

MASTER

THE TOXICITY OF X MATERIAL

The use of X metal and its compounds in industry presents two possible hazards: first, the chemical toxicity of the materials, and secondly, possible harmful effects from their natural radioactivity.

1. Chemical Toxic Effects

The development of toxic effects depends upon the ease with which the substance can be introduced into the body. Fortunately, most of the compounds are water-insoluble, and others have a limited degree of solubility in dilute acids, including hydrochloric acid. However, some of the compounds possess a high degree of solubility in both water and in fatty solvents.

a. Experimental Chemical Toxicity

Experimental studies in animals have demonstrated clearly that following parenteral injection of the salts of the metal, damage of the kidneys may be produced, affecting chiefly the convoluted tubules and to less extent the glomerulus. When the kidney has been damaged in this way albuminuria occurs, and numerous hyaline and granular casts appear in the urine. Glycosuria may be present; and occasional red blood cells can be found.

While the most severe changes appear in the kidney, the liver also has been reported to be damaged by X material. This appears to be most pronounced in pregnant animals.

b. Toxicity for Humans

The use of the metal by intravenous injection for the treatment of human cancer has been reported. The material was given in rather large amounts and signs of renal irritation were encountered. Certain of the compounds have been administered by mouth in the treatment of diabetes without obvious toxic effects.

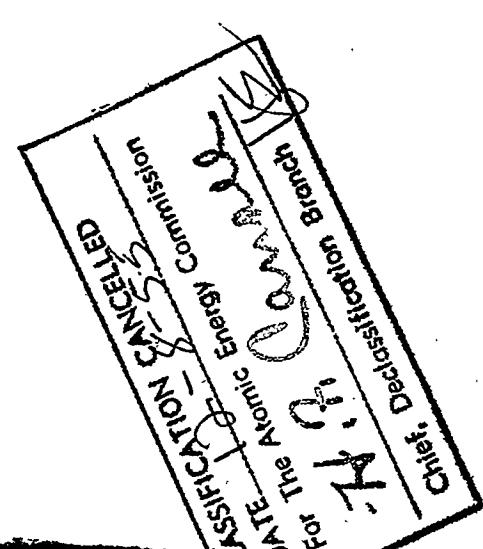
c. Routes of Absorption:

There are several routes by which the material may be introduced into the body. These include the respiratory system, the gastro-intestinal tract and the skin. It is difficult to determine which of these routes is the most important, but it is obvious that precautions should be taken that the material becomes inaccessible to the body through any of these routes.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

10/08



DISCLAIMER

**Portions of this document may be illegible
in electronic image products. Images are
produced from the best available original
document.**

The Toxicity of X Material (Continued)

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

(1) Ingestion:

There is conflicting evidence at present as to whether or not the ingestion of this material by animals will cause renal damage. It has been demonstrated that the ingestion of large amounts of soluble compounds will produce damage, but the question of the effect of smaller amounts taken over a long period of time remains unanswered. Certainly the employees should take precautions to see that their food, chewing tobacco, candy, etc. is uncontaminated by the material.

(2) Inhalation:

The possibility that the material may be absorbed directly through the lungs is seriously being considered, and a number of experiments are under way to establish the importance of this route. Meanwhile, the concentrations of the material in the air should be kept at a minimum and where dusts cannot be adequately controlled by ventilation or other procedures, the use of respirators is imperative. No definite limit for the dust content of the atmosphere has been set, but we have arbitrarily used as a standard the stated limit for lead (150 micrograms per cubic meter of air).

The possibility that insoluble material may be permanently deposited in the lung has been considered. Experiments are being carried out to determine whether or not this route may be of importance from the standpoint of long range toxicity. In some industrial operations, workmen have been exposed, for many years, to atmospheres contaminated with insoluble compounds of X material and have not been found to show damage from its presence.

(3) Skin Absorption:

The possibility of absorption through the intact skin is now being investigated. Experimental attempts to transfer the nitrate in ether solution through the skin have been unsuccessful. Similar experiments to determine the absorption through superficial abrasions are also being carried out.

25/108

The Toxicity of X Material (continued)

The question has been raised as to the possibility of absorption occurring from the deposition of the material into an open wound. The amount which may be absorbed in this manner has not been determined. It seems clear, however, that should a wound become contaminated, vigorous cleansing with soap and water should be done to decrease the possibility of material being left in the wound.

All persons who have open wounds shall be required to wear proper protection (water tight dressing, rubber gloves, etc.) to avoid contamination, or be assigned to work which does not involve exposure to the X materials. If neither is possible, the person should not work until the wound is healed.

d. Evidence of Absorption of X Material:

Toxic effects from the absorption of X material probably will be indicated first by the appearance of urinary abnormalities similar to those seen in animals after injection of the substance.

II. Natural Radioactivity of X Material:

The radioactivity of the X material is similar to that of radium, except that its intensity is much lower. One microgram of radium, is equivalent to several grams of X material. The radioactivity of X is therefore less than one millionth as great as that of radium. The particles which are emitted by the natural decay of X metal include alpha particles, beta particles and small amounts of gamma rays.

a. Alpha Particle Radiation:

The alpha particles have a very low penetrating power, and have a range of less than three centimeters in air, which would mean that they would be completely absorbed by less than 0.1 millimeter of tissue. For all practical purposes, it would appear, therefore, that the alpha particle radiation can be ignored if it arises from an external radiating source.

b. Beta Particle Radiation:

The beta particles from the material are more penetrating, and have an average range in tissue of approximately two millimeters. The intensity which may be expected

35¹⁰⁸

The Toxicity of X Material (Continued)

from the most concentrated X material, that is, X metal, is approximately 0.2 of a roentgen per hour. This would occur only when the material is directly in contact with the body, since the range of beta particles is very limited and they are absorbed completely by several meters of air. Since beta radiation would be absorbed for the most part in the first two millimeters of tissue, it has been suggested by the Medical Section of the Manhattan District that the maximum daily exposure to the hands be set at 0.5 r per 24 hours of beta radiation, although it is not unlikely that even more radiation might be given to the hands without any deleterious effect. However, it is recommended that all reasonable precautions be taken to eliminate the beta radiation.

c. Gamma Ray Radiation:

The actual amount of radiation in the form of gamma rays which may be obtained from metals stored in unlimited amounts is well below the daily tolerance dose and no hazards are expected from this source. The daily tolerance dose of gamma radiation has been set at 0.1 roentgen unit per 24 hours.

d. Disintegration Products:

In processing the material, it must be remembered that there are several daughter products of the X metal which in themselves are highly radioactive, but which make up only a minute portion of the total mass of the material. However, in some of the plant procedures, some of these highly radioactive shortlived products are concentrated, the amount of concentration depending upon the procedure involved. In this case, the radiation hazards of the X metal are multiplied, and any recycling process which would tend to concentrate the daughter products should be carefully surveyed to determine the exact amount of radioactivity.

e. Effects of the Natural Radioactivity on the Skin:

The natural radioactivity of the material conceivably might cause damage to the skin of the hands. Should this appear, the first changes would be noted in the ridges of the finger tips and in the nail beds.

f. Measures to Protect the Skin:

15¹⁰8

When the metal is handled, the workmen should be required to wear gloves having the palm and palmar surface of fingers of leather of at least two millimeters thickness. This covering will absorb approximately two thirds of the beta rays.

For the handling of dry compounds of X material, the use of canvas gloves has been recommended. The gloves should be laundered daily. Canvas gloves are preferable to leather in this instance because of the possibility of the inside of the glove becoming contaminated with the material. There might be a gradual accumulation of the material in the inside seams of leather gloves, where it could not be removed. Canvas gloves should be turned inside out for washing.

In handling wet compounds of X material and in cleaning filter presses, it is recommended that heavy rubber gloves of the type used in the handling of acids be worn. Tests made on extra heavy, rubber acid gloves, wall thickness 0.31 inches demonstrated that 72% of the beta radiation was absorbed. Those gloves should be washed inside and out daily.

In certain specific instances, recommendations other than those given above will be made.

g. Systemic Effects from Natural Radioactivity:

Systemic effects from the natural radioactivity of X material deposited in the body would be noted first by the development of mild to moderate anemia, depression of the total white blood count, and the appearance of a relative lymphocytosis.

The appearance of systemic effects is not anticipated.

h. Prevention of the Development of Systemic Effects:

Protection against the development of systemic effects as a result of the natural radioactivity of X material will be afforded by:

(1) Keeping dust concentrations at a minimum, and the use of respirators at those places where the dust count is excessive.

(2) Care on the part of the employees to prevent ingestion of the material.

55'08

The Toxicity of X Material (Continued)

(3) Keeping the skin free from the material whenever possible.

III. Recommendations Concerning Personal Hygiene:

a. Each employee who gets either X metal or its compounds in his skin shall be required to wash his hands and face thoroughly before eating.

b. Each employee whose skin becomes contaminated with X material shall be required to take a shower before leaving work each day.

c. Washing before meals and taking of showers will be supervised.

d. Washing of hands will be done with soap and water and a brush. Care will be taken to remove the material deposited under the nails.

e. It is recommended that the use of vanishing creams or of active wetting agents be prohibited in the clean-up process.

f. Street clothing will not be worn at work in any operation involving contact with X material; likewise work clothing will not be worn away from work.

g. Each employee will wear a clean suit of work clothes each week. He will change at more frequent intervals if his clothing becomes excessively soiled or if it becomes soaked with wet X materials.

h. Eating in work rooms will be forbidden.

i. If the employee uses chewing tobacco, adequate precautions will be taken to prevent the tobacco from becoming contaminated in the package, and to prevent transfer of X material from soiled hands to his mouth. The same precautions also apply to the use of chewing gum.

j. In dusty operations, respirators, certified by the Bureau of Mines as being safe for use against toxic dusts, will be worn.

k. Filters of the respirators will be changed when they become contaminated to such an extent that breathing

6 P¹⁰⁸

The Toxicity of X Material (Concluded)

causes an effort, or when traces of the material appear on the inside surface of the filter. In cold weather, changes may have to be made more often because of moisture condensing on the inside of the respirator.

75¹⁰⁸

THE TOXICITY OF NITROUS FUMES

Nitrous fumes are produced in the pickling of metals, in the combustion of explosives, and whenever nitric acid comes in contact with organic materials. Nitrous fumes represent a mixture of nitrogen dioxide, nitrogen tetroxide, nitrogen oxide and in addition, in the presence of moisture, there is a mist of nitric and nitrous acids. The proportions of the various gases and fumes as well as the individual susceptibilities of the persons exposed account for the variations in the clinical pictures seen.

In contrast to a number of other fumes, toxic concentrations of nitrous fumes can be inhaled without causing severe cough or laryngospasm.

Symptoms of Acute Exposure to Nitrous Fumes:

Inhalation of high concentrations of nitrous fumes may produce shock-type symptoms with severe asphyxiation, convulsions and respiratory arrest. Death presumably results from interference with the pulmonary circulation.

In lesser concentrations, there may or may not be marked irritation with pain and burning in the throat and chest. There is often cough with yellow sputum which may contain some blood. There may be dyspnea, cyanosis, vomiting, vertigo, and loss of consciousness. Continued exposure may cause the poisoning to end fatally.

If the exposed person is removed from the fumes, he may show no further symptoms. However, after a latent period of six to twenty-four hours, a severe cough may develop; the patient becomes cyanotic, and pulmonary edema appears, which may have a fatal termination in the next few days.

If the pulmonary edema is not immediately fatal, pneumonia may develop as a sequel to the pulmonary irritation.

Dangerous exposures may occur without the individual aware of irritation. He may be perfectly comfortable during the latent period, and appear to be perfectly well, and yet some hours later develop distressing pulmonary edema which may end fatally.

For this reason, all persons who have been exposed to nitrous fumes must be carefully observed by a physician. All employees who work where they may be exposed to nitrous fumes must be warned of the dangers and be cautioned to report to the physician as soon as they are exposed.

Important Physical and Laboratory Findings:

85"08

The Toxicity of Nitrous Fumes (Continued)

Immediately after the exposure there is a marked rise in the respiratory rate, which has been found not to be a result of CO₂ accumulation. Within thirty minutes, there is a marked increase in the blood platelets, and a marked drop in the systolic, and a moderate to slight drop in the diastolic blood pressure.

Symptoms of Chronic Exposure to Nitrous Fumes:

Chronic exposures to low concentrations of nitrous fumes may produce chronic irritation of the mucous membranes of the eyes, and upper respiratory tract. The teeth may also be affected and become dull, rough and corroded. Chronic bronchitis and emphysema have been ascribed to long-continued chronic exposure. The circulatory apparatus may be affected and hypotension and bradycardia develop.

Safe Levels in the Atmosphere:

Various investigators have given the maximum safe level of nitrous fumes in the atmosphere as 1.4 up to forty parts per million by volume for long-continued chronic exposure.

Treatment of Chronic Exposures:

The treatment of chronic exposures is one of prevention. Excessive concentrations in the atmosphere must not be present over any protracted period, and those persons who work in areas which have more than the maximum safe level must wear appropriate respirators.

Treatment of Acute Exposures

The treatment of acute exposures to nitrous fumes is directed primarily toward reducing the patient's oxygen demand and supplying additional oxygen.

Treatment outlined by Fleming

First, estimate the hour at which the exposure occurred, the duration of the exposure, and the amount of activity the person has had since.

If the person has had any of the following symptoms, he is placed at absolute rest in a warm bed, and oxygen is administered: coughing, choking, nausea, vomiting, headache, inability to take a deep breath without discomfort, or undue lassitude.

90 108

The Toxicity of Nitrous Fumes (Continued)

The rate and type of respiration is observed and recorded.

The lungs are examined for rales.

The patient is observed for cyanosis and pallor.

The blood pressure and pulse rate are recorded hourly.

The hemoglobin, red blood count, hematocrit reading, and the direct platelet count are made hourly for eight hours. If the platelet count is up 50 to 100% and continues to rise for the first five hours, the gassing has been moderate to severe.

If no pathological findings have been discovered at the end of eight hours, the patient may be discharged.

Venesection is used only if cyanosis and venous engorgement are present.

Depressant drugs including the barbiturates should be avoided. Circulatory stimulants are contraindicated.

Treatment outlined by Carlisle

Carlisle, in a personal communication, reports excellent results from a treatment which he has used in a large number of cases of nitrous fumes exposure. In this series, there have been no fatalities from pulmonary edema in the past nine years.

The treatment is designed primarily for the prevention of pulmonary edema. All persons who have been exposed to nitrous fumes are treated, even if no symptoms are present. A considerable effort has been made to impress the plant personnel with the necessity for treatment at the earliest possible moment.

In Carlisle's experience no case treated promptly and adequately has gone on to develop pulmonary edema.

The treatment consists essentially of absolute bed rest and the immediate administration of oxygen under atmospheric pressure with a provision for expiration against a calibrated resistance of from one to six centimeters of water.

At the start 100% oxygen is administered with the pressure on the expiratory tube set at one centimeter of water. This pressure is raised gradually in the next 5 to 10 minutes to 6 centimeters of water. The oxygen is continued for a period of one to three hours

100%^o

The Toxicity of Nitrous Fumes (Continued)

depending upon the condition of the patient. At intervals, the patient is allowed to breathe without the mask for a period of 5 to 15 minutes. If, during this period, any increase in the respiratory rate, difficulty in breathing, cyanosis, or coughing are observed, the use of oxygen by the method given above, is resumed.

A special mixing valve in the oxygen tank allows the admixture of air. It has been learned, however, that the use of more than 25% air in the oxygen allows the patient to start coughing again, and as a routine not more than 20% air is used. If sufficiently high concentrations of oxygen are used, the cough is usually well controlled. In some instances it has been found that allowing the patient to have swallows of milk helps control the cough and may be more effective than medication.

When considerable time has elapsed, or if pulmonary edema has developed, administration of 1/100 epinephrine solution by means of a nebulizer is beneficial in relieving the bronchial spasm. This may be given before or during the oxygen therapy. In some cases it may be advisable to administer the oxygen under a pressure of 2 to 3 centimeters of water in addition to the pressure used against expiration.

Although the particular benefit of this method of treatment is in the prevention of pulmonary edema, it seems to be more effective than any of the usual methods in treating pulmonary edema.

The method has been used successfully in treating exposures to other noxious substances. These include: phosphorus oxychloride, phosphorus pentachloride, phosphorus trichloride, methyl bromide, chlorine, cadmium, and the dust from certain alkaloids.

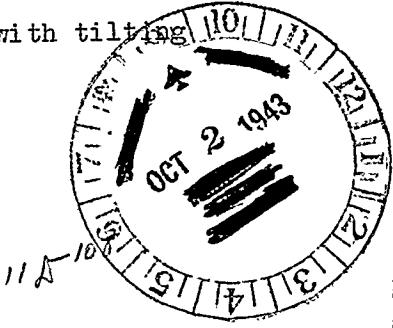
In general, it is Dr. Carlisle's opinion that the use of carbon dioxide-oxygen mixtures, morphine, venesection, or mercurial diuretics, is ill-advised. In some instances he considers oxygen-helium mixtures to be of value.

Safe Operating Procedure:

In general, operations which may result in the formation of nitrous fumes in considerable quantities should be carried on in one story buildings, and if that is impossible, the floors and ceilings should be fireproof and easily accessible exits should be provided.

Carboys of nitric acid should be provided with tilting

5039



The Toxicity of Nitrous Fumes (Continued)

devices for pouring, and should be stored in rooms which have acid-proof floors, adequate ventilation and running water.

All operations which result in the formation of any quantity of nitrous fumes must be provided with local exhaust ventilation.

If large quantities of nitric acid are spilled, they should be washed away with water. No absorbent materials of any organic nature should be used. If water is not available, clean sand may be used.

When fumes form in a room, it should be evacuated without delay, and no entry made without proper gas masks or open air helmets.

CAUTION:

TOXIC CONCENTRATIONS OF NITROUS FUMES CAN BE INHALED WITHOUT CAUSING SEVERE COUGH OR LARYNGOSASM.

DANGEROUS EXPOSURE MAY OCCUR WITHOUT THE PERSON BEING AWARE OF IRRITATION.

DURING THE LATENT PERIOD THE EXPOSED PERSON MAY APPEAR TO BE PERFECTLY WELL.

ATTACKS RESEMBLING ASTHMA OCCURRING IN PERSONS WHO MAY HAVE BEEN EXPOSED TO NITROUS FUMES, REQUIRE THE IMMEDIATE SERVICES OF THE PLANT PHYSICIAN WHETHER THEY OCCUR DURING THE DAY OR AT NIGHT.

125¹⁰⁸

THE TOXICITY OF FLUORINE

The principal hazard from the use of fluorine in industry results from the corrosive action of a number of fluorine compounds. Of much less significance is the effect of inhaling or ingesting fluorine compounds.

1. Hydrofluoric Acid Burns:

Anhydrous HF, hydrofluoric and hydrofluosilicic acids and the acid-reacting salts of the fluorides, especially the bifluorides and fluosilicates, all are capable of producing unusually severe and painful burns.

Burns which result from concentrations of less than 20% are not felt for several hours and cause a deepseated reaction. In concentrations of 20% to 60%, there is a shorter latent period before pain is experienced. Burns resulting from anhydrous HF and the stronger aqueous solutions (above 60%) cause pain at the time of or shortly after the exposure.

If there is a short exposure (one to two minutes) to a low concentration or a momentary exposure to a high concentration of acid, the skin becomes blanched and white, slightly edematous, and appears to be macerated. A longer exposure to a low concentration or for about a minute to a high concentration produces redness of the skin which turns to a grayish-purple. There is considerable edema and tension. Vesicles may appear. Burns under the nails are common. Where the skin is thick, as on the palms, the burns tend to be lighter in color than the surrounding skin. In more tender areas, the skin is reddened. The most severe burns are apt to occur in the areas where the skin is thickest for the acid penetrates freely while the agents used in treatment do not.

In addition to its immediate local effect, hydrofluoric acid has the ability to keep on penetrating and destroying tissue until it is removed or precipitated.

2. Treatment of Hydrofluoric Acid Burns of the Skin

The most important single factor in the treatment of burns of this type is to treat them promptly, regardless of the concentration of the acid which has been in contact with the skin, and regardless of whether or not pain has been present.

A number of methods of treatment are available. In all of them an effort is made first to remove the acid from the skin, and second, to neutralize the effect of the acid which has already combined with the tissue.

135¹⁰⁸

The Toxicity of Fluorine (Continued)

As a routine, copious quantities of tap water will be used to flush the skin thoroughly. Contaminated clothing should be removed. If the burn is not so extensive as to cause shock, flushing should be continued for a period of fifteen minutes.

This may be followed by the use of soaks or compresses of 5% to 10% soda bicarbonate solution, or washing with lime or ammonia water, or a solution of ammonium carbonate, alternated with tap water. Evans recommends soaking in an iced 70% solution of alcohol.

It is recommended by some that this treatment be continued until the skin regains a pink color, several hours if necessary. Others follow the washing with the application of special ointment (formulas appended) which is rubbed into the skin.

The consensus is that greasy ointments should not be applied to HF burns, and that the use of greasy ointments increases the severity of the damage.

The National Institute of Health recommends application of triple dyes instead of the special ointment recommended above.

If blisters form, they should be opened. If there is macerated tissue, it should be debrided down to healthy tissue.

Whenever coagulation of the tissue occurs, it is recommended that calcium gluconate be injected into and under the coagulated area and into the surrounding tissue. Strengths recommended vary from 3% to 20%. It is the opinion of the Medical Section that the 3% calcium gluconate will be adequate.

If burns occur under the nail, the finger should be anesthetized, the nail cut away, and calcium gluconate injected.

Dressings should be made for the first four to six days with the special ointment. After that, any bland ointment may be used.

3. Hydrofluoric Acid Burns of the Eye

When burns of the eye occur, the eye should be washed immediately with copious quantities of tap water, and medical treatment sought at once. A bubbler fountain has proved to be convenient for emergency use in washing burned eyes. Later the eye should be washed for fifteen minutes with a 3% solution of boric acid. If anesthesia is required, cocaine is to be avoided. Boric acid ointment may be instilled, and a very loose bandage applied. Subsequent treatment should be directed by an ophthalmologist.

145¹⁰⁸

The Toxicity of Flourine (Continued)

4. Hydrofluoric Acid Fumes:

Hydrofluoric acid fumes in the atmosphere are sufficiently irritating that under ordinary circumstances the workmen will not be able to tolerate a concentration which is more than locally irritating. In case an excessive exposure should occur, there is danger of lung damage. There is no specific treatment available. Supportive measures including treatment of shock and resuscitation should be instituted.

5. Protracted Exposure to Fluorides in the Atmosphere:

It has been noted that workers in the cryolite industry and rarely those of other industries, who have had a considerable intake of fluorine compounds over a period of years have developed bone changes which are a type of osteosclerosis. These occur as a result of the fluorine being deposited in the bones. The daily intake of fluorine of these persons has been estimated as about 25mg. The earliest recognizable changes appeared in from five to ten years.

6. Ingestion of Fluorides:

When fluorides are taken by mouth, there is severe local irritation and a paralyzing effect on the central nervous system. If death does not result, a toxic nephritis develops.

As an antidote, the use of lime water or 2% solutions of calcium chloride have been recommended. Gastric lavage with calcium solutions is used. It has been advised calcium chloride 1% or calcium gluconate be given intravenously, but this measure is of doubtful value.

7. Special Ointments:

a. LARSHAW CHEMICAL COMPANY:

Magnesium Sulfate	20%
Magnesium Oxide	6%
Glycerine	18%
Procaine Hydrochloride	1.2%
Water base	

b. ESTM/N KOD/K

150/108

The Toxicity of Fluorine (Continued)

Magnesium Sulfate	100.0
Magnesium Oxide	20.0
Gum Arabic	2.0
Glycerine	60.0
Water	145.0
Procaine Hydrochloride	4.0

Preparation of Ointment:

Add the gum arabic, moistened with alcohol, to 20cc. of water. Add this to the glycerine in 110cc. of water. The finely ground magnesium sulfate and magnesium oxide is added slowly with stirring to the above liquid. Heat to 90 degrees C. in a double boiler, with occasional stirring, until it thickens (about 1½ hours). Cool to room temperature and add the procaine in 15cc. of distilled water. Stir until thin enough to pour into opaque jars, reworking to proper consistency after three to four days if necessary.

This ointment may be purchased from the Karel First Aid Supply Company, 4342 West Ogden Avenue, Chicago, Illinois.

CAUTION:

Treatment of Hydrofluoric acid burns should be instituted at the earliest possible moment.

Employees will be warned to report for treatment as soon as they are aware of exposure to hydrofluoric acid.

16 μ 10 8

THE TOXICITY OF VANADIUM

The industrial use of vanadium and its compounds is hazardous only when they are handled in a dry, powdery state.

I. Experimental Toxicity

Experimentally, when considerable quantities of these substances are given to animals by mouth or by injection, there is marked irritation of the gastro-intestinal tract and congestion, hemorrhages, perivascular leukocytic infiltration, and cell necrosis of almost all of the organs. There is marked central nervous system depression.

II. Industrial Toxicity

Industrially, in the absence of adequate protection against dust, there is considerable irritation of the conjunctiva and the upper respiratory tract. There is conjunctivitis with purulent secretion; and rhinitis with a watery coryza. There is cough with sputum which may be bloody from the pharyngeal irritation. There is a sensation of dryness of the larynx and of constriction of the chest. Rales and rhonchi may be heard in the examination of the lungs.

III. Effect of Chronic Exposure

Careful examinations of persons who have worked several years in such atmospheres showed no change in the hemoglobin or the red or white blood counts. There was no evidence of toxic effects on the circulation. X-rays failed to show tuberculous involvement, but did show signs of chronic bronchitis.

No evidence of chronic ill health was found from work over a period of years from various vanadates or vanadium pentoxide.

IV. Precautions for Industry

Effective control of the irritation from this dust involves elimination of manual transfer, adequate exhaust ventilation, and the wearing of respirators.

175'8

THE TOXICITY OF MAGNESIUM

I. The use of magnesium in industrial processes presents two principal hazards:

a. Magnesium Burns

Because of the inflammable nature of the metal and the violence with which it catches fire, burns occur frequently. Particles of metal may be deposited in the burn and cause a peculiar and severe inflammatory reaction.

b. When pieces of the metal become embedded under the skin an unusual sort of gas gangrene results. This occurs from the decomposition of metallic magnesium into magnesium hydroxide and hydrogen on contact with water or body fluids. The hydrogen under the skin causes the area to be crepitant and to show vacuoles on section. The alkaline magnesium hydroxide causes necrosis. A slow-healing painful ulcer results.

II. Treatment of Magnesium Burns

The following treatment for magnesium burns has been recommended: the burned area and the surrounding skin is thoroughly cleaned. The burned area is anesthetized with a local anesthetic. Then the burn is scraped down until normal tissue is reached. If the involved area is large, an ointment of 5% sulfanilamide is applied. This method is said to result in a normal healing time in these burns.

III. Treatment of Embedded Magnesium

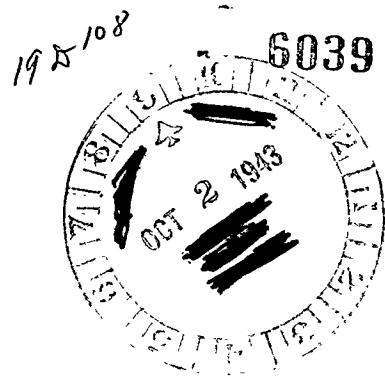
When wounds are received in which magnesium may be deposited in the tissues, it is necessary to lay open the wound to remove all the particles of the metal. In general, larger particles cause less severe reaction than smaller, finely divided pieces.

18B¹⁰⁸

TREATMENT OF LIME BURNS OF THE EYE

The following treatment has been found useful in the treatment of burns of the eye from lime:

The eye is washed with a 10 to 15% of glucose which serves to remove any particles not embedded in the eye. This is followed by irrigations with boric acid solution. A local anesthetic is instilled and any embedded material is removed. Sterile bland oil is then instilled (either castor or mineral oil) and the eye covered with a patch.



GENERAL QUESTIONS OF POLICY

1. What should the employees be told in regard to the substances with which they are working?

In general, they will be told that the substances with which they are working are new compounds which may be somewhat dangerous to handle. For this reason, they will be observed carefully in order that their job may be changed if any signs appear which indicate that they are not tolerating the work. This is to prevent any serious consequences and to insure early treatment.

2. Should persons who have albumin in the urine be employed in any work which involves direct contact with the metal or its compounds?

It is the opinion of the Medical Section that no person who has albumin in the urine, whether or not it indicates disease, should be employed in a place where he will have direct contact with special materials. If he has a benign orthostatic albuminuria, he may be employed elsewhere in the plant and may have casual contact with the compounds, but he should not work in close contact with these materials. For should he develop renal irritation, it would be difficult to tell that it was developing; and should he later develop organic kidney disease, one could not say that the work did not play a part.

3. Should any person who has sugar in the urine be employed in work which places him in direct contact with the metal or its compounds?

It is the opinion of the Medical Section that no person who has sugar in the urine should be employed in direct contact with the special materials, even if the sugar is on the basis of a renal glycosuria. If such individuals are employed, the sugar present in the urine might obscure the presence of reducing substance occurring as a result of exposure to compounds of the metal.

4. Should any person who has syphilis in a stage requiring treatment be employed in a place at which he will have direct contact with the metal or its compounds?

For the present it seems undesirable for persons infected with syphilis to work with the special materials.

20A/108

There is the possibility that the agents commonly used in the treatment of syphilis which are toxic for the liver and kidneys might have their effects accentuated by absorption of compounds of X metal. For this reason, it has been recommended that persons who have syphilis in a stage requiring treatment, or who have received treatment in the preceding year not be employed in direct contact with special materials.

5. How thorough should the physical examinations and laboratory work be?

Our opinion is that at the start at least, the workup should be quite complete. If, later on, we are able to say without equivocation that the rules are too strict, then they will be relaxed.

6. The desirability of having a simple test of excretion of the metal in the urine has been discussed.

The need for such a test has been agreed upon, and experimental work is now being done to try to devise such a test which could be carried out by the regular plant technician.

7. What is the scope of activity of the Medical Section? What is its relation to the Safety Section?

In general the Medical Section will be concerned with the supervision of those health hazards which may result from the toxicity of the materials being used. The Safety Section will be concerned with the prevention of accidents which may result from the construction and operation of the plant.

8. What is the safe level of the metal in the air?

A figure of 150 micrograms per cu. meter has been set tentatively as the safe level of the metal in the air. Where the concentration exceeds this, respirators should be worn. The figure given as safe is thought to be quite conservative.

9. What exposure results from handling the metal?

The only radiation with which we need be concerned from the metal itself is the Beta radiation. The metal gives off about 0.2 r of Beta radiation per hour. The safe limit is 0.5 r of beta radiation to the hands per

2/18/68

24 hours. Consequently, the [REDACTED] should not be held in direct contact with the skin for more than 2 to $2\frac{1}{2}$ hours per day. In very few jobs would this be necessary. Further, the use of gloves made of leather of at least 2 mm. thickness will keep out about $2/3$ of the beta rays. With their use it is safe for an employee to have metal in his gloved hand constantly about 6 hours per day. Standing or working near even a large quantity of the metal is without danger. The Medical Section has recommended the use of gloves of this type by all employees who handle the metal.

10. As a further check, finger print studies will be made on all persons who handle the metal. It is known that changes from radiation are seen earliest in the ridges of the finger tip.

11. Question of using gloves in handling other radioactive compounds.

Those employees who handle the dry compounds of the metal will be provided with canvas gloves which will be laundered daily.

Those employees who handle wet salts or solutions of the metal will wear rubber gloves of heavy and protecting type, and the gloves will be washed inside and out daily.

225¹⁰⁸