	19	19-67	10 (53%)
3/5/79	18	<5-60	11 (61%)

Overall, 58% (40/69) tests were greater than 40 ug/dl which indicates increased level absorption for this group of workers. Although there was mention of at least one worker being removed from the clevite area temporarily until his blood lead level decreased, it was seldom necessary using company criteria of 2 consecutive blood leads above 70 ug/dl.

(2) NIOSH blood-lead screening (November 1, 1979).

Since the present lead screening program at Gould was limited to the clevite line workers, and lead is a possible exposure throughout the plant, NIOSH invited all workers to participate in this testing.

A total of 191 employees (approximately 50%) participated. Each worker was notified of his/her blood lead level by letter. The distribution of the blood-lead results is as follows:

Blood-Lead Distribution (ug/dl)	# of Workers
<5-9	1
10-19	60
20-29	78
30-39	29
40-49	14
Over 50	9

Twenty-three (12%) were found to be elevated. Of the 14 clevite workers, 12 participated in this study. Their mean value was 57.66 ug/dl (range 34-104 ug/dl). Ten of the twelve were greater than 40 ug/dl.

Elevated blood leads were most striking for clevite workers, however, elevated tests were also obtained on 13 employees outside of the clevite area (7.3%) as follows:

Job	# Elevated	Blood Lead (ug/dl)
Progressive	2	44, 46
Bushing sample	1	41
Chamfer	2	49
Quality control	1	44
Slitter operator	1	44
Ball indent/Scarf anneal	2	49, 41
Maintenance	1	41
Material segregation/Lubrication	2	53, 51
Shipping/Receiving	1	41

Except for the material segregation/lubrication job, none of these positions were reported as requiring repeated or prolonged trips to the clevite area. Some are adjacent to the clevite area, therefore, contamination may occur if metal fumes are not completely exhausted from the work environment.

(3) Review of company blood-lead data obtained in December 1980.

Twenty-one blood-leads were run on primarily clevite operators. Results were distributed as follows:

Blood-lead Distribution (ug/dl)	# of Workers
<40	10
40-49	3
50-59	5
≥60	3

This screening was done a year after the NIOSH study. Results ranged from 15 to 63 ug/dl. Approximately 50% (11/21) were elevated (40 ug/dl).

VII. CONCLUSIONS

1. There is no evidence that exposure to environmental contaminants at Gould has resulted in the development of MS in any plant employees. Two of 4 employees who have M.S. had it before working at Gould. There were no detectable concentrations of any organic solvent vapors that have been associated with peripheral neuropathy in the work environment.

2. The primary exposure at Gould that offers the greatest potential for adverse health affects is lead exposure. Blood lead data from screening programs conducted in 1977, 1978, 1979, and 1980 indicate that clevite personnel are experiencing increased absorption of lead. One clevite operator had a blood lead of 104 ug/dl when tested by NIOSH. Factors which are believed to have contributed to these increased blood leads are:

   a. Marginal capture efficiency of the furnace exhaust system in the clevite area.

   b. Smoking and eating were allowed in the clevite area.

   c. A medical surveillance program that allowed blood leads to exceed 70 ug/dl for as long as six months.

   d. An apparent lack of enforcement of the respiratory protection program along with a lack of total support by employees resulted in a program that was less than totally effective.

VIII. RECOMMENDATIONS

1. Gould was informed that Bio-cool 500 contained nitrosamines. The use of this oil was reported to be discontinued by February 1980. Before new synthetic oils are introduced into the work area, they should be tested for the presence of nitrites and, if found, further tested for nitrosamines.

2. The respiratory protection program and medical surveillance of lead exposed workers should be upgraded in accordance with the applicable sections of the OSHA lead standard and NIOSH Technical Publication on respiratory protection. Both documents were forwarded to union and management representatives in January 1980. The following actions are recommended to decrease exposure to lead fume and dust at Gould. Their implementation would be expected to significantly reduce the blood-lead levels in workers. The goal of the lead program should be to maintain environmental exposure to less than 50 ug/M^3 and blood-lead levels to less than 40 ug/dl.

   a. Engineering Controls

      (1) The adequacy of the current ventilation systems in the clevite area and the need for additional systems should be thoroughly evaluated by a ventilation design expert. Plumes with extremely high concentrations of lead fumes need to be totally captured and evacuated from the work environment. As an interim measure, consideration should be given to increasing the capture efficiency of the existing hood by decreasing the distance from the top of the furnace to the bottom of the hood. A heat resistant curtain, for example, would accomplish this and also allow for the necessary equipment movement.

(2) Since the highest source of employee exposure occurs when the worker is required to skim the surface of the molten metal in the furnace, alternative methods of accomplishing this task should be studied.

b. Environmental Monitoring

Air sampling for lead should be accomplished in accordance with the applicable sections of the OSHA Lead Standard and Appendices. Area sampling should be accomplished in locations throughout the clevite area to confirm that airborne lead concentrations are below 50 ug/M^3 except for the furnace platforms. Respirator protection may be required for tasks other than tending the furnaces.

c. Medical Surveillance

Medical surveillance of employees potentially exposed to airborne lead concentration above 30 ug/M^3 should be tested according to applicable sections of the OSHA lead standard. NIOSH test results indicated that 13 employees not assigned to the clevite area had blood-lead levels above 40 ug/dl therefore, workers who spend an appreciable amount of time in the clevite area or make frequent trips to this area should be included in the medical surveillance program. Maintenance personnel and Material Segregation/Lubrication personnel are likely candidates in this regard.

Workers found to have blood-leads greater than 50 ug/dl should be retested within 2 weeks and, if still above 50, assigned to another work area and retested monthly until the blood-lead level returns below 40 ug/dl.

d. Housekeeping

The clevite work area should be vacuumed periodically to minimize the buildup of lead contamination.

e. Respirator Protection

Clevite operators were wearing a NIOSH approved half mask respirator while charging, or otherwise tending, the furnaces. More recently, a NIOSH approved replaceable or reuseable mask is being used. It is important to realize that both of these protection devices are accepted as having a maximum protection factor of 10 and, therefore, are not adequate in environments where the lead fume concentration is higher than 500 ug/M^3 (10 x 50 ug/M^3). Data obtained as part of this study, over the furnace in the clevite indicates that levels above 1000 ug/M^3 are possible. The fact that the number of instances that a worker is in this atmosphere (3-5 times per shift when workers are rotated) and the short length of time (<5 min) required to do the job may mean that either of these forms of protection are adequate. However, if blood-lead levels continue to be elevated, full-face respirators (Protection Factor $\geq$50)or airline respirators may be necessary to adequately protect workers.

3. Oil mist results were all below exposure criteria but two chamfer operators BZ samples were 3 times as high as other chamfer operator samples. These values are considered as minimums since sampling filters were clogged to a degree that flow was severly restricted. Chamfer machine #6127 and #6129 should be inspected to determine why they produced higher exposure levels and corrective action, such as installation of mist shields or covers, should be taken.

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XI. DISTRIBUTION AND AVAILABLITY OF DETERMINATION REPORT

Copies of this complete Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Gould, Incorporated
2. United Steelworkers of America
   a. Subdistrict Director
   b. Local Union President at Gould Inc., Caldwell, Ohio
3. OSHA, Region V
4. NIOSH, Region V

Table 1

Airborne Lead and Copper

Gould Incorporated
Caldwell, Ohio
HE 79-84
November 15, 1979

Field Number	Job Description/Location	Sample Type[1]	Sample Time	Sample Volume (m^3)	Airborne Concentration (ug/M^3) Lead	Copper
AA27	Clevite Desk	A	0655-1447	.69	22	<1
AA28	Above Ajax Furnace	A	0656-1449	.69	1217	41
AA29	Material Segregation	BZ	0702-1420	.66	5	<1
AA30	Blanker Operator	BZ	0707-1420	.65	5	<1
AA31	G-die Operator	BZ	0710-1430	.66	5	<1
AA32	G-die Operator	BZ	0715-1427	.65	8	<1
AA33	Clevite Operator	BZ	0720-1402	.60	37	13
AA34	Clevite Operator	BZ	0721-1412	.62	61	3
AA35	Clevite Operator	BZ	0725-1407	.60	23	<1
AA36	Clevite Operator	BZ	0728-1412	.60	217	25
AA37	Clevite Operator	BZ	0730-1407	.60	58	15
AA38	Scarf Operator	BZ	0734-1419	.59	24	7
AA39	NIOSH Team Member	BZ	0735-1430	.58	12	2
AA40	First and Final Form	BZ	0740-1422	.59	7	<2
AA41	First and Final Form	BZ	0743-1422	.58	3	<2
AA42	Bushing Operator	BZ	0745-1432	.60	13	2
AA43	Bushing Operator	BZ	0747-1435	.60	13	2
AA44	Burnish Operator	BZ	0750-1422	.59	7	<2
AA45	Progressive Operator	BZ	0756-1423	.58	5	<2
AA46	Progressive (Job Setter)	BZ	0755-1436	.59	7	<2
AA47	Inspector	BZ	0800-1430	.58	5	<2
AA48	Porgressive Operator	BZ	0802-1430	.53	9	<2
AA49	Chamfer Operator	BZ	0804-1410	.45	<4	<2
AA50	Chamfer Operator	BZ	0807-1405	.53	6	<2
AA51	Bore Operator	BZ	0810-1402	.53	9	4
AA52	Bore Operator	BZ	0813-1402	.52	12	2
AA53	Tool Maker	BZ	0820-1406	.52	6	<2
AA54	Clinic	A	0824-1430	.55	<4	<2

Note:[1] BZ-Breathing zone sample, A-Area sample

Table 2

Organic Vapors

Gould Incorporated
Caldwell, Ohio
HE 79-84

November 15, 1979

Field Number	Job Description/Location	Sample Type[1]	Sampling Time	Sample Volume[1]	Toluene (ppm)	Airborne Concentration Stoddard Solvent (mg/M^3	MBK	n-hexane
CT1	Clevite Desk	A	0657-1448	22.2	0.1	0.5	ND[2]	ND
CT2	Material Segregation	BZ	0703-1420	10.9	0.5	6.4	ND	ND
CT3	Blanker Operator	BZ	0707-1419	18.5	0.2	2.1	ND	ND
CT4	G-die Operator	BZ	0712-1432	20.5	0.2	1.7	ND	ND
CT5	G-die Operator	BZ	0715-1427	21.9	0.2	1.6	ND	ND
CT6	Clevite Operator	BZ	0722-1412	19.0	<.1	<.5	ND	ND
CT7	Clevite Operator	BZ	0725-1407	21.6	<.1	<.5	ND	ND
CT8	First and Final Form	BZ	0741-1422	14.6	<.2	<.7	ND	ND
CT9	First and Final Form	BZ	0743-1422	18.3	0.2	2.7	ND	ND
CT11	Burnish Operator	BZ	0751-1423	17.1	<.2	2.1	ND	ND
CT12	Progressive Operator	BZ	0757-1425	12.7	0.6	4.1	ND	ND
CT13	Inspector	BZ	0800-1430	20.4	0.2	3.4	ND	ND
CT14	Progressive Operator	BZ	0802-1430	12.5	0.5	6.0	ND	ND
CT15	Chamfer Operator	BZ	0805-1410	17.0	0.4	5.0	ND	ND
CT16	Chamfer Operator	BZ	0807-1405	18.4	0.3	4.5	ND	ND
CT17	Bore Operator	BZ	0812-1405	20.5	0.6	8.1	ND	ND
CT18	Bore Operator	BZ	0815-1402	15.9	0.7	9.8	ND	ND
CT19	Tool Maker	BZ	0820-1406	16.9	<.1	<.6	ND	ND
CT20	Clinic	A	0824-1430	17.5	<.1	<.6	ND	ND
CT21	Maintenance	BZ	0830-1432	17.0	1.0	13.3	ND	ND

Note: [1] BZ-Breathing Zone, A-Area
[2] ND-Not Detectable

Table 3

Oil Mist Results

Gould, Incorporated
Caldwell, Ohio

November 20, 1980

Field Number	Job/Location	Sample Time (min)	Sample Vol. (M^3)	Sample Type(1)	Total Wt. (mg)	Extract Wt. (mg))	IR Results (mg)	Fluorescence Results (mg)	Oil Mist (2) (mg/M^3)
F/IR-1 & 26	Chamfer Op(HF)	430	0.65	BZ	0.64	0.47	0.96	0.37	2.2*
F/IR-2 & 24	Chamfer Op(HF)	298	0.45	BZ	1.56	1.00	1.36	0.32	3.0*
F/IR-3	Chamfer Op(HF)	435	0.65	BZ	0.41	-	0.30	0.48	0.5
F/IR-4	Chamfer Op(Auto)	435	0.65	BZ	0.30	-	0.18	0.24	0.3
F/IR-5	Chamfer Op(Auto)	432	0.65	BZ	0.42	-	0.22	0.35	0.3
F/IR-6	Grinder Op	427	0.64	BZ	0.49	-	0.23	0.60	0.4
F/IR-7	Chamfer Op	454	0.68	BZ	0.35	-	0.20	0.21	0.3
F/IR-8	Grinder Op	420	0.63	BZ	0.64	-	0.18	0.26	0.3
F/IR-9	Auto Bore Op	420	0.63	BZ	0.30	-	0.18	0.31	0.3
F/IR-10	Auto Bore Op	430	0.65	BZ	0.45	-	0.23	0.45	0.4
F/IR-11	HF Bore Op	230	0.35	BZ	0.15	-	0.08	0.13	0.2
F/IR-12	Bore, Exit Chute	415	0.62	A	0.77	.51	0.54	0.28	0.9
F/IR-13	Bore Area, Insp. Desk	410	0.62	A	0.28	-	0.18	0.27	0.3
F/IR-14	HF Bore Op	270	0.41	BZ	0.09	-	0.07	0.13	0.2
F/IR-15	Above Bore #2805	400	0.60	A	0.26	-	0.16	0.18	0.3
F/IR-16	Chamfer 163668 Above Equalizer	400	0.60	A	0.42	-	0.37	0.22	0.6
F/IR-17	Chamfer 6127 Airline	405	0.61	A	0.23	-	0.18	0.23	0.3
F/IR-18	Chamfer 6129 Airline	380	0.57	A	0.48	0.36	0.39	0.19	0.7
F/IR-19	Chamfer 4675 Power box	375	0.56	A	0.22	-	0.12	0.19	0.2
F/IR-20	Bore #4500 Airline	Belt flyoff, lost sample							
F/IR-21	Rafter	380	0.57	A	0.22	-	0.14	0.19	0.3
F/IR-22	Rafter	380	0.57	A	0.26	-	0.15	0.17	0.3
F/IR-23	Rafter	380	0.57	A	0.37	-	0.24	0.16	0.4
F/IR-27	Blank	-	-	-	-	-	.04	.02	.07
F/IR-28	Blank	-	-	-	-	-	.04	.02	.07

* Both sets of samples were clogged to the point where flow was significantly restricted. Therefore these values are minimum concentrations. Actual concentrations were probably igher by an undetermined amount.

(1) BZ = Breathing Zone, A = Area
(2) Results of IR analyses were considered to represent the best estimate of exposure to mineral-based oils for this sample set.