AN

INDUSTRIAL HYGIENE SURVEY

OF THE PLANTS

OF THE ACME WHITE LEAD AND COLOR WORKS

HAMTRAMCK (DETROIT) MICHIGAN

PARTICIPANTS:

Representing
The Sherwin Williams Company

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Representing
Acme White Lead and Color Works

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Period of Study--July 12, 1937 to August 12, 1937

REPORT PREPARED BY THE INDUSTRIAL HEALTH CONSERVANCY LABORATORIES

10 Peterboro, Detroit, Michigan

Aerial View of Plant Showing General Layout and Type of Construction.
Storage Tanks in Rear.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

THIS IS A CONFIDENTIAL REPORT

INTRODUCTION

The advent of an Occupational Disease Law in the State of Michigan has provided impetus to many manufacturers to establish with reasonable certainty the extent of exposures to occupational diseases existing in their plants. Michigan's Occupational Disease Law was signed by Governor Murphy on June 8th and prospectively will go into effect near October 1st. A discussion of the merits of this law constitutes one section of this report.

The Acme White Lead Company, located at 8250 St. Aubin, Hamtramck, has, in the past, provided many services related to the conservation of the health of its employees, and now falls into the category of those Michigan Manufacturing Establishments that desire to obtain more extensive information with reference to possible injurious exposures connected with work conditions. This long established manufacturing concern, engaged in the production of various lines of paints, lacquers, varnishes and other coating materials, employed the Industrial Health Conservancy Laboratories to carry out a comprehensive investigation of all of its work conditions with the aim in view of detecting unwanted exposures and if such were found to devise ways and means for the elimination or control of such undesirable conditions.

In the conduct of this work, the following objectives have governed the employing company and the investigating group.

1) What are the health exposures, potential or actual, associated with the manufacture of paints, varnishes, lacquers and other coatings?

2) Do any or all of these exposures exist in the plants of this Company?

3) Are these exposures potential or actual?

4) Are there actual disease states prevalent among workers traceable to work in these plants as the source?

5) What measures should be taken by this Company fully to safeguard the health of its employees?

6) Are conditions in the plants of this Company average, superior or inferior on comparison with other plants in this industry carrying out relatively similar operations?

7) What program of endeavor should be provided for the procurement and maintenance of high standards as to industrial hygiene, in the event that a need for such a program exists?

8) What is the legal responsibility of this Company in the event that objectionable conditions exist or in case actual occupational diseases may be detected?

In order to gain necessary information relative to the aforementioned objectives of the study, the investigating group have been given full access to the entire premises, records, procedures and practices of this manufacturing company. In particular, appropriate technical studies have been carried out, including dust counts, air analyses, determinations of gases and vapors, the measurement of illumination, noise, together with general appraisal of every portion of the activities of this Company's plants.

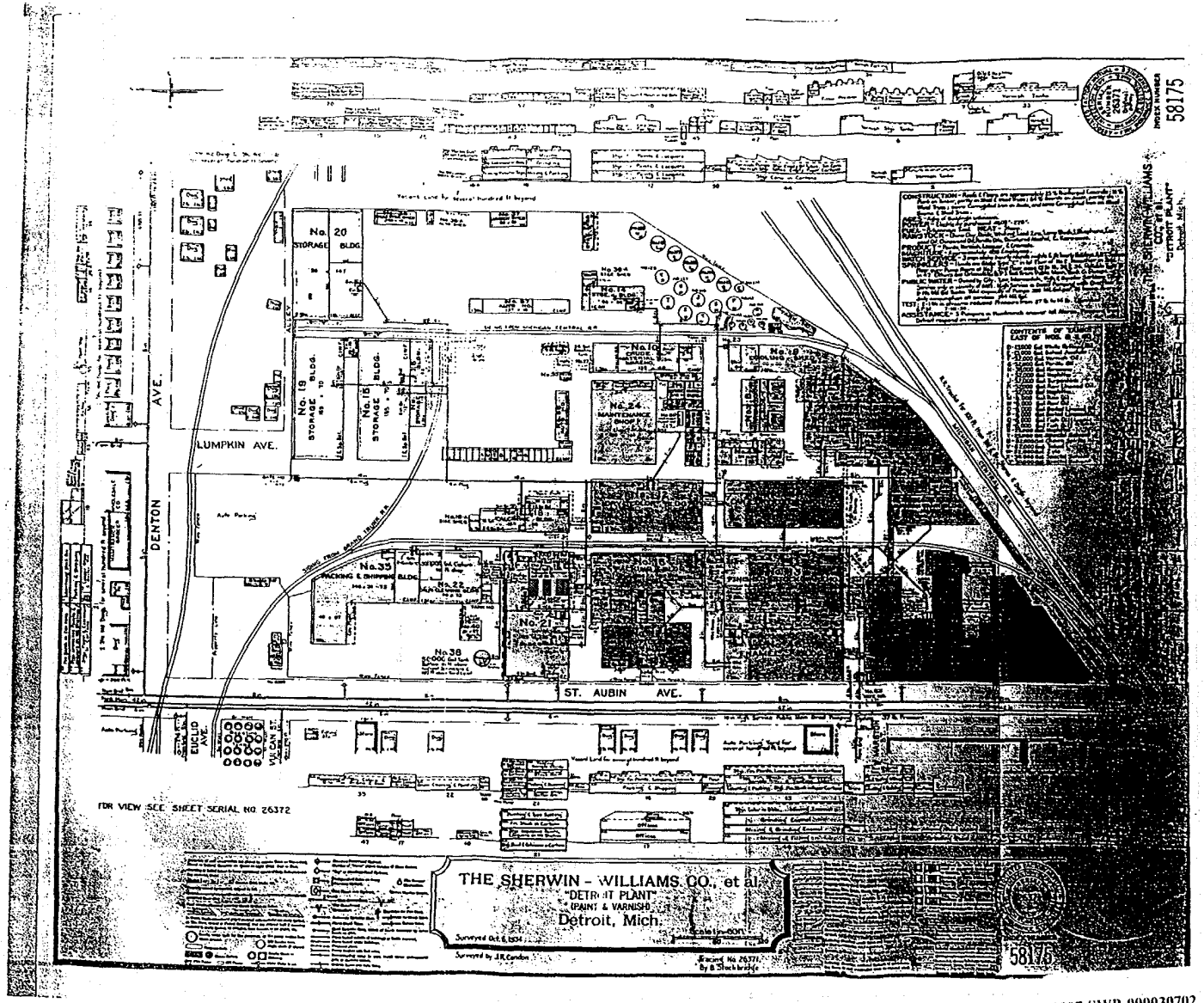
Through necessity, the scope of this investigation is limited to industrial hygiene and distinctly does not embrace such other related topics as mechanical safety, fire hazards, explosion hazards, disability compensation, relief association activities, sickness from causes unrelated to work, etc. Although casual comment may be made in the report to these matters, no attempt has been made to furnish comprehensive discussions of these other problems.

Inasmuch as a satisfactory arrangement with respect to the medical care of injured workmen, the physical examination of applicants, etc. already exists, only limited comment is made in this report relative to the Medical Department. The limited information bearing upon routine medical department activities is furnished with the thought that

such discussion should be brought to the attention of physicians at the Henry Ford Hospital for their consideration and advices. The entire attitude governing the present investigators grows out of the desire not to interfere with the existing satisfactory arrangement with the Ford Hospital.

This industrial hygienic investigation in the plants of the Acme White Lead Company represents approximately thirty days' work for four qualified persons, headed by Dr. Carey P. McCord, an experienced investigator. This investigation has led to the present extensive report, which furnishes in unprejudiced fashion a complete appraisal of the potential and actual exposures provided in the Company's plants. In nearly all instances, ways and means are suggested for the elimination or control of undesirable conditions. The prime purpose of this report is to acquaint the management with its present condition and to provide adequate guiding material for a continuous program of plant protection.

The title page of this report records the names of the Company's representatives who day by day participated in the problems of this investigation. In addition, it is desirable that recognition be given to a much larger number of officials, superintendents, foremen, chemists, personnel supervisors and others who contributed to the investigation and the preparation of this report. The workers of the Industrial Health Conservancy Laboratories take occasion to thank all persons connected with the Acme White Lead Company for their cooperation in the acquirement of valuable data leading to this report.



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SUMMARY

No two paint manufacturing establishments present identical health exposures. Of the nine plants investigated by these workers, over a period of years, each one stands out as an entity, calling for different methods of appraisal and different remedial procedures. The investigation conducted in the plant of the Acme White Lead and Color Works has disclosed a series of potential and practical exposures calling for varying degrees of improvement. A record of the investigation made and the recommendations proffered constitute the contents of this report.

By way of summary of the elaborate discussions shortly to follow, a number of items may be shown, epitomizing the high points of the investigation. These now follow:

1) No gross exposures exist in the plant immediately threatening the health of large numbers of workers.

2) A large number of moderately important situations have attracted attention and have led to suggestions for improvement.

3) The type of occupational disease most likely to appear in this plant is industrial dermatoses--skin inflammation of varied sorts.

4) The most significant exposure detected through suitable inquiry is related to liquid materials used as solvents, thinners and vehicles chiefly as found in the Lacquer and Varnish Departments.

5) Lead compounds, although widely distributed--intentionally and unintentionally--constitute less of a hazard to occupational disease than is true for most paint manufacturing establishments.

6) The total list of raw and intermediate materials manipulated in this plant embraces large numbers of substances of potentially harmful nature.

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6) The total list of raw and intermediate materials manipulated in this plant embraces large numbers of substences of potentially harmful nature.

7) At this very time a few cases of characteristic or borderline occupational diseases are believed to exist among workers casually observed. This number includes a mild incipient case of lead poisoning, one borderline case of benzol poisoning, two or three low-grade skin affections and two instances of involvement of the eyes with pterygii, which condition is not characteristically occupational in origin, but well may be so regarded.

8) Primarily this investigation has been directed to physical conditions rather than to the physical status of workers. Only such examinations of workers have been carried out as were necessary in appraising the extent of exposures in work environments.

9) The old age of many buildings introduces a detrimental effect in the procurement of the best possible type of work conditions.

10) At the present time, the plant management is lacking in adequate facilities for supervising work conditions in relation to health problems.

The chief recommendation made by these investigators involving mechanical installation, is with respect to the following departments or work places:

1) The varnish department, including the manufacture of carbon-nitrocellulose paste, presents proved health exposures warranting the introduction of several items of protective equipment. Among others, these include remedial devices associated with a) the manufacture of paint and varnish remover, b) the manufacture of glycerol anhydride type of resins, c) the filtering of resins, d) the manufacture of cold cut varnishes, e) the blowing of fish oil.

2) Drum and other container cleaning with alkalies is now carried out under conditions that are not praiseworthy and call for the institution of improved conditions.

3) Present practices connected with the disposal of waste and refuse introduces potential legal hazards as well as exposure for workers of this company. A better type of procedure for meeting

this situation is suggested.

4) The Lacquer Department has been found to contain grossly high concentrations of mixed vapors of substances, some of which are known to be distinctly toxic. Owing to the statement that extensive alterations are an early prospect, no detailed items of protective equipment are specified, but the definite recommendation is made that in connection with the rearrangements to be made, facilities be introduced for the elimination of toxic concentrations of vapors.

5) At no known point is the concentration of lead in the atmosphere such as to justify the installation of dust collecting equipment. Education of workers and changes in common practices will maintain the lead concentration within tolerable limits.

6) Illumination in this plant, while not grosaly inadequate, is far below desirable standards in many portions of the plant. In addition, many fixtures are worn out and in a few places where safety lighting equipment should be universal, unprotected lamps are interspersed with safety lamps.

Apart from these major considerations, this report discusses scores of comparatively trivial items calling for remedy. In the aggregate, the significance of these minor items approach in importance the major matters discussed.

Conditions found in this plant reflect obvious interest on the part of the management in the well being of its workers. At no time has any evidence been encountered that the management is disposed to avoid responsibility for undesirable work conditions or to be niggardly in the furnishing of necessary moneys to rectify wrongs. There is no evidence of willful neglect or a desire to place personal responsibility on workers for their misfortunes connected with injury or ill health. Conditions found at the time of our first entry into this plant were such as to make improbable any large number of cases of occupational diseases per year. If the major number of recommenda-

tions made in connection with this report are put into operation, it is believable that apart from occasional skin affection, no occupational diseases will arise except on rare occasions.

Finally, it is the intent of this report to maintain that if the major recommendation herein made are applied, this plant will then be ready to face with equanimity any requirements that may be made by state or local legal agencies, trade unions, worker committees and insurance carriers with respect to occupational disease exposures.

GENERAL PLANT DESCRIPTION

Historical

The Acme White Lead and Color Works was organized in December, 1884, with a capital stock of $10,000. The active men in the original organization were Messrs. Thomas Neal and W. L. Davies. Earlier, Mr. Neal had been engaged in the insurance business and prior to these insurance activities had served as an engineer. Mr. Davies had been connected in the capacity of salesman with Farrand, Williams and Clark, which is now McKesson, Farrand, Williams. This business was founded with the idea of manufacturing paint and marketing it in cans. The first product was "Neal's Carriage Paint", the sales of which rapidly increased. The volume of business grew from $30,000 during the first year of operation to millions within a few years. This rapid expansion called for increased financial resources, which were furnished by Messrs A.E.F. White and H.K. White. These gentlemen were connected with the D. M. Ferry Seed Company in the respective capacities of Vice President and Auditor. These gentlemen served as directors of the Company during the early years of history, as did also Mr. Neal and Mr. Davies, in respective capacities of General Manager and President, until the transfer of the Company to the Sherwin Williams Company in 1921. During a portion of this period, three members of the group, namely Messrs. Neal, White and White served as directors of the old First National Bank. During this period the General Motors Corporation suffered financial distress and from this bank and other Detroit banks obtained $15,000,000.00. Mr. Thomas Neal, because of his banking connections was made President and General Manager of the General Motors Corporation, which position he continued to occupy over a period of years. Mr. Neal, while not active in business, is still interested in the affairs of this company at the advanced age of 78 years.

In the building up of the integrity of the Acme White Lead and Color Company, Mr. Neal displayed great interest in the Company's employees and provided at one time that all employees might obtain stock in the Company at low cost, to be paid for through time payments. Those employees who took advantage of this opportunity were well repaid when years after this organization was absorbed by The Sherwin Williams Company.

The original location for this company was on Grand River Avenue and Fourth Street. Soon the company outgrew these small quarters and moved to the present location during or near the year 1896. The affairs of the company prospered and rapid expansion took place. A number of concerns in related enterprises were purchased. Among others were the Peninsular Paint and Varnish Company, acquired in 1904. The identity of this company is still retained as a sales department of the Acme White Lead and Color Works. In 1911, the Lincoln Paint and Color Company was purchased, which company still functions as a sales division of the present organization. Earlier, in 1908, there was purchased the properties and business of the Howley Lead Company of St. Louis, which acquisition led to the building of the large structure north of the present office building, for the manufacture of white lead, by a then new process. This activity was continued for several years until favorable arrangements were made with the National Lead Company for the supply of this raw material. At the same time (about 1913) the manufacture of lead oxide was likewise discontinued. Also, about 1908, there was purchased the John Briggs Company, which engaged in the manufacture of whiting, as well as paint. A little later this company acquired the M.R. Tibbetts Company of Los Angeles, California and San Diego. Although the Tibbetts name has disappeared, these plants are still operated as divisions of The Sherwin Williams Company.

The absorption of these companies and others led to the creation of an outstanding manufacturing establishment in the field of paint, varnish and lacquer manufacturing. In 1920, it was deemed

desirable to dispose of the Acme White Lead and Color Works to the Sherwin Williams Company of Cleveland, Ohio. At that time it appeared to Messrs. Davies, Neal and White necessary to maintain large quantities of raw materials, calling for heavy investments. By this time these pioneers were approaching old age, which fact served as an influence leading to the disposition of the Company's possessions to The Sherwin Williams Company. Since 1920, this Cleveland Corporation has completely owned and controlled the activities of this Company. Since 1920, marked changes have taken place in the paint industry, but this company, serving as an allied unit of The Sherwin Williams Company, has more than kept abreast with the industry's progress and at the present time its affairs are superior to those at any time in its history.

The operation of this company from its first organization has been characterized by concern for the well being of workers. Long before such matters became common practice in this City, Mr. Neal provided rest rooms, fostered the development of an employee relief association, encouraged parties, picnics and outdoor recreation. The result of this interest in workers is reflected in the fact that up to the present time 113 testimonial watches have been awarded employees in the service of the company for 25 years or more. At the present time, 48 of the company's work force have served for 25 to 50 years, although only one person falls into the fifty year period.

Since the acquisition of this company by The Sherwin Williams Company, in March, 1920, the Detroit White Lead Works has been absorbed and now functions solely as a sales division.

At the present time, the local officers of the Acme White Lead and Color Works, an allied company of The Sherwin Williams Company, are: Mr. C. A. Campbell, Vice President and General Manager, Mr. R. H. Stephens, Treasurer and Controller, Mr. F. L. Knapp, Secretary, and Mr. C. T. Ellis, Factory Manager.

At various times, the name of the Company has been different, such as the Motor City Paint Company, Interstete Paint and Varnish Company. Since March 2, 1920, the name Acme White Lead and Color Works has been used without interruption for the designation of this allied company of The Sherwin Williams Company.

Thus the Acme White Lead and Color Works briefly sketches its 53 years of honorable history.

Physical Properties:

The main plant of the Acme White Lead and Color Works is located in the City of Detroit (Hamtramck). The plant covers some 14 acres and is bounded on the West by St. Aubin Avenue, on the South and East by the Michigan Central and Grand Trunk Railroad tracks, and on the North by Denton Avenue.

The plant is made up of some forty odd buildings, which vary in construction from wooden frame to fire-proof steel and concrete. Practically all manufacturing takes place in the more modern buildings, the older frame buildings being used almost entirely for raw material storage and warehousing.

The lacquer plant, paint plant and enamel plant all face St. Aubin Avenue. The main office and one brick warehouse for finished stock also faceSt. Aubin Avenue. The balance of the plant, namely the varnish works and warehouses are back of these buildings.

Acme White Lead and Color Works engages in the manufacture of a general line of protective coatings, for both interior and exterior use, as well as materials for industrial uses. These may be divided into four distinct lines, paints, varnishes, lacquers and enamels.

The paint plant is housed principally in building #2, which is a two-story brick building. In this building are manufactured all paints of the oil type both for trade sales and industrial use. Mixing is done on the second floor and grinding on the first floor.

The varnish works is housed in several buildings, due to the need for considerable tank space for storage. The varnish works not only supplies the trade but also supplies the other manufacturing units with varnishes for use in the manufacture of paints and enamels.

There are storage tanks available for the storage of finished varnish in excess of one million gallons. These tanks are all connected by pipe lines to the paint and enamel plants for their use. All tanks for finished varnish are housed in heated buildings. Directly behind the varnish works are the outdoor tanks for storing raw materials for both factory and varnish manufacturing use. These tanks are also connected by pipe lines to the factory and have a total capacity in excess of one million gallons.

The lacquer plant is housed in building #4, which is a two-story brick building. Practically all grinding for the lacquer plant is done in the enamel building, and in a small building adjacent to the varnish works. Only the thinning and shading is done in the lacquer plant. The first floor is devoted entirely to the filling of lacquers while the thinning and shading are done on the second floor. The second floor is also devoted to small batch production on lacquers.

The enamel plant is housed in building #46, which is a four story building of brick concrete and steel construction. Mixing is done on the fourth floor, grinding on the third floor, thinning on the second floor and filling on the first floor. Part of the first floor is also devoted to small batch production. This building being the newest building used in the manufacturing end of the business is also the best laid out. The gravity system is employed, starting on the fourth floor with raw materials and ending on the first floor as finished enamel.

The raw material warehouses, buildings 15, 19, 20 and 26 are all located at the north end of the plant, adjacent to Denton Avenue. These are all one story wood and corrugated iron buildings and are used entirely for the storage of raw materials.

The main office is centrally located, facing St. Aubin Avenue. This is a two-story brick building and is used solely for the clerical and executive offices.

The maintenance shop is housed in building #24, which is a one story brick building. General mechanical work is done by this

department, and maintenance of machinery throughout the factory.

The drum cleaning department is housed in building #22. General cleaning of drums and buckets used throughout the factory is done in this department.

The printing department occupies the third floor of building #21. General printing of advertising material and stationery is done here. Also the assembling of color cards and advertising displays takes place in this department.. The balance of this building is used for the storing of finished stock.

Buildings 13, 12, 16 and 18 are all used for finished stock storage.

Products:

At the present time, this company produces for sale, under varied trade names, extensive lines of house and industrial paints, essentially all types of natural and synthetic varnishes and an extensive variety of lacquers. In addition, sales are made of certain products elsewhere manufactured by the Sherwin Williams Company, such, for example, as insecticides. The trade names of this company's products are readily available through published advertising bulletins.

Number of Employees:

Factory

Hourly Employees		Salaried Employees	
Male	Female	Male	Female
379	74	54	0

Office

Salaried Employees		
Male	Female	
19	21	(factory office)
52	147	(main office)
71	168	TOTAL 746

4.2% of this employed group are colored; with the exception of four or five engaged in janitor work around the offices, they all work in the factory

This census of employees does not include certain salesmen, sales managers, branch organizations' personnel or the personnel of retail stores.

Employees' Service Provisions:

This company fosters, but does not operate the Acme White Lead and Color Works Employees Relief Association, which was organized in 1900. Any employee of the company is eligible for membership in this association, membership being divided into two classes. In class 1, the admission fee is .75 and the monthly dues are .52. In the second class, the admission fee is .50 cents and the monthly membership charge is .26 cents. Benefits from the first class of membership are $12.00 a week on account of sickness and $75.00 as a death award. For class 2, the weekly sick benefits are $6.00 and $50.00 is payable as a death award. A maximum of eight weeks' benefit is the limit for any one sickness. The funds of the association primarily are derived from membership fees, although the company itself contributes to the association at irregular intervals as the need arises. Further details as to the Employees' Relief Association may be found by those interested in the printed constitution and by-laws readily available.

In addition to the local relief association, life insurance and certain other benefits are proffered the employees of the Acme White Lead and Color Works by the parent corporation, The Sherwin Williams Company.

Through legal requirement, liability insurance is provided in full compliance with the laws of the State of Michigan. At the present time, this is limited to coverage for accidental injuries, but in a short time this coverage will extend to occupational diseases in compliance with a new law in this state, not yet in effect.

The Cafeteria:

Owing to the peculiar geographic location of this company, which is somewhat inaccessible to restaurants and other sources of

food, a lunchroom or cafeteria has been operated continuously since 1896, the time of first occupancy on the present location. Although this service to employees has never paid for itself, it is regarded as highly desirable as a convenience to all employees who may care to make use of this facility and in order to encourage the adequate consumption of wholesome food.

Medical Services:

Through arrangement with Henry Ford Hospital, care is provided for injured employees and to a limited extent the sick employees of this company. Pre-employment physical examinations also are made on all applicants at the hospital. In addition, a graduate nurse is on duty during all work hours, functioning in the small first aid station centrally located in the plant.

Labor Organization:

The workers of this company are not organized into any group with national affiliations. Without any connection with the management, the workers maintain their own local labor organization for deliberation of problems of interest to employee groups. The management regards this group with favor and duly considers and acts upon such matters as may be brought to the management's attention by representatives of this group.

Company's Attitude to Worker Protection:

A statement made by Mr. A. C. Campbell, Vice President of The ~~Sherwin-Williams Company, in charge of the~~ Acme White Lead and Color Works, relative to the promotion of the well being of all employees follows:

July 26, 1937

"The Acme White Lead and Color Works, and I believe the Institution's attitude toward employees is rather briefly summed up as follows:

We believe in the right of an employee to a wage which not only provides mere sustenance, but provides as well for some of the pleasures and good things of life, which will vary to quite some extent with his willingness and ability to produce.

We believe in steady, continuous work and deprecate the necessity for extended lay-offs.

We believe it to be the employer's duty to so arrange production that peaks and valleys will be minimized as greatly as the nature of the business will permit.

We believe and acknowledge our responsibility towards the workman injured either thru accident, or because of his occupation, and feel it our duty to stand by even and considerably beyond the requirements of the laws of the Federal Government or the State of Michigan.

We believe in the worker's right to continue on his job so long as he is loyal, efficient, industrious, capable and physically able.

We believe it to be our duty to privde a certain sustenance for our superannuated employees.

We believe in the right of the employee which will permit him to appeal to higher authority than his immediate superior, thus eliminating to a large degree the possibility of enmity or favoritism entering the picture.

We believe in providing the best working conditions possible commensurate with our business.

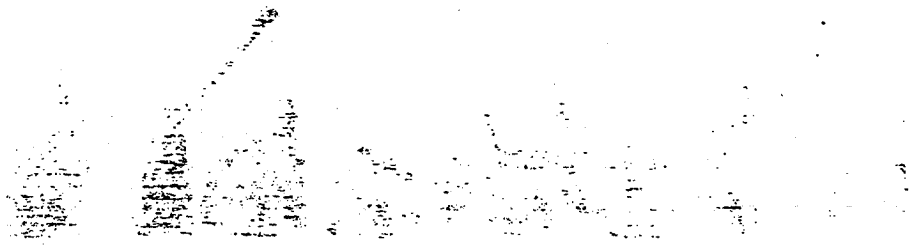
We believe in a 40 hour week, and only such overtime as is necessary for the so far inevitable peaks of the business.

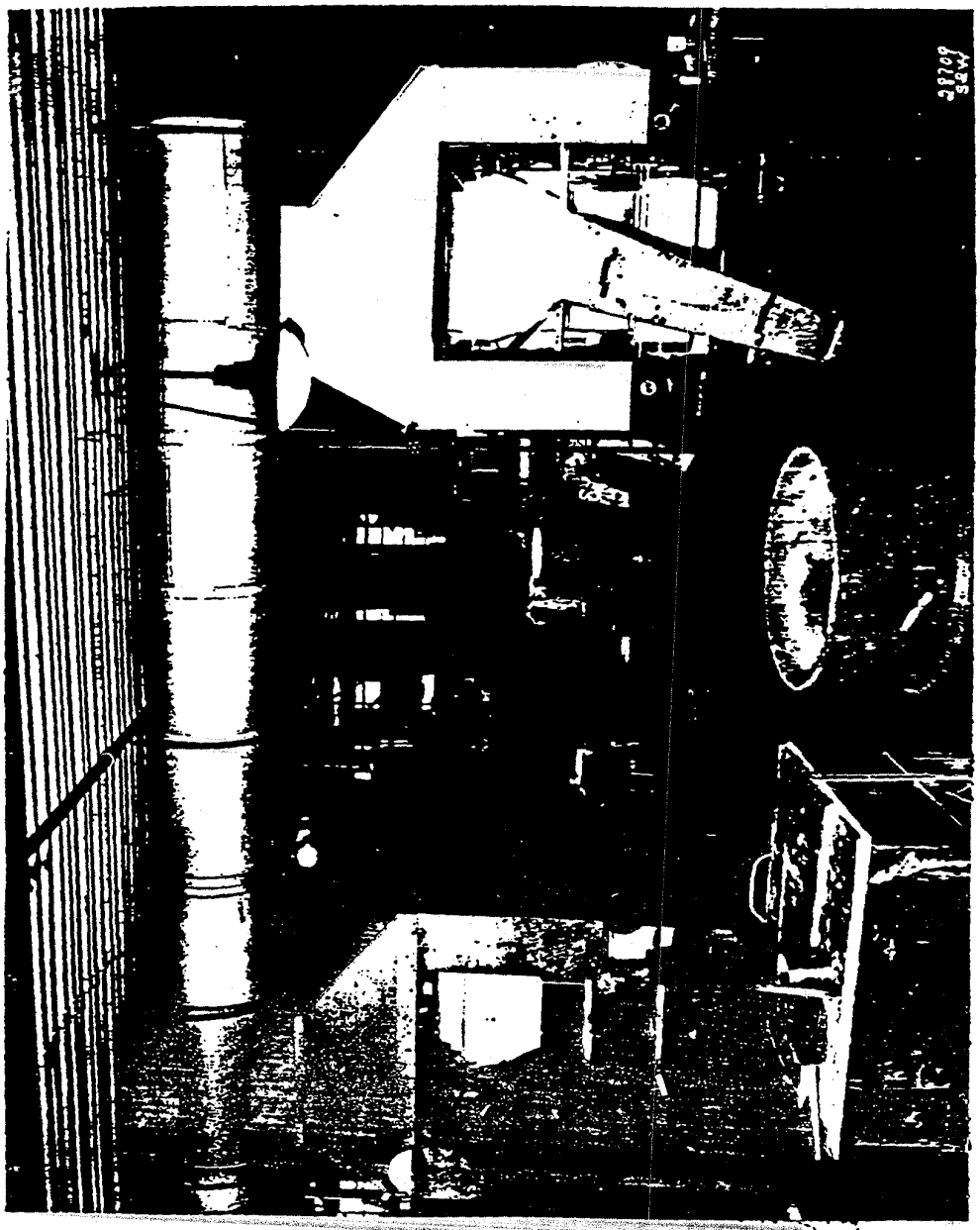
We believe in the inalienable rights of the worker to choose his employment; to work for whom he pleases at such wages as he is willing to accept free from coercion on the part of the employer or any other organization or group either inside or outside the plant.

We believe in short in the rights of labor as well as the rights of capital, and lastly we believe that capital and labor each recognize that neither can do without the other, and, therefore, each must be not only tolerant recognizing the risk of capital and the sweat of labor, but must be co-operative in the true sense.

We not only believe in the above course of procedure, but are practicing this procedure to the best of our ability in dealing with our fellow workers in this Institution.

(Signed) C. A. Campbell
Vice President and General Manager.





Commendable Type of Exhaust System for Vapors From Paint Mill.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

A. LEGAL ASPECTS OF OCCUPATIONAL DISEASES

At the rear of this section of the report may be found a copy of the recently enacted Occupational Disease Law of Michigan. This law, which has not gone into effect, probably will become effective near October 1st of this year. Not for two or three years will the full purport of several portions of the law become established through precedent and court action. It is therefore unwise that any attempt be made to interpret the significance of certain portions of this law.

On the other hand, solely with respect to medical features of the law, it is possible to make, with reasonable assurance, a fair amount of interpretation. Such a medical interpretation now follows:

On June 8th, Governor Murphy signed "An act to amend the title of act number ten of the public acts of the first extra session of nineteen hundred twelve, entitled 'An act to promote the welfare of the people of this state, relating to the liability of employers for injuries or death sustained by their employees, providing compensation for the accidental injury to or death of employees and methods for the payment of the same, establishing an industrial accident board, defining its powers, providing for a review of its awards, making an appropriation to carry out the provisions of this act, and restricting the right to compensation or damages in such cases to such as are provided by this act,' as amended, being sections eight thousand four hundred seven to eight thousand four hundred eighty-five, inclusive, of the compiled laws of nineteen hundred twenty-nine, and to add thereto a new part to stand as part seven, and to consist of sections one to thirteen inclusive," providing Michigan's Occupational Disease Act, which bears the final designation of "Senate Enrolled Act No. 28". This new law probably will become effective ninety days after the adjournment of the Michigan Legislature, or about October 1st. In view of the fact that Michigan is without legislation of this particular character, it may be advantageous to present from a medical point of view some of the

features of this new law. It must be recognized that not for two or three years will enough decisions have been made by the Commissioners of the Department of Labor and Industry, associated with court decisions, to provide an adequate understanding of the application of this law. Further, it must be recognized that any medical interpretations here made are at best tentative and although the desire is to avoid expression of opinion as to legal matters, inevitably medical and legal situations are intertwined.

General Provisions:

This Michigan Occupational Disease Law is of the schedule variety, providing coverage for some thirty-one items, some few of which are blanket in their ramifications. This act represents an amendment to the now existing Industrial Accident Law of 1912. While the present amendment appears to be weak in administrative features, this situation is largely righted through the fact that the entire procedure, with some few exceptions, governing the application of the Accident Compensation Law will apply to this amendment with reference to occupational diseases. Apparently no separate election is provided for either the employer or the employee, apart from the elective features of the basic law of 1912. This new law provides coverage and other benefits only in the case of disability or death from the disease and not solely because a disease exists. The same benefits provided for disability growing out of industrial accidents are extended to occupational diseases, except in the case of silicosis and other dusty lung diseases, where it is specified that in no event shall such compensation exceed an aggregate total of three thousand dollars. A system of apportionment of responsibility for the payment of compensation and other benefits is provided, if the employer at the time of the onset of disability shall have reason to believe that previous exposures led to the occupational disease in question. Coverage becomes applicable provided there is any exposure to the causes of any alleged occupational disease at any time after the effective date of this law. However, with the knowledge that exposures antedating the effective date of this law probably were the principal causes of the affection, provisions are made that if disability arises in the case of silicosis or other dusty lung disease during the first calendar month in which this act

becomes effective, the total responsibility for compensation shall not exceed $500.00, and in the second month $550.00 and so on. This new law contemplates the use of a medical commission, consisting of three qualified, impartial physicians, whenever medical matters are in dispute in regard to any occupational disease claim. A medical report, when signed by at least two of the three members of the medical commission is by law final and conclusive as to the condition of the claimant with respect to the alleged disease or diseases. Adequate provisions are made for the times of notice and claims. This act does not apply to cases of occupational diseases originating prior to the effective date of this act, nor does it apply to agricultural, nursery or orchard pursuits under any circumstances.

A General Estimate from a Medical Point of View of the Strength and Weakness of this Law.

It is granted at the outset that no legislation of this character is likely to be perfect or anywhere near free from flaws when it makes its first appearance as an act. At once the opinion is expressed that in this new law good features outweigh the objectionable ones and that this law is without especial leanings either toward labor or employers. Justification no less exists for the contention that this law is weak in some respects, both because of objectionable omissions and inclusions. This law does not bear the earmarks of intelligent guidance by qualified physicians and others familiar with the occupational disease situation in Michigan. In many respects, this law is the type that might well have appeared twenty years ago in the State of Michigan and very definitely does not meet the needs of the immediate period. However, all in all, this law is commendable as a start and its deficiencies may be remedied through supplemental legislative action, if, as, and when objectionable contents work undue hardship either on industrial workers or employer groups. In short, this law should have the support both of labor and of capital.

The Schedule:

From no known records available in the State of Michigan is

it possible to forecast the experience likely to arise in the application of this law. The schedule of 31 items embraces some occupational diseases likely to arise with comparative frequency in this State. Other items are not likely to lead to reported cases once in ten years. Moreover, occupational diseases not listed as items on the schedule are likely to arise with a greater frequency than the majority of those items appearing on the schedule. A better basis of comparison may be found in the occupational disease experience of a sister state, Ohio, which is operating under a schedule similar in many respects to the Michigan schedule. The Ohio Occupational Disease Law has been in effect about sixteen years, which time is sufficient to have built up an extensive experience, useful in anticipating Michigan's prospective experience. The individual items are now listed, as they appear in the law, and in each case are followed by some medical comment.

Disabilities arising from	Caused by
1. Anthrax	Handling of wool, hair, bristles, hides or skins.

Anthrax is a bacterial disease, commonly called "wool-sorters' disease". The bacteria responsible or their spores may lie dormant for a very long while in hair, wool, animal bristles, skin or hides. The hair or skin of goats is the most common source of infection. Sheep hair is perhaps second. Cases have appeared among dairy workers, brush makers, particularly shaving brush makers and workers in wool. Instances of anthrax as an industrial disease are quite rare, but on occasion widespread outbreaks do arise, involving a large percentage of exposed workers. This fact justifies the appearance of this item on the schedule, but in the nine year period beginning in 1928, no single case was accepted for compensation in the State of Ohio. Technically speaking, anthrax as it arises in industry should be regarded as an accident and not as an occupational disease. This, however, is a matter of definition and this item does appear on many occupational disease schedules throughout the world. In the absence of a severe epidemic, such as took place three years ago in an Eastern woolen mill town, it is predicted that this item will produce few cases for consideration by Michigan's Commissioners of the Department of Labor and Industry.

2. Lead Poisoning or its Sequelae	Any process involving the use of or direct contact with lead or its preparations or compounds.

This occupational disease is one of the most important appearing on the schedule. There are perhaps not less than sixty distinct industries

in the State of Michigan making use of metallic lead or some one or more of the compounds of lead. The chief source of danger to lead poisoning is associated with breathing of lead dust or lead fume. Ingested lead, such as in the form of paste or paint, less frequently gives rise to lead poisoning. Lead is not absorbed through the skin in toxic quantities, except in its organic compounds, such as tetraethyl lead, such as is used in gasoline. With rare exception, lead does not produce local action, such as a dermatitis. In Ohio, in the nine year period ending in 1936, 1269 cases have been compensated as properly traceable to industry as the source of the lead poisoning.

5. Zinc Poisoning or its Sequelae.

Any process involving the use of or direct contact with zinc or its preparations or compounds or alloys.

Zinc poisoning is a comparatively innocuous disease, usually limited to metal fume fever from zinc and commonly found in brass foundries, galvanizing plants, etc. "Zinc chills", "brass chills","braziers chills" are common names for zinc poisoning or zinc metal fume fever. This is an acute disease, without any known chronic form. A more serious form of zinc poisoning may arise when zinc oxide in fume form, such as arises around galvanizing work and brass or zinc foundry work comes in contact with such other vapors as sulphuric or sulphurous acid, leading to the formation in the air of zinc sulphate. Such a chemical in the air may give rise to ulcers of the stomach or other serious inflammatory processes. The compounds of zinc may give rise to entirely different types of manifestations. Zinc chlorids, for example, may lead to serious skin affections. Zinc sulphate may produce gastro-intestinal disturbances. Even zinc stearate powder, such as is widely used as a baby powder, may occasionally lead to minor skin disease. Impurities in zinc, such as lead or arsenic, are ordinarily responsible for the chronic diseases commonly attributed to zinc. This item on the schedule is destined to lead to a fair number of claims, many of which will prove to be unwarranted. Workers with molten zinc are frequently over-alcoholic, since the action of the zinc is such as to produce an insatiable thirst in some instances. Resort to excessive alcohol sometimes results in more evil consequences than those produced by zinc itself. The Ohio experience, in nine years, reveals an average of seven cases of zinc poisoning per year.

4. Mercury Poisoning or its Sequelae.

Any process involving the use of or direct contact with mercury or its preparations or compounds.

Mercury poisoning as an occupational disease is quite common in the fur cutting and hat making industry. An even more serious type of disease is found among workers in those states in which mercury is mined, such as Texas and California. Local mercury poisoning is quite common in the cartridge industry. Occasional cases arise in connection with insecticide manufacture. In the State of Michigan, some instances of poisoning have come to light in the instrument industry, among attendants in hospitals, and possibly among technical workers in laboratories and in chemical industries. The use of mercury in small quantities is so widespread that an occasional case inevitably will appear in connection with the application of this act. However, in Ohio, no cases appeared in the nine-year period mentioned under Item 1.

5. Phosphorus Poisoning or its Sequelae.

Any process involving the use of or direct contact with phosphorus or its preparations or compounds.

Actual cases of phosphorus poisoning are now quite infrequent. Phosphorus poisoning is a tradition throughout the world because of direful experiences related to the manufacture of old fashioned matches. Of three kinds of phosphorus, only the white or yellow is outstandingly harmful. With the disappearance of yellow phosphorus in the manufacture of matches, phosphorus poisoning was largely limited to the manufacture of fireworks and warfare material. Both of these sources of cases are at the present time relatively unimportant, particularly in the State of Michigan. While cases of true phosphorus poisoning are rare, injury from phosphorus compounds are somewhat more frequent. These include phosphurated hydrogen, which at times is an impurity in acetylene, phosphorus as found in phospho-bronze, phosphorus as an impurity in ferro-silicon steel, phosphorus compounds in fertilizers. All told, the array of compounds is so large and so diversified that a few cases may arise in Michigan. However, only one case has appeared in the State of Ohio during the past nine years.

6. Arsenic Poisoning or its Sequelae.

Any process involving the use of or direct contact with arsenic or its compounds or preparations.

Arsenic poisoning conceivably may arise in almost any industry. Largely, this is due to the fact that arsenic is an impurity in many industrially used substances, such as pigments, paints, acids, sprays, metals, etc. This matter of arsenic as an impurity is important since only very small quantities of arsenic are necessary to produce

injury. Within the experience of this writer, arsenic poisoning has been caused by the pigments on wall paper, the pigments that enter into the coloring of window shades, pigments formerly used in impregnating leather, from the handling of sulphuric acid containing arsenic as an impurity, in the smelting of lead, in which arsenic was present only as a minor contaminating ingredient. In the State of Ohio during the past nine years, 15 cases of arsenic poisoning have been accepted for compensation. In Michigan, a similar experience is predictable together with the reasonable expectancy that an occasional severe outbreak will arise with the simultaneous involvement of fairly large groups of workers.

7. Poisoning by Wood Alcohol.	Any process involving the use of wood alcohol or any preparation containing wood alcohol.

This substance, also known as methyl alcohol and methanol, may be derived naturally from wood or may be made synthetically. From the language of this item in the law, it will require court decision to determine whether the synthetically made methanol is subject to coverage. Properly speaking, synthetic methyl alcohol is not wood alcohol. Regardless of the source of this material, its action is the same. It is a source of severe damage and best known as the cause of permanent total blindness. Other injuries arise, including nephritis, hepatitis and skin disease. As little as one spoonful of wood alcohol has produced death. It may enter the body through the skin, through inhalation of its vapors or through ingestion as a liquid. Regardless of the portal of entry, the nature of the injury produced is in general the same. The use of wood alcohol in industry has been subject to rather wide fluctuation, largely depending upon public opinion hostile to its use. One of the famous early outbreaks of occupational disease in this country occurred among the "Danbury hatters", where wood alcohol was used as a solvent for shellac used in stiffening hats. During the prohibition era, wood alcohol led to hundreds of deaths because of the misuse of industrial wood alcohol or materials denatured with wood alcohol. At the present time, wood alcohol is used in some paint coatings, paint removers as a denaturant and ethyl alcohol as an anti-freeze and as a solvent. Interstate shipments of wood alcohol are subject to appropriate labeling of major units. Industrial wood alcohol poisoning led to only three awards in the State of Ohio during the past nine years. Wood alcohol poisoning will occasionally arise in the application of this act, but the greater number of poisonings throughout the country may be traced to improper non-industrial uses of this dangerous substance.

8. Poisoning by benzol or nitro-, hydro-, hydroxy-, and amido-derivatives of benzene (dinitro-benzol, anilin and others), or its Sequelae.	Any process involving the use of or direct contact with benzol or nitro-, hydro-, hydroxy-, or amido-derivatives of benzene or its preparations or compounds.

The language of this item is such as to provide coverage for very numerous derivatives of coal tar benzol. So dissimilar are some of the chemicals covered that the diseases produced have little or nothing in common. For example, the clinical states produced respectively by benzol and dinitrobenzol are entirely different entities. The chief manifestation of benzol poisoning is the destruction of the cellular elements of the blood through injury to the blood forming organs, while the chief manifestation of dinitrobenzol poisoning is asphyxiation, resulting from the formation of methemoglobin.

As extensive as the array of chemicals extended coverage under this item is, it is chemically true but not necessarily legally or judicially true, that coverage has not been extended to the much more widely used sister chemicals to benzol, namely toluol and xylol. These substances are homologues of benzol rather than compounds, but if regarded as compounds they are methyl compounds rather than any of the varieties specified in the language of this item. Benzol is no longer widely used in dry cleaning plants or as a solvent for paints, lacquers, varnishes, etc. There are some forty industries in Michigan that might make use of benzol, but disasters during the past twenty years have built up widespread objection to its use. Deaths have occurred from the use of benzol in the rubber industry, in the leather industry and in dry cleaning. Under this item, many cases will be reported under the allegation that the chemical responsible is derived or derivable from benzene as the basic substance. This item will constitute one of the most difficult for the Commission to apply with any full assurance as to facts involved. This will become apparent when mention is made of hundreds of pharmaceuticals derived from benzene, hundreds of dyes and scores of chemicals, enjoying technical application throughout industry. In the State of Ohio, 63 cases led to awards during the past nine years.

9. Poisoning by carbon bisulfide or its sequelae, or any sulfide.

Any process involving the use of or direct contact with carbon bisulfide or its preparations or compounds, or any sulfide.

This disease is said to arise in the following industries: Ammonium salts makers, artificial silk makers, asphalt testers, carbon bisulfide makers, celluloid makers, cementers (rubber shoes), cement mixers (rubber), dry cleaners, dryers (rubber), enamelers, glue workers, insecticide makers, match factory workers, oil extractors, paint makers, paraffin workers, putty makers, reclaimers (rubber), smokeless powder makers, sulfur extractors, tallow refiners, vulcanizers.

Of greater importance in this item than the mention of carbon bisulfide is the supplemental language ("or any sulfide". This extension paves the way for coverage for a considerable number of

other chemicals, including for example hydrogen sulfide, a very deadly gas. Hydrogen sulfide in any measurable quantity, such as reflected by one part in a million, is dangerous. It is prophesied that an extensive number of cases will be reported under this item and that more will arise from hydrogen sulfide than from carbon bisulfide. In Ohio, carbon bisulfide has led to thirty cases during the past nine years.

10. Poisoning by Nitrous Fumes or its Sequelae. — Any process in which nitrous fumes are evolved.

Popular interest was attracted to this item, due to the Cleveland Clinic disaster a few years ago, when the burning of x-ray films, consisting of nitrocellulose, gave rise to deadly nitric oxide. gases, which may arise in a variety of industries. Whenever nitric acid comes in contact with organic metal, nitrous gases appear. Whenever very high temperatures react on the atmosphere, nitrous gases may appear. In the State of Michigan, claims revolving about nitrous gases chiefly will be derived from the arc welding industry. The action of these gases chiefly is limited to the respiratory tract, leading to profound edema, particularly of the lungs. This item inevitably will lead to spurious as well as genuine disease claims. Among welders, almost any respiratory diseases, such as pneumonia, bronchitis, bronchiectasis and even tuberculosis will serve the basis of claims. It is in cases of this character that the Medical Boards provided for by this law will be called upon for differential diagnosis in the weighing of medical evidence. Fortunately, the manifestations of the action of nitrous gases are fairly typical, so that unwarranted claims should not lead to great difficulty in their detection in order that they may be eliminated from favorable consideration under the provisions of this act.

11. Poisoning by Nickel Carbonyl or its Sequelae. — Any process in which nickel carbonyl is evolved.

This is one of the unimportant items in this law. This substance is formed when carbon monoxide is passed over powdered nickel and is an intermediate step in the Mond process of nickel production. When cases do arise, they are severe in nature, associated with profound edema along the respiratory tract, shortness of breath, high fever, cough and bloody sputum, high pulse rate, with damage to the brain. This writer has never seen a case of this rare disease and has no reason to believe that any high frequency of cases will appear in the State of Michigan. This item does not appear on many schedules for other states so that no precise statistics for this country are readily available.

12.	Dope Poisoning (poisoning by tetrachlormethane or any substance used as or in conjunction with a solvent for acetate of cellulose or nitrocellulose), or its Sequelae.	Any process involving the use of or direct contact with any substance used as or in conjunction with a solvent for acetate of cellulose or nitrocellulose.

This inelegant terminology is such as to include scores of solvents used in coating and similar industries. The embrasure includes hydrocarbon solvents, such as benzol, toluol, xylol, solvent naphtha, many alcohols, many esters used in connection with varnishes, lacquers, paints and other coating materials. Since this one item is blanket in its extent, it is impractical to refer either to symptomatology or to statistics of frequency. No less, it is asserted that this item will become of outstanding importance because of the wide use of coating materials in connection with automobiles, trucks, furnitures, etc., such as are produced in this state.

13.	Poisoning by Formaldehyde and its Preparations.	Any process involving the use of or direct contact with formaldehyde and its preparations.

Formaldehyde as a gas is used as such only in a few industries, such as for fumigation. It is well known, through medical use, as formalin, a 40% water solution of the gas. Wherever exposure is provided, this substance is highly dangerous, since it produces a direful disease. Its manufacture and that of its compounds constitutes one of the chief exposures. Other exposures may be found in the synthetic resin industry. It is a product of the decomposition of wood alcohol. Very few cases arise in industry so that its inclusion in this law will probably not lead to any very great frequency of claims.

14.	Chrome Ulceration or its Sequelae or Chrome Poisoning.	Any process involving the use of or direct contact with chromic acid or bichromate of ammonium, potassium, or sodium or their preparations.

Chromium scarcely ever leads to poisoning, but instead only to local injury, such as "chrome holes" or nasoseptal perforations or dermatitis. Nasal perforations are not disabling and very seldom are local ulcerations totally disabling. Unfortunately, chromium compounds in contact with flesh are not neutralized so that injurious action is persistent, leading to under-mined, jug-like ulcers. Occasionally, workers become sensitized to chromium so that the most trivial subsequent exposures lead to troublesome skin affections, asthma, etc. It is forecast for this item that large numbers of cases will appear, but that the chief

number will involve medical treatment expenses rather than compensation for lost time. In Ohio, where this disease was made compensable in 1931, it is noted that 322 cases have appeared in the past nine years, only a portion of which were awarded compensation due to absence from the schedule during the earlier years of this period. Not all forms of chromium are injurious. Certain valences of chromium are innocuous and in addition many compounds of chromium are without injurious properties. Chromic acid, chromic oxides and chromates are the chief offending agents. Under the Michigan Law, this item, referable to chromium, will be a troublesome one, because it is about the only agent for which compensation is provided that is used in plating. At least twenty other substances used in plating are injurious, but it will be human nature to attribute all injuries related to work to chrome, provided chrome is used instead of the non-compensable agents.

15. Epitheliomatous cancer or ulceration of the skin or of the corneal surface of the eye due to tar, pitch, bitumen, mineral oil or paraffin, or any compound, product or residue of these substances.

Handling or use of tar, pitch, bitumen, mineral oil, or paraffin or any compound, product or residue of any of these substances.

A growing body of information establishes full well that skin cancers may be produced by various industrially used substances, chiefly coal tar derivatives. In proportion to the exposures, the number of cancers incurred is low, only 13 in the State of Ohio during the past nine years. It is possible that chemicals other than those mentioned may produce epithelioma, such, for example, as wheat germ oil.

16. Glanders.

Care of handling of any equine animal or the carcass of any such animal.

This is an old time infectious disease, belonging to the horse days with livery stables, drays, and racing tracks. The disease, which in horses is called "farcy" is transferred to men and is then called glanders. However, other animals may transfer this disease. It is quite rare. The writer has never seen a case in a human being, but has seen many in animals. Not a single case has appeared in Ohio, I believe, from the origin of the law in 1921 and certainly not in the past nine years. This sort of item should have been left off the schedule and might very well have been replaced by some useful item, such as carbon tetrachloride.

17. Compressed Air Illness or Its Sequelae.

Any process carried on in compressed air.

Wherever underwater work is done, such as in tunnel construction, diving, some types or cofferdam work, workmen may be subject to the effects of increased atmospheric pressure. As an occupational disease problem, this disease is usually associated from time to time with some outstanding project such as the building of an underwater tunnel. It is commendable that this disease appears upon the schedule against the day of these special projects. However, it must be recognized that apart from such activities, few industries are likely to provide any condition whatever of high atmospheric pressure. No less, it is to be stressed that in Ohio's experience, to which reference is regularly made in this review, 170 cases have appeared during the past nine years. It is to be noted that 121 of these occurred in the years 1929 and 1930, which undoubtedly would prove on investigation to be associated with some one or two underwater projects.

18. Miners' Diseases, including only cellulitis, bursitis, ankylostomiasis, tenosynovitis and nystagmus.

Any process involving mining.

It is unfortunate that any group of diseases should be set apart as "miners' diseases" when, as a matter of fact, these specified diseases are not specific for miners and for the most part are already covered by other items of this law. Bursitis and tenosynovitis are covered by Item 26. Nystagmus, while a very common miners' disease in Europe, is scarcely known to exist in this country. It requires some thirty years of exposure prior to the appearance of most cases of nystagmus in England. In England, nystagmus is the most prevalent occupational disease, at least among miners, but in this country superior work conditions have led to the statement of United States Public Health Officials that it is non-existent. When this disease does arise, it is mostly non-disabling, is at least frequently a neurosis and is the basis of much malingering. Ankylostomiasis is a fancy term for hookworm disease. This disease has appeared in the mines of South Africa and in Wales and in a few other places where lack of sanitation leads to indiscriminate defecation throughout the mining area. This writer has been unable to locate any authentic figures indicating any existence of hookworm disease in the State of Michigan, except a few instances of the disease imported from other states and chiefly Southern States. Although the City of Detroit is extensively populated by Southern negroes, no case of hookworm has been reported, so far as known.

19. Cataract in Glass Workers.

Processes in the manufacture of glass involving exposure to the glare of molten glass.

It is possible that this item should have been extended to include more than glass workers and embrace all workers exposed to emanations from any incandescent material such as molten iron, brass, steel, etc. Also, this item would have been more acceptable if it had extended coverage to eye conditions other than cataract, such as corneal opaqueness, retinitis, choroiditis, etc. Such needs, however, may be rectified in coming years. Also, actual experience may show that such cases are so infrequent as to be unimportant either through inclusion or exclusion. To this writer's best knowledge, the glass industry in the State of Michigan at the present time is very limited insofar as molten glass is concerned.

20. Radium Poisoning or Disability due to radio-active properties of substances or to roentgen rays. (x-rays).

Any process involving the use of or direct contact with radium or radio-active substance or the use of or direct exposure to roentgen rays (x-rays).

A few small plants in the State of Michigan are carrying out radium dial manufacture. A much larger number of persons are exposed to the harmful action of x-rays. One of the chief actions of the roentgen ray is to produce sterility both in the male and in the female. Such sterility should not be adjudged to constitute disability. Skin diseases from roentgen rays are quite common and should lead to compensation, even though such affliction possibly may not be strictly interpreted as radium poisoning. The majority of these cases, however, will require medical services only rather than medical services and compensation. A fair number of roentgen ray workers in this state have such deformity of their hands resulting from x-ray exposures as to justify an interpretation of total disability.

21. Methyl Chloride Poisoning.

Any process involving the use of or direct contact with methyl chloride or its preparations or compounds.

This substance has attracted attention chiefly because of deaths produced by the use of it as a refrigerant; doubtless there are other uses than as a refrigerant, but these are not extensive. Cases of methyl chloride poisoning chiefly have arisen under non-industrial conditions, such as among householders or apartment residents exposed to the deadly action of methyl chloride escaping from leaky refrigerators. However, in the manufacture of refrigerators using methyl chloride as a refrigerant, considerable numbers of cases have taken place, particularly in Indiana. When methyl chloride poisoning arises, it is substantially methyl alcohol poisoning, since methyl chloride decomposes into methyl alcohol within the body. The cases in Michigan will be few and far between, since the use of methyl chloride as a refrigerant is on the wane. It would be much more practical to have introduced sulphur dioxide on this schedule instead of methyl chloride.

22.	Carbon Monoxide Poisoning.	Any process involving direct exposure to carbon monoxide in buildings, sheds or enclosed places.

Most carbon monoxide poisoning should be accepted for compensation purposes as an accident, which they truly are. Heretofore, they have been covered in this State as accidents and the shift to a classification within the domain of occupational diseases will lead to a great deal of confusion. A true chronic form of carbon monoxide poisoning resulting from long continued or oft repeated exposures to low concentrations of the gas is denied by most workers, but recognized by a few. On the other hand, the sequelae from an acute carbon monoxide poisoning are fairly common. These, no less, might very well be handled the same as the sequelae to any accident. It inevitably will come about that almost every workman engaged in any occupation leading to the formation or presence of carbon monoxide will be prone to blame any infirmities that arise on this gas. There are difficulties ahead for the Commission, Medical Boards, employers and insurance companies connected with the settlement of carbon monoxide claims.

23.	Poisoning by sulphuric, hydrochloric or hydrofluoric acid.	Any process involving the use of or direct contact with sulphuric, hydrochloric or hydrofluoric acids or their fumes.

The wonder is that nitric acid was not included in this list. A possible answer may be found in that most of such cases will be covered by item 10. A further wonder is that this item did not include in addition to mineral acids, organic acids, such as acetic, which groups of acids in the aggregate cause more occupational diseases than the mineral acids. One reason for this is that sulphuric acid does not evaporate. Left wide open, its volume will not appreciably diminish. It only enters the atmosphere as a vapor in considerable quantities in association with steam or is the result of the evolution of bubbles, such as in pickling work. Direct contact with sulphuric, hydrofluoric or hydrochloric acid naturally will give rise to accidents. Cases arising following continuous or frequently repeated exposures to vapors are rare and comparatively unimportant. Eroded teeth, bronchitis and gastro-intestinal inflammation are characteristic of mineral acids and more especially sulphuric acid.

24.	Respiratory, Gastro-Intestinal or Physiological Nerve and Eye Disorders due to Contact with Petroleum Products and their Fumes.	Any process involving the use of or direct contact with petroleum or petroleum products and their fumes.

It is unfortunate that such a departure should have been made in this item, specifying peculiar aspects of petroleum poisoning rather than making an all-inclusive item such as "petroleum poisoning" or "disability from petroleum products".

The language of this important item is such as to exclude damage to the liver, kidneys, skin, etc. This is one of the most important items on the list, as the derivatives of petroleum are almost as legion as those from coal tar. Chief among these are gasoline, kerosene, naphtha, Stoddard's solvent, light oils, heavy oils, together with their many derivatives and compounds, possibly including a variety of chlorinated hydrocarbons. In Ohio, 51 cases have appeared during the past nine years.

25. Disability arising from Blisters or Abrasions.

Any process involving continuous friction, rubbing or vibration causing blisters or abrasions.

Heretofore such things as blisters and abrasions have been compensated as accidents, which they chiefly are. However, there are types of blisters arising not from accidental and fortuitous circumstances, but from long sustained, repetitive motions. Therefore, there can be no objection to this item, although there will be endless confusion as to when a blister or abrasion is the result of an accident and when it is an occupational disease. More work for the Commission and Medical Boards.

26. Disability Arising from Bursitis or Synovitis.

Any process involving continuous rubbing, pressure or vibrations of the parts affected.

This is a good item, as there are endless tools operated by air, electricity, water, etc. leading to incessant vibration. A typical example is known to all in the noisy, vibrating concrete drill, widely in use in street repair work, making days and nights hideous for those nearby, but frequently leading to inflammation along tendon sheaths of the operator. More difficulty will be experienced in associating bursitis with industry, in that there are many causes of bursitis other than work, infection being a primary one. In Ohio, where tenosynovitis has been compensated as an occupational disease since 1929, there have been 1297 instances of tenosynovitis of the hand in the past eight years, and 186 instances of bursitis about the knee joint in the same period. Thus it may be seen that synovitis or tenosynovitis may become the outstanding item in Michigan's occupational disease schedule.

27. Dermatitis (venenata)

Any process involving the use of or direct contact with acids, alkalies, acids or oil, or with brick, cement, lime, concrete or mortar capable of causing dermatitis (venenata).

This item, which should have been a blanket one, is unfortunately drawn in the Michigan Act,

apparently because of lack of familiarity with the many causes of occupational dermatitis. Instead of a provision apart from acids, alkalies and oils, it is limited to "brick, cement, lime, concrete and mortar". There should have been coverage for those hundreds of skin diseases which make up 65% of the total number of occupational diseases. There are no less than 700 causes of skin disease in industry, while this act steps off into the by-path of brick, cement, lime, concrete and mortar. More cases of dermatitis will arise among florists, gardeners and nurserymen than from all the workers in brick, cement, lime, concrete and mortar throughout the state. In Ohio, 7,660 cases of dermatitis have arisen in the past nine years, with only 19 in 1936 arising from lime and cement. In that year, 930 cases of dermatoses arose, which was 68.4% of the total number of compensable cases. This item should be the first one changed in any modification of this law.

28. Hernia.

Clearly recent in origin and resulting from a strain, arising out of and in the course of employment and promptly reported to the employer.

It is just a little ridiculous to class hernia as an occupational disease. This ridiculousness is further apparent in the limitation language about this item, which specifies that it must "result from a strain". Thus the very definition of an occupational disease breaks down. A strain is inevitably an accident. As a matter of fact, hernias are foremostly congenital and are neither accidents or occupational diseases. Accidents may lead to pre-existing hernias coming into prominence and making themselves first known to their victims. It is not very important, however, into which category hernias are placed, both being anomalous and industries at this time expect to be saddled with responsibility for them in most instances. In the case of a valuable worker, it will naturally be the disposition of employers to procure the repair of hernias in order to safeguard the worker's interests, earning and producing capacities. No less, the qualified occupational disease worker cringes just a little bit to see hernia appearing in any list of characteristic occupational diseases.

29. Stone Worker's or Grinder's Phthisis.

Quarrying, cutting, crushing, grinding or polishing of stone, or grinding or polishing of metal.

Stone worker's or grinder's phthisis was an excellent term about 1890, but is not very important in the concept of disease in this day and time. "Phthisis" then and presumably now is descriptive of old fibroid tuberculosis. The condition to which this term "stone worker's or grinder's phthisis" formerly applied is foremostly silicosis. Doctors now know better, or should. On medical matters, legislators should be guided by doctors, but good ones.

30. Silicosis. Mining.

The wonder is why compensation for silicosis was limited to mining. There are at least 35 industries in Michigan providing exposures to silica. The workman who develops silicosis in a foundry is just as disabled, just as needy, just as deserving, just as subject to pain, just as afraid of death as the workman exposed to silica in mining.

31. Pneumoconiosis. Quarrying, cutting, crushing, grinding or polishing of metal.

Apparently in the minds of the legislators, there was a three-way desire to establish compensation for some dusty lung disease, namely "stone workers' phthisis", "silicosis", and "pneumoconiosis". "Pneumoconiosis" means dusty lung disease, but the only pneumoconioses of significance are silicosis and asbestosis. There is no metal that will produce a disabling pneumoconiosis and it is noted that in this list of employments the mining of metal is omitted. Let it be understood that such dusts as silver, platinum will not in themselves produce a disabling pneumoconiosis.

The Medical Board:

This act fails to provide a fixed Medical Board, but perhaps does better in that provisions are made for the appointment of a Commission of three qualified physicians, for the consideration of every individual disputed case. The report of this Commission, whenever signed by any two members of the three-man board, definitely binds the Industrial Commission, insofar as medical facts are concerned. This is an admirable feature. It appears, from the nature of this provision, that the Medical Commission will not be comprised of the same physicians on any large number of cases. If it so happens that some Commissions are little qualified and render questionable services, other Commissions will be better qualified and may be expected to render valuable services in the adjudication of occupational disease claims.

Definitions:

The definition of an occupational diseases appearing in this act is not elaborate, but is fairly good. However, there are no definitions as to what constitutes a number of occupational diseases, such as "silicosis", "stone worker's phthisis", "pneumoconiosis", etc. This omission will lead to confusion unless definitions are prepared in connection with cases acted upon by the Commission, which thus may serve

as precedents.

Omissions from the Schedule:

Earlier discussion has been presented as to the significance of the various items of the schedule; also some earlier comment has been made as to the worth of the schedule itself. Through repetition, it may be emphasized that the schedule in its entirety is limited in its worth, both because of the omission of many needed items and because of restrictions placed upon the extent of application of coverage in some instances, such as the limitation of "silicosis" to "mining". It appears that there is no coverage for such important items as carbon tetrachloride, trichlorethylene, cyanide, many forms of skin diseases, eye diseases other than cataract (except cancer), etc., etc.

Extent of Coverage:

It is noted that compensation is provided only for disability or death from a given occupational disease and not merely from the fact that such a disease exists. This is salutary. However, many instances will arise in which claims will be made because of the existence of a disease which will call for alert activities on the part of the medical, claims and legal departments to insist upon the enforcement of the provision that disability is required as a requisite for compensation. Even in the absence of disability, it is not probable that medical relief will be in order, which provision should not be combated, because in the absence of medical relief, actual disability may develop.

Monetary Awards:

It appears that the rates of payment and extent of payment for occupational diseases are the same as for accidental injuries, except in the case of silicosis, possibly pneumoconiosis, phthisis, etc. Here it seems established that a maximum of three thousand dollars is provided.

Common Law Action:

This law provides coverage for those cases in which there has been even trivial exposure to specific injurious substances after the effective date of the law. This means that some coverage, but not necessarily full, is extended to large numbers of cases, the chief exposure leading to which took place prior to the enactment of this law.

This step is regarded as commendable and to be favored. Undoubtedly a fair number of claims will arise shortly after the beginning of the operation of this law, in which no injurious exposure may be shown after the effective date of this law. Such cases will require adjudication on whatever basis they might have been settled if this law had not appeared.

The most important question to be considered is whether occupational diseases not appearing on the schedule may lead to common law action, or instead if such cases may not be made the basis of any claim with the prospect of favorable action. Such a matter as this is naturally for legal and judicial decision rather than medical. Insofar as a physician is entitled to make any comment, the opinion is expressed that occupational diseases not on this schedule may not be made the basis for action at common law, which will be given consideration by the Courts. The reasons for this interpretation are the title of this bill, 1) which in its last phrase reads "and restricting the right to compensation or damages in such cases to such as are provided by this act" and 2) the language of Section 12, which reads "Nothing in this act shall affect the rights of an employe, or his dependents, to recover compensation in respect to a disease to which this act does not apply, if the disease, apart from this act, is one for which compensation is payable under the other provisions of this act", but more important than either of the two foregoing, the fact that this law constitutes an amendment to the compensation law of 1912 and imposes upon this new section of that law the same restrictions attending the basic law, which in one portion clearly states further that the employer operating under the provisions of this act shall be subject to no other liability whatsoever in connection with claims growing out of worker injury. While this provision of the early law has always existed, it now takes on peculiarly new significance in view of the addition of this occupational disease section. For these three reasons, it appears to this writer that the worker afflicted with an occupational disease not covered by this new act is without legal recourse under ordinary circumstances. This writer hastens to emphasize that this is a matter for interpretation by the Commission, by the Court and possibly by the Supreme Court of the State.

Payment for Members of Medical Commissions:

This law provides for the payment of the services of the physicians serving on Medical Boards from general funds available to the Department of Labor and Industry. No charges are made directly upon industry for the provision of any such services.

Apportionment of Compensation and other Benefits under this Act:

This law provides, under certain circumstances, that the cost of awards made and other benefits shall be shared by the last employer with previous employers, providing similar exposures. Any appraisal of the procedure provided should be made by legal personnel and not by physicians. Viewed from a strictly medical point of view, the opinion has been formed that the application of these apportionment provisions will be difficult. A correlary to this statement is that new employees should be subject to a better type of physical examination than heretofore with respect to occupational diseases, occupational disease exposures and to types of previous employment. It is emphasized that from the point of view of the employer, it may become necessary to deny employment to persons who may harbor occupational diseases in fact or who have been so extensively exposed to make occupational diseases acquired in other employments a reasonable future expectancy.

Addition of New Items to the Schedule:

It is not known that items not now appearing on the list may be added by other than legislative action two years hence, in the absence of special sessions of the legislature.

Reporting of Occupational Diseases:

Two bills are now awaiting action of the legislature calling for the reporting to the State Department of Health of all occupational diseases. Since such bills have not been enacted into laws, it is not possible to make any meritorious comment at this time.

Costs of Occupational Disease Coverage Under this Act:

The cost for occupational disease compensation, medical relief, etc. will approximate 2% of the present costs for accident compensation, etc. If contrariwise, claims for additional occupational diseases, not appearing on the schedule, are settled in a different manner, but at approximately the same rate, only meritorious cases are extended benefits,

then the total cost for the two classes of occupational diseases should not exceed 3% of the present cost for accident compensation, etc. In the United States, the average cost for each case of occupational disease from 1920-29 was $191. The amounts paid for the commonest diseases were as follows: Toxic vapors, gases and fumes, $414; "germs" $322; irritant dust and fibers, $298; toxic fluids $52; and miscellaneous irritants $47.00.

Possible Joker:

Under the provisions of this act, with respect to dusty lung diseases, including silicosis, the provision is made that if disability or death arises during the first month after the effective date of the law, entire responsibility on the part of the employer may be liquidated by the payment of $500.00. This opens up the possibility of much offensive action on the part of vicious employers. Disability is not something that may be determined by the worker himself, but in large measure may be determined by physicians acting in good faith. Any employer, under this provision, conceivably may find it desirable to examine all workers in his employ during the first month after the effective date of this act and in the event outstanding degrees of silicosis or other dusty lung disease are found, it may be well within the physician's justifications to announce that such workers should not continue further employment and that total disability at least for that form of employment in fact exists, whereupon it appears that such cases may be permanently disposed of upon the payment of $500.00.

Total Number of Occupational Diseases Per Year in Michigan:

During the period of legislative agitation connected with occupational diseases, large numbers of persons have gained the impression that the numbers of cases of occupational diseases in this State will be comparable to the number of accidents, or at least that the number is to be reckoned in many thousands, such as ten or twenty per year. This is a fallacy. It is unwise to make any close prediction, but there is some warrant for maintaining that throughout the State, there may not be more than 1000 or 1200 cases per year of genuine occupational diseases of the type covered by the Michigan Law. Of course, during the first year or two the number of claims will be considerably higher, owing to lack of familiarity on the part of physicians, attorneys, employers and workers

because of lack of precise knowledge as to the nature of occupational diseases, etc.

Constitutionality of the Michigan Occupational Disease Law:

Any such matter is remote to the domain of medicine, but already there are some legal rumblings to the effect that the constitutionality of the law may be questioned and that attacks may be made on the law by mining interests.

Supplemental Interpretation:

This review and comment is made within that week in which this measure became a law through the affixation by the Governor of his signature. Undoubtedly there are faulty interpretations herein. This writer wishes to be the first to recognize the necessity for modifying and extending the views here expressed as additional experience and information becomes available through the application of this new law.

B. DISCUSSION OF THE OCCUPATIONAL DISEASE LAW WITH PARTICULAR REFERENCE TO THE ACME WHITE LEAD COMPANY.

Of the 31 items appearing on the schedule, it is most likely that not more than 12 may lead to legitimate claims in this plant as now operated. Three of these items refer respectively to Item 25, "blisters and abrasions", Item 26, "bursitis or synovitis" and Item 28, "hernia. These items of course may appear in any factory and are in no wise characteristic of paint manufacture. This leaves eleven items for which exposure may be provided in the paint industry as a natural consequence of contact with materials manipulated. These eleven items are: 2) lead poisoning, 3) zinc poisoning, 6) arsenic poisoning, 8) benzol poisoning, 9) carbon bisulfide poisoning, 12) dope poisoning, 13) formaldehyde poisoning, 14) chrome poisoning, 22) carbon monoxide poisoning, 24) petroleum poisoning, 27). dermatitis.

Without any proof, except that growing out of past experiences, these eleven characteristic items are arranged in order of anticipated frequency of cases.

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Without any proof, except that growing out of past experiences, these eleven characteristic items are arranged in order of anticipated frequency of cases.

1. Dermatitis.
2. Lead Poisoning.
3. Dope Poisoning.
4. Petroleum Poisoning.
5. Benzol Poisoning.
6. Formaldehyde poisoning (from synthetic resins)
7. Chromium Poisoning.
8. Carbon Monoxide Poisoning.
9. Zinc Poisoning.
10. Carbon bisulphide Poisoning.
11. Arsenic Poisoning.

It is to be understood that this list is prophetic and at best is without great significance.

In the absence of some unusual outbreak, such as of skin disease, it is anticipated that of the diseases appearing on the schedule as now provided, this Company will have not more than ten genuine cases of occupational diseases per year. Probably this statement should be qualified for the first year after this law goes into effect, when, in all likelihood there will be considerable agitation connected with long existing cases, which no less are entitled to compensation if additional exposure is provided after the effective date of this law.

C. MEDICAL WORK.

Another section of this report is extensively devoted to a general discussion of medical work in this plant. The following items with particular reference to medical procedure connected with the new occupational disease law should be regarded as supplemental.

1) The occupational disease law provides for the apportionment of responsibility in case the employer believes that an occupational disease originated in part or in toto in previous employments. For this reason, whenever applicants are being considered for employment, careful work histories covering previous employments should be obtained. These histories should provide not only the names of previous employers and their addresses, but also the precise work performed. This procedure may not be very important immediately after the law goes into effect, but in the course of a few years, such records will lead to substantial savings in some instances.

2) At the time of making a physical examination and the taking of medical histories, every applicant should be questioned as to his having suffered previously from occupational diseases of any nature. Both negative and positive statements in this respect should be signed by the applicant. A provision of the law is such that if a worker

wilfully mis-states his past experience with occupational diseases, he is unentitled to the full provisions of the occupational disease act.

3) At the time of making physical examinations and the taking of medical histories, more care than heretofore should be exercised in preventing the employment of workers extensively exposed to dust such as silica or lead or to any other substance that may provide a background of latent disease of occupational origin. For example, it would be most unwise to employ an applicant with ten years' exposure as a sand quarryer, sandblaster, pottery worker, miner, etc.

4) If there be in the plant one or more workers who are known to harbor an occupational disease such as silicosis, lead poisoning, etc., such workers should be made the recipient of careful re-examination shortly after the law becomes effective, if there be any likelihood that at any future time such workers may become a claimant for a condition that existed before the application of the law. The law makes provision that such cases, at least of dusty lung disease, may be completely disposed of in equitable fashion at a lower rate immediately after the effective date of the law than will be true after the law has existed for a few years, at which time it is unknown that this statement applies to all occupational diseases or solely to dusty lung diseases. At any rate, the theory of the law is such as not to tax the employer beyond a limited amount for those cases foremostly produced prior to this law.

5) One of the most troublesome features of this law with respect to diagnosis will be in connection with skin diseases. In any event, not more than half of the skin diseases that arise among the workers of this plant will be of occupational origin. Of this one-half, not more than 1/5 apparently will be covered by the present language of the law as set forth in Item 27. As noted elsewhere in this report, the provisions made for occupational dermatitis are somewhat unsatisfactory from the point of view of the worker. In particular, the language of the law is such as not to affect the majority of operations engaged in in this plant.

6) Elsewhere in this report mention is made of the various places at which exposures are provided in the operations of this plant to the various substances specified in the list above as potential sources of occupational diseases. In most instances, adequate information is furnished as to diagnostic procedure.

Notwithstanding all of the foregoing discussion, it is pointed out that the Governor of this State has called an extra session of the legislature for August 1st and thereafter and that one of the items for consideration is the revision of the Occupational Disease Law. This may mean that the entire law here discussed will be extensively modified.

STATE OF MICHIGAN
59TH LEGISLATURE
REGULAR SESSION OF 1937

Senate Bill No. 106 — Introduced by Senators Hittle and Burke

SENATE ENROLLED ACT No. 28

(Ordered to be known as the "Hittle-Burke-Rowell-Smith-Martin Act.")

AN ACT to amend the title of act number ten of the public acts of the first extra session of nineteen hundred twelve, entitled "An act to promote the welfare of the people of this state, relating to the liability of employers for injuries or death sustained by their employes, providing compensation for the accidental injury to or death of employes and methods for the payment of the same, establishing an industrial accident board, defining its powers, providing for a review of its awards, making an appropriation to carry out the provisions of this act, and restricting the right to compensation or damages in such cases to such as are provided by this act," as amended, being sections eight thousand four hundred seven to eight thousand four hundred eighty-five, inclusive, of the compiled laws of nineteen hundred twenty-nine, and to add thereto a new part to stand as part seven, and to consist of sections one to thirteen inclusive.

The People of the State of Michigan enact:

Section 1. The title of act number ten of the public acts of the first extra session of nineteen hundred twelve, entitled "An act to promote the welfare of the people of this state, relating to the liability of employers for injuries or death sustained by their employes, providing compensation for the accidental injury to or death of employes and methods for the payment of the same, establishing an industrial accident board, defining its powers, providing for a review of its awards, making an appropriation to carry out the provisions of this act, and restricting the right to compensation or damages in such cases to such as are provided by this act," as amended, being sections eight thousand four hundred seven to eight thousand four hundred eighty-

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five, inclusive, of the compiled laws of nineteen hundred twenty-nine, is hereby amended, and a new part is hereby added to said act to stand as part seven, and to consist of sections one to thirteen inclusive, said amended title and added part and sections to read as follows:

TITLE

An act to promote the welfare of the people of this state, relating to the liability of employers for injuries or death sustained by their employes, providing compensation for the disability or death resulting from occupational injuries or disease or accidental injury to or death of employes and methods for the payment, and apportionment of the same, establishing an industrial accident board, defining its powers, providing for a review of its awards, making an appropriation to carry out the provisions of this act, and restricting the right to compensation or damages in such cases to such as are provided by this act.

PART VII

Sec. 1. Definition. Whenever used in this act:

(a) The word "disability" means the state of being disabled from earning full wages at the work at which the employe was last employed;

(b) The word "disablement" means the event of becoming so disabled as defined in sub-paragraph (a);

(c) The term "occupational disease" means a disease which is due to causes and conditions which are characteristic of and peculiar to a particular trade, occupation, process or employment.

Sec. 2. The disablement of an employe resulting from an occupational disease or condition described in the following schedule shall be treated as the happening of a personal injury by accident within the meaning of this act and the procedure and practice provided in this act shall apply to all proceedings under this part, except where specifically otherwise provided herein:

Disabilities arising from	Caused by
1. Anthrax	Handling of wool, hair, bristles, hides or skins.
2. Lead poisoning or its sequelae	Any process involving the use of or direct contact with lead or its preparations or compounds.

3. Zinc poisoning or its sequelae	Any process involving the use of or direct contact with zinc or its preparations or compounds or alloys.
4. Mercury poisoning or its sequelae	Any process involving the use of or direct contact with mercury or its preparations or compounds.
5. Phosphorus poisoning or its sequelae	Any process involving the use of or direct contact with phosphorus or its preparations or compounds.
6. Arsenic poisoning or its sequelae	Any process involving the use of or direct contact with arsenic or its preparations or compounds.
7. Poisoning by wood alcohol	Any process involving the use of wood alcohol or any preparation containing wood alcohol.
8. Poisoning by benzol or nitro-, hydro-, hydroxy-, and amido-derivatives of benzene (dinitro-benzol, anilin, and others), or its sequelae	Any process involving the use of or direct contact with benzol or nitro-, hydro-, hydroxy-, or amido-derivatives of benzene or its preparations or compounds.
9. Poisoning by carbon bisulphide or its sequelae, or any sulphide	Any process involving the use of or direct contact with carbon bisulphide or its preparations or compounds, or any sulphide.
10. Poisoning by nitrous fumes or its sequelae	Any process in which nitrous fumes are evolved.
11. Poisoning by nickel carbonyl or its sequelae	Any process in which nickel carbonyl is evolved.
12. Dope poisoning (poisoning by tetrachlormethane or any substance used as or in conjunction with a solvent for acetate of cellulose or nitro cellulose), or its sequelae	Any process involving the use of or direct contact with any substance used as or in conjunction with a solvent for acetate of cellulose or nitro cellulose.

13. Poisoning by formaldehyde and its preparations	Any process involving the use of or direct contact with formaldehyde and its preparations.
14. Chrome ulceration or its sequelae or chrome poisoning	Any process involving the use of or direct contact with chromic acid or bichromate of ammonium, potassium, or sodium or their preparations.
15. Epitheliomatous cancer or ulceration of the skin or of the corneal surface of the eye, due to tar, pitch, bitumen, mineral oil or paraffin, or any compound, product or residue of any of these substances	Handling or use of tar, pitch, bitumen, mineral oil, or paraffin or any compound, product or residue of any of these substances.
16. Glanders	Care or handling of any equine animal or the carcass of any such animal.
17. Compressed air illness or its sequelae	Any process carried on in compressed air.
18. Miners' diseases, including only cellulitis, bursitis, ankylostomiasis, tenosynovitis and nystagmus	Any process involving mining.
19. Cataract in glassworkers	Processes in the manufacture of glass involving exposure to the glare of molten glass.
20. Radium poisoning or disability due to radio-active properties of substances or to Roentgen rays (X-rays)	Any process involving the use of or direct contact with radium or radio-active substance or the use of or direct exposure to Roentgen rays (X-rays).
21. Methyl chloride poisoning	Any process involving the use of or direct contact with methyl chloride or its preparations or compounds.
22. Carbon monoxide poisoning	Any process involving direct exposure to carbon monoxide in buildings, sheds or enclosed places.

23.	Poisoning by sulphuric, hydrochloric or hydrofluoric acid	Any process involving the use of or direct contact with sulphuric, hydrochloric or hydrofluoric acids or their fumes.
24.	Respiratory, gastro-intestinal or physiological nerve and eye disorders due to contact with petroleum products and their fumes	Any process involving the use of or direct contact with petroleum or petroleum products and their fumes.
25.	Disability arising from blisters or abrasions	Any process involving continuous friction, rubbing or vibration causing blisters or abrasions.
26.	Disability arising from bursitis or synovitis	Any process involving continuous rubbing, pressure or vibrations of the parts affected.
27.	Dermatitis (venenata)	Any process involving the use of or direct contact with acids, alkalies, acids or oil, or with brick, cement, lime, concrete, or mortar capable of causing dermatitis (venenata).
28.	Hernia	Clearly recent in origin and resulting from a strain, arising out of and in the course of employment and promptly reported to the employer.
29.	Stone worker's or grinder's phthisis	Quarrying, cutting, crushing, grinding or polishing of stone, or grinding or polishing of metal.
30.	Silicosis	Mining.
31.	Pneumoconiosis	Quarrying, cutting, crushing, grinding or polishing of metal.

Sec. 3. If an employe is disabled or dies and his disability or death is caused by one of the diseases mentioned in the schedule contained in section two of this part and the disease is due to the nature of the employment in which such employe was engaged and was contracted therein, he or his dependents shall be entitled to compensation for his death or for his disablement, and he shall be entitled to be furnished with medical and hospital

services, all as provided in part two of this act, except as hereinafter stated in this part: *Provided, however,* That if it shall be determined that such employe is able to earn wages at another occupation which shall be neither unhealthful nor injurious and such wages do not equal his full wages prior to the date of his disablement, the compensation payable shall be a percentage of full compensation proportionate to the reduction in his earning capacity.

Sec. 4. Compensation shall not be payable for partial disability due to silicosis or other dust disease. In the event of temporary or permanent total disability or death from silicosis or other dust disease, notwithstanding any other provisions of this act, compensation shall be payable under this part to employes in the employments enumerated in section three of this part, or to their dependents in the following manner and amounts: If disablement or death occurs during the first calendar month in which this act becomes effective not exceeding the sum of five hundred dollars; if disablement or death occurs during the second calendar month after which this act becomes effective not exceeding the sum of five hundred and fifty dollars; thereafter the total compensation and benefits payable for disability and death shall increase at the rate of fifty dollars each calendar month. The aggregate amount payable shall be determined by the total amount payable in the month in which disablement or death occurs. In no event shall such compensation exceed an aggregate total of three thousand dollars.

Sec. 5. Neither the employe nor his dependents shall be entitled to compensation for disability or death resulting from such occupational disease, unless such occupational disease is due to the nature of his employment and was contracted therein, or in a continuous employment similar to the one in which he was engaged at the time of his disablement, within twelve months previous to the date of disablement, whether under one or more employers. The time limit for contraction of the occupational disease prescribed by this section shall not bar compensation in the case of an employe who contracted such occupational disease in the same employment with the same employer by whom he was employed at the time of his disablement and who had continued in the same employment with the same employer from the time of contracting such occupational disease up to the time of his disablement thereby.

Sec. 6. In case the employe is alleged to be suffering from an occupational

disease and there shall be a dispute with respect thereto, the said board, or any member thereof, shall appoint a commission of three qualified impartial physicians to examine the injured employe and to report. The report, when signed by at least two of the members of said commission, shall be final and conclusive as to the condition of said employe with respect to the alleged disease or diseases. Members of the commission shall receive such compensation for their services as shall be fixed by the board, to be paid from the appropriation to the department of labor and industry.

Sec. 7. For the purposes of this part the date of disablement shall be such date as the board may determine on the hearing of the claim.

Sec. 8. No compensation shall be payable for an occupational disease if the employe, at the time of entering into the employment of the employer by whom the compensation would otherwise be payable, or thereafter, wilfully and falsely represents in writing that he has not previously suffered from the disease which is the cause of the disability or death. Where an occupational disease is aggravated by any other disease or infirmity, not itself compensable, or where disability or death from any other cause, not itself compensable, is aggravated, prolonged, accelerated, or in any wise contributed to by an occupational disease, the compensation payable shall be such proportion only of the compensation that would be payable if the occupational disease were the sole cause of the disability or death as such occupational disease, as a causative factor, bearing to all the causes of such disability or death, such reduction in compensation to be effected by reducing the number of weekly payments or the amounts of such payments, as under the circumstances of the particular case may be for the best interests of the claimant or claimants.

Sec. 9. The total compensation due shall be recoverable from the employer who last employed the employe in the employment to the nature of which the disease was due and in which it was contracted. If, however, such disease was contracted while such employe was in the employment of a prior employer, the employer who is made liable for the total compensation as provided by this section may appeal to said board for an apportionment of such compensation among the several employers who since the contraction of such disease shall have employed such employe in the employment to the nature of which the disease was due. Such apportionment shall be propor-

tioned to the time such employe was employed in the service of such employers, and shall be determined only after a hearing, notice of the time and place of which shall have been given to every employer alleged to be liable for any portion of such compensation. If the board finds that any portion of such compensation is payable by an employer prior to the employer who is made liable for the total compensation as provided by this section, he shall make an award accordingly in favor of the last employer, and such award may be enforced in the same manner as an award for compensation.

Sec. 10. The employer to whom notice of death or disability is to be given, or against whom claim is to be made by the employe, shall be the employer who last employed the employe during the said twenty-four months in the employment to the nature of which the disease was due and such notice and claim shall be deemed seasonable as against prior employers. The requirements as to notice as to occupational disease and death resulting therefrom and the requirements as to the bringing of proceedings for compensation for disability or death resulting from such occupational disease shall be the same as required in section fifteen of part two of this act, except that the notice shall be given to the employer within one hundred twenty days after the disablement.

Sec. 11. The employe, or his dependents, if so requested, shall furnish the last employer or the board with such information as to the names and addresses of all his other employers during the said twenty-four months, as he or they may possess; and if such information is not furnished, or is not sufficient to enable such last employer to take proceedings against a prior employer under section ten of this part, unless it be established that the occupational disease actually was contracted while the employe was in his employment such last employer shall not be liable to pay compensation, or, if such information is not furnished or is not sufficient to enable such last employer to take proceedings against other employers under section ten of this part, such last employer shall be liable only for such part of the total compensation as under the particular circumstances the director may deem just; but a false statement in the information furnished as aforesaid shall not impair the employe's right unless the last employer is prejudiced thereby.

Sec. 12. Nothing in this act shall affect the rights of an employe, or his dependents, to recover compensation in respect to a disease to which this

act does not apply, if the disease, apart from this act, is one for which compensation is payable under the other provisions of this act.

Sec. 13. This act shall not apply to cases of occupational disease in which the last injurious exposure to the hazards of such disease occurred prior to the effective date of this act.

This act shall not apply to any employer or employe in agricultural industry or in the nursery or orchard business, or to any labor incidental to farming, including repairs on buildings and other property in connection therewith.

_____

Secretary of the Senate.

_____

Clerk of the House of Representatives.

Approved_____

_____

Governor.

RAW MATERIALS AND POTENTIAL HAZARDS

The paint industry ordinarily makes use of a greater number and a greater variety of raw materials than almost any other. Moreover, the number of dangerous substances that are handled in the paint industry is higher on a percentage basis of the total number than is true for almost all other equally large industries.

The Acme White Lead Company, because of the nature of its manufacturing operations and sales activities provides a list of raw materials of various types exceeding that found in any other paint establishment investigated by these workers.

By no means, does the presence of a dangerous substance in a factory establishment mean that inevitably injurious effects will be produced. Similarly, it does not follow that the large number of raw materials coming into this plant means that the nature or number of exposures is necessarily high. Whenever any dangerous substance is present in a work place, its very presence constitutes a potential threat to workers in that vicinity. However, of the total number of potential exposures, the percentage of practical ones may be comparatively very low. Such is the case in this plant.

These remarks preface a long listing of raw materials finding their way into this plant together with the approximate consumption for a recent twelve months' period. These investigators have noted those substances that are known to have caused damage to workers either in other paint establishments or in other industries making use of the same or very similar materials. Necessarily the comment associated with any one item is very limited. For example, scores of pages might be written describing the ill effects of benzol. Instead, it is necessary to limit such comment to a few lines. In a few instances, it has proved impossible to obtain any information relative to the toxic properties of some agents. These substances are catalogued as possessing unknown properties as to toxicity. Those substances possessing well known dangerous properties are starred in order to attract additional attention to the fact that they should be manipulated with respect.

. No attempt has been made in this elaborate listing to include finished products in all instances. Inevitably some intermediate stages appear as raw materials; also certain finished products are re-used in the manufacture of other products. Notwithstanding, this omission of comment on finished products, it may well be recognized that some possess a degree of dangerous properties. For example, paint and varnish removers, as used by the consumer, are substantially as dangerous as the raw materials entering their manufacture.

A listing of raw materials, with various items of comment now follow, on crosswise pages.

Hand Scraping of Post Agitator Tanks After Burning.
Definite Lead Exposure in the Absence of Protection.
Filter Type of Respirator Adequate. Respirators
Should be Well Fitted and Well Serviced.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

RAW MATERIALS--DRY

Code#		Name	Factory (x,y,z) Consumption	Composition	Toxic Properties
2		Zinc Oxide (French Process)	86,164#	1% Impurities 99% Zinc Oxide (ZnO)	Freshly produced zinc oxide, such as found in galvanizing rooms may lead to zinc chills, an acute disease. As used in the paint industry, zinc oxide is substantially harmless. Prolonged gross exposure may produce minor increase in lung markings as seen in x-ray. Also, zinc oxide rarely produces a low grade dermatitis. Essentially non-toxic.
3	**	Silica F.S.A.	188,470	Silicon Dioxide	This substance is the cause of silicosis, a direful dusty lung disease. Extensive exposure is required, over a long period of time, such as from 5-30 years. Lung disease characterized by peculiar nodular scar tissue formation. Presents characteristic x-ray picture. Workers affected become short of breath and are unable to expand chest on breathing. Afflicted workers prone to develop tuberculosis. Very fine particles only (below ten microns) capable of producing the disease. Danger to workmen proportional to dust concentration and duration of exposure.
8		China Clay (American)	170,495	Aluminum Silicate containing 13% combined water of hydration.	China clay is chiefly a mixture of several silicates with varying but low contents of free silica (SiO_2). Silicates nearly harmless as producers of dusty lung disease. Rarely silicosis produced by free silica content when sufficiently high.

Footnotes

(x) Fiscal year beginning September, 1935.
(y) Subsequent items in pounds until otherwise noted.
(z) New material, estimated for 1936-37.

Code#		Name	Factory Consumption	Composition	Toxic Properties
9	**	Lead Sulphate (Sublimed White Lead)	74,800	11-18% Lead Oxide (PbO) 9% (max.) Zinc Oxide (ZnO) Balance Lead Sulphate ($PbSO_4$)	Somewhat less toxic than some other compounds of lead due to decreased solubility. Solubility, however, relatively unimportant, particularly when lead enters the body through inhalation. Small quantities of lead or any of its compounds entering lungs on the order of 1.5 to 5 mgm. per day sufficient to produce lead poisoning in time. Inorganic lead compounds do not enter body through skin, but do enter through ingestion and inhalation. Lead poisoning is a characteristic occupational disease. For extensive details, see "Lead Poisoning", published by the American Public Health Association, 1936. Lead poisoning may effect any portion of the body, such as nerves, muscles, blood vessels, intestinal tract, brain, eyes, glands, etc. It is especially dangerous for women, since it produces abortion and miscarriage. Common manifestations: weakness, loss of appetite, foul taste in mouth, constipation, abdominal cramps, cramps in leg muscles, blue line on gums, etc.
15		China Clay, Imported (White Filler)	48,000	Aluminum Silicates and other Silicates. 13% combined water of hydrogen.	See 8.
17		Indian Red	6,193	97% Ferric Oxide.	This material is almost entirely harmless. In fact, its dust, mixed in with silica, may retard the action of silica. Ordinarily will not produce any skin disease except from mechanical action. Here rated as non-injurious.

Code#		Name	Factory Consumption	Composition	Toxic Properties
18	**	Basic Lead Carbonate (Carter Process)	571,661	Basic Lead Carbonate. (Pb_2CO_3)v	See 9. Slightly more toxic than lead sulphate.
19	*	French Ochre	79,998	19% Iron Oxide (ferric oxide) Balance silica, silicates and combined water of hydration.	Because this ochre contains free silica, extensive exposures to dust may lead to silicosis, although the iron oxide will in some measure act as an inhibitor. See 3.
20	**	Asbestos Pulp (Asbestine)	1,493,850	8% Calcium Carbonate (max.) 8% Magnesium Carbonate (max.) Balance Magnesium Silicate.	Asbestos dust, under conditions of sufficient exposure will produce asbestosis. This disease resembles silicosis. See 3 above. X-ray picture, clinical manifestations and susceptibility to tuberculosis different from conditions arising from silica exposure.
20 (H-O)	**	Asbestos Pulp	205,600 (±)	See 20.	See 20.
20L	*	Talc	359,050	Extra fine magnesium silicate.	Chemically similar to asbestos, but is not fibrous. Gross exposure to talc may produce lung condition analogous to asbestosis. Talc may contain free silica
21	*	Umber (Raw Turkey)	10,633	12-17% manganese dioxide 44% iron oxide. 9% calcium carbonate. Trace of silica and silicates.	Manganese dioxide is present in sufficient percentage to produce manganese poisoning through inhalation of dusts. This disease rarely seen in paint industry. When present, is a permanently, totally disabling affection of brain and nervous system leading to bizarre paralyses, uncontrollable laughter and crying, inability to control legs and arms, etc.

Code#		Name	Factory Consumption	Composition	Toxic Properties
22	*	Umber (Burnt Turkey)	34,610	55% iron oxide 12% manganese dioxide 30% silica and silicates. 2% calcium carbonate	Manganese poisoning conceivably might arise. See item 21, above; the 30% of silica and silicates conceivably might lead to silicosis in the presence of gross and prolonged exposure.
25	*	Italian Sienna	25,442	Chiefly iron oxide (60%). Remainder manganese dioxide, silica and silicates.	See 22, above.
26	*	Italian Sienna (Burnt)	12,060		See item 25.
27		VanDyke Brown	6,683	Chiefly organic material.	No more toxic than coal dust, that is, practically harmless.
29	**	Red Lead	31,333	Lead Oxide (Pb_3O_4)	See 9 above.
42	*	Keystone Filler	24,769	8% carbon, 4% volatile, 88% free silica and silicates.	Under conditions of adequate exposure, sufficient free silica is present to produce silicosis. See item 3.
44	**	Lead Acetate (White)	27,934 (x)	Lead Acetate.	Ready source of lead poisoning when exposure is provided. More soluble than sulphate. For symptoms refer to item 9.
45		Gypsum	73,600	100% hydrated calcium sulphate.	Produces no dusty lung disease--in fact serves to prevent silicosis when admixed with silica dust. Infrequently produces low-grade skin disease from mechanical action chiefly.

Code #		Name	Factory Consumption	Composition	Toxic Properties
48	**	Litharge (powdered)	22,980	Lead Oxide	Ready source of lead poisoning. See item 9.
54		Indian Red	11,998	Iron Oxide. 2% silica and silicates	See item 17.
56		Mineral Black	22,599 (±)	72% Carbon 3% Volatile 25% Silica	Practically harmless. Have seen one case of silicosis from the free silica content of this substance. See 3.
57-O	**	Chrome Yellow (nitrate)	1,992	70% Lead Chromate 30% Lead Sulphate	Definite Source of lead poisoning. See item 9 above.
61		Ultramarine Blue	7,474	May be the same as Prussian blue and therefore chiefly ferric ferrocyanide or may be sodium aluminum thiosilicate. 100% ultramarine blue	If ferric ferrocyanide, any heating to high temperature may give rise to the formation of cyanides and other dangerous nitrogen compounds.
66		Paris Whiting	120,176	Calcium Carbonate	Practically harmless.
91		Metallic Mineral Brown	17,100	50% Iron Oxide, 3% Calcium Carbonate, remainder silica and silicates.	Harmful in proportion to content of free silica. Actual injury unlikely.
96		Marble Dust	133,000	100% Calcium Carbonate ($CaCO_3$)	Essentially harmless. Dust not capable of producing any dusty lung disease of note.
98		Blue Ultra C.U.	13,519	100% Ultramarine Blue	See item 61.

Code #	Name	Factory Consumption	Composition	Toxic Properties
101	Carbon Black	11,775	Essentially pure carbon. Trace of oil.	Essentially harmless.
104	Lamp Black	12,820	100% pure carbon. Trace of oil.	See item 101.
108P	Zinc Oxide	79,400	99% ZnO	See item 2.
119	Winter's Metallic (Iron Oxide)	36,200	65% iron oxide, 4% calcium carbonate, balance silica and silicates.	The percentage of free silica probably not high enough to produce silicosis. Presence of iron oxide tends to inhibit the action of silica.
121	Oxide # 8	4,229	80% iron oxide, 20% mixed silica and silicates.	See item 119.
132	Red Iron Oxide	7,200	80% iron oxide, 20% mixed silica and silicates.	See item 119.
134	Venetian Red	214,760	33% iron oxide, 41% calcium sulphate, 24% calcium carbonate, trace of silica.	Essentially harmless. See item 119.
182	Persian Gulf Oxide	3,883	70-73% iron oxide, 24% silicates 2% calcium carbonate.	Essentially harmless. See item 119.
202 **	Paint Grinders Red Lead	128,642	92% true red lead (Pb_3O_4) 8% litharge (PbO)	Potential source of lead poisoning. See item 9.
213	Blanc Fixe	9,430	100% barium sulphate	Barium is a toxic element but this compound of barium is essentially harmless. Not known as an industrial poison.

Code #	Name	Factory Consumption	Composition	Toxic Properties
214	Bright Red Oxide	2,368	95% iron oxide, 5% silica and silicates.	Essentially harmless.
265	Powdered Starch	6,300	100% amylose.	Essentially harmless. workers develop sensiti starch and may present asthma or starch dermat
298	Bronze Aluminum	15,617	98% metallic aluminum.	Aluminum dust or conta metallic aluminum leads Aluminum dust tends to action of silica and to is beneficial. Aluminu conducive to rapidly pr and to explosion.
306	Barytes # 100	313,950	100% barium sulphate.	Harmless. See item 213
322	Ground Glue	1,067	Animal glue as used dissolved in water.	Rarely this substance l grade skin disease. Un
340 **	Reno Umber Filler	7,390	Approximately 55% iron oxide, 12% manganese dioxide, 30% silica and silicates, 2% calcium carbonate.	See item 22.
354	Black Iron Oxide Magnetic	4,905	Approximately 95% magnetic iron oxide. Trace of silica and silicates.	See item 119.
377	Plaster of Paris	5,984	93% calcium sulphate 7% combined water.	Essentially harmless.

Section of Chemical Laboratory. Just as Continuous Attention is Paid to the Technical Aspects of Paint Products, so Highly Skilled Consideration Should be Extended Possible Dangerous Exposures Throughout the Plant.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

Code #	Name	Factory Consumption	Composition	Toxic Properties
392	Paraffin Wax	11,438	100% paraffin.	Essentially harmless, although vapors of molten paraffin are irritating. Paraffin may lead to skin diseases and rarely to paraffin cancers. As here used, unimportant.
398	Bee's Wax	915	Natural yellow wax.	Rarely produces low grade skin disease. Relatively unimportant.
404 *	Manganese Dioxide	6,810	70% manganese dioxide	Manganese dioxide is a dangerous substance under conditions of extensive exposure. See item 21.
411P **	Pipe Line Cleanings	68,400	65% zinc oxide, 35% basic lead sulphate.	Practical source of lead poisoning. See item 9.
412A **	Leaded Zinc	1,488,733 (z)	65% zinc oxide, 35% basic lead sulphate.	Practical source of lead poisoning. See item 9.
412D **	Leaded Zinc	1,825,800	65% zinc oxide, 35% basic lead sulphate.	Practical source of lead poisoning. See item 9.
412E **	Leaded Zinc	59,750	65% zinc oxide, 35% basic lead sulphate.	Practical source of lead poisoning. See item 9.
440	Magnesium Carbonate	4,150	98% magnesium carbonate, 2% calcium carbonate.	Almost entirely harmless. Used in medicine.
443	Aluminum Silicate	12,400	Aluminum silicate with 13% water hydration.	See item 8.

Code #	Name	Factory Consumption	Composition	Toxic Properties
461H	Special High Body Lithopone	842,700	70% barium sulphate, 30% zinc sulphide.	Essentially harmless. Although barium is toxic, barium sulphate is not toxic. Zinc sulphide possesses no known toxic properties. Long used in paint as substitute for more harmful lead.
461V	Lithopone	387,650	70% barium sulphate 30% zinc sulphide.	See item 461H
461E	Lithopone	101,800	70% barium sulphate 30% zinc sulphide.	See item 461H
461NH	Lithopone	897,732 (x)	70% barium sulphate 30% zinc sulphide	See item 461H
461S	Lithopone (manufacturers)	1,470,245	70% barium sulphate 30% zinc sulphide	See item 461H
488	Graphite (natural)	240,366	72-74% carbon 27% silica and silicates.	Because of free silica content, there is a remote possibility that this may be a source of dusty lung disease. Occasionally produces skin disease. Practically harmless.
528	Carbon Black	14,775	Practically 100% carbon, trace of oils.	See Item 101.
539	Pumice Stone (powdered)	2,667	100% silica and silicates	Because of a fair percentage of free silica, pumice is possible source of silicosis under conditions of gross exposure. As here used, essentially harmless. From mechanical action, skin disease occasionally appears.

Code#	Name	Factory Consumption	Composition	Toxic Properties
547	Aluminum Stearate	23,750	100% aluminum stearate	Occasional source of skin disease.
566	White Mineral Primer	305,200	100% calcium carbonate	See 66.
622	Hydrated Lime (Hydro-Caloine)	55,168	Mixture of oxides of calcium and magnesium	Essentially harmless. Very rarely contains arsenic as an impurity in traces.
809	Venetian Red	6,642	85% iron oxide 5% calcium sulphate 10% silica and silicates	See 119.
1003	Lamp Black	7,890	100% carbon	See 101.
1006 *	French Ochre	6,360 (z)	19% iron oxide 81% silica and silicates and combined water of hydration.	See 19. Ochres at times contain lead as an impurity. Remote source of lead poisoning.
1026	Cobalt Acetate	3,200	Contains not less than 23% cobalt.	The toxicity of cobalt is uncertain. It should be used with respect. In the mining of cobalt, lung cancer is frequent.
1044	Zinc Oxide	193,140	Essentially 100% zinc oxide.	See item 2.
1044A	Zinc Oxide	104,932 (z)	Essentially 100% zinc oxide.	See item 2.
1093	Super-cel Filtering Agent	30,862	Exact composition not known.	Believed to be silicdous powder. Harmful in proportion to the free silica content and in proportion to exposure provided.
1097	Titanox Pigment	368,250	25% titanium dioxide 1% aluminum 74% barium sulphate	Titanium dioxide is a very inert substance. Recent reports describing "titanosis" as a dusty lung disease, probably not warranted. Here rated as innocuous.

Code#		Name	Factory Consumption	Composition	Toxic Properties
1117	*	Antimony Oxide (Timonox)	3,200	98% antimony oxide	Antimony is a dangerous substance, particularly when inhaled as dust. It is more toxic than lead. Chief manifestations related to gastro-intestinal tract. Small quantity used in this plant precludes extensive practical hazard.
1119		Tuscan Red	1,655	24% iron oxide 16-20% organic coloring matter Balance silica and silicates	Harmful in proportion to content of free silica. Contains small percentage of phosphorus. However, unknown to be dangerous.
1122		Flax Soap	5,417	Linseed oil soap.	Occasional source of skin disease, including boils (furuncles).
1128	**	Litharge	31,953	Lead oxide	See item 9.
1132		Ochre (ferrite, yellow, light)	78,987	87% ferric oxide 13% silica and silicates	See item 119.
1133	**	Litharge	16,775	78% iron oxide 5-12% calcium sulphate	See item 119.
1140	**	Lead Carbonate (white lead)	20,267	Pure basic lead carbonate	See item 9.
1147		Ultra Blue CS	3,008	100% ultramarine blue	See item 98.
1151	**	Lead Carbonate (electrolytic process)	5,235	Pure basic lead carbonate.	See item 9.

Code#	Name	Factory Consumption	Composition	Toxic Properties
1157	Red Indian	12,392	95% iron oxide 5% silica and silicates	See item 119.
1159	Oxide Venetian Red	23,285	85% iron oxide 15% silica and silicates	See item 119.
1165	Metallic Princes	6,432 (z)	80% iron oxide 2% calcium carbonate 18% silica and silicates	See item 119.
1166	Red Indian	4,746	85% iron oxide 15% silica and silicates	See item 119.
1167	Oxide #6	4,000	90% iron oxide 10% silica and silicates	See item 119.
1168	Oxide #9 (purple)	4,125	82% iron oxide 18% silica and silicates	See item 119.
1194	Whiting	583,877	100% calcium carbonate	See item 96.
1195	Bone black (cosmic black)	18,811	4-10% carbon Balance calcium phosphate, calcium carbonate and moisture	Substantially harmless.
1206 *	Slate Flour (green)	7,544	Mixture of free silica and silicates with other minerals. Content of free silica as high as 27%.	Because of a fairly high con of free silica, possible sou dusty lung disease. See ite

Code#	Name	Factory Consumption	Composition	Toxic Properties
1208H	Cryptone (double strength lithopone)	358,900	52% zinc sulphide 48% barium sulphate	See 461H
1208N	Cryptone	1,411,800	52% zinc sulphide 48% barium sulphate	See 461H
1208S	Cryptone	152,500	52% zinc sulphide 48% barium sulphate	See 461H
1211 *	Raw Turkey Umber	8,850	12-77% manganese dioxide 44% iron oxide 9% calcium carbonate	See item 21.
1212 *	Burnt Turkey Umber	17,550	55% iron oxide 12% manganese dioxide 30% silica and silicates 2% calcium carbonate.	See item 21.
1213 *	Raw Italian Sienna	37,250	47-50% iron oxide Balance manganese dioxide, silica and silicates.	See item 25.
1214 *	Burnt Italian Sienna	6,400	63% iron oxide Balance manganese dioxide, silica and silicates	See item 25.
1220	Mepham's Oxide	8,465	90% iron oxide 3% calcium carbonate 7% silica and silicates	See item 119.
1226	1/2 Sec. R.S. Cotton	98,883	100% 1/2 Sec. nitrated cotton.	As such, nitrocellulose is r burned, may give rise to hig oxides of nitrogen gases. A substance may be wetted with natured with methanol and at

Code #	Name	Factory Consumption	Composition	Toxic Properties
1231	Mepham's Oxide	6,550	Chiefly iron oxide, with a considerable percentage of free silica and silicates.	See item 119.
1246	Powdered Soapstone	152,745	Mixture of complex silicates with some free silica.	Harmful in proportion to free silica content and extent of exposure.
1259	Lamp Black	1,660	Approximately 100% carbon.	See item 101.
1263	Lamp Black	5,080	Approximately 100% carbon.	See item 101.
1271	Calcium Titanox	75,650	30% titanium oxide 70% calcium sulphate	Essentially harmless. See item 1097.
1288	Chinese Blue	1,225	100% ferric ferrocyanide.	Harmless unless highly heated. Dangerous in the presence of fires.
1400	Prussian Blue	3,883	100% ferric ferrocyanide.	See item 1288.
1403	C. P. Oxide	320,120	Chiefly iron oxide.	See item 101.
1403X1	Titanium Dioxide	160,704 (x)	100% titanium dioxide.	Harmless. See item 1097.
1403V	Titanium Oxide	128,100	Titanium Dioxide.	Harmless. See item 1097.
1409	Zinc Stearate	5,280	Pure zinc stearate.	Widely used as a baby powder although a few persons acquire skin disease from its action.
1417	Alizerine Lilac Lake	615	25% organic color 75% alumina hydrate.	Essentially harmless.

Code #	Name	Factory Consumption	Composition	Toxic Properties
1421	Alumina Bronze	600	100% metallic aluminum powder.	See item 292.
1430 *	Napico Yellow	6,440 (z)	Believed to be chrome yellow.	Obvious possible source of lead poisoning. See item 9.
1448 *-*	White Star Timinox	10,040	100% antimony oxide.	See item 1117.
1508	Ultramarine Blue	674	100% ultramarine blue.	See item 61.
1509	Air Floated Snow Floss	2,900	Pure zinc stearate.	See item 1409.
1510	Bone Black	15,870	10-12% carbon, contains organic material.	Essentially harmless.
1522	Atlantic Blue	7,820 (z)	100% ferric ferrocyanide.	See item 1288.
1526 **	Leaded Zinc	627,150	50% zinc oxide, 40% basic lead sulphate.	Obvious possible source of lead poisoning. See item 9.
1531 *	Asbestos fibre	1,400	Complex magnesium silicate with impurities.	See item 20.
1533	Pale Gold Lacquer Striping	350	Inadequate information.	Inadequate information.
1538	Zinc Sulphide	214,957	100% zinc sulphide.	Harmless. See item 461H.
15380	Zinc Sulphide Off Shade	46,200	Zinc sulphide.	See item 461H

Code #	Name	Factory Consumption	Composition	Toxic Properties
1539 **	Asbestos Fibre	28,440	Complex magnesium silicate with impurities.	See item 20.
1548	Yellow Crude Scale Wax	1,288 (s)	Low grade paraffin.	Possible source of minor skin disease. See item 392.
1550	Zinc oxide	109,090	Zinc oxide (ZnO).	See item 2.
1552	Filtering Agent	32,790	Information incomplete.	See item 1093.
1570 **	Orange Mineral Triple A	2,700	95% true red lead.	Obvious source of lead poisoning. See item 9.
1571.	Bone Black	34,885	10-12% carbon. Contains organic material.	See item 1510.
1576	Vernaluminum	31,261	65% aluminum minimum 35% naphtha.	Aluminum content harmless. Naphtha, like all light petroleum derivatives may produce acute or chronic systemic disease or localized skin disease. Acute intoxication common. Commonly termed "naphtha jag". Chronic form rare and resembles multiple sclerosis. Associated with damage to liver and kidneys. For elaborate discussion see Hayhurst's article, "Industrial Medicine", 1935 or 1936.
1577	Calcium Linoleate Pulp	48,852	70% water, 30% calcium linoleate.	Frequent source of low grade skin damage.

Code #	Name	Factory Consumption	Composition	Toxic Properties
1721 **	Permanent Green	4,928	100% hydrated chromium oxide	Some, but not all, chromium c toxic. Systemic disease unkn least rare. Produces deep bu resisting treatment. Leads t characteristic ulcer known as Perforation of nasal septum v lesion. Will act on unbroken workers become sensitized to they react to most trivial ex
1728	Cosmic Black	7,688	Carbon Black.	Essentially harmless.
1746	Aluminum Bronze	8,700	100% aluminum bronze.	Harmless except in connection explosions. See item 292.
1747	Standard Varnish Aluminum	9,250	100% aluminum bronze.	See item 292.
1748	Special Toning Black	4,068	Lacquer paste dye.	No known toxicity.
1749	Franchon Maroon	650	Information incomplete.	Information incomplete.
1750	Midway Maroon	944	See T-293	No known toxicity.
1779	Powdered Mica	30,500 (±)	Complex sodium, potassium magnesium silicate. Unfixed chemical constituency.	Action of mica dust similar t talc. See item 20L. Practic unlikely.
1796 **	Ming Orange	2,875	72% lead chromate 19% lead sulphate 9% other lead compounds.	Obvious possible source of le See item 9.
1814	Petrolatum Paste	1,844	Stanoline amber petrolatum paste.	Possible source of low-grade

Code#		Name	Factory Consumption	Composition	Toxic Properties
1817		Surfex	7100	Treated calcium carbonate.	Calcium carbonate essentia See item 66.
1825		Lithopone (treated)	153,650		See item 461H.
1830		Chinese Blue	2,033	100% ferrioferrocyanide.	See item 1288.
1831		Chinese Blue	4,253	100% "	See item 1288.
1832		C.P. Prussian Blue	1,800	"	See item 1288.
1857	*	Dry Ice	47,824 (z)	Solid carbon dioxide	Used in varnish manufactur burns following direct con of finger tips almost inev direct handling.
1877		Extra Fine Lining Bronze	4,600 (z)	100% aluminum	See item 292.
1897		Titanium Dioxide	117,264 (z)	Titanium-barium mixture, 30% TiO_2	See item 1097.
D1785	*	Chrome Yellow	2,868 (z)	Mixture of lead chromate and lead sulphate.	Obvious source of lead poi item 9.
10109		Para Toner (deep)	11,910 (z)	95% organic color 5% calcium carbonate	Theoretically may contain Real toxicity not proved. material possibly highly t
10121		Para Toner (light)	19,845 (z)	92% anilin color 8% calcium carbonate	See 10109.

Code#	Name	Factory Consumption	Composition	Toxic Properties
10132	Alizarine Lake Red	1500 (z)	19% organic coloring matter 68% aluminum hydroxide 15% barium sulphate 3% calcium phosphate	No proved toxicity.
10180	Scarlet Lake	900 (z)	23% organic color 12% aluminum hydroxide 65% barium sulphate	No proved toxicity.
10189	Toluidine Toner Red	15,735 (z)	Pure toluidine toner and chloroform extraction over 98%	Raw materials and intermediates believed to be highly toxic. May produce acute nephritis, cyanosis, dizziness, bladder disturbances, bloody urine, damage to the blood. As here used, essentially unimportant.
10257	Lake Maroon Toner	1,116 (z)	40% anilin color 10% aluminum hydrate 50% barium sulphate	No proved toxicity.
10265 **	Vermillion Ruby (deep)	8,100 (z)	42% barium sulphate 6% aluminum hydrate 37% orange mineral 15% eosine lake	Because of red lead and lithrage content, this pigment material may be definite source of lead poisoning under conditions of exposure. See item 9.
10276	Tuscan Red	11,187 (z)	26% blanc fixe 28% Indian red 39% barytes 7% organic dye	This complex mixture is essentially harmless. More closely related to item 119, which see.
10277	Lake Turkey Red (light)	2,418 (z)	20% organic dye 80% blanc fixe	This dye may contain free anilin which is toxic and possibly a skin irritant. As here used, not known to be important.

Code#		Name	Factory Consumption	Composition	Toxic Properties
10293		Para Red (light)	1266 (z)	25% organic coloring matter 75% barium sulphate.	See item 10109.
10294		Para Red (dark)	5,022 (z)	75% barium sulphate 25% organic coloring matter.	See item 10109.
11023		Chinese Blue	8,490 (z)	Ferricferrocyanide.	See item 1288.
11024	**	Milori Green	35,442 (z)	Green chromic oxide.	See item 1721.
11025	**	Chrome Green (light)	60,141 (z)	83% lead chromate 9% lead sulphate 8% ferrocyanide.	See item 9.
11080	*	Salvaged Green	3,480 (z)	25% chrome green 67% barytes 8% china clay.	Because of chromium content, this agent may be harmful. See 1721.
11087	**	Chrome Green (olive)	3,138 (z)	100% chrome green.	See item 1721.
11095		Prussian Blue	7,380 (z)	97% ferrocyanide blue.	See item 1288.
11112		Lake Green Deep	150 (z)	39% blanc fixe 21% aluminum hydrate 40% coloring matter .	If green pigment be either of chromium or lead, which is not known from information available, this substance is potentially harmful.
11133	*	Chrome Green Dark	3,024 (z)	100% chrome green.	See item 1720.

Code#	Name	Factory Consumption	Composition	Toxic Properties
11163 **	Chrome Green Light	17,133 (x)	80.9% lead chromate 11.5% lead sulphate 7.6% ferrocyanide.	Obvious potential source of lead poisoning. See item 9.
11164 *	Chrome Green Medium	40,467 (x)	100% chrome green.	See item 1721.
11165 *	Chrome Green Dark	528 (x)	100% chrome green.	See item 1721.
11212 *	Light Chrome Green	2,208 (x)	100% chrome green.	See item 1721.
12007 **	Chrome Yellow	30,948 (x)	73% lead chromate 27% lead sulphate.	Obvious potential source of lead poisoning. See item 9.
12010 **	Chrome Yellow Medium	24,030 (x)	100% lead chromate.	See item 9.
12054 *	Zinc Yellow	3,408 (x)	60-70% combined zinc chromate.	Potential source of chromium poisoning. See item 1721.
12204 **	Nitrate Yellow	629 (x)	54.68% lead chromate 44.35% lead sulphate.	Obvious potential source of lead poisoning. See item 9.
12311 **	Chrome Yellow Orange	111,411 (x)	36.5% lead oxide 2.5% lead sulphate 61% lead chromate.	Obvious potential source of lead poisoning. See item 9.

In the foregoing comment upon the potential toxic properties of dry substances used in this plant, many specific items are eliminated in order to avoid unnecessary repetition. In this listing there appears a score or more various shades of green, orange, yellow, lemon, etc., all representing mixtures of lead chromium combinations. Nothing would be gained by the inclusion of every individual item. Sufficient have been included to indicate that chromium and lead respectively are toxic.

A few items have been left off this list due to the lack of any information as to their chemical nature. This statement refers particularly to various maroons and similar substances in which aniline dyes of unknown composition have entered. However, in substantial fashion this listing provides information as to toxic properties of practically all dry substances used in this plant.

Code#	Name	Factory (x,y,z) Consumption	Composition	Toxic Properties
82	Standard T.N. Shellac	58,076	Natural orange shellac. Probably contains traces of arsenic as an impurity or as a preservative.	Dry shellac is essentially non-irritating but occasionally produces skin disease through sensitization. As used, shellac may be definitely irritating due to cutting agents. Many cases of intoxication from wood alcohol used as solvent for shellac.
102	"E" Rosin	284,421	Natural Conifer Rosin.	Low grade skin irritant.
253	Kauri Gum Brown	24,979	Natural gum.	Possible source of skin disease.
259	Damar Singapore	68,017	Natural gum.	Possible source of skin disease.
268	Rosin "M"	273,732	Natural gum.	Minor source of dermatitis.
568	Congo # 4	17,070	Natural gum.	Potential source of skin disease.
587	Shellac Bone Dry Bleached	102,350	Natural gum with possible trace of arsenic as an impurity or preservative.	See item 82.
596	East India Nibs Pale	64,454	Natural gum.	Possible source of skin disease.
630	Ester gum	270,190	Synthetic rosin. Glyceride of abietic acid.	Possible source of skin disease.
637	Rosin "WW"	423,016	Natural gum.	May cause skin affections.

Code #	Name	Factory Consumption	Composition	Toxic Properties
996	Asphaltum Gum # 5	162,697	Asphaltic tar bituminous.	When heated emits a diversity of vapors, many of which are irritating to the eyes, mucous membranes and skin.
1084	Damar "Batavia"	16,559	Natural Gum.	Potential source of skin disease.
1087	Gilsonite	245,475	Mineralized tar-like body, general order of asphaltum.	See item 996. Remote possibility of respiratory tract irritation. A possible source of skin disease.
1238	Damar	27,492	Natural gum.	Has caused skin disease.
1239	Damar Gum D^{L} Grade	8,250	Natural gum.	Potential source of skin disease.
1262	Amberol	75,506	Modified synthetic glycerol resin.	Known source of skin disease.
1297	Resin N (synthetic)	223,628	Synthetic type of resin.	Possible source of skin disease.
1298	Resin EH (synthetic)	32,720	Synthetic type of resin.	Potential source of skin disease.
1431	Rezyl # 19	42,971	Rezyl type condensation resin. Phthalic glyceride.	Known irritant to the respiratory tract, eyes and skin.
1434D	Amberol # 801 (dark)	27,604	Modified synthetic glycerol resin.	Possibly capable of inducing skin disease.
1512 **	Phthalic Anhydride	279,465	Phthalic acid.	Definite source of skin disease. Causes bronchitis, eye irritation, etc.

Code #	Name	Factory Consumption	Composition	Toxic Properties
1575	Super-Beckacite	100,403	Synthetic type of condensation resin.	Known source of skin disease.
1714	Amberol # 102	12,906 (x)	See item 1434 D.	See item 1434D.

Of all of the thousands of gums or resins, natural and synthetic, potentially used in the manufacture of varnishes and closely related coating materials, nearly every one may be the cause of skin injury to workmen. The natural resins or gums are less likely than synthetics to be an active skin irritant or skin sensitizer. In any one varnish plant, it is unlikely that a large experience will be developed relative to skin affections among workers, and yet in the aggregate the total number of such cases throughout the country is appreciably high. This matter of skin diseases from resins has been investigated by the United States Public Health Service and published in various papers emanating from the Treasury Department of the Federal Government, such as in the Public Health Bulletins. One article appears in the American Journal of Public Health for the year 1936. A fairly elaborate dermatologic bibliography may be brought together covering this aspect of varnish manufacture. Additional discussion may be found in a subsequent section of this report, dealing with skin diseases.

(See Journal of the American Public Health Association, June 1936, Vol. 26, No. 6 "Dermatitis from Synthetic Resins and Waxes" by Louis Schwartz)

RAW MATERIALS--LIQUIDS--CIRCLES

Code#	Name	Factory Consumption	Composition	Toxic Properties
(1)	Acid Refined Linseed Oil	12,400 gal.		Occasionally leads to minor skin disease. In connection with storage in enclosed areas and when coated on surfaces, may give off carbon dioxide or other asphyxiants. Tank cars and other tanks lately empties of this oil should not be entered without due caution and protection.
(2)	Raw Linseed Oil	295,299 gal. (x)		See item 1.
(3)	Raw Perilla Oil NB	172,984 gal.		See item 1.
(13)	Boiled Linseed Oil (common)	17,181 gal.		See item 1.
(14) **	Turpentine Spirits (steam distilled)		Discontinued.	This variety of turpentine has in years past proved to be exquisitely irritating to the skin. Some batches appear to be more irritating than others. Outbreaks of skin disease have occurred in epidemics. The steam distilled wood turpentine apparently is more irritating than the destructively distilled. It is noted that this grade of turpentine has been discontinued by this Company. This is commendable, primarily for customer protection and satisfaction, but to a considerable extent for the protection of workers in this plant.
(44)	Varnish Makers Linseed Oil	80,844 gal.		This is a 100% linseed oil. See item 1.
(63) *	Liquid Petroleum Naphtha (benzine)	327,274 gal.	100% mineral spirits.	See general discussion under item 1576, drys.

Code#		Name	Factory Consumption	Composition	Toxic Properties
					Petroleum hydrocarbons in general are practically harmful in proportion to the volatility. Those agents falling into the general category of gasolines or so-called benzine naturally are more troublesome than higher boiling agents such as kerosene, naphtha, Stoddard's solvent, etc.
(92)	*	Gum Base Dryer	600 gal.	19% vegetable oil 12% gum 47% mineral spirits 17% turpentine 5% dryer	See items 63 and 1576.
(113)		Raw Castor Oil	16,937 gal.		In spite of the bland qualities of this oil, and its extensive use in medicine internally and externally, it still occasionally leads to sensitization and violent skin disease. This statement is not to be regarded with apprehension.
(114)	**	Wood Alcohol (Methyl alcohol, methanol)	539 gal.		To the fullest extent possible, this agent should be eliminated from all coatings manufacture. Its use and misuse has been accompanied by disaster throughout the land. The fact that it produces total and permanent blindness makes of this agent a source of most pathetic occupational affections. The fact that it possesses intoxicating properties and a fairly agreeable taste tempts the unwary to consume this deadly agent for beverage purposes. The total number of deaths from the use and misuse of wood alcohol in this country in the past 25 years is high and particularly was high during the prohibition era. If it be necessary to use this agent,

Code#		Name	Factory Consumption	Composition	Toxic Properties
					all workers should be fully acquainted with its properties, warnings should be definite and protection should be extensive. However, the 5% of wood alcohol used for denaturing purposes is not known to be sufficient to bring about disaster under ordinary manufacturing conditions.
(140)		Raw China Wood Oil (Tung oil)	254,581 gal.	100% vegetable oil.	Rather frequent source of skin disease. Otherwise, refer to item 1 above.
(141)		Kerosene (deblocmed)	65,922 gal.	100% mineral spirits.	See items 63 and 1576.
(149)	***	90% Benzol (benzene)	21,283 gal.	100% benzol.	At the present time, the consumption of benzol in paint manufacture is practically nil compared with the period ten or fifteen years ago. The reason for this diminution in use is primarily the well known dangers to users of benzol coatings and to a lesser extent the manufacture of such articles. The toxicologic literature of this country is replete with articles on benzol poisoning. The present investigators have written a small book presenting the outstanding features of benzol poisoning and the conditions under which it may arise. This coal tar hydrocarbon, when present in such concentrations as 100 parts per million of air may in time cause chronic poisoning. Such a concentration as 1000 parts per million almost inevitably will affect the majority of workers long exposed. A very high concentration will lead to acute benzol poisoning, which

Code#	Name	Factory Consumption	Composition	Toxic Properties
				is entirely different to the better known chronic form. In the acute variety, the outstanding manifestetion is narcotism, with death occurring in a few hours or a few minutes. In the chronic variety, the chief point of action is upon the cells of the blood leading to marked diminution in both white and red cell counts. The ensuing condition is described as aplastic anemia. It is the intent of this extended comment to discourage the use of benzol and to urge full protective apparatus and procedure connected with its every use in this plant.
(186)	* Fish Oil	55,832 gal.		It is not determinable from the information at hand that this item refers to fish oil or to blown fish oil. The fish oil itself is malodorous, but not particularly injurious. It may produce nausea, distaste for food, neuroses, but after all is not highly toxic. On the other hand, when this oil is air blown and heated, its offensive properties become multiplied and in addition acrolein and other aldehydes are produced. Acrolein is a highly irritating substance to the eyes and mucous membranes. Lately it has been described by McNally as conducive to systemic disease. At the present time, this last statement is open to question. This substance is rated as offensive rather than highly toxic.

Code#		Name	Factory Consumption	Composition	Toxic Properties
(187)	*	Methyl Acetone	19,442 gal.		Until recently acetone has been regarded only as a skin hazard. Recent work tends to attach some significance as a source of systemic disease. See the Journal of Industrial Hygiene, Vol. 18, February, 1936, "The Relative Toxicity of Acetone, Methyl Alcohol and their Mixtures".
(213)	*	Blown Linseed Oil	696 gal.		See item 1. However, blown linseed oil is apt to be a more active skin irritant than ordinary linseed oil. Still, not dangerous.
(225)		Coal Tar Creosote Oil	5,145 gal.	100% creosote oil.	This oil represents a hodge-podge of organic acids, phenolic bodies, etc., nearly all of which are capable of definite skin injury. These investigators have seen outbreaks of skin diseases caused by creosote oil. However, this term creosote oil is applied to a variety of chemicals so that the condemnation above made may not apply to all varieties.
(235)		Turkey Red Oil	179 gal.		This bland oil is essentially harmless.
(241)	**	Toluol	248,011 gals.	100% C.P. toluol.	This widely used solvent is a homologue of benzol, and possesses toxic properties of very similar nature. It is less toxic only because its boiling point is higher. The clinical picture produced through the action of toluol is identical or at least very similar to that for benzol. See item 149.

Code#		Name	Factory Consumption	Composition	Toxic Properties
(291)	*	Mixing Varnish	1,744 gal.	31.19% wood oil 32.2 % perilla oil 35.55% mineral spirits .64% manganese .32% cobalt.	This mixture is significant chiefly because of its petroleum spirits content. The manganese and cobalt present are in such low quantities as to be comparatively unimportent. Practical source of skin disease.
(293)		Pine Oil	1,325 gal.	100% pine oil.	This distillation product connected with turpentine manufacture has both been a source of skin disease and recommended treatment for skin disease. It has proved useful in the treatment of athlete's foot and other ring worm infections. As here used is fairly unimportent.
(330)	*	Ethyl Alcohol	93,511 gal.	95% drain alcohol.	When used under conditions facilitating evaporation such as around Banbury materials so much evaporation may take plase as to produce alcoholic intoxication. When gross evaporation takes place connected with work operation exhaust devices are desirable.
(348)	*	Mineral Spirits Naphtha	916,236 gal.	100% mineral spirits.	See item (63) and 1576 Dry.
(418)		Raw Soya Bean Oil	18,055 gal.	100% soya bean oil.	Possible source of skin disease. See item (1).
(423)		Bodied Soya Bean Oil	14,695 gal.	100% vegetable oil.	See item (418).
(423)	*	Glycerine	8,569 lbs.	100% glycerine.	Contact with glycerine of concentration greater than 25-30% may lead to skin irritation. Irritating when heated to high temperatures.
(515)		Heat Bodied Oil	3,180 gal.	100% linseed oil.	See item 1.

Code#		Name	Factory Consumption	Composition	Toxic Properties
(584)	*	Xylol	169,084 gal.	100% xylol.	This solvent is a higher homologue of benzol and along with toluol has been much substituted for benzol. Having a higher boiling point, its vapors do not readily arise in connection with its use. It is a preferred substitute on this account for benzol. However, it is highly toxic and should be used with caution. It produces disease states similar to benzol but cases are rare. See item(149).
(1167)	**	Butyl Alcohol	47,157 gal.	100% butyl alcohol (butynol).	In low concentrations beginning at 100 p.p.m. may produce dermatitis, nephritis, anemia, pulmonary hemorrhage, degeneration of the liver, etc.
(1170)	*	Butyl Acetate	151,632 gal.	Butyl acetate.	More of an irritant than ethyl acetate, but is regarded as less injurious than synthetic amyl acetate, which, in turn, is believed to be more objectionable then the natural product.
(1171)		Amyl Acetate	7,415 gal.	Amyl acetate.	The synthetic variety is more active toxicologically than its natural counterpart. Both varieties lead to irritation of the eyes, mucous membranes, respiratory tract and occasionally the skin. Comparatively harmless.

Code#	Name	Factory Consumption	Composition	Toxic Properties
(1257) **	High Flash Solvent Naphtha	78,972 gal.	In an earlier day solvent naphtha usually consisted of a mixture of benzol and toluol, but in recent years specifications have changed so that solvent naphtha contains only traces of benzol with a high percentage of a mixture of xylol and toluol, with the former predominating.	For toxicity see items (241) and (584) which in turn refer to item (149).
(1273)	Fine Soya Bean Oil	5,850 gal.	100% Soya Bean Oil.	See item (418)
(1467)	Eldorado Engine Oil	323 gal.	Paraffin oil.	When highly heated vapor or fume is nauseating and slightly irritating. Rarely skin disease may be produced. Even more rarely skin cancers may be produced by paraffin.
(1518)	Eldorado Engine Oil	2,503 gal.	Paraffin Oil.	See item (1467)
(1620)	Dibutyl Phthalate	80,825 lbs.	Dibutyl Phthalate	Little information available. As observed in other industries by these investigators quite innocuous. Does not evaporate at all easily.
(1621) *	Lindol Tricresyl Phosphate	17,424 lbs.	Tricresyl Phosphate	This substance is the source of the famous "jake paralysis" epidemic during the prohibition era. It is therefore an outstanding toxic agent when taken internally. It is not known that any industrial cases have arisen or that they may arise in ordinary pursuits. No less, it should be manipulated with caution.

Code#		Name	Factory Consumption	Composition	Toxic Properties
(1622)		M.L. Ansol	2,605 gal.	Full information not available.	Full information not available.
(1634)		Blown Castor Oil	67,554 lbs.	Oleum ricinus	See item (113)
(1657)	*	Lacquer Base	973 gal.	Butyl acetate, isopropyl acetate, special naphtha dryolene, xylol, toluol, butyl alcohol and 1/2 Sec. R. S. cotton	This complex mixture of coal tar hydrocarbons, acetates, esters, naphtha and alcohol may lead either to acute or chronic disease of serious nature, also skin disease may be produced.
(1674)		Plasticizer	446 gal.	No information as to exact type of plasticizer specified.	No information as to exact type of plasticizer specified.
(1682)	*	Butyl Cellosolve	24,039 lbs.	Butyl cellosolve.	Slightly more toxic than ethyl cellosolve which is reported by the Federal Government as possessing only limited toxicity. Chiefly a respiratory tract irritant.
(1686)		Special Naphtha Dryolene	183,223 gal.	Chiefly a petroleum fraction.	See 1576 Dry and (63)
(1695)	*	Eastman's Film Scrap Solution	1,638 gal.	Exact composition not known. Probably represents a mixture of coal tar solvents, esters, acetates, and alcohol.	Breathing of these vapors may lead to mixed intoxication.
(1696)		Lacquer Base	37,139 lbs.	See (1657).	See (1657).
(1711)		Fish Oil Settlings	31,222 lbs.	100% fish oil.	See (186).

Code#	Name	Factory Consumption	Composition	Toxic Properties
(1764)	Guaiacol Liquid	507 gal.	Guaiacol 100%.	Used medically in cough syrup. Industrial intoxication not known.
(1807)	Cotton Solution	563,243 lbs.	See specimen formulae of thinners, solvent bases, flatting bases, reducers, etc. furnished at the end of this section.	See comment on toxicity at the end of this section.
(1830)	Cotton Solution	2,012 lbs.	See item (1087)	See item (1087)
(2049)	Dipentine	2,477 gal.	Fraction from wood distillation constituent of turpentine.	Chiefly skin irritant resembling turpentine in its action.
(2100)	China Wood Oils - Fatty Acids	4,144 lbs.	China wood oil - fatty acid.	The solid fatty acids are relatively innocuous. Occasionally produce minor skin disease.
(2113)	Synthetic Short Oil Mixing Varnish	847 gal.	Please refer to specimen formulae synthetic vehicle oil types at the end of this section.	See comment on toxicity at the end of this section.
(2120)	Fatty Acids - Linseed	99,742 lbs.	Solid fatty acids of vegetable origin.	See (2100).
(2211)	* Nuodex Lead Drier	397 gal.	Gum 20%, mineral spirits 80%. However, this drier is believed to have a 24% lead content.	Important toxicologically in proportion to the lead content. See item 9 Dry. Also contains mineral spirits. See item (63).
(2310) F	* Elastoil "K"	3,003 lbs.	100% fish oil.	See item (186).

Code#	Name	Factory Consumption	Composition	Toxic Properties
(2506)	Nuodex 6% Manganese	4,544 lbs.	Gum 20%, mineral spirits 80%, with manganese.	(2211) Analogous to/manganese. However, manganese is present instead of lead. 6% of manganese may not be an important source of manganese poisoning. May not be accepted as entirely harmless. See item (2211).
(2507)	Nuodex 6% Cobalt	1,900 lbs.	Similar to items (2211) and (2506) except for presence of cobalt instead of manganese or lead.	Toxicity of industrially used cobalt somewhat uncertain. This agent may be chiefly important because of mineral spirits content. See item (63).
(2608)	Base Lacquer	162,659 lbs.	See specimen formulae at end of this section.	See discussion of toxocity of complex mixtures furnished at the end of this section.
(2611)	Isopropyl Acetate	66,738 gal.	100% isopropyl acetate.	Same order of toxicity as ethyl acetate, which is known to produce low grade respiratory irritation, nausea and rarely headache.
(2646) *	Hydrogenated Naphtha	13,383 gal.	Hydrogenated naphtha.	This modified naphtha is believed to possess no toxic properties beyond those possessed by straight naphtha. Lately there has been some claim that hydrogenation of naphtha leads to the formation of a variety of cyclic compounds of higher toxicity than straight naphtha. Very extensive use of hydrogenated naphthas in the experience of these investigators has lead to no single case of poisoning through a period of nearly two years. For the time being this agent is rated as no more toxic than naphtha.

Code#	Name	Factory Consumption	Composition	Toxic Properties
(2722)A *	Mar Proof Mixing Varnish	2,536 gal.	Yellow scale wax 3.77% Amberol gum 24.91% Wood oil 19.55% Mineral spirits 51.77%	Chiefly important because of the mineral spirits contained which is comparatively harmful. See item (63)
(3051)	Sunflower Fatty Acid	35,982 lbs.	Solid vegetable fatty acid.	Comparatively harmless. Occasionally may cause low grade skin disease.
(3060) *	Glycerine	148,564 lbs.	98% glycerine.	Concentrated glycerine readily produces skin disease. See item (434).
(3085)	Para Thinner	53,227 gal.	See specimen form.furnished at the end of this section.	See general discussion of complex mixtures, leading to mixed intoxication, at the end of this section.
(3096)	Methyl salicylate	450 lbs.	Synthetic oil of wintergreen.	This is much used as a rubbing oil for rheumatism, therefore substantially harmless. Taken internally this oil may be poisonous in large doses, although salicylates are much used orally in medicine. Relatively unimportant.
(3097)	Beckasol	13,596 lbs.	Phenol formaldehyde condensation product.	Possible source of dermatitis.
(3098)	Beckasol	2,073 lbs.	Phenol formaldehyde condensation product.	Possible source of dermatitis.
(4090) *	Soligen Drier	333 lbs. (z)	Contains 25% lead.	Possible source of lead poisoning.

Code#	Name	Factory Consumption	Composition	Toxic Properties
(4091)	Soligen Manganese Driers	162 lbs. (z)	Contains 6% manganese. Mineral spirits.	Related to corresponding nuodex drier. No proof that this low % of manganese leads to a practical manganese hazard. Mineral spirits may be more significant.
(4092)	Soligen Cobalt Drier	156 lbs. (z)	Contains 6% cobalt. Mineral spirits.	Related to Nuodex drier. The toxicity of cobalt little established. If mineral spirits present these may be more significant. See item (63)
(5091) *	Benzoyl Peroxide	53,095 gal.	Benzoyl Peroxide $(C_6H_5CO)_2O_2$	Explodes above 108°C.
(6090) T-388	Bakelite Resin Solution	11,250 gal. (z)	See specimen formulae for divers solutions, thinners, etc. at the end of this section.	See comment at end of this section on mixed intoxication induced by chemical mixtures.

RAW MATERIALS--T NUMBERS

Code#	Name	Factory Consumption	Composition	Toxic Properties
T-42	Germantown Lamp Black	1,550 lbs.	Practically 100% carbon. Trace of oil.	Essentially innocuous
T-77	Hexalin	300 lbs. (z)	Is used in conjunction with various soaps to form solutions and emulsions for cleaning type. May be used in conjunction with dangerous hydrocarbon solvents. If also hexalin is a trade name for a substance akin to tetralin, tetralin is a trade name for tetrohydro-nephthalene, is a turpentine substitute.	Is a skin irritant. Leads to irritation of throat, headache, mental confusion, green urine.
T-83	Mapico Yellow Ochre	7,200 lbs.	98% ferric oxide hydrate	See item 119, drys.
T-182	Refined ABC Bentonite	2,700 lbs.	Mixed silicates with some free silica.	In animal experiments, bentonite may lead to formation of scar tissue analogous to that in silicosis. Remote source of dusty lung disease.
T-281	Cadmium	400 lbs.	22% Cadmium sulphide 20% Cadmium selenide 58% barium sulphate	Cadmium and its salts are highly toxic. 10 mgms. daily breathed for a short period, such as two or three days may lead to active gastro-intestinal disease. 1 mgm. over a prolonged period may prove to be injurious. All cadmium compounds should be handled with caution.
T-287	Gum Tragacanth	1,210 gal.	Vegetable gum.	This gum is widely used in medicine. No less, a few workers become sensitized and present skin disease following contact with this substance.

Code#	Name	Factory Consumption	Composition	Toxic Properties
T-294	Celite	1,500 lbs.	Loss on ignition 16% Inorganic matter 12% Silica 72%	This material, which resembles tripoli, is a possible source of silicosis. See item 3, dry.
T-307	Argent Aluminum Lining	225 lbs. (z)	100% aluminum	Essentially harmless. See item 292, dry.
T-341	Mapico Super Black Oxide	11,319 lbs. (z)	Believed to be black iron oxide, Fe_2O_3.	Essentially harmless.
T-449	Korite Asphaltum	20,250 lbs.	Asphaltum.	Bituminous tarry body. Complex chemical mixture. When heated, may give off mixed fume of irritant nature to eyes, respiratory tract and to skin. Asphaltum workers frequently present low grade skin disease, plugged pore openings, comedones, etc.
T-465	Wyandotte Portland Cement	423 lbs. (z)	Portland cement.	Contact with Portland cement readily leads to caustic burns, ulceration. However, the small amount here used makes this item insignificant.
T-468	Micronized Fibrous Talc	300 lbs. (z)	Magnesium silicate.	See items 20 and 20L.

In the foregoing long lists of drys,, liquids "T" numbers and compositions, made into thinning compounds, bases, toners, etc. there is much duplication insofar as toxicologic properties are concerned. For example, in the Purchasing Department lists and laboratory manuals from which these items have been listed for discussion, there may appear as many as twenty types, varieties or grades of "lithopone". Although a fair number of these are mentioned in the present hygienic discussion, gradually these items referring to "lithopone" became so numerous that all further reference was omitted. This type of discussion equally applies to a great variety of other substances brought into this plant. For this reason, the hygienic listing of raw materials falls far short of the items appearing in the volumes of the Purchasing Department. Further, the hygienic listing refers to no items for which purchase has not been made subsequent to the fiscal year of 1935-36. Still further, it is noted that the hygienic listing fails to include a fair number of items listed only by trade name, for which we hold no data as to chemical constituency. For example, this statement applies to "Peraplex", "Crystone", "Byerlite", etc.

Specimen Formulae for Coating Compounds, Thinners, Bases, Etc., together with a Discussion of the Toxicity Resulting from Complex Mixtures.

Foremostly, the preceding discussion deals with individual chemical substances and fairly simple mixtures. Thus, comment has been made upon such basic substances as benzol, toluol, ethanol, butanol, silica, naphtha, manganese, chromium, lead, cadmium, etc. In paint work, it is inevitable that much activity will center about the use of mixtures of various types of solvents, thinners, bases, etc. On this account, there is now presented a series of formulaw showing the composition of a variety of compounds utilized in the making of still more complex products. After the listing of these formulae, brief discussion is provided concerning the toxicity of these compounds.

Representative Formulae

1. Lacquer Base #223 Deep Para Red	23#	10109 Para Toner, Deep
	12#	(113) Raw Castor Oil
	28#	(1620) Dibutyl Phthalate
	24#	(1651) Ester Gum Solution
	13#	(1519) Damar Gum Solution

Of these five ingredients, three still represent compounded articles, namely (10109), (1651) and (1519). Thus (10109) Para Toner, Deep is made up of an organic color and calcium carbonate. The Ester Gum Solution consists of 650# of ester gum and 350% of (584) xylol and further Damar Gum Solution consists of 474# of 1239, Damar Gum, plus 185# of (584) xylol plus 341# of (330), which is 95% ethyl alcohol.

Thus it comes about that under the somewhat innocuous term "Deep Para Red" there lurks the possibility that in the successive stages of manufacture there conceivably might be brought about distinct exposure to two substances definitely known to be toxic, namely toluol and xylol.

2. Thinner 04516 (1628)	110 gals.	(149) Benzol
	50 gals.	(2611) Isopropyl Acetate
	10 gals.	(1167) Butyl Alcohol
	30 gals.	(1170) Butyl Acetate.

Under this term "thinner", use is made of four solvent materials, all of which are known toxic agents and two of which are distinctly dangerous. However, it is noted that the very formula carries reference to "caution" as required in connection with the use of benzol.

Since this formula may not be taken as representative, the formula for a second and more widely used thinner is here shown in the following item:

(1616) "B" Grade Thinner Acme Use

3. 207.5 lbs. (1170) Butyl Acetate
49 " (2611) Isopropyl Acetate
81.5 " (1686) Special Naphtha Drioleum
109 " (584) Xylol
241 " (241) Toluol
27 " (1167) Butyl Alcohol

Again it appears that in the more or less standard thinners, liquid substances capable of fairly ready evaporation widely are used. This comment stands distinctly in relation to the complaints being made by these investigators about the undesirable work conditions in the Lacquer Department.

4. (1696) 1/2 Sec. Base Lacquer (Cotton Solution)

415 lbs. 1226 1/2 sec. Nitrocellulose
106 " (2611) Isopropyl Acetate
166 " (1170) Butyl Acetate
28 " (1167) Butyl Alcohol
15 " (330) Grain Alcohol
225 " (241) Toluol
45 " (584) Xylol.

Again the comment may be made that such a cotton solution potentially involves exposure to dangerous solvent material.

5. (2619) T-245 Gum Solution V-8632

374 lbs. T-245 Rezyl Gum
93.5 " (1170) Butyl Acetate
93.5 " (2611) Isopropyl Acetate
280 " (241) Toluol

6. Lacquer Tint 507, Canary Yellow

142 lbs. L.B. 207
14 lbs. (1651) Ester Gum Solution
59 lbs. (1519) Damar Gum Solution
613 lbs. (1807) Cotton Solution
52 lbs. (1616) Solvent Base B

Of the foregoing five ingredients, themselves representing complex compounds, all require still further analysis in order to reach the individual constituents. In this case, further analysis is not here listed to save space, but the point remains obvious, that in all instances widespread use is being made of substances, the toxicity of which is well established.

7. Synthetic Base 507, Deep Green

.5 lb. 547 Aluminum Stearate
16⅔ " 11024 Milori Green
19¼ " 11025 Chrome Green (light)
6 " 1195 Bone Black
9.5 " 1538 Zinc Sulphide
47.5 " (2142) Synthetic Oil Mixed Varnish

(2142) is (1257) high flash naphtha and (3085) para thinner. In turn, certain of these ingredients may further be broken down.

Here again, under terminology that discloses no hint as to possible dangerous material, we are dealing with lead compounds, chromium compounds, high flash naphtha and other substances of potentially harmful properties.

The objective in mind in presenting this discussion of the make-up of compounds is to point out that with practically every ramification of paint, varnish, lacquer and other coating manufacture, theoretical opportunities for exposure almost regularly exist. It is not argued that actual and practical exposures prevail, but instead it is maintained that these toxic compounds, being so widely spread, might, on occasion, give rise to cases of occupational diseases at almost any point in the plant.

The Toxicity of Mixtures of Harmful Substances

In the world of industrial toxicology, much is known about the dangerous properties of a great variety of individual substances, including liquids, solids, dusts, vapors, gases, mists, etc. Ways and means have been devised for measuring the concentration of these various agents under divers circumstances. When, however, these substances are found as mixtures in the atmosphere and particularly as mixed gases or mixed vapors, an enormous lack of information exists.

It is well nigh impossible, with any of the equipment and procedures now available, readily to measure on a percentage basis the presence of such vapors as those from benzol, toluol, ethyl alcohol, butyl alcohol, isopropyl acetate, glycol, when these substances, or any similar grouping, co-exist. With reasonable certainty, the extent that various constituents of a vaporous mixture may be estimated from a knowledge of the respective chemical and physical properties. However, in complex mixtures, this accuracy may still provide for a thirty or fifty per cent error.

Equal difficulty is encountered in delineating the effects of individual members of a group of mixed vapors or gases. To some extent, the action of one particular constituent may mask the manifestations of harmful action of some other constituent. In industrial hygiene work, this situation gives rise to a well recognized but little known field of mixed intoxication. Such a situation exists in the Lacquer Department of this Plant. Here it is known that a very high concentration of mixed vapors is widely present, but it is not known that this vapor concentration is

paramountly made up of any one vaporous material present, such as toluol, xylol, butanol, ethanol, naphtha, acetates, or others.

By common consent, under such circumstances, much significance is attached to the most toxic body present in a mixture and to assume that at least a portion of the vapors present arise from this outstanding agent. In the case of the Lacquer Department, such significance is to be attached to toluol and to butanol. Because of the inability precisely to measure quantitatively the presence of harmful vapors in mixtures of vapors, it becomes necessary to stress the importance of providing preventive appliances and practices such as will largely eliminate the entire lot of disturbing vapors or gases.

ILLUMINATION SURVEY

In order to present a better understanding of the results of this survey, some of the factors entering into the recommendations, appearing later in this report, are first briefly considered. These factors relate to the more common defects of industrial illumination, such as (1) intensity; (2) quality (color or spectral composition); (3) distribution; (4) steadiness; (5) diffusion; and (6) direction.

One of the most important factors of industrial illumination is the intensity of light. The time required for a worker to see an object is dependent upon the quantity of light on that object. For example, it requires twice as long to see at 3 foot candles as at 30 foot candles. Where the industrial worker has defective vision, the time element increases and since a large percentage of industrial workers have defective vision, illumination intensities become an important factor.

The quality of light as mentioned above refers to the color or spectral distribution of that light and it is generally agreed that light which approaches diffused daylight is best from an industrial point of view. In most artificial lighting installations the light employed is too yellow. This fact becomes of even greater importance where color judgements are to be made. Regardless of these facts, however, ordinary light is entirely satisfactory if all other factors of illumination have been properly considered.

The distribution of light in any workroom is an exceedingly important factor in industrial illumination. The ideal situation exists when the general workroom illumination is high with local lighting for those areas requiring close work. In case of defective distribution, the worker in the well lighted area is unable to see for a period of time when walking into a relatively dark area. This condition of course presents a definite accident hazard and produces ocular fatigue.

The unsteadiness of artificial illumination is the source of fatigue due to constant demands upon the eye for readjustment. This

factor is of little importance in this plant, but in plants where low frequency current is used, it becomes an important factor.

From the industrial standpoint, diffused light plays a very important part, since workers in properly diffused light avoid rapid fatigue and dyestrain. Diffused light does not produce sharp, dense shadows which are a prolific cause of industrial accidents. In general diffused light is furnished by providing frosted glass reflectors, indirecting lighting and reflecting surfaces.

In most cases of industrial illumination, direction of light is of little importance when proper diffusion and distribution of light is furnished. However, if the eye receives direct reflection or is in direct line with the source of light, careful consideration should be given. These two conditions produce glare which permanently injures the eye and affects the nervous system.

Since the factors of illumination mentioned above directly affect the workman's physical condition or the quality and quantity of work produced, illumination becomes an important consideration for this company. In making this survey and recommendations, these factors were kept in mind at all times.

The unit of illumination is the foot candle and it is in these terms that the field data and lighting requirements are specified in this report. The instrument used in this study for the collection of field data was the Weston Foot Candle Meter. Its size and the rapidity with which readings can be taken make it particularly adaptable for the conduct of a survey of this type. The field data were collected with the assistance of Mr. J. M. Glynn who located the various manufacturing departments and obtained certain necessary information.

In general this survey was conducted in the following manner. First the building and floor or department numbers were recorded. General observations were then made and recorded of the general conditions affecting illumination such as conditions of fixtures, cleanliness of windows and skylights, cleanliness of fixtures, condition of walls and ceilings, position of outlets and a general evaluation of the present lighting conditions. Information as to the

kind of day and whether or not the sun was shining was also recorded. Foot candle readings were then taken at the plane of work and at operator's position. Although readings were not taken at all points of work, representative readings were taken in each workroom which gave an average picture of the working area. In the case of the general offices, readings on every second or third desk were made. The survey covers the manufacturing departments, general offices, laboratories, printing department, maintenance department, power house and certain other miscellaneous work places. Although very few, if any, readings were taken in warehouses and stairways, certain observations were made and some consideration is given in this report.

Discussion

On the day which the survey was conducted the atmospheric conditions were somewhat changeable. During the greater part of the forenoon the sun was either partially or entirely hidden. The visibility was generally poor. However, in the afternoon the sun appeared and disappeared several times, but in general visibility was good and the sky bright. The changing atmospheric conditions necessarily affects illumination readings and in making the specific recommendations these factors were taken into consideration. In general it was considered that outside atmospheric conditions increased the illumination readings by 30-50%. However, in some cases it was believed that outside light was almost entirely responsible for the foot candle readings obtained and recommendations were made accordingly. In still other cases, outside illumination entered in little, if any.

Referring to the specific recommendations which follow it will be noted that in certain cases no suggestions were made to increase illumination. In some of these cases the illumination is already sufficient while in other cases it is believed that the illumination will be increased sufficiently providing the general recommendations are followed.

It was noted that in several manufacturing departments of this plant a reflector was being used which was equipped with a screen over its face. Although this type of reflector protects against breakage and other damage it filters out a fair percentage of the light, thus reducing its efficiency. This type of reflector also traps considerable dirt and unless it is cleaned frequently, the light furnished the workroom is reduced to a minimum.

In a previous section of this report a mention of glare was made. Throughout this plant it was observed that many workmen were exposed to glare. In many departments, especially the storage rooms, large numbers of bare lamps were used as a source of light. Aside from the fact that these lamps produce glare which causes injury to the workmen, the efficiency of such illumination is very low. A large percentage of the light produced by these lamps is absorbed in the ceiling. If these lamps were equipped with approved reflectors, all light would be directed toward the floor which would probably result in adequate illumination for this type of work place. In still other cases, reflectors of an ancient type which have not been properly maintained were being used.

One of the greatest factors in the low foot candle readings observed throughout this plant was the accumulation of dirt on the sources of light. Since it is possible for dirt to cut out practically all of the light from a particular source, it is reasonable to believe that the general level of illumination has been greatly reduced in this plant through dirty fixtures, windows and skylights. Since reflected light plays an important part in industrial lighting, it is believed that the general level of illumination has been reduced through poor reflecting walls and ceilings. This condition was in evidence in many departments of this plant.

Referring to the accompanying table, there were two cases in which desk lamps were recommended where it was not feasible to increase the general illumination. The lamp referred to is the

I. E. S. Lamp #778. This lamp is especially made for offices and is approved and recommended by the Illuminating Engineering Society.

Recommendations:

Aside from the individual recommendations appearing in accompanying tables, the following general comments are in order, if it may be assumed that nearly perfect illumination is to be obtained. It is pointed out that the standards set in this section are quite high and in some measure almost unattainable in this establishment with some old buildings. On this account it seems only fair that these investigators recognize that if the company comes within 15% of attaining the high standards set that a very good job will have been accomplished in improving lighting in this plant. In short, all recommendations made throughout this section may be discounted 15% should the need arise.

1) Wash walls and ceiling or paint walls and ceiling in general offices (main offices). If feasible, this should also be done in many of the manufacturing departments.

2) Clean lighting fixtures in all offices and printing department and clean once each month thereafter.

3) Clean lighting fixtures in all other departments and clean once every two months thereafter.

4) Replace burned out lamps and those lamps which have had 1000 or more hours of service. Change lamps every 1000 hours of service thereafter.

5) Wash windows and skylights and repeat process at least twice each year.

6) Replace old type of reflector with new approved type in all cases where old type is now being used.

7) Install approved type of reflector where bare lamps are now in service.

8) Make frequent checks of the lighting system to insure adequate maintenance of equipment.

9) Eliminate all open lights in those sections of the plant dominated

by safety light equipment. It is quite foolish to install 80% of spark proof lamps and then intersperse 20% of unprotected lamps. Such is reported to be the case in a few departments.

ILLUMINATION SURVEY

Field Data and Results

Position	Foot Candle Reading	Std.* Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Laboratories - 2nd floor					
	16	15-10	106	160	)
	8	"	53	80	) Rearrange Desk
E. Bench - Lab. # 2	30	"	200	300	)
W. Bench " "	30	"	200	300	)
	16	"	106	160	)
	12	"	80	120	)
E. Bench - Lab. # 1	30	"	200	300	) See General Recommendations
W. Bench - " "	24	"	160	240	)
	30	"	200	300	)
	36	"	240	360	)
E. Bench - Lab. # 3	15	"	100	150	)
W. Bench - Lab. # 3	17	"	113	170	)
	12	"	80	120	)
REDACTED	5	"	33	50	Increase General Room Wattage by 100%
	2	"	13	20	Install Desk Lamp
E. Bench - Lab. # 4	14	"	93	140	----------
W. Bench - Lab. # 4	24	"	160	240	----------
Spray Booth	35	8-5	430	700	----------
Humidity Bath	8	"	100	160	----------
Lab. Roll Mill - Grind. Room	10	15-10	66	100	)
Stone Mill - Grind. Room	4	"	27	40	) Increase Room Wattage by
Mixing Bench - Grind. Room	7	"	47	70	) 100%
Stationary Wash Bench	10	"	66	100	)
	6	"	40	60	Increase Wattage in Lamp Nearest Desk by 100%
	50	"	330	500	----------

* Code of Lighting. Illuminating Engineering Society. 1930

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
REDACTED	11	15-10	73	100	Increase Wattage in Lamp Nearest Desk by 30%
	47	"	314	470	
	10	"	66	100	Increase Wattage in Lamp Nearest Desk by 30%
E. Bench - Talbots Lab.	4	"	27	40	Increase Wattage in Lamps Nearest Bench by 100%
W. Bench " "	6	"	40	60	Same as E. Bench
	20	"	133	200	
	30	"	200	300	
Large Table	16	"	106	160	
Laboratories - 3rd floor					
Telephone Board	0	"	0	0	Lamp Burned Out - Install 200 Watt Lamp
- 3 desks	8	"	53	80	)
	14	"	93	140	) Increase General Wattage by 50%
	4	"	27	40	)
	3	"	20	30	Install Desk Lamp
	32	"	213	320	
Mixing Bench	7	"	47	70	Increase Wattage by 50%
Double Working Benches	11	"	73	100	" " " 30%
Dept. - 3 desks	14-12-13	"	87	130	
Bench	9	"	60	90	)
Bench	3	"	20	30	) Increase Room Wattage by
	13	"	87	130	) 50-100%
	6	"	40	60	)
Balance	7	"	47	70	Install Balance Lamp
Chem. Hood	4	8-5	27	40	See General Recommendations
Stairway - Building # 3	0-2	3-2	0-67	0-100	Increase Watta e by 100% and Install Froste Glass Fixture

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
First Floor					
E. Labeling Machine	6-10	10-6	80	133	Install Approved Reflectors
Stenciling Machine	3	"	30	50	)
- Desk	2	10 -8	20	25	) Increase Room Wattage by 150%
Labeling Desk	2	10-6	20	33	) and Install Approved Reflectors
Bldg. # 2 - Paint Dept.					
N. E. Filling Machine	3	10-6	30	50	)
Filling Machine Next to					)
Vibrating Screen	3½	10-6	35	59	)
Bench	6	10-8	60	75	)
Desk REDACTED	4	10-8	40	50	) Increase Room Wattage by 100%
	50/	10-8	500	625	) and Install Approved
30" Stone Mills	2	10-6	20	33	) Reflectors - Wash Windows
Filling Station	½	10-6	5	8	)
Liquid Paint Mills (6)	2½	"	25	42	)
Bldg. # 2 - 2nd floor					
Mixing Room - Whites	0-1	"	0-10	0-16	)
8 Mixers - Dark Colors	0	"	0	0	)
Center Pipe Station	½	"	5	8	)
Desk - Tinting Dept.	½	10-8	5	6	)
Tinting Dept. - E. Wall	3	12-8	25	37	) Install 150 Watt Lamps in All
Tinting Tanks - Center Aisle	0	"	0	0	) Outlets and Install Approved
" " - W. Aisle	30	"	250	375	) Reflectors - Wash Skylights
Pony Mixers - W. Aisle	5	10-6	50	83	) and Windows
Bldg. # 4 - 2nd floor - Lacquer Dept.					
Weighing Station	4	"	40	67	)
Lacquer Tanks	3-5-10	"	30-50-100	50-83-166	)
Small Batch Tinting	25	12-8	210	310	) Increase Wattage by 50%
	6	10-8	60	75	)
	10	"	100	125	)

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Mixing Room - Oil Colors	0	10-6	0	0	Increase Wattage Around Mixers to Maximum for Outlets
West Aisle	7	3-2	230	350	----------
Aluminum Room	10-15	10-6	100-150	167-250	----------
Bldg. # 4 - 1st floor - Lacquer Dept.					
Ball Mills	0-2	5-3	0-40	0-67	Increase Wattage near Ball Mills by 100%
Pulley Chaser	10-15	10-6	100-150	167-250	----------
Lacquer Filling	6	10-6	60	100	Increase Wattage by 30%
Lacquer Filling - E Aisle	1-3	5-3	20-60	33-100	Increase Wattage in this Area by 50%
Bldg. # 4- Oil Color Dept.					
W. Filling Mach. - Small Tubes	2	10-6	20	33	)
W. Crimping Mach.	1-3	"	10-30	17-30	)
Tube Filling Bench	3-6	"	30-60	50-100	)
Grinding Mills - Lead Dept.	0	"	0	0	)
Synthetic Filling	2	"	20	33	) Increase Wattage by 150%
Oil Color Mills - 30"	1-3	"	10-30	17-50	)
Oil Color Mills - 20"	2	"	20	33	)
S. Staub - Order Desk	25	10-8	250	310	)
Stone Dressing Dept.					
Lathe	35	15-10	233	350	) Wash Windows - Increase Wattage
Grinder	3	10-6	30	50	) by 150%
Bldg. # 1 - Power Plant					
Compressor Room	3-13	"	30-130	50-216	) Wash Windows - Increase Wattage
Generator Room	3	"	30	50	) by 100% - Install Approved
Switchboard	2	"	20	33	) Reflectors
Boiler Room	3-15	5-3	60-300	100-500	Install Approved Reflectors - Increase Wattage by 50%

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Bldg. # 46 - Enamel Dept.					
- Desk	31	10-8	310	388	----------
Desk	30	"	300	375	----------
W. Aisle	7-10	3-2	233-300	350-500	----------
Small Batch Tinting	18	12-8	150	225	----------
- Desk	40	10-8	400	500	----------
Center Aisle	1-3½	3-2	33-116	50-175	----------
Pipe Station	½	10-6	5	8	Increase Wattage by 100%
Filling Mach.	3	"	30	50	" " " "
Bldg. # 46 - 2nd floor					
Furn X Filling	3-7	"	30-70	50-116	)
Center Aisle	0	3-2	0	0	) Increase Wattage in Outlets
Front of 20" Stone Mills	1-40	10-6	10-400	17-667	) on East Side of Room to
Paint Tank Balcony	0	5-3	0	0	) Maximum
Bldg. # 46 - 3rd floor					
6 Mills N. W. Corner	20-50	10-6	200-500	333-833	----------
Aisle Between 30" Mills	10-35	"	100-350	167-600	----------
Aisle Between 3 Roll Mills	2	10-6	20	33	Increase Wattage by 100%
S. Side Lehman Roll Mill - Inside Guard	6	12-8	50	75	Thoroughly Clean Reflectors and Cover Glasses
N. Side Lehman Roll Mill - Inside Guard	13	"	108	163	Same as S. Side
Aisle Between White Mills	5-45	10-6	50-450	83-750	----------
A. Kleck - Order Desk	30	10-8	300	375	----------
Bldg. # 46 - 4th floor					
Pipe Station	1	10-6	10	17	Increase Wattage in this Area to Maximum for Outlets
Aisles E. Side	8-25	"	80-250	133-416	----------
Aisles W. Side	18-40	"	180-400	300-667	----------
Aisles White Room	6-8	"	60-80	100-133	----------

REDACTED

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Bldg. # 13 - 3rd floor					
Warehouse	2-4	3-2	67-133	100-200	Install Approved Reflectors
Bldg. # 3 - 2nd floor					
Storage Conveyor	1-3	3-2	33-100	50-150	" " "
Bldg. # 3 - Test Room					
- Desk	21	10-8	210	262	----------
	50/	12-8	416/	625/	---------- ----------
A. B. - Bench	50/	"	416/	625/	----------
- Bench	50/	"	416/	625/	----------
Wash Tank	10	10-6	100	167	----------
Water Sanding Table	50/	"	500/	833/	----------
Storage Room	3-9	3-2	100-300	150-450	----------
	40	15-10	267	400	----------
Spray Booth	21	8-5	262	420	----------
Bldg. # 13 - Labeling Dept.					
C. McGee	2	10-8	20	25	)
Paper Box Stitcher	2	10-6	20	33	)
Small Tube Labeling	4	"	40	67	)
Small Quart Labeling	3-5	"	30-50	50-83	) Increase Wattage to Maximum for
Tube Filling	4	"	40	67	) Outlets and Install Approved
Sealing Mach.	3	"	30	50	) Reflectors
Label Bench - N. W. Corner	7	"	70	116	)
Bldg. # 13 - Label Stock Room					
	7-13	10-8	70-130	87-162	Increase Wattage by 25%
Aisles Between Stock Bins	½-2	3-2	17-67	25-100	Install Approved Reflectors
Bldg. # 13 - Label Printing					
Type Setting Bench	50/	100-25	50/	200/	Install Approved Reflectors
Press - Small	33	12-8	265	412	" " "
Press - Large	7	12-8	57	87	Increase Wattage by 100% and Install Approved Reflectors

REDACTED

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Bldg. # 44 - Can Warehouse					
Can Cover Stamping E.	28	10-6	280	450	)
Can Cover Stamping Center	9	10-6	90	150	) Increase Wattage of Room by
Can Cover Stamping W.	4	"	40	67	) 50%
Office - Desk	29	10-8	290	363	Wash Windows
Bldg. # 41 - Varnish Wks.					
Filer Press Room	35-45	6-4	573-750	875-1120	----------
Shellac Thinner Room	20-50	10-6	200-500	333-833	----------
Telegage Station	$1\frac{1}{2}$	10-8	15	19	Drop Outlets to Lower Level - Increase Wattage by 100%
Order Desk	45	"	450	563	----------
Labeling Desk	8	10-6	80	133	----------
Aisle Between Tks.	2-5	3-2	67-167	100-250	----------
Thinner Storage	6-12	10-6	60-120	100-200	----------
- Desk	14	10-8	140	175	) Increase Wattage by 50%
; - Desk	9	"	90	112	)
Varnish Lab. - Desk	32	15-10	213	320	)
Bench	23	10-6	230	383	) Wash Windows
Hood REDACTED	$7\frac{1}{2}$	8-5	94	150	)
Bldg. # 42					
Bandbury Control Room	$\frac{1}{8}$	10-6	5	8	) Increase Number of Outlets -
Bandbury Mill Room	1	"	10	17	) Use Lamps of at Least 150 Watts
Roll Mill Room	1	"	10	17	Increase Wattage to Maximum for Outlets
Bldg. # 16 - Shipping Dept.					
Office -	1	15-10	7	10	Install Desk Lamp
	10	"	67	100	Increase Wattage by 50%
	1	"	7	10	Install Desk Lamp
	6	"	40	60	) Increase Wattage by 100% - If
Typewriters - Clockwise	7-3-2-3	"	47-20-13-20	70-30-20-30	) not possible Install Additional Outlets

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Dispatching Desk N.	45	10-8	450	562	Install Approved Reflectors on Lamps Not Already Equipped
Dispatching Desk S.	30	10-8	300	375	
Storage Aisles	3	3-2	100	150	
Bldg. # 21 - Shipping Dept.					
Parcel Post - Express Bench	4	10-8	40	50	Improve General Level of Illumination of Room by Increasing Wattage by 75% and Installing Approved Reflectors and Replacing Obsolete Reflectors
- Desk	13	"	130	162	
Shipping Desk	8	10-8	80	100	
Carton Stitcher	2½	10-6	25	42	
Relabeling - E. End	1	"	10	17	
Relabeling - W. End	15	10-6	150	250	
Bldg. # 18 - Paint & Varnish Remover Dept.					
Copper	4	"	40	67	Increase Wattage by 100%
Filling Tank REDACTED	4	"	40	67	
Office Desk	20	15-10	133	200	----------
Bldg. # 12 - Export Shipping - 1st floor					
Order Desk	21	10-8	210	263	----------
Order Desk (Doc)	10	10-8	100	125	----------
General Workroom	½-3	6-4	8-50	12-75	Increase Wattage by 100%
Bldg. # 12 - Export Shipping - 2nd floor					
General Workroom	½-8	"	8-133	12-200	Increase Wattage in Center of Room by 100% - Add Reflectors
Bldg. # 12 - Export Shipping 3rd floor					
General Workroom	20-10	"	333-167	500-200	----------

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Varnish Works					
Stacks # 3	40-50	5-3	800-1000	1333-1667	----------
Stacks # 4	3-7	"	60-140	100-233	) Install Approved Reflectors - Install
Stacks # 1	3-10	"	60-200	100-333	) Outlets for General Room Illumination
Synthetic Varnish					
Drum Filling	3-4	10-6	30-40	50-67	) Drop Outlets to Lower Level - Install
Inert Gas Station -					) Reflectors for Two Outlets - Increase
Filter Press	1-4	6-4	17-67	25-100	) Wattage by 100%
Telegage Station	3-15	10-6	30-150	50-250	)
Synthetic Stocks	3-7	5-3	60-150	100-233	Wash Skylight
Bldg. # 24 - Maintenance					
	6	10-8	60	75	)
	5	"	50	62	) Increase Wattage by 100%
Typewriter REDACTED	4	15-10	27	40	)
	5½	10-8	55	69	)
Stockroom - General	4-13	6-4	67-217	100-325	----------
Tin Smith Bench	15	10-6	150	250	)
Drill Press	7	"	70	117	)
Mechanics Bench	10-45	10-6	100-450	167-750	) Wash Windows on Three Sides of
Electricians Bench	11	"	110	183	) Shop. Wash Skylights. Replace
Power Saw	1	15-10	7	10	) Burned Out Lamps. Add Outlets
Power Grinder	1	15-10	7	10	) At Certain Work Points. Increase
Plumbers Bench	2-15	10-6	20-150	33-250	) General Wattage by 75%. Install
Auto Mechanics Bench	19	"	190	317	) Approved Reflectors on All Outlets.
Blacksmith Shop	3-8	"	30-80	50-133	)
Carpenters Bench	5-8	"	50-80	83-133	)
Circular Saw	3	15-10	33	30	)
Drum Cleaning Dept.	3-8	8-5	37-100	60-160	Increase Wattage by 50% - Replace Old Reflectors with Approved Reflectors

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Receiving Dept.					
	11	15-10	73	110	)
	38	"	253	380	) Increase Wattage by 25 to 50%
N. Desk	16	"	107	160	)
- S. Desk	5	"	30	50	)
	50/	10-8	500	625	----------
Warehouse Aisles	1-4	3-2	33-133	50-200	Wash Skylight - Add Approved Reflectors to Bare Lamps
REDACTED					
Lacquer Shop					
C. Gerard	12	10-8	120	150	----------
Label Pasting Table	14	12-8	117	175	)
Mixing Bench	14	12-8	117	175	)
Spray Booth	7	8-5	87	140	) Repair Damaged Outlets. Install
Mixing Bench	30	12-8	250	375	) Reflectors Where Needed
Mixing Bench	7	12-8	58	87	)
Mixing Bench	14	12-8	117	175	)
Stock Bins	1	3-2	33	50	)
Storage	1	"	33	50	)
Spray Shop	4-10	10-6	40-100	67-167	Clean Fixtures - Sufficient to Give Proper Illumination
Bldg. # 21 - 2nd floor					
Wrapping Desk	10	"	100	167	) Replace Old Reflectors with Approved
Wrapping Desk - Large	8-10	"	80-100	133-167	) Type - Add Reflector to Bare Lamps
	6	10-8	60	75	)
Bldg. # 21 - 3rd floor - Printing Dept.					
	20	15-10	133	200	----------
	33	15-10	220	330	----------
	21	"	133	210	----------
	14	"	93	140	----------
Typewriter Desk	6	"	40	60	Install Desk Lamp or Rearrange Desk
# 1 Cutter	12	12-8	100	150	) Adjust Local Illumination for
# 3 Cutter	20	"	167	250	) Greatest Efficiency
# 2 Cutter	20	"	93	125	)

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
Desk - REDACTED	6	10-8	60	75	Increase Wattage in Outlets Nearest Desk by 50%
Wrapping Bench	15-30	10-6	150-300	250-500	----------
Multigraph	30-40	15-10	200-300	300-400	----------
Multilith	15-30	15-10	100-200	150-300	----------
Gordon Press # 9	25	12-8	208	313	----------
Gordon Press # 10	6	12-8	50	75	)
Gordon Press # 12	10	"	83	125	) Increase General Wattage of This
Gordon Press # 13	6	"	50	75	) Area by 50%
Gordon Press # 14	13	"	108	163	)
Cylinder Press # 7	13-50/	"	108-413	162-625	)
Cylinder Press # 8	10-50/	"	83-413	125-625	) Equip Bare Lamps at Bed of Press
Cylinder Press # 6	14-50/	"	117-416	175-625	) with Approved Refoectors
Cylinder Press # 4	15-45	"	125-375	187-563	)
Cylinder Press # 3	17	12-8	142	213	----------
Verticle Press # 2	10	"	83	125	----------
Verticle Press # 1	11-18	"	92-150	137-225	----------
Type Setting	10-15	100-25	10-15	40-60	) Install Local Illumination for
Type Setting	13-18	"	13-18	52-72	) All Type Setters
H. Knowles	12	15-10	80	120	----------
Folder	7-9	10-6	70-90	117-150	----------
Folding Table	9	10-6	90	150	----------
Mailing Table	4	10-6	40	67	Increase Wattage in Area by 50%
Pasting Table	13	"	130	216	----------
Inspection - Color Chips	50/	15-10	333/	500/	----------
Pasting	15	10-6	150	250	----------
Color Card Machine # 9	5	12-8	42	62	Increase Wattage in Area by 50%
Color Card Sorting	10	"	83	125	----------
Color Card Machine # 2	30	"	250	375	----------
Color Card Machine # 3	32	"	267	400	----------

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
General Offices					
	4	15-10	27	40	)
	6	"	40	60	)
	6	"	40	60	) Wash or Paint Walls. Increase
Billing Typewriter	8	"	53	80	) General Room Wattage by 50%
	9	"	60	90	)
REDACTED	8	"	53	80	)
	5	"	33	50	)
	12	"	80	120	)
	5	"	33	50	)
	5	"	33	50	)
	5	"	33	50	)
	6	"	40	60	)
	6	"	40	60	)
	6½	"	43	65	)
	6	"	40	60	) Increase General Wattage of
	4	"	27	40	) Room by 75%. This Recommendation
	14	"	93	140	) May be Disregarded in Cases
	6	"	40	60	) Where Desks Border on Non-
	6	"	40	60	) Obstructed Windows
	9	"	60	90	)
	7	"	47	70	)
	25	"	167	250	)
	35	"	233	350	)
	5	"	33	50	)
	11	"	73	110	)
	5	"	33	50	)
	10	"	67	100	)
	8	"	53	80	)
	4	"	27	40	)
	5	"	33	50	)
	7	"	47	70	)

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
REDACTED	9	15-10	60	90	See Preceding Page
	3	"	20	30	
	7	"	47	70	
	4	"	27	40	
	12	"	80	120	
	8	"	53	80	
	5	"	33	50	
	3	"	20	30	
	5	"	33	50	
	4	"	27	40	
	23	"	153	230	Wash or Repaint Walls. Increase
	6	"	40	60	Wattage of Rooms by 75%. In rare
	6	"	40	60	Cases Where One Desk is Receiving
	3	"	20	30	Very Little Illumination It May
	9	"	60	90	Be Possible to Move the Desk
	9	"	60	90	So that Maximum Benefit is
	8	"	53	80	Received from the Illumination
	8	"	53	80	At Hand.
	6	"	40	60	
	13	"	87	130	
	50/	"	167/	500	
	4	"	27	40	
	4	"	27	40	
	8	"	53	80	
	4	"	27	40	
	6	"	40	60	
	3	"	20	30	Increase Wattage by 100%. Wash or
	5	"	33	50	Paint Wall. Although the Windows
	9	"	60	90	on the East and South Affect the
	16	"	107	160	General Illumination, the Desks

Position	Foot Candle Reading	Std. Foot Candles	Percent of Maximum Std.	Percent of Minimum Std.	Recommendations
REDACTED	10	15-10	67	100	) Along the Walls are More Greatly
	3	"	20	30	) Affected. The Recommended
	3	"	20	30	) Wattage Increase Will Necessarily
	9	"	60	90	) Affect All Outlets Since They in
	9	"	60	90	) in Turn Affect the General Illumination

NOISE

One of the most neglected aspects of industrial hygiene centers about the ill effects produced by noise. In truth, the Acme plant is not outstandingly noisy on comparison with some other industries, such as the automobile industry.

Prior to mentioning, by way of example, several noisy places and practices in the Acme plant, a series of comment is introduced into this report, bearing on noise. These items of comment have been made by various persons in this country and in Europe, and are not especially directed to industrial noises, but instead include street noises, disturbed sleep, etc. The items now follow:

Statements made by Sir Robert Armstrong-Jones, C.B.E., M. D., D. Sc., etc.

"The ordinary worker, if he is to support himself and his family and to carry on, has a pre-arranged and proper setting for his period of rest, and his life is of necessity one of routine. He goes to bed tired and exhausted, but he is repeatedly roused, and his sleep disturbed by loud and most distressing noises. He rises in the morning shaky, confused and unrefreshed after his so-called "night's rest." His health suffers, his work deteriorates and he eventually joins the highly sensitive neurasthenic, who jumps even when the clock strikes and he may in consequence of loss of sleep end his life in the asylum, or he may try to get sleep from drugs and so become an "addict" to sedatives or to drink. In any case unless he can secure natural sleep his health is ruined."

Statement by Professor George Robertson, M. D., etc.

"The effect of noise, especially prolonged noise, on the nervous system may be in the nature of a constant strain and drain on nervous energy and this may lead ultimately to exhaustion. It is this action of noise, causing nervous and mental exhaustion, that leads to neurasthenia. This seems to be a much more common disease now than formerly....The consequence of neurasthenia, apart from the misery it entails, is a loss of national efficiency, which is an important matter in these days of struggle and competition....It is alleged that loss of sleep occurs either as a cause of a symptom of mental breakdown in about 75 per cent of the cases....Undoubtedly loss of sleep is one of the causes of insanity -- and the production of sleep one of the means by which insanity is prevented and also cured."

Report of the Committee on the Effect of Noise on Human Beings.

"This committee, after a study of data so far made available through research, declared that the continual pressure of strident sound to which New Yorkers are subject tends to produce

impairment of hearing, to induce harmful strain upon the nervous system leading to neurasthenic and psychasthenic states, to cause loss of efficiency of workers and thinkers, and finally to interfere so gravely with sound, refreshing sleep that rest is difficult and in some cases impossible.

Aside from the effect which constant noise has upon many individuals and particularly upon their hearing, the committee found that the abatement of noise is imperative because it interferes with sleep.

Growing children, many invalids and all convalescent patients are in need of complete quiet during the day as well as the night. In addition to these, New York contains many night workers who must obtain their necessary rest during the daylight hours. These facts make it clear that a partial abatement of noise during the night will not fit the need of a city as large and diverse as this. The whole chorus of sound must be decreased at all hours."

Summing up its preliminary report, the Committee on the Effect of Noise on Human Beings found that:

"Hearing is apt to be impaired in those exposed to constant loud noises.

Noise interferes seriously with the efficiency of the worker. It lessens attention and makes concentration upon any task difficult.

In the attempt to overcome the effect of noise, great strain is put upon the nervous system, leading to neurasthenic and psychasthenic states, and necessitating frequent recuperation in the country to maintain mental efficiency and alertness.

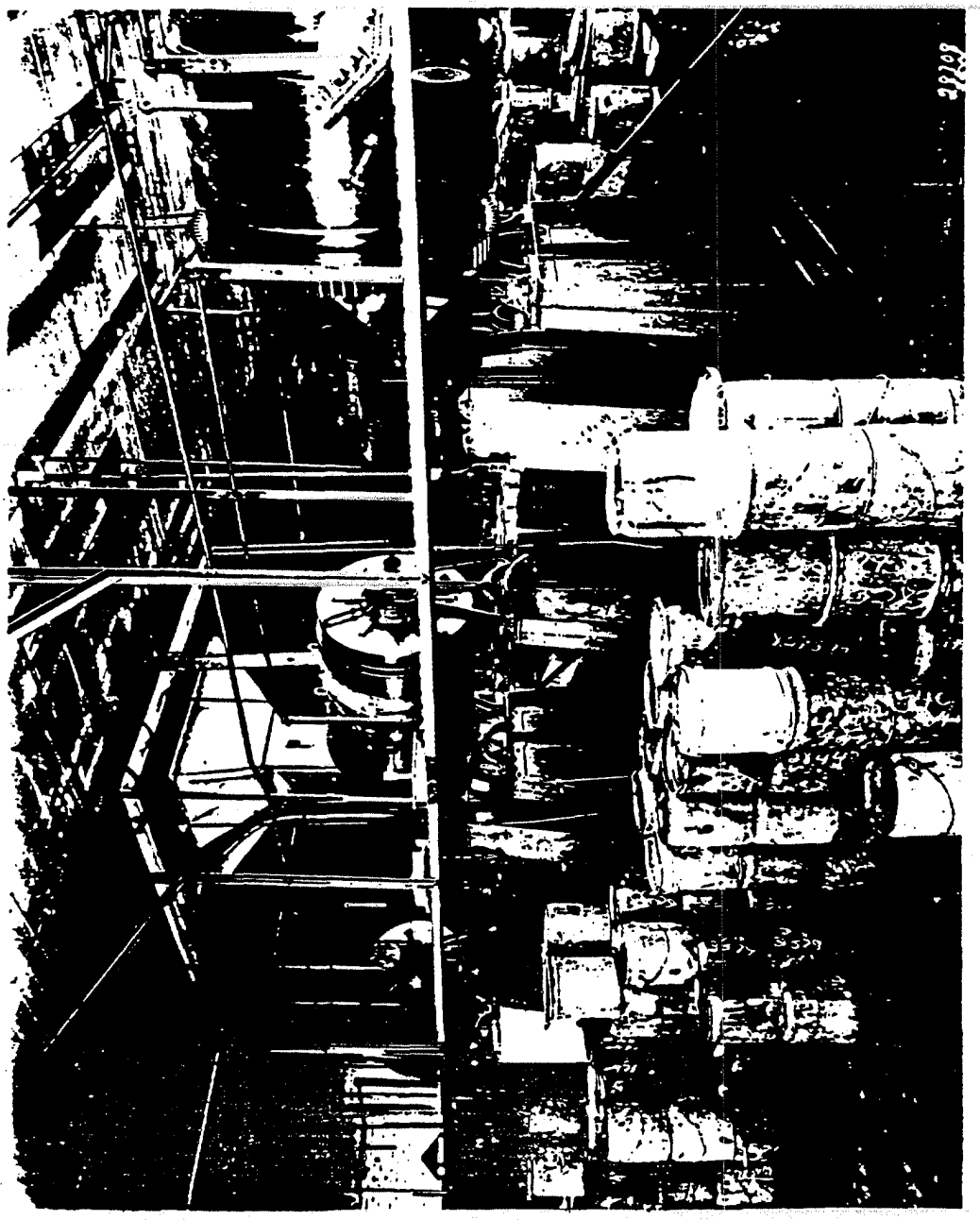
Noise interferes seriously with sleep, even though in some cases it appears that the system is able to adjust itself so that wakefulness does not result.

It is well established that, in addition to these other evil effects, the normal development of infants and young children is seriously interfered with by constant loud noises."

Statement made by Professor Henry J. Spooner in the Guildhouse Monthly Magazine, London, November 1929.

"Noise -- the most insidious and harmful plague that has ever affected the human race.

One of the most serious aspects of the noise problem is that of sleep; particularly in cases where mental wokers and invalids are concerned. Normally about a third part of our lives is given up to sleep, that "sweet restorer of tired nature." Now science tells us that those who think most and do most mental work require most sleep, and that if the recuperation does not equal the expenditure of the brain's energies, that organ withers, causing insanity. The ancient torturers well knew that persons prevented from sleeping always died raving maniacs; and the Chinese torture of the noise, and the inquisition sleep prevention, were based upon this fact. Countless people living near late-traffic noises are deprived of sufficient sleep and are thereby injured in health, even when the bedroom windows are closed to keep out the din. But the danger to health and life is greatly increased in the cases of invalids who are deprived of that vital balmy repose; life's nurse, sent from heaven to create us anew, day by day.



Free Silica is Extensively Introduced into Ball Mills but Irregular Operation Eliminates Practical Exposure to Silica Dust. Ball Mills are Universally Noisy.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

Statements from radio talk by Lewis H. Brown, Chairman, Noise Abatement Commission, over Station WEAF, January 28, 1930.

"It has been shown beyond peradventure of a doubt that --

Hearing is undoubtedly affected by exposure to continuous noises.

Noise interferes seriously with the efficiency of anyone engaged in mental tasks; it affects memory and the ability to concentrate.

In an attempt to compete with noise, great strain is put upon the nervous system leading to neurasthenic and psychasthenic states.

Noise interferes seriously with sleep, and this is of serious import in the case of the sick and convalescent.

The normal development of infants and young children is seriously interfered with by constant loud noise."

Tests made in the Department of Neurology at Bellevue show this:

"Noise is more harmful to the brain than powerful drugs.

The fact that people can not concentrate so well under the influence of noise has a profound influence on our daily working lives and on the work of school children and college students.

It has been shown that hearing is definitely affected in those persons who are constantly exposed to loud noises.

Noise interferes very seriously with the efficiency of the worker. It lessens attention and makes concentration difficult. In attempting to overcome the effects of noise, great strain is put on the nervous system -- leading to neurasthenic and psychasthenic states.

Noise may break or interrupt sleep, may make sleep disturbed and unrefreshing, or may produce insomnia.

The lack of sleep or the inability to obtain refreshing sleep -- because of noise -- represents a definite insult to the organism's normal physiology.

It is a well established fact that the normal development of infants and young children is seriously interfered with by constant loud noises.

It is a proven fact that, to the busy brain worker, to the sick, to the nervous, or to the wakeful, noise is a serious menace to which adaptation may be impossible."

In this plant it should be a general policy to eliminate, to the extent practical, all possible noises. Within the plant itself there are three classes of noise now specified:

(1) Noisy machines. Examples - filter pumps in varnish filtering room, ball mills.

(2) Noisy practices. Examples - faulty operation of can lid dating

work, incessant ringing of auto call bells

(3) Unnecessary noise made by workers in quiet areas such as unnecessary whistling, shouting, etc. in laboratory area.

It is at once granted that all noise may not be eliminated from this plant. However some noise may be completely irradicated and some may be mitigated in large measure. Three items are here discussed for the purpose of indicating control measures.

(1) The noise produced in connection with tin lid stamping is chiefly due to the falling of tin on tin after the lids are stamped. In due course each of the two girls observed working on this operation will become partially deaf and in time partially permanently deaf due to this continuous din. By simply arranging for these dated lids to flow from the machine without dropping much of this noise may be eliminated. A few simple tricks such as keeping the piles of lids small through using a small rather than a large container for receiving these lids and avoiding metal receptacles will add to the noise abatement.

(2) It is a practice of this plant, in searching for persons absent from their offices through the ringing of the auto call bells to keep up this ringing somewhat indefinitely, and for some such period as ten or fifteen minutes. Such a bell located near to these investigators' office has necessitated postponing considerable work until nights or Saturdays and Sundays. Undoubtedly other persons are similarly affected. There is no such thing as "getting used to" the noise, even though a person consciously fails to notice the noise present. The hearing apparatus registers every sound, even though a person's consciousness does not. It has been observed that the same call is repeated large numbers of times, believed to be as high as forty or fifty. In the absence of emergencies would it not be sufficient to limit these auto calls to six or eight ringings and then

repeat after an interval if the person sought does not respond.

(3) Workers in the filter press room inevitably will be made partially deaf by the noise of pumps, provided this noise as heard by these investigators continues. Possibly this noise may be irradicated through the remedying of mechanical defects. Conceivably other types of pumps may be substituted. If neither of these suggestions are practical, then at least workers in this area may be furnished ear plugs of inexpensive type such as are manufactured by Flents Products Co., Inc., 103 Park Avenue, New York, N. Y.

As an item in a general program of industrial hygiene noise abatement should be included. New operations should be considered in terms or whether or not excessive noise will be produced. Defective machinery such as worn bearings should be repaired in order to eliminate excessive noise. Through education workers should be encouraged to avoid continuous whistling, unnecessary shouting such as takes place within certain office areas, at the present time.

BLOOD EXAMINATIONS

Whenever typical lead poisoning arises, no difficulty is encountered in making a diagnosis. On the other hand, when persons are suffering from a long existing lead poisoning and conversely when persons are absorbing lead but do not have any clinical lead poisoning state, precise diagnosis is most difficult. This second situation, that is "lead absorption" is most important to lead using industries. At the present time, the best knownmethod for determining minor intakes of lead into the bodies of workers is through the application of what is known as the "Basophilic Aggregation" Test. This examination is quite simple and is based upon variation in the type of red blood cell, which change apparently consistently takes place whenever workers are absorbing very minor quantities of lead. In the City of Detroit, in the past two years, approximately 200,000 of these tests have been carried out by various laboratories and various technicians. In some instances the work may have been performed badly, so that the results obtained were not entirely reliable. Under our own control, approximately 30,000 such tests have been carried out, all of which we believe to be free from technical imperfection. This test is positive in certain other disease states besides lead poisoning, including all of the anemias. Workers exposed to the fumes of benzol, toluol, xylol and possibly other liquids used in paint work provide positive tests. However, for substances other than lead very much less is known about the test.

A detailed description of this test is to be found in an accompanying reprint entitled "Basophilic Aggregation Test in the Lead Poisoning Epidemic of 1934-35". Also a second reprint is provided entitled "The Atmospheric Content of Lead and Its Correlation with Basophilic Aggregation Tests in Exposed Storage Battery Workers". The second reprint is based on a small study in the storage battery industry, but the

data there furnished may very well be applied to the paint industry in showing a correlation between the quantity of lead present in the air and blood changes in workers breathing that air.

In this plant, 103 persons have been tested by this basophilic aggregation method. The details of these tests shortly will be presented. Those workers showing a result of 2% or higher may be regarded with definite suspicion of having recently absorbed lead. Those below 1.5% ordinarily may be regarded as normal. Between 1.5% and 2% is an uncertain zone, but no great attention is paid the findings in this bracket.

Name	Dept.	B.A.
REDACTED	Lab. Technician	0.5%
	" Clerk	1.0
	" Technician	0.5%
	" "	0.7
	" "	0.8
	" "	1.0
	" "	0.4
	" "	0.5
	Dry Mix Enamel	1.9
	" " "	2.0
	" " "	2.2
	Lacquer, Mixer	0.05
	Aluminum Mixer	0.5
	Dry Mix Enamel	0.6
	Lacquer Mixer	0.6
	" "	0.9
	" "	0.6
	" "	0.4
	Dry Mix Enamel	0.4
	" " "	0.5
	Lacquer Mixer	1.3
	Dry Mix Enamel	0.7
	Lacquer Mixer	1.6
	Dry Mix Enamel	0.9
	" " "	1.0
	Lacquer Mixer	0.4
	Gen'l work in Lacquer	0.5
	Tube filling	0.5
	Wet Mixer	0.4
	" "	0.6
	Tube filling	0.7
	Dry Mixer	1.2
	Supt. House Paint	0.4
	Paste Paint Filler	0.9
	Wet Mixer-paint	0.8
	Dry Mixer	1.4
	Wet Mixer	0.5
	Dry Mixer	0.7
	" "	0.7
	Tube Filling	0.5
	Dry Mixer	0.6
	Wet Mixer	0.7
	Tinter	0.4
	Dry Mixer	1.7
	Drum Cleaning	0.9
	" "	1.0

While Most Container Labeling is Performed Automatically
Some Hand Work is Done Involving Skin Contact with Irritant
Paste and at Times with Lead on Terne Plate Containers.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

Name	Dept.	B.A.
REDACTED	Wet Mixer	0.4%
	Tube Filling	1.0
	Mix Foreman	0.8
	Paste paint foreman	1.7
	Dry Mixer	1.1
	" "	0.8
	" "	0.5
	Paint and Varnish Remover	1.5
	Varnish Technician	1.0
	Varnish Cooker	0.3
	Varnish Gum Warehouse	0.4
	Varnish Research	0.5
	Filter Varnish	1.5
	Varnish Gum Warehouse	0.6
	Varnish Cooker	1.0
	Drum Cleaning	0.4
	Varnish Cooker	1.5
	Lacquer Grinder	0.6
	Varnish Filterer	0.7
	Lacquer Thinner	0.6
	Varnish Cooker	0.9
	Varnish Cooker	0.9
	Varnish Thinner	0.3
	Receiving	0.6
	"	1.4
	"	1.5
	"	1.0
	"	0.5
	"	0.9
	"	0.8
	"	0.7
	" yard gang	0.5
	"	0.5
	Yard man	0.6
	Receiving	1.0
	" yard gang	1.3
	" " "	0.3
	" Sup't	0.7
	"	1.6
	"	0.9
	"	0.8
	"	0.5
	"	0.6
	"	0.5
	"	0.5
	Labeling	0.6
	"	0.9
	"	1.0
	"	0.9
	"	0.4
	"	2.7
	Janitor	0.9
	"	1.2
	Yard man (refuse pile burner)	2.5
	CONTROLS	
	Unexposed to Lead	
	Vice President	0.5
	Factory Manager	0.7
	Survey Director	0.8

Continually series of basophilic aggregation tests are being made on persons wholly unexposed to lead, and inasmuch as lead in small quantities is so widely distributed throughout this plant, no large number of control tests have been made directly in the plant. We, however, are influenced by control tests continually being made in other portions of the City. The average worker, unexposed to lead, presents a basophilic aggregation test of approximately .8%.

From the above list, those persons showing near 2% or over 2% are:

Name	Dept.	B.A.
REDACTED	Yard Man (Refuse Pile Burner)	2.5%
	Dry Mix Enamel	1.9
	" " "	2.0
	" " "	2.2
	Labeling	2.7

It is believed that these persons are absorbing lead and conceivably might become clinical cases of lead poisoning. At this writing, four of these five persons have been interviewed, three of whom are hale, free from complaints and free from the ordinary signs of lead poisoning. A fourth, . on casual examination, presented evidence of weakness in the right hand and forearm; he also showed a suggestive lead line on three teeth. It is believed that this man is a borderline case of lead poisoning. However, if any one of these workers suffered a gastro-intestinal upset or some ordinary infection, or engaged in an alcoholic bout, they might become cases of lead poisoning. This, however, is unlikely except in the case of the fourth workman.

Three of these workers are employed in the Dry Mix Department, where a lead exposure is known to exist. A fourth handles containers made from terne plate material and her hands are almost regularly liberally coated with black lead material, presumably a lead oxide, rubbed off of containers. The fifth burns the refuse pile which is known to contain a fairly high percentage of lead. It is thus maintained that an appropriate exposure has been shown accounting for the blood condition described.

In at least two other sections of this report, additional discussion is extended to the matter of lead exposures in this plant. In order to avoid undue repetition, no further comment is made at this time, but other sections will include certain recommendations bearing on these slightly leaded workers.

As far as is known among the large number of cases, there have been no proved deaths, little profound encephalitis, very few instances of wrist drop or foot drop, etc. With certainty it may be believed that there have been milder degrees of neuromuscular injuries, encephalitis, etc. The outstanding and almost uniform manifestations have centered about involvement of the gastrointestinal tract, accompanied by excessive fatigability and blood changes.

Already the work conditions that produced this recent epidemic of lead poisoning have been modified in many plants to the extent that large numbers of additional cases of lead poisoning are unlikely. In some plants elaborate protective devices and procedures have been introduced. As yet no practical substitute has been found for the lead-tin alloy, inasmuch as certain other alloys that otherwise might be used may not be used due to prohibitive costs, undue shrinkage, etc. All in all, it may be stated that at least in some automobile plants the lead hazards have been brought under control.

This recent epidemic has provided us a long sought opportunity for the extended investigation of a diagnostic procedure first utilized by us in 1924.[2] Already a publication[3] has been made on this recent experience up to the time that 1,600 tests had been carried out. At this time the results of nearly 8,000 tests are available for the appraisal of the method. This test is based upon the enumeration of the total number of basophilic containing cells in the blood, in distinction to the widely used procedure of enumerating preformed stipple cells, the value of which method is now somewhat questioned. The method as carried out is similar to that lately used by Jones and his associates.[4] Since the basophilic formations as seen in the microscope do not exist as such in the blood stream and are artifactually produced in the process of preparation and staining, we prefer to use the term "Basophilic Aggregations," which term uniformly appears in the subsequent discussion of this test and our experience with it, which now follow.

BASIC PRINCIPLES

In normal adult human life, the content of erythrocytes in the blood stream is maintained on a fairly uniform level by the orderly entry of new cells from the bone marrow replacing those that have been destroyed.

These new cells are essentially mature, only about 1 per cent exhibiting any of the several known characteristics of immaturity. In bone marrow, during the formative period of erythrocytes, an entirely different cytology takes place varying with the stage of development of the red cells. Readily there may be demonstrated nuclei, protoplasm, and basophilic substance. In due time a change not known for any other cells of the body occurs; a chemical (hemoglobin) replaces the protoplasm and the nucleus is extruded. The erythrocyte is then ready for its chief function in the circulatory blood. These phenomena are set forth admirably in Key's[5] fundamental paper on erythrocytic cytology. The mechanism which liberates cells when mature and conversely retains undeveloped cells is not known. However, the functioning of such a mechanism is well established.

Under conditions in which toxic agents exert an action on bone marrow, and under other conditions in which physiologic demands are made, increased numbers of erythrocytes enter the blood stream. As examples of the former may be cited lead, benzol, toluol, xylol, possibly arsenic and chlorinated hydrocarbons, such as carbon tetrachloride; of the latter the effects of high altitudes constitute an obvious instance. The chief charac-

teristic of these liberated immature cells is the presence of basophilic substance.

Polychromasia (polychromatophilia), punctate stippling, and reticulation are but different manifestations of one phenomenon—the presence of basophilic substance. The exact form of this basophilic substance existing in the unaltered blood is little known. Probably the picture observed as polychromasia after staining is nearest to the natural state of this material. The impression furnished by all available evidence is that of thousands of ultramicroscopic particles in acid suspension, or possibly in their innate form in acid solution. Reticulated cells probably are produced only as a result of laboratory manipulation and thus while not being true artifacts are laboratory creations. With suitable laboratory facilities one is able to observe through the microscope the actual formation of reticular processes in cells not previously exhibiting such reticulation. Through variations in laboratory technic, the experimenter may produce at will in a single blood smear all the well known varieties of reticulation, as fragmented, anastomosing, wreaths, mossy forms, etc. If the artificiality of reticulation be accepted as fact, then such terms as "reticulocytosis" conceivably may be regarded as anomalous, in so far as these terms betoken the existence of reticular forms in the circulating blood. However, stippled cells are believed to exist as such in the unaltered blood. Through unknown processes, the ultramicroscopic particles observed as polychromasia or the basophilic materials in acid solutions, are caused to arrange themselves into masses characteristic of stippling. From the literature these concepts are well borne out in substantial publications, brief excerpts from which are now recorded.

Key[5] notes:

> If an individual reticulated cell be watched carefully during the process of staining, the net can be seen to grow under the eye of the observer as though it were being formed by precipitation of the substance from the surrounding medium.
>
> It is difficult to conceive that fixatives cause a definite network to break up into ultramicroscopic particles and become uniformly distributed through the cell (*i.e.*, polychromatophilia). Fixatives tend to fix intracellular products *in situ*. It is consequently felt that the conclusion is warranted that the reticular network as seen in supravitally stained erythrocytes is formed only during the process of staining and that no such structure exists in the unaltered erythrocyte.
>
> My observations lead to the belief that the granules of punctate basophilia are formed of the same basophilic substance which in simple anemias gives pictures of polychromatophilia and that because of the pathologic process the substance is aggregated into small granules in the cell (punctate stippling).
>
> With Wright's stain allowed to dry on a slide to which salt solution and blood is added, no polychromatophilia is seen but a definite basophilic reticulation slowly appears in the basophilic erythrocytes.
>
> Basophilic substance (*i.e.*, as a term) is preferable to "reticular substance" since reticulations are artifacts due to the action of a stain on a substance distributed uniformly through the cell.

In Hawes's[6] work no distinction was made between polychromatophilia and stippling, but when total percentages of the two were added the results corresponded with fair constancy with the total percentage of reticulated cells enumerated by other means on the same blood. Such differences as were encountered were attributed to differences in the delicacy of the methods used and not to any true excess of reticulated cells.

Jones[4] observes: "This (basophilic) substance is demonstrated either in the form of polychromatophilia, punctate basophilia, or reticular designs, depending upon the staining method used."

Basophilic substance long has been regarded as the foremost blood finding in lead poisoning, but to an overwhelming extent reliance has been

placed upon the determination of stippled cells. Recognition that polychromatophilia, punctate stippling and reticulation are but different aspects of the same material, should prompt the placement of greater diagnostic dependence upon examinations for the totality of erythrocytes containing basophilic material. Of the three forms of basophilic substance, stippled cells are the least common. The positive diagnostic significance widely attached to the qualitative finding of stippled cells in suspected lead poisoning is becoming more and more questionable; conversely less uncertainty is believed to attend the quantitative determination of all basophilic erythrocytes.

TECHNICAL PROCEDURE

The blood of normal human adults rarely contains more than 1 per cent of basophilic erythrocytes. The average in our experience lies between 0.4 and 0.8 per cent. With workers absorbing lead without clinical manifestations and in early lead poisoning, the percentage commonly ranges from 1.5 to 4.0 per cent, with occasional findings up to 20.0 per cent. The zone between 1.0 and 1.5 per cent represents the threshold, findings within which being open to doubt. In the absence of other pathology, any finding in lead exposed workers of, or in excess of, 1.5 per cent at once suggests the probability of lead absorption. Findings in excess of 2.0 or 3.0 per cent are to be associated with an increased imminence of clinical lead poisoning.

Search for these basophilic forms is best made in laked cells. When laking takes place some of the basophilic substance probably leaves the cell with the hemoglobin. The remainder, being insoluble in water, salines, and some stains, collects in masses, strands, and reticula, as laboratory artifacts. Such forms are far more visible than polychromatophilic cells and are more numerous than stippled cells.

In our first work[2] a thick, even blood smear was entirely laked. The number of basophilic aggregations in an average of many uniform microscopic fields was interpreted in relation to our clinical observations of the persons examined either as controls or as leaded patients. This procedure justly has been criticized as not readily transferable to others for quantitative work, since the making of uniformly thick smears by divers persons is most unlikely. Under rigid research conditions this earlier method will yield quantitative results but now is not the preferred procedure. The technic now employed is here presented:

The Sussmann-Weindel stain advocated by Jones is quite satisfactory when its several ingredients are pure. The formula is as follows:

Toluidine blue	0.5 gm.
Borax	0.05 gm.
Methylene blue solution (Loeffler's)	5 c.c.
Distilled water	100 c.c.

Our experience with this stain has been that it is not uniform from one batch to the next. Most of the trouble may be traced to the toluidine blue. Of six samples of this dye recently purchased by us from various supply houses, only one was found to be satisfactory.

A modified Manson's methylene blue yields more consistent results. The formula is as follows:

Borax	1.0 gm.
Methylene blue	2.0 gm.
Distilled water (boiling)	100 c.c.

The borax is dissolved in the boiling distilled water and to this is added the methylene blue. After filtering, this stain is ready for use and provides a stable, satisfactory, and uniform stain for at least 2 weeks. If used for long periods, a progressive formation of

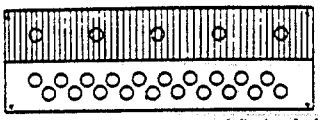


FIGURE I. Schematic arrangement indicating fixed (x, z) and unfixed (y, y) portions of slide, together with counting procedure on uniform slide.

precipitate may appear. However, due to the low cost and ease with which this stain is prepared, we consider this a small handicap. This stain is less stable than the Sussmann-Weindel, but in our experience gives more trustworthy results.

Thin, even blood smears are made on slides and allowed to dry. The proper drying of these smears becomes important. If permitted to become excessively dry, that is, longer than 12 hours, some of the basophilic containing cells will not lend themselves to aggregation of their basophilic material. On the other hand, insufficient drying facilitates removal of cells during the staining period. Ordinarily the optimum time lies between 1 and 3 hours. Under peculiar industrial conditions, involving high temperatures and low humidity, or conversely high humidity, special consideration for the drying period may be required.

FIGURE III. Typical microscopic field from fixed portion of same slide as in Figure II, presenting unlaked, stained red blood cells. Lines of Whipple grid used as guide in counting may be seen.

After drying, one-half of the slide is overlaid by a strip of filter paper, as set forth by Jones, and cautiously there is applied with a pipette or dropper the minimum amount of methyl alcohol C. P. (methanol, wood alcohol) required to moisten the filter paper until it clings to the slide. This is allowed

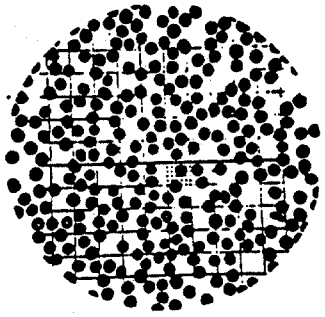


FIGURE II. Typical microscopic field from unfixed laked portion of slide presenting numerous basophilic aggregations.

FIGURE IV. Semi-schematic drawing of a basophilic aggregation in laked red blood cell. Manson stain. Magnification in original drawing: 17,000.

to dry until the filter paper becomes loose.

The slide is now submersed in a Coplin staining jar, containing the Manson stain, for approximately 10 minutes. The time is of minor importance since a readable stain may be had in 2 minutes, and on the other extreme it is impossible to overstain. After staining, it is necessary to wash the slides through 3 or 4 rinses of distilled water. In some cities tap water may be safely used for this purpose. Air drying of the slides is recommended.

The microscopic arrangements as used by us provide an oil immersion objective and a 10X ocular, which is fitted with a Whipple grid. The outer lines of this grid determine our microscopic field (Figure III). The average field in a good preparation contains approximately 150 red blood cells. Before counting, the slide should be examined for an area showing suitable distribution of the red cells. In the unfixed portion of the slide, customarily 10 consecutive fields in two parallel rows are counted, making a total of 20 fields, but in the more evenly distributed slide 20 consecutive fields. Then moving to the fixed portion of the slide, 5 appropriately corresponding fields are counted (Figure I). The basophilic aggregations are then expressed as a percentage of the latter.

Thus, if in the 20 fields counted in the unfixed portion of the slide there were found 76 B.A.s (Basophilic Aggregations), and if in the 5 fields of the fixed portion 1,000 red blood cells (or 4,000 in 20 fields), the obvious percentage is 1.9.

The physical features of the B.A.s are best presented in the accompanying photographs and photomicrographs (Figures II, IV). The color of the cells varies with the stain employed. A clear, brilliant blue is obtained with the Manson stain. A hand tally is used in the enumeration of the cells.

RECENT RESULTS

During 1934 and the first two-thirds of 1935, approximately 8,000 examinations were made, using the technic just described. The examinees represent employees in 16 plants and 6 different industries. Included in the 8,000 tests made are several hundred controls usually obtained from office groups. The lead exposed workers were distributed over the following industries: lead pigment manufacture, paint and other coatings manufacture, soldering, lead casting, lead oxide manufacture and application, and lead smelting. In some plants, but not all, concurrent determinations were made as to the amount of lead in the atmosphere expressed in terms of mgs. of lead per 10 cu. m. of air. In the aggregate, 416 quantitative lead determinations were made. The results from the basophilic aggregation tests have been correlated with the findings of the quantity of lead in the atmosphere breathed by exposed workers.

During 1934, basophilic aggregation tests were carried out simultaneously with stipple cell determinations, and in some instances with hemoglobin measurements and total red cell counts. Very early it was established that no consistent correlation was present. In many persons wholly unexposed to lead an occasional stipple cell was encountered and among lead workers approximately 90 per cent presented large numbers of stipple cells in the absence of clinical lead poisoning, and often after 3 months of no exposure to lead. The number of stipple cells in lead-using workers without clinical lead poisoning ordinarily was lower than 3,000 per million. The qualitative demonstration of stipple cells proved of no value in the diagnosis of clinical lead poisoning or in the making of decisions as to acceptability of men for continued work. Many workers regularly exhibiting stipple cells in

their blood smears passed through the entire automobile production season without illness and without any lost time. In similar fashion it was found that no significant diagnostic values resided in the routine determination of hemoglobin percentages or in total red cell counts. Over and over high percentages of basophilic aggregations were detected with no significant changes either in the hemoglobin or in the erythrocyte counts. For this reason all blood work other than the basophilic aggregation tests was abandoned as routine procedure in plant surveys, although complete blood work was carried out in the management of clinical cases of lead poisoning.

The trend of findings from 8,000 basophilic aggregation tests are now shown in three specimen tables.

Table I comprises the results from 25 representative controls. In establishing normal ranges of basophilic cells only such persons were utilized as were known to be essentially unexposed to lead and definitely unexposed in industrial pursuits. Almost without exception control examinees present less than 1 per cent of basophilic containing cells.

TABLE I

Initials	*Per Cent Basophilic Cells*
R. T.	0.4
E. T.	0.7
J. J.	0.4
L. H.	0.9
G. O.	0.5
S. M.	0.3
K. F.	0.6
R. H.	0.3
H. D.	0.9
M. G.	0.4
G. C.	0.5
O. L.	0.4
W. F.	0.2
J. B.	0.7
F. W.	0.4
H. K.	0.6
W. B.	0.2
J. R.	0.3
H. F.	0.7
W. K.	0.5
E. S.	0.3
C. W.	0.6
R. B.	0.3
L. K.	0.6
C. V.	0.4

TABLE II

Initials	*Age*	*Per Cent Basophilic Cells*	*Length of Time on Present Job*
C. S.	41	2.1	14 years
V. D.	37	1.2	8 years
J. M.	48	1.4	6 years
T. E.	34	3.5	9 years
J. K.	46	1.1	7 years
G. F.	41	3.2	1 year
A. S.	47	3.1	4 months
D. T.	38	2.3	6 years
G. B.	37	0.4	2 years
G. K.	30	1.5	10 months
T. M.	35	5.5	2 months
K. W.	29	1.6	5 years
E. C.	53	0.7	8 years
S. P.	30	2.0	5 years
V. T.	28	1.6	4 months
A. C.	36	3.3	1 month
F. N.	45	1.7	8 years
S. H.	28	1.4	3 years
J. G.	33	2.5	6 years
J. C.	32	0.5	2 years
C. C.	27	1.4	3 years
F. L.	40	2.4	4 years
J. S.	33	2.5	6 years
L. K.	47	1.9	4 years
C. R.	50	1.3	21 years

In Table II may be found the results of 25 workers in an atmosphere containing lead to the extent of 14 mgs. per 10 cu. m. of air. In contrast to the control table just preceding, a fair number of these examinees present findings above 1.5 per cent. It is among workers having such findings as these that clinical cases of lead poisoning may be expected to arise. Almost uniformly it has been noted that the higher the lead content of the atmosphere the higher the percentage of exposed workers showing positive basophilic aggregation findings. On the other hand it has not been found that the percentage of basophilic cells increases with any uniformity in keeping with increases in the lead content of the atmosphere. An occasional worker may yield as high a figure as 10 or 15 per cent of B.A.s but this is not the rule and the majority of affected

workers regardless of the amount of the exposure will present positive findings in the range of from 2 to 6 per cent.

With the procurement of better work conditions, as reflected by lowered quantities of lead in the atmosphere, there occurs a corresponding diminution in the number of persons showing positive tests, although there is a lag of from 1 to 2 weeks before this drop may be demonstrated. This correlation between lead in the atmosphere and positive blood smears is reflected in Table III.

TABLE III

BASOPHILIC AGGREGATION TEST RESULTS ON WORKMEN BEFORE AND AFTER THE LEAD CONCENTRATION WAS REDUCED FROM 75 MG. PER 10 CU. M. OF AIR TO 4 MG. PER 10 CU. M. OF AIR. ELAPSED TIME: 35 DAYS.

Initials	Per Cent B. A. Cells When 10 cu. m. of Air Contained 75 mg. of Lead	Per Cent B. A. Cells When 10 cu. m. of Air Contained 4 mg. of Lead
M. V.	2.0	0.8
T. S.	2.1	0.7
A. L.	2.0	1.0
J. B.	3.2	4.6
W. H.	2.0	0.9
C. H.	3.6	1.6
J. T.	2.1	0.6
K. S.	2.7	2.0
C. S.	4.3	3.4
C. M.	2.6	1.6
V. K.	2.4	0.5
M. S.	3.0	0.9
C. G.	2.0	0.8
C. B.	2.0	1.0
J. E.	2.0	1.7
D. D.	2.5	2.2
D. T.	2.2	1.2
W. W.	1.1	4.0
J. K.	3.2	1.3
G. R.	3.0	0.8
G. C.	2.0	0.5
J. P.	2.1	1.6
A. R.	2.0	0.8
T. L.	3.1	2.4
P. P.	8.5	5.3

This specimen material is characteristic of the entire investigation, with one exception. In one plant, manufacturing a great variety of pigment materials, lead poisoning was known to be present but the basophilic aggregation tests were not found to be in keeping with our general experience. The assumption is that because of the multiplicity of chemicals manipulated some biological antagonistic factor interfered with the usual reaction of the embryonic red cell to lead.

The chief application of this test has been in the routine examination of large groups of lead exposed workers. The results of such tests have been utilized as a guide for the transfer of workers to less hazardous departments, in the appraisal of the degree of exposure in different departments, in determining the effect of preventive measures, and in the differential diagnosis between lead poisoning and conditions simulating this disease, but in routine work its greatest single value has been associated with the detection of malingerers. During this epidemic in some plants, as high as 90 per cent of all exposed workers have simulated lead poisoning presumably in order to be eligible for insurance and sick benefits during the nonproductive season in the automobile industry. In some instances this basophilic aggregation test has been accepted as a sufficient criterion for the weeding out of these malingerers.

GENERAL COMMENT

In persons exposed to lead, otherwise free from disease, the detection of basophilic containing red cells in percentages in excess of 1.5, and particularly in excess of 2 per cent, suggests lead absorption and the possibility of approaching clinical lead poisoning.

Inconclusive proof is available that this test may be positive after exposure to other substances such as benzol, toluol, xylol, arsenic, etc. Occasionally in infectious diseases numbers of basophilic aggregations above the usual may be found. Manifestly in anemias and other types of diseases involving the red blood cells, normal ranges may be exceeded.

The length of exposure to lead ap-

pears to have no significant bearing upon the basophilic aggregation findings. Two weeks' exposure is ample to bring about increased numbers of basophilic containing red cells. New workers employed alongside of workers employed for a longer period are prone to show a greater frequency of response than the older workers.

In prolonged chronic lead poisoning the test described appears to be of limited value. The recession in the number of basophilic aggregations may be definite in long existing lead poisoning even in the presence of frank manifestations. Under such conditions punctate stippling may persist.

In many publications the minimum amount of lead that may lead to lead poisoning is specified as from 1 to 2 mg. as a daily intake. While this figure may represent a primary threshold at which an occasional case of lead poisoning may arise, it is our experience that many hundreds of workers continue at employment in concentrations much higher without demonstrable impairment. Without denying the possibility that a daily intake of 1.5 mg. of lead may produce lead poisoning, the belief is expressed that the practical threshold may be considerably higher and in the general range of from 4 to 8 mg. At least, years of exposure to such concentrations have not led to a single recognized case of plumbism in several plants included in this investigation.

One of the practical advantages served by this test as described lies in the fact that large numbers of persons may be examined daily. In our experience, a single worker has been able to collect as many as 300 specimens per day. Laking, staining, and cell counting, subsequently carried out, necessarily must be at a slower rate, but on a single day, as many as 70 counts have been made by one experienced technician. This rate of work stands in contrast to stipple cell enumeration, which if properly carried out ordinarily yields not more than 20 determinations daily.

SUMMARY

In the 1934–1935 epidemic of lead poisoning in the automobile industry, 6,900 basophilic aggregation examinations of the blood were made. In addition during this period 1,100 tests were made in other industries, thereby totalling 8,000 tests during the investigation. This number includes approximately 500 control examinations made upon workers unexposed to lead.

Positive basophilic aggregation tests, the method for which is described in detail, have served as an index for lead absorption prior to the appearance of clinical manifestations of lead poisoning. This test has proved to be of value in the diagnosis of early cases of lead poisoning. An approach to this test was described by us in 1924. Through technical improvements, made by others and by us, this procedure is now suited to application by any physician or laboratory carrying out any blood examinations.

The basic principle in the basophilic aggregation test is the enumeration of red blood cells containing basophilic substance, in contrast to the customary procedure of qualitative or quantitative examination for stipple or polychromatophilic cells.

The native state of basophilic material in unaltered red blood cells is not known, but in the process of laking and staining red cells this substance may be artificially aggregated into readily visible masses. In normal human adults, these aggregates rarely exceed 1 per cent of the total number of erythrocytes, but in lead exposed individuals the percentages ordinarily lie above this normal maximum, when considerable lead is being absorbed or when clinical lead poisoning is im-

minent. Findings of percentages above 1 to 1.5 per cent and especially above 2 per cent in persons exposed to lead at once suggest lead absorption and the possibility of approaching lead poisoning, or the actuality of early lead poisoning.

In chronic lead poisoning this test usually is not, but may be, positive. As lead poisoning progresses to extended chronicity, the reliability of the procedure diminishes. This test has been utilized in lead-using industries to determine the number of exposed workers absorbing lead, as some proof of existing lead hazards, as a guide for the transfer of lead absorbing workers to lead-free departments, as a measure of the efficacy of preventive devices and practices, and as a means for the detection of malingerers.

There are varied types of diseases leading to positive basophilic aggregation tests, but in groups of workers in lead industries, presumably normal except for the possible effects of lead exposures, the positive basophilic aggregation test stands in some relation to lead absorption and its subsequent action.

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The Atmospheric Content of Lead

—And Its Correlation with Basophilic Aggregation Tests in Exposed Storage Battery Workers—

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SINCE the last published report[1] made by these workers on the use of the basophilic aggregation test as a measure of lead absorption and early lead poisoning, the number of tests made under our control has increased to approximately 24,500.

As the use of this method extends, it inevitably becomes desirable to seek out the nature and extent of correlations that may be established between the findings from this test and those from urinary and fecal analyses, atmospheric concentrations of lead, clinical manifestations and other blood changes such as are frequently carried out in relation to examinations for lead absorption and lead poisoning. Already some investigative work has been carried out for the purposes of determining the extent of these correlations, but only under conditions that preclude disclosure. Lately, a limited inquiry has been directed to lead exposures in a series of small scale storage battery plants. The results, while not elaborate, unfailingly indicate the association of high basophilic percentages in workers exposed to high concentrations of atmospheric lead. These results, together with pertinent comment, have led to this report.

The Use of Lead in the Storage Battery Industry

IT IS not the design of this minor publication to describe in detail the various steps in storage battery manufacture, potentially and often practically leading to lead exposures. Adequate descriptions may be found in publications by Hamilton,[2] Wigdortschik and Kupritz,[3,4] Balsac, Lafont and Feil,[5] Wells,[6] Greenburg, Schaye and Shlionsky,[7] Russell, Jones, Bloomfield and others.[8]

In general it may be noted that the chief operations are the mixing of lead oxides preparatory to grid pasting, pasting of mixed lead oxides into grid plates, casting of lead grids, plate forming, lead burning, battery assembly, lead salvaging, and miscellaneous janitor and clean-up work. In a few plants, lead oxides are produced on the premises, but only in the very largest of establishments. Ordinarily, chief exposures grow out of the manipulation of the dry lead oxides, the preparation of grid paste, the application of paste to lead grids, the cleaning and inspection of plates prior to forming. In addition, practical exposures frequently grow out of lead reclamation and janitor services.

As a general rule, freedom from exposures to lead in this industry is in proportion to the size of the manufacturing plant. Large establishments, almost without exception, have introduced protective devices, automatic features and other safeguards to the point that clinical lead poisoning is a rarity. Conversely, in every city a few petty battery manufacturing plants are likely to exist, operating in two or three rooms under conditions obviously exposing all workmen. In the aggregate, these plants produce definitely more clinical lead poisoning than arise out of employment in larger plants. This paper is based upon a survey of minor manufacturing plants in one city where the total number of employees in any one plant rarely exceeds 10.

Conditions of Work in the Usual Petty Plant

AT ONCE it is necessary to draw a distinction between those plants that merely assemble battery parts and those other plants which carry out substantially all operations necessary in battery manufacture. Without exception, work conditions in the assembly plants are far superior to those in the manufacturing plants, and on the whole, these assembly plants are not highly culpable with respect to producing lead exposures.

In the city concerned in this investigation, it was found that as little as $400 would purchase sufficient equipment to carry out storage battery manufacture and that an additional $200 would purchase raw materials sufficient to start operations. These plants customarily operate under conditions without any adequate exhaust or ventilating systems and without any machinery for the enclosed mixing of lead oxides into paste—instead the mixing may be carried out in open devices such as tubs or barrels. Without exception, no facilities, or inadequate facilities, were found for bathing, consumption of food, change of garments, etc. In the 13 battery plants investigated, more than half make use of no more than two workers. In many of these plants, it is found that no two manufacturing processes are carried out at any one time; starting with the unmixed dry lead oxides, operations are carried out step by step to the point of the completion of the battery, ready for sale. Activities in these plants not only are highly seasonal, but ordinarily are highly intermittent. Several plants operate not more than five days in any one month. During this period, sufficient batteries may be produced to tax the selling capacity of the organization concerned. These factors tend to mitigate the probability of lead poisoning, but even so, on a proportional basis, this industry and this type of the industry, produces more clinical lead poisoning than any other industry in this city. Employment ordinarily is so distasteful that workers rarely remain for more than one or two months, and the cessation of employment is often brought about by the actuality of lead poisoning, for which there is no required compensation in this State. Often circumstances are such that no monetary responsibility may be imposed upon these small employers. This work is classified by some workers as a "last chance" job, in which the labor turnover is enormously high, due to the occurrence of the almost inevitable lead poisoning or to the procurement of more desirable work. Other plants in entirely dissimilar industries frequently inherit clinical lead poisoning in the absence of exposures in their own plants, but arising in workers who have been able to abandon

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employment in low types of storage battery factories.

In making the study of this stratum of the storage battery industry, the work was divided into three parts, as follows:

1. An engineering survey of each plant was first conducted to establish familiarity with the various manufacturing processes.

2. Collection of air samples and the determination of the concentration of lead at the various manufacturing operations in each plant. Other samples were collected to indicate the general workroom atmospheric content of lead.

3. Blood specimens were secured from all employees working at the time the plants were visited. From these specimens, basophilic aggregation cell counts were made. Two or three weeks elapsed between collecting air samples and making the basophilic aggregation tests. This delay in the making of basophilic aggregation tests was through design, inasmuch as there is a known lag with respect to the time of exposure prior to the appearance of increased numbers of basophilic aggregations. This lag ranges from one to three weeks.

Health Hazards and the Various Operations

ALTHOUGH it is our belief that exposures connected with the various manufacturing processes differ greatly, it is difficult to demarcate these exposures because all operations are usually carried out in the same work room. In other words, it is believed that the mixing operation might contaminate the air of the whole workroom with lead, and greatly affect the lead findings around the burning table, which may be only a few feet from the mixer.

No less, the individual manufacturing operations briefly are appraised with regard to their health hazards.

1. Melting and Casting:

The melting and casting operations will be considered as one because of their close relation. In all cases, the operator stands close to the melting furnace and does casting. In those plants which are using unhooded furnaces (this is usually the case) the operator is exposed to lead fume arising from the molten lead. The extent of this lead fume depends upon the temperature of the molten lead. The higher the temperature is, the greater the quantity of lead being expelled into the air. In no case were these lead pots controlled with thermostats and as a result the temperature of the molten lead was much higher than necessary. In this survey, this fact greatly affected the lead exposure connected with lead melting and casting.

2. Mixing:

It is our opinion that the greatest hazard connected with the storage battery industry, as conducted on a petty scale, accompanies the mixing operation. Large quantities of lead oxide dust are usually expelled into the air, both in transferring the oxides to the mixer and when the mixer is first started. Because of the small particle size of these dusts, they are suspended in the air and gradually float to all parts of the work room. Although this operation is carried out only for short periods of time each day, sufficient lead oxide may be expelled to cause serious exposure throughout the work day.

3. Pasting:

The lead oxides as handled by the paster are in the form of a paste and as such are of little significance, except if taken into the body through the mouth while smoking or other similar procedures. However, it is usually found that the pasting tables are littered with dry lead oxides and dusts are easily thrust into the air while the paster is working. This may be caused by dropping of tools or otherwise fanning the dry dusts in carrying out his regular work. Because of the close proximity in most cases, of the mixer and pasting table, the exposure at these two positions is found to be about the same.

4. Burning:

The exposure connected with the lead burning operations is probably the least hazardous of all the manufacturing operations, except assembly and forming and charging, because of the short period of time the operator is actually burning lead. Approximately 75% of the operator's time is spent in placing of plates and posts on the rack. This does not mean that he is not exposed to lead at all times, however, because he frequently stirs up lead oxide dusts which accumulate on the table.

5. Assembling:

The dust exposure accompanying the assembling operation is not great, as the only lead oxide handled is in the form of dry pasted plates. Proximity to other and more dangerous activities represents the outstanding source of injury.

6. Forming and Charging:

Providing these operations are confined, the worker will not be exposed to lead.

Experimental

THE apparatus used for collecting air samples for lead determinations was a modified Greenburg-Smith impinger apparatus.[8] The apparatus consists of a rotor pump which is equipped with a standard orifice and measuring devices for metering the air. The pump was connected to an impinger tube and the lead collected in the water. These samples were obtained as near as possible to operators' positions and at all manufacturing operations. In general, air samples were taken over a period of 20 minutes at the rate of one cubic foot per minute.

After the samples were collected, they were treated according to the method of Harrold, Meek and Holden,[10] and the lead determined. Calculations were then made to convert the amount of lead in the sample to milligrams per 10 cubic meters of air at standard conditions.

In addition to making lead determinations, basophilic aggregation cell counts were made of all workers. The blood of healthy human adults rarely contains more than 1.0% to 2.0% of basophilic cells. The percentage of basophilic cells for those workers absorbing lead without clinical manifestations is usually 2 to 4, while in some cases the counts may be as high as 15%. Findings of 2% or greater at once suggest lead absorption.

Table 1 is a combined table, showing the results of lead determinations and the basophilic aggregation counts.

Comment on Experimental Study

OF THE entire number of controls, it is to be noted that not one person yields a basophilic aggregation percentage in excess of 1.7%. As

many times pointed out, this is characteristic of the healthy, unexposed adult. On the other hand, of the total number of battery workers, including those persons performing only clerical services, 44% presented basophilic aggregations in excess of 2% of the total number of red blood cells. While this percentage may seem high, it is to be emphasized that the conditions of work in most places were favorable to universal lead poisoning. The lack of proof of universal lead absorption or lead poisoning probably is due only to the intermittency of work, not only on a seasonal basis, but on a month by month basis as well.

While no physical examinations were carried out, it is known that several of the persons here classified as showing lead absorption were instances of early lead poisoning of clinical type, which impression was formed from casual inspection and from offhand remarks made by workers in the course of survey activities.

While these basophilic aggregation tests numerically represent only a small fraction of the near 25,000 that have been conducted, they are regarded as possessing significance in that they were made on workers exposed to high atmospheric concentrations of lead in a combined form.

Table 1. Atmospheric Lead Determinations and Corresponding B. A. Counts

Plant	Position	Lead per 10 cubic meters of air (in mgms.)	Worker	B. A. Cell Count (percentage)
No. 1	Pasting	6.4	Paster's Helper	6.6
	Mixing	248.0	Paster	3.0
	Racking	3.9	Melter and Caster	10.0
	Melting and Casting	7.7	Melter and Caster	5.0
	Lead Burning	23.6	Lead Burner	2.3
	Blank	00.0	Lead Burner	1.4
			Assembler	4.1
			Manager	1.5
			Office Worker	1.1
No. 2	Pasting	8.1	Office Worker	1.9
	Mixing	6.8	Office Worker	1.3
	Melting	12.0	Office-Plant Worker	1.1
	Blank	00.0	Deliverer	0.9
			Paster	4.0
No. 3	Pasting	1.8	Manager	1.0
	Mixing	2.3	Baby	0.6
	Melting	4.9		
	Melting	2.7		
	Blank	0.0		
No. 4	Burning	0.55	Burner	1.1
	Burning	2.00	Burner Helper	1.0
	Blank	0.00	Foreman	0.7
			Fireman	0.9
			Charger	1.4
			Manager	0.8
			Repairer	1.5
			Shipper	1.3
			Assembler	1.2
			Former and Charger	1.4
No. 5	Pasting	3.1	Paster	10.2
	Mixing	23.0	Paster	5.2
	Melting	2.8	Helper	3.0
	Workroom	0.53	Caster	7.7
	Blank	0.00	Assembler-Charger	8.5
			Paster	2.0
No. 6	Pasting	5.9	Assembler	4.0
	Pasting	7.8	Paster	6.5
	Mixing	16.7	Office Worker	1.0
	Workroom	5.6	Office-Plant Worker	2.0
	Blank	0.00	Office Worker	2.5
No. 7	Pasting	4.1	Paster	2.4
	Pasting	3.7		
	Melting	2.05		
	Workroom	2.23		
	Blank	0.00		
No. 8	Pasting	2.8	Wrecker	4.6
	Pasting	3.34	Foreman	3.3
	Pasting	2.60	Paster	9.8
	Mixing	1.22	Wrecker	5.8
	Mixing	7.10	Handy Helper	1.7
	Mixing	1.01	Rebuilder	1.7
	Burning	5.45	Wrecker	3.5
	Blank		Rebuilder	2.1
			Assembler	1.8
			Assembler	3.5
			Manager	1.1
			Wrecker	3.6
			Melter and Caster	4.1

In general, wherever a high concentration of lead was established in the atmosphere, this was accompanied by an increase above the usual of basophilic aggregations in the blood of exposed workers.

Comment

AS THE application of the basophilic aggregation test, as a measure of lead intake increases in extent and in value, it becomes highly desirable that this method come into no degree of disrepute because of deficiencies in technical procedure. From extensive correspondence that has grown up about this method, it becomes well established that some unfavorable results are related to demonstrable technical difficulties. A number of these are now mentioned:

1. In the preparation of the Manson stain, best results will be obtained if the boiling water to which the borax is added is allowed to cool to room temperature prior to the addition of the methylene blue. Otherwise, a precipitate may be formed in some instances.

2. The Manson stain is best used in covered jars, into which the slides to be stained are submerged. However, prior to the staining of any batch of slides, the surface of the stain should be skimmed off with a sheet of filter paper, in order to remove possible accumulations of precipitate, which sometimes forms at the surface.

3. From slides sent in for examination, it has been determined that the greater number present blood smears so thick as to make enumeration difficult and onerous. A single layer of discretely separated cells is desirable.

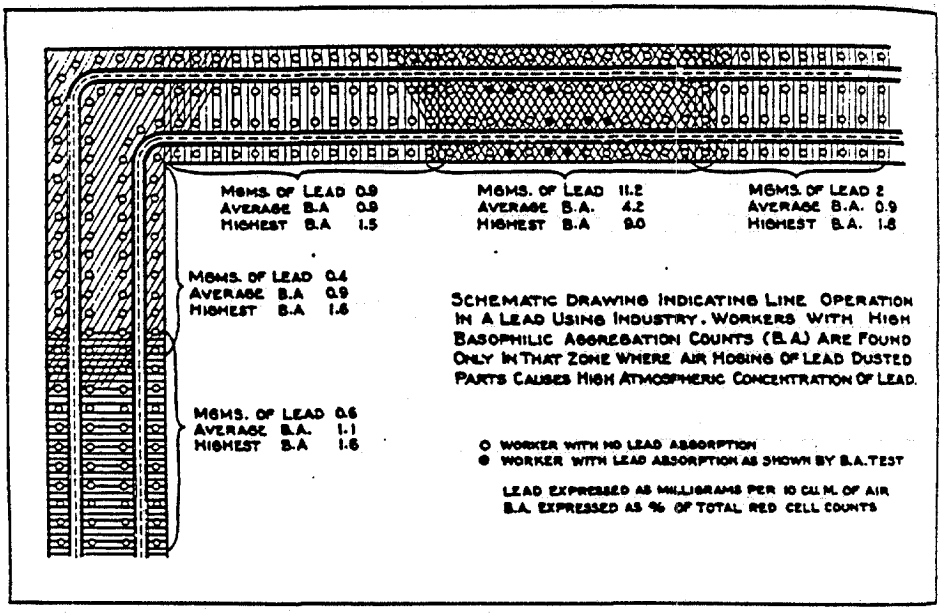
4. The use of xylol, alcohol or almost any other solvent commonly employed in the cleaning off of cedar oil leads to the removal from the slides of many basophilic aggregations, to the end that subsequently check counts may be unreliable.

5. Some batches of dry stain are inherently unsuited to this test because of chemical impurities which lead to unwanted and inaccurate results.

Some laboratories report in connection with instances of proved lead poisoning a percentage of basophilic aggregations in that zone regarded by us as within the usual limits for unexposed persons. Appropriate investigation of all circumstances usually establishes that as a result of some technical inaccuracy, the full number of basophilic aggregations potentially present are not being recognized as such and counted. In one instance, an industrial technician reported a 1.2% basophilic aggregation in a known case of early lead poisoning. A more experienced worker, making a count on the same slide, detected a percentage of 4.6 of basophilic aggregations, which is expectable.

No known reason exists for any recession from the statement that healthy persons, unexposed to lead or other sources of increased basophilic aggregation counts usually will not present percentages of basophilic aggregations in excess of 1.5, although very rarely apparently normal persons may present a percentage near 2. Such persons, on investigation, usually may be shown to exhibit an undue amount of oral sepsis, a tonsillar infection, sinus disease or some little apparent and comparatively unimportant condition.

One accompanying schematic drawing is designed to present the application of the basophilic aggregation test in spotting exposure points in lead using departments in industry. In the factory department leading to this drawing, all of the approximately four hundred workers employed were sent to the dispensary during the course of a two-day period for the purposes of



supplying blood smears for basophilic aggregation examination. These workers were sent to the dispensary without any selection as to precise work points and no information was procured by the examiner as to types of employment—in fact no information was procured other than the name of the employee and his badge number. In due time, basophilic aggregation counts were made with the result that nine workmen presented counts well above the normal range. Then with the colored pin system, all workers were spotted on a blue print of the work department concerned. Through this maneuver, it was established that without exception the workers showing positive tests were employed at identical duties located in an area with a radius of about 30 feet. Then and then only quantitative determinations of lead in the atmosphere were made through the method described by Harrold, Meek and Holden[10], at this point and at other appropriate stations in the entire department. Only at this one location was the concentration of lead sufficiently high to have induced lead poisoning and to have provoked the high basophilic aggregation test encountered.

From this storage battery work or from any other investigations in which correlations have been sought between the quantity of lead in the atmosphere and the B. A. test, it may not be maintained that with any given increase in the atmospheric content of lead is there a corresponding and commensurate increase in the percentage of basophilic aggregations in the blood. It is unlikely that any such precise conformity ever may be demonstrated, since the content of lead in the atmosphere in most work places obviously varies from hour to hour and day to day and even greater difficulty is encountered through the fact that the basophilic aggregation count determined on any given day probably is influenced by a lead intake of several days' priority, and possibly as much as two or three weeks. Therefore, no contention is made with respect to a correlation other than the demonstrable fact that in the sustained presence of an atmospheric lead content above that which is tolerable, or in the presence of other lead exposures, such as a proved carrying of lead to the mouth by fingers, there will arise in due time among workers so exposed increased percentages of basophilic aggregations extending beyond the range regarded as usual for unexposed and healthy persons.

In view of statements frequently made that there is no known tolerance to the action of lead, the issue is frequently created as to why all workers under apparently equal exposures do not uniformly present increased basophilic aggregation percentages. The response and explanation leaves no uncertainty as to the rationality of this occurence. The intake per day or per any other considerable unit of time by different workers engaged in substantially the same work markedly varies due to a number of factors, such as the efficacy of the nasal passages as a barrier to the entrance of dust, the rate and depth of respirations, different heights of workers which introduces variables as to proximity of the breathing zone of workers in relation to exposures, the manner in which workers manipulate tools, such as blow torches in the burning operation of storage battery manufacture, and lastly the variations in hygienic habits of different workers as to cleanliness, change of garments, etc. It is therefore expectable and almost inevitable that some workers will exhibit evidences of lead absorption or lead poisoning while their fellows appear to be unaffected.

Summary:

IN AN industrial city, an investigation has been made of work conditions as to lead exposures in a series of very small storage battery manufacturing plants, some of which were operating under manifestly objectionable work conditions. As a part of appropriate engineering hygienic surveys, lead determinations were made of the atmosphere in all operations. Later, and with due regard for an inevitable lag period, basophilic aggregation tests are carried out on the blood of all workers.

In those plants leading to quantitative determinations of lead in the atmosphere in excess of the threshold of tolerability, corresponding basophilic aggregation tests were likewise such as to fall beyond the zone characterizing healthy, unexposed persons. Conversely, in those plants providing no high amounts of lead in the atmosphere, no workers exhibited basophilic aggregation findings beyond the percentage accepted as characteristic of healthy unexposed persons.

Table 2.
Basophilic Aggregation Test Controls
Unexposed, Healthy Adults

Worker	B. A. Cell Count (percentage)
Technician	1.2
Technician	0.8
Technician	1.7
Secretary	0.4
Secretary	0.5
Secretary	0.5
Secretary	0.8
Salesman	0.5
Salesman	0.8
Salesman	0.7
Salesman	0.9
Student	1.0
Student	1.2
Dentist	0.9
Doctor	1.0
Housewife	1.3
Housewife	0.6
Housewife	0.8
Housewife	0.9
Housewife	0.6
Doctor	1.1
Druggist	0.8
Doctor	1.5
Secretary	0.7
Engineer	0.4
Engineer	1.0
Office Worker	0.9
Accountant	0.7
Cashier	0.9
Secretary	1.1
Clerk	0.4
Manager	1.0
Accountant	0.5
Clerk	0.8
Secretary	0.4
Clerk	1.0
Office Worker	1.3
Secretary	0.7

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Fractures of the Spine

—*The Surgical Aspect*—

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IN THIS modern time of fast living, rapid transportation and strenuous playing, fractures of the spine are no longer uncommon.* It would appear that the bony framework which supports the body and covers the spinal cord is no longer adequate to take care of the increased demands made on it. Formerly a rare condition, spine fractures are now quite common. Intelligent knowledge and management of this type of fracture is now demanded of every doctor whether he be a surgeon or not.

When the spine is fractured there are usually two problems with which we are concerned:

First: Compression fractures in which dislocation is not evident by x-ray and in which there is little or no neurological or manometer evidence of cord injury.

Second: Compression fractures in which dislocation and cord injury are evident by x-ray, neurological and manometer findings, either one, two or all.

In the first group are fractures which cause mild or slowly progressive neurological symptoms. These cases usually make a good recovery under competent orthopedic management. They are rarely surgical and certainly never early surgical. Our objective in this class is just the same as in any type of fracture, that is to secure anatomic, economic, and functional restoration. Occasionally for various reasons a proper reduction of this type of fracture is not done early. It may then become necessary to resort to surgery because callus formation and contractions gradually cause cord compression.

In the second group are placed those cases which present immediate evidence of x-ray, neurological and manometer changes. These changes vary from moderate neurologic disturbance to a frank paralysis with complete subarachnoid block. The neurologic disturbance may be due to slight bony pressure, edema, hemorrhage, or cord and dura laceration. The complete paralysis is most always due to bony pressure—especially if it takes place at the time of injury. It is rare that a cord is so torn or lacerated at the time of injury as to cause a complete paralysis. Then too, in most cases a torn or lacerated cord will not cause an early subarachnoid block as will bony pressure. This is an important point to be kept in mind in differentiating the cause of the block and the paralysis. Cases in this group which do not have major manifestations of cord pressure are not surgical. A reduction of the fracture on a Hawley table with use of the fluoroscope is the proper treatment.

Certain cases with bony pressure, immediate paralysis and subarachnoid block call for surgical intervention. I am less inclined to surgery than formerly, and this is because of our results with conservative treatment. We always try a reduction first. This is done on a Hawley table with the use of a shock proof fluoroscope and without anesthesia. I am of the opinion that no fractured spine should be operated until a reduction has been attempted.

Surgery should be resorted to in those cases in which x-ray shows bony pressure on the cord, in in which there is a total paralysis occurring at the time of injury, and in which there is a complete block of the subarachnoid space. It is rare that orthopedic measures help this type. Immediately after attempting an unsuccessful reduction it is wise to remove the bony pressure from the cord. I think it poor judgment to wait on this type of case, and delay means mortality or permanent morbidity. I am aware that certain neuro-surgeons oppose surgery in any type of compression fracture. I cannot see the wisdom of allowing bony pressure to remain on a cord, and when other attempts have failed to remove the pressure, I believe it good surgery to remove that pressure. I am aware that laminectomy does not leave an ideal situation for the patient but it is better than permanent paralysis and slow death.

In dealing with an injury so severe as to cause spine fracture we, in practically all cases, have a patient who is severely injured in other parts of the body. I think a rapid and careful examination should be done before the patient is manipulated in any manner. It is useless to manipulate or operate on the spine of a patient in which there are other major injuries likely to prove fatal. Several years ago we did a beautiful and successful laminectomy on a fat man with a first lumbar fracture and complete paralysis only to have him die four days later from a torn mesentery and ruptured cecum. This experience certainly made me look around more carefully.

Surgical intervention in spine fractures is becoming less popular. This is due to several factors: first, most of these injured who would be considered surgical are fatally hurt; second, the use of reduction under shock proof fluoroscope, and third, receiving these cases after paralysis has existed for 24 hours or longer .

In conclusion I would say that when definite indications exist for surgery we should not hesitate. I would warn against foolishly fast surgery. Most of these cases are referred to us and often times it takes courage to refuse an operation when it is urged on you by a colleague who is a good friend. After all nothing is to be gained by operating on a patient who will get well without it and one who will die with it.

* Presented at the Annual Meeting of the Association of Surgeons of the Atlanta and West Point Rail Road, the Western Railway of Alabama, and the Georgia Railroad, at Atlanta, Georgia, March 30, 1937.

The Technical Materials on Lead Analyses are Combined with Those on Dust Counts and Are Presented in the Following Section

LEAD ANALYSES

The chief source of lead taken into the bodies of paint workers is respired dust. Apart from organic lead compounds, lead does not enter through the portal of the skin. Some lead is transferred to the mouth by the hands, in handkerchiefs, and from lead dust deposited on the lips. Some of this lead reaches the intestinal tract and may be absorbed. About five times as much lead is required for the average worker, entering the body through the intestinal tract, to produce lead poisoning as is true for that taken into the lungs. In other words, practically all of the lead entering the lungs is absorbed, while perhaps not more than 1/5 of the lead ingested is absorbed.

The above being true, appropriate measurement of atmospheric lead provides the best index of contaminated air in a given paint plant. Seventeen such samples have been collected at suitable points in this plant. The method of collecting measured quantities of air used by us is that described in the United States Public Health Reports, Vol, 45, No. 12, March 18, 1932, "The Construction and Use of Impinger Dust Sampling Apparatus". In brief, the apparatus employed consists of a motor driven rotor type of pump, carefully calibrated in such a fashion as to pass through the apparatus a predetermined amount of air per minute. The usual rate is one foot of air per minute of time. The dust in the air is thrown out of the air through the procedure of impinging. Thus the air is stripped of its lead content and the lead is retained for analytic purposes. An accompanying picture portrays this equipment.

After the collection of samples, analyses were carried out by a new method which is described in accompanying reprints of an article entitled "A Practical Method for the Rapid Determination of Lead When Found in the Atmosphere". This method is highly sensitive and whenever the need arises will measure very minute fractions of a milligram of lead.

Theoretically, some lead compounds are more toxic than others. This is based on differences of solubility. The sulphate is known to be

more insoluble than the carbonate for example. Practically, these differences are of little importance, except for that quantity of lead taken into the gastro-intestinal tract. So far as known, all respired lead eventually is absorbed and becomes available for damage to body tissue. So far as this report is concerned, no variations in degree of importance is ascribed to any one compound of lead.

Just what quantity of lead taken into the body daily will produce lead poisoning is speculative. By common consent, many published articles and many legal standards set the threshold of danger at 1.5 mgms. of lead in ten cubic meters of air. The last figure cited approximates the quantity of air breathed by a workman in the course of an eight hour day. From our own experience, we have come to believe that the daily intake quantity required to produce lead poisoning is considerably higher and on the order of 8 mgms. It is difficult to prove this point, so these investigators join in the "common consent figure" of 1.5 mgms and endeavor to devise conditions that will provide exposures below that point. The practical fact involved is that most persons will not acquire lead poisoning at the level mentioned, that is 1.5 mgms. per day, but occasionally one worker will. Not all persons equally exposed will provide the same response to lead. Those who are alcoholic, those who are constipated, those who are given to repeated infections, such as common colds, those who are afflicted with gastro-intestinal upsets, those who have nasal abnormalities, and those who breathe rapidly are more likely to acquire lead poisoning than wholly normal persons equally exposed. The counting of dust particles is not a proper procedure for the measurement of exposures to lead in any plant. Since, however, lead is never used as such alone, in most operations it has been deemed appropriate to make dust counts along with lead analyses in order to have in hand some information as to the general dustiness of the air concerned. The method used in particle enumeration is well described in that United States Public Health Report above cited.

Below is furnished a tabulation of the lead analyses and dust counts made in this plant:

Sample #1 House Paint, Dry Mix B, loading mixer, with dry lead pigments.

40.3 mgms. of lead per 10 cu. meters of air over a 20 minute sampling period.

Dust: 46,200,000 particles per cubic foot.

(Note: In subsequent samples, it is assumed that lead in air is measured per 10 cu. meters of air and dust in particles per cubic foot)

Sample #2 House Paint, Dry Mix B, loading mixer with dry lead pigments.

Lead: 7.6 mgms. over 20 minute sampling period.

Dust: 13,400,000

Sample #3 House Paint, Dry Mix B, loading mixer with dry lead pigments.

Lead: 8.7 mgms. over 11 minute sampling period.

Dust: 10,100,000

Sample #4 House Paint A, loading mixer with asbestine and other materials.

Lead: 15.4 mgms. over 10 minute sampling period.

Dust: 10,100,000

Sample #5 Aluminum Bronze Mixing Room D, wetting down aluminum powder with solvent.

Lead: 6.5 mgms. over 10 minute sampling period.

Dust: 24,800,000 (approximately)

Sample #6 House Paint B, Chrome Green Dry Mix.

Lead: 13.8 mgms. over 10 minute sampling period.

Dust: Over 25,000,000.

Sample #7 House Paint B, Chrome Yellow Dry Mix

Lead: 10.5 mgms. over 8 minute sampling period.

Dust: 66,400,000.

Sample #8 White Enamel Mixing, 4th Floor, D-4 Dept.

Lead: 5.7 mgms. over 7 minute sampling period.

Dust: 21,300,000.

Sample #9 White Enamel Mixing, 4th Floor, loading ball mill.

Lead: 8.0 mgms. over 12 minute sampling period.

Dust: 45,700,000.

Sample #10 White Enamel Mixing, 4th Floor, loading mixers.

Lead: 2.8 mgms. over 5 minute sampling period.

Dust: 34,800,000.

Sample #11 White Enamel Mixing, 4th Floor, loading mixers.

Lead: 1.4 mgms. over 10 minute sampling period.

Dust: Over 250 000,000.

Sample #12 House Paint B, Dry Mixing, Second Floor, mixing Ferrite Ochre.

Lead: 1.5 mgms. over 8 minute sampling period.

Dust: 49,700,000.

Sample #13 House Paint B, General Air Sample.

Lead: 2.2 mgms. over 22 minute period.

Dust: 8,230,000.

Sample #14 House Paint B, Dry Mix, Second Floor, Mixing French Ochre.

Lead: 4.4 mgms. over 15 minute sampling period.

Dust: 167,000,000.

Sample #15 Resin Room, Gum Warehouse, Varnish Department, loading varnish pots with gums and resins.

Dust: 6,700,000 over 7' period.

Note: Sample collected in dilute alcohol solution, which dissolved most of the dust.

Sample #16 Resin Room, Gum Warehouse, Varnish Department, loading varnish pots with gums and resins.

Lead: 0.35 over ten minute sampling period.

Dust: 16,900,000. (dust badly agglomerated. Count definitely too low)

Sample #17 Nitrocellulose Milling Room, Department D-6, operating Banbury Mill.

Dust count over 15 minute sampling period 2,920,000.

Sample #18 Lacquer Mixing Room, Second Floor, Dept. D-4L, dumping nitrocellulose into lacquer mixing tank.

Lead: 0.1 mgms. over 20 minute sampling period.

Dust: 5,300,000.

Sample #19 Stone Dressing Room, facing mill stone on lathe.

Lead: 0.6 mgms. over 30 minute sampling period.

Dust: 1,290,000.

From the above list, it may be noted that the following locations show lead concentrations above 1.5 mgms. per ten cubic meters of air:

House Paint, Dry Mix B	40.3 mgms.
House Paint A	15.4 mgms.
Aluminum Bronze Mixing Room	6.5 mgms.
House Paint B, Chrome Green Dry Mix	13.8 mgms.
House Paint B, Chrome Yellow Dry Mix	10.5 mgms.
White Enamel Mixing	5.7 mgms.
House Paint B (general air)	2.2 mgms.
House Paint B (mixing French Ochre)	4.4 mgms.

The problems created by this lead exposure are discussed in a subsequent section entitled "Lead Problems".

Additional Notes Made by Dr. Fredrick:

1) The low type of dry mixers used in this plant have little to be said in their favor from a safety standpoint, but from a dust control standpoint appear to be preferable to the higher forms with underneath drives. Much less dusting occurs during charging at the mixers and the workers' breathing zone is well above the localized cloud of dust which is emitted.

2) When interpreting these data, collected in nineteen representative areas about the plant, it must be remembered that summer time conditions prevailed, with high humidities and excellent window ventilation. Unquestionably higher dust concentrations will prevail in winter months when the relative humidity is correspondingly low and the doors and windows tightly closed.

3) The present wet type of grinding and chiseling practiced in the stone dressing department appears to have the silica dust problem well under control. Such practice is highly commendable and should be continued.

4) The dry mixing and the wetting down of dry aluminum and other bronzing powders is accompanied by large clouds of metallic dust. It is suggested that whenever possible, the material be wetted down in the original container and subsequently manipulated in paste form. The wearing of properly designed respirators tends to alleviate the exposure.

5) It was observed that respirators were almost universally worn during the dustiest phases of the operations, but were removed as soon as the work was completed. This practice affords no protection against the resident dust concentrations in the air, which may remain high for considerable lengths of time in the absence of frequent air changes.

The Quantitative Determination of minute traces of Lead Salts for Highly Specialized Equipment.

See Accompanying Reprint for Description of Method For Atmospheric Lead Analyses Carried out in This Investigation.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

6) Further it is believed that proper servicing and maintenance of respirators is not being made. All respirators should be cleaned and inspected daily in a special department for this work and by an experienced workman. In order to avoid the need of two respirators for every man, this work should be done at night after the regular shifts have ceased work. Every workman in dusty areas should have his own respirator, cleaned and sterilized daily and worn by no one else.

7) The respirators in use, in the writer's opinion, are of a satisfactory type and probably the best now available for protection against lead and other dusts.

8) The exposure to high concentrations of organic dust in the gum warehouse, especially during varnish pot loading operations should be viewed with suspicion. Suitable control and protective measure should be inaugurated in the near future. At the present time, these workmen do not use respirators and only natural ventilation is provided. Certain experimental work, if done, might successfully reduce the dusting of the resins. Moistening with water, alcohol or alcohol-water solutions may be both feasible and adequate.

9) The enormously high counts and the extremely small particles found associated with samples taken about color pigment mixing operations indicates a real need for dust control in the form of local exhaust hoods. The mixing of chrome pigments presents an especially dangerous exposure to both lead and chromium. Respirators of the type which are used at present will protect against the lead, but not against the possibility of chrome dermatitis and chrome ulcers. The chemical compositions of other color pigments in use are not known to the writer, but unquestionably provide similar exposures to other metals and irritating agents.

10) Mixing caulking compound releases numerous asbestos particles into the air as shown by counts made about this manufacture. Howe the extent of the exposure is sufficiently limited that the use of respirato by exposed workers and the introduction of some general exhaust ventilation into the work room will prevent the appearance of asbestosis.

11) In conclusion it may be said that the dust conditions of the Acme White Lead and Color Works, as pictured by the several dust counts here reported, are not alarmingly bad and do not require the application of drastic and immediate control measures. However, this company should consider as a long range course of action the gradual reduction of all high dust exposures in the plant, either by installation of local exhaust hoods, increasing the general ventilation, changing manipulation procedures and processes, or a combination of these devices.

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A PRACTICAL METHOD FOR THE RAPID DETERMINATION OF LEAD WHEN FOUND IN THE ATMOSPHERE*

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THE determination of lead in small amounts found in air has been carried out in the past by some modification of Fairhall's chromate method (1, 2). These modifications include those using the S-diphenylcarbazide developed by Cazeneuve (3) as an indicator for hexavalent chromium. Kehoe (4, 5) and others found this method inferior to a spectroscopic determination (6, 7) especially when used for biological material. Electrolytic methods have also been proposed (8) as have various colorimetric procedures (9, 10). Recently a number of investigators (11, 12, 13, 14, 15) have developed modifications of Fischer (16) and Leopoldi's (17) dithizone method for the quantitative determination of lead for use in various types of investigations. We have for some time used a modification of this method for the determination of lead in air.

Inasmuch as we know of no other method which permits one to collect and analyze so many samples of air that may be lead-contaminated, we describe here the sampling and analyzing procedure in the hope of contributing to the development of rapid and accurate methods for the determination of toxic substances in the field of industrial hygiene. Since it is felt that too many of the methods require equipment not available to the average worker in industrial sanitation, we propose in this method to limit the use of expensive or special equipment.

The details of the sampling apparatus can be obtained from papers written by Greenburg *et al.* (18) and Bloomfield (19). Ordinary items of Pyrex laboratory glassware will be the only other items of equipment necessary.

Sampling procedure for lead.—Using a modified Greenburg-Smith impinger and air sampler, one collects ordinary lead dust composed of lead oxides, etc., in 250 cc. of lead-free distilled water. For some lead compounds and lead fumes where it is best to collect the sample in a dilute nitric acid solution, one uses 10 cc. of concentrated nitric acid (C.P., Sp. G. 1.42–1.43) in the 250 cc. of distilled water. Inasmuch as we, for the sake of convenience and accuracy, in evaporation, ordinarily use 500 cc. Pyrex wide-mouth Erlenmeyer flasks with 250 cc. of distilled water, the quantities of acid and subsequent reagents are based on that procedure. Should one use other collection bottles, containing less distilled water (75–150 cc.) as in some types recently described (20), modified reagent amounts should be used.

*Received for publication May 20, 1936.

The sampling time for quantities of lead which will approximate 1.5 or less mg. per 10 cu. m. of air should be from 30 to 40 minutes. In areas where the amounts of lead are greater than 1.5 mg. per 10 cu. m. of air, the time of sampling should be reduced according to the concentration as the amounts of lead analyzed by this method are in the neighborhood of thousandths of a milligram, and should not exceed 0.1 mg.

The sample is collected either with the 10 cc. of concentrated nitric acid added or in pure distilled water. If collected in pure distilled water, add the same quantity (exactly 10 cc.) concentrated nitric acid after collection. The sample is boiled in the original sampling flask until the quantity is slightly less than 90 cc. After cooling, place in 100 cc. volumetric flasks. Wash the sampling flask with two 5 cc. portions of distilled water and add this wash water to the volumetric flask. Then dilute to the mark with distilled water. Remove an aliquot portion of 5 cc. which quantity will contain approximately 0.5 cc. of concentrated nitric acid. It is important to add exactly 10 cc. of nitric acid and no more. Too little acid will cause destruction of the dithizone reagent. Too great an amount will lower the pH below 9.7 which is the alkalinity to which the lead extractive solution has been adjusted. This has been shown to be the optimum pH by Clifford and Wichmann (21). The reagents have been adjusted to care for all commonly interfering metallic ions, but this will not be true unless the described conditions are followed precisely.

Chemical Analysis

Preparation of Solutions.—Prepare (1) a 5 per cent ammonium citrate solution from citric acid by the addition of ammonium hydroxide until just alkaline to litmus paper.

(2) 10 per cent solution of potassium cyanide.

(3) *Lead extractive solution.*—Mix 15 cc. of 10 per cent potassium cyanide solution and 20 cc. of ammonium citrate solution with 53 cc. of concentrated ammonium hydroxide (Sp. G. 0.9), and then add 450 cc. of water. (This solution is used to neutralize the excess nitric acid, and provide the proper pH of from 9.5–10.)

(4) *Dithizone extractive solution.*—5 cc. potassium cyanide 10 per cent, 15 cc. concentrated ammonium hydroxide to 500 cc. of water.

(5) *Dithizone solution.*—25 mg. dithizone per liter of pure chloroform.

Standard lead solution.—1.598 gr. lead nitrate (recrystallized) in 1000 cc. of 0.1 per cent nitric acid solution.

1 cc. of this solution = .001 gr. lead = 1 mg. lead.

10 cc. of above is diluted to 1000 cc.

Whence 1 cc. of the dilution solution = .01 mg. lead.

All reagents should be of the highest purity obtainable.

Detailed procedure.—15 cc. of the lead extractive solution is placed in each of the Squibb separatory funnels. Exactly 5 cc. of the unknown sample contained in the 100 cc. volumetric flask is added. Then add the dithizone solution from a burette in 0.3 cc. portions, shaking the separatory funnel after each addition until a slight purple tinge is noticed in the chloroform layer. The dithizone in

lead extractive solution containing the lead, until a slight purple tinge appears, one adds a known volume of known concentration of the dithizone reagent. These concentrations are so adjusted as to give colors ranging from green through blue-green to purple shades, and finally a cherry red.

We have found it advantageous to use small known amounts of the weakest dithizone reagent for the unknown sample and the same solution for the standards nearest the unknown in lead concentration.

Then by adding a definite volume of the stronger solution, the unknowns having larger lead content may be determined. Other standards will then be made up containing larger known quantities of lead and the dithizone will be added in two portions, one, the known amount of weak dithizone as added to the weak standards, and the second portion of stronger dithizone as added to the unknown sample.

By following this method of adding the dithizone reagent, an unknown containing up to 0.2 mg. of lead may be accurately determined. Most routine work demands no more than four to six standards.

Detailed procedure.—Collect sample as previously mentioned. Add 5 cc. of the unknown sample contained in 100 cc. volumetric flasks to 15 cc. of lead extractive solution. Shake thoroughly and add 5 cc. of the dithizone solution containing 4 mg. per L. Shake vigorously. This amount and concentration is very sensitive for from 0 to 0.005 mg. of lead. If the dithizone solution turns a cherry red indicating that the unknown contains larger amounts of lead, one then adds 5 cc. of the 10 mg. per L. dithizone reagent which will be sensitive with the dithizone already added, up to about 0.015 mg. of lead. Should the color still be cherry red, it is recommended that 5 cc. of the 25 mg. per L. solution be used. This will increase the lead which can be determined up to about 0.05 mg. If still larger quantities of lead are present, one may add the successive increments of the 25 mg. per L. dithizone up to about 25 cc. when the sensitive limit will be reached. This procedure will allow a top limit of about 0.25 mg. to be determined. It is recommended, however, that a smaller aliquot portion of the total lead sample be used, should one have over 0.15 mg. in the sample. Draw off the chloroform layer containing the lead dithizone complex into the comparator tubes and compare with the standards. The greatest sensitivity is found when using the deeper purple shades.

The standard lead solutions made as previously described are the same volume as the unknown sample. They must be treated exactly as the unknown sample. It is cautioned that the analyst should never compare unknown samples which approach to near cherry-red color. It is further recommended that when greater accuracy is desired the number of standards be increased so that the range in lead content is never more than 0.002 mg. between any two standards.

Discussion.—This procedure has, in addition to a greater accuracy, the advantage that larger samples can be analyzed with no sacrifice in accuracy. Using this modification with an aliquot of 1 cc. of the 100 cc. sample, it would be possible to analyze air accurately

Results obtained using the modified method compared to results obtained by the method when all excess dithizone is removed are shown in table 2. These figures indicate that an analyst familiar with the variations in tints produced by addition of excesses of dithizone can obtain results accurate to less than 3 per cent of the lead present. The error is of course greater when very small quantities are analyzed. For this reason, the analyst should so choose his sample aliquot that it contains between 0.005 and 0.15 mg. of lead. This is not difficult after a short familiarity with the method. The speed of the method is not appreciably affected inasmuch as the extractions with dithizone extractive solution are eliminated.

Interference of Metal Ions

The only interference which occurs with diphenylthiocarbazone in the solutions used is that due to stannous tin, bismuth and thallium. We have neglected thallium because of the small amounts of this material used in industry. Bismuth and tin do not interfere due to the *excess* ammonium hydroxide and ammonium citrate which remove these metals while in combination with dithizone. It is not known how completely this procedure removes the interferences. It may be that compensatory errors cause the removal to appear complete. However, it has been observed that, in the analysis of air containing solder particles with a composition of approximately 50 per cent tin and 50 per cent lead, no appreciable error is evident.

The following experiment was made. Air samples containing the unknown material were divided into two equal parts after the addition of nitric acid. One portion was treated as suggested by Clifford and Wichmann (21) for removal of tin and the lead then determined by the "mixed color" method. The other portion was treated by the "one color" method described in this article. No appreciable error was evident. The results are shown in table 3.

TABLE 3

	Lead found (lead and tin)	Lead found (tin removed)
	mg.	mg.
1	0.023	0.022
2	0.02	0.022
3	0.04	0.040
4	0.013	0.011

TABLE 4

Lead Found in Presence of Interfering Elements

Lead added	Bismuth added	Stannous tin added	Lead recovered
mg.	mg.	mg.	mg.
0.02	0.01		0.021
0.02		0.01	0.019
0.04	0.01		0.041
0.04		0.01	0.04
0.02	0.01	0.01	0.02
0.04	0.01	0.01	0.041

It may prove advantageous if a problem involving bismuth and lead should arise to remove the bismuth by Willoughby's procedure (22), although it appears that reasonable results for routine work can be obtained without such preliminary removal if quantities for analysis are above 0.01 mg. This stand is taken in view of the errors of air sampling but cannot be condoned should extreme accuracy be desired.

These results shown in table 4 were obtained by using the method as given in the general procedure, using the dithizone extractive solution to remove excess dithizone. In actual practice, where it is used with lead, the interference is found to be negligible even when the shortened routine method is used.

Comparison of three methods.—It was found that, when using a modified indirect chromate method, results were invariably higher than they should have been. As used by us, the excess of standard hexavalent chromium was determined colorimetrically using diphenylcarbazide as the indicator, after lead chromate had been separated by filtration.

Our results seem consistent with the spectroscopic results obtained by another laboratory, and about the same order of accuracy as other results previously presented.

Discussion of error in air analysis.—The accuracy of this method when a 0.01 mg. sample or more is taken for analysis is certainly greater than needed when the errors of sampling technic are considered. Inasmuch as there is no point in having a method much more sensitive than the whole process of collection of sample and analysis, it is felt that, because of the speed in analysis and the smaller sampling time that is directly related to the smaller quantities of lead which can be accurately analyzed, this method is much superior to the methods previously used in lead analysis of air samples.

It is further to be noted that no blank has been found necessary because the same solutions and amounts of chemicals are used in making up the standards that are used in the analysis of the unknown sample. We have used the method for other determinations than air analysis and, in such cases, it is of course necessary to determine an accurate blank. This, however, we find in most cases to be 0.001 mg. or less. This is not true for various organic materials requiring digestions and other manipulations.

In conclusion, it should be explained that the value of this procedure is felt to lie in the rapid sampling and analysis of lead in air to the end that control of industrial hazards may be accomplished. Much difficulty in studying complex industrial problems arises because not enough determinations can be made in the time allotted for such study.

TABLE 5

ACTUAL SAMPLES WITH INTERFERING SUBSTANCES PRESENT

RESULTS OF CHROMATE METHOD, LEAD	RESULTS OF DITHIZONE METHOD, LEAD	SPECTROSCOPIC ANALYSIS, LEAD
mg.	mg.	mg.
0.025	0.017	0.0162
0.035	0.024	0.0245
0.032	0.018	0.0161
0.034	0.021	0.0227

SUMMARY

We have presented a means of collecting and analyzing lead in any form using a minimum of expensive equipment. No colorimeter need be used if this procedure is followed, and the only special equipment needed is the air sampler and impinger. It is recognized that by making blank determinations Pyrex separatory funnels and high purity chemicals are not required.

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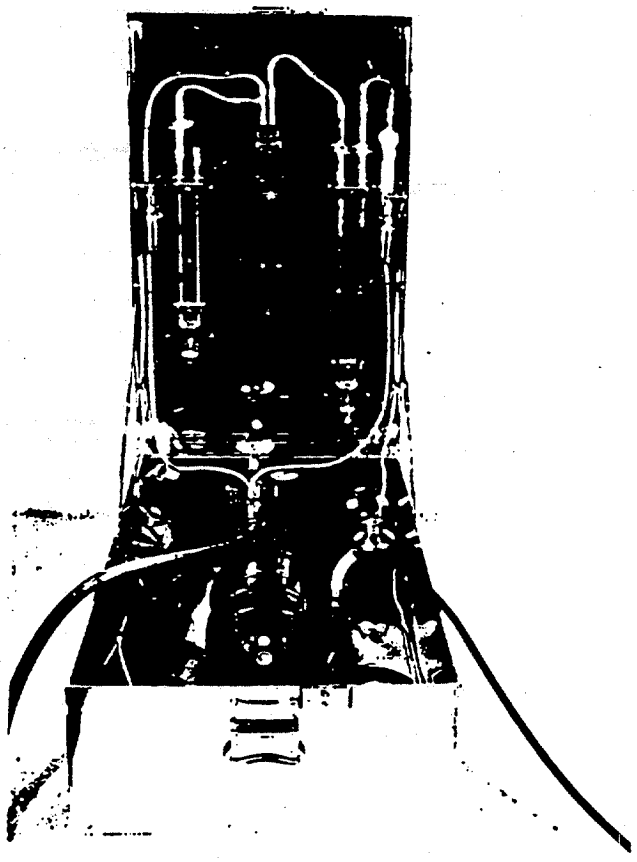


Apparatus Used for Collection of Samples of Atmosphere
Containing Dusts, Lead and Other Contaminants.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

Additional Comment by Dr. Fredrick on Lead Analyses and Dust Counting

Method of Sampling and Counting

All samples were collected in lead free distilled water by the same procedure as described under the heading "Dust." Adequate precautions were taken to prevent the accidental contamination of the sample with lead. Blank determinations on reagents and solvents used demonstrated their very low lead content. In every instance the average blank value was deducted from the total lead content of the sample.

The lead content of the samples was determined by the dithizone method of Holden, Meek and Harrold, described elsewhere in this report.

All results are expressed in terms of milligrams of metallic lead in 10 cubic meters of air at standard condition of temperature and pressure (0°C and 760 mm Hg pressure).

Comments on Results and Recommendations

The maximum concentration of lead which may be present in the atmosphere without danger of lead absorption taking place has been fixed at 1.5 mg. per 10 cubic meters. This volume of air is a close approximation to that breathed by the average workman during an eight hour working day. However, in our experience, the threshold limit before lead absorption takes place as revealed by the basophilic aggregation test is nearer to 5 mg. for most people. In spite of this fact, a better legal position will result if the concentration of lead is kept within the 1.5 mg. limit.

Due consideration must be given to the fact that samples were usually collected during the most intensive liberation of dust and thus tend to show maximum values. The general eight hour level will not run so high. For example, the mixing of paint involving the use of dry white lead produced atmospheric concentrations of from 8-40 Pb/10m^3 while a general air sample taken in the room at greater distances from the operations showed only 2 mg. The wearing of lead dust type respirators during the changing operations greatly reduces the exposure.

Most operations in the house paint B department gave rise to high lead concentrations. The dry white lead used comes in small barrels. It is the practice of some workmen to empty the barrels on the floor in front of the mixer, shovel the contents into it, and sweep

up the balance with a broom. This procedure gives rise to excessive lead concentrations. The operations studied in tests 1, 2 and 3 were practically identical except that in test 1 the mixer was charged according to the above described procedure. In tests 2 and 3, the lead was shoveled or poured directly from the barrel into the mixer. The corresponding atmospheric lead contents were 40.3 mg., 7.7 mg., and 8.7 mg. per 10 cubic meters of air.

The mixing of colored pigments such as lead chromate and especially leaded chrome green leads to very high concentrations of lead dust in the atmosphere. It is suggested that exhaust hoods be supplied on mixers of these materials some time in the near future. It should be noted that most French ochres contain large amounts of lead and can become a serious source of contamination.

General lead conditions in the enamel mixing department were good. Only a few operations seem to give rise to high lead concentrations. The use of respirators should continue at all dusty operations, especially if any lead containing compounds are to be used in the enamel formulae.

The mixing of caulking compound is attended by a rather severe exposure to lead. The mixing of aluminum bronzing powder gives rise to surprisingly high lead concentrations, perhaps due not to the operation itself but to general room contamination from other nearby lead using operations.

Lead in significant concentrations was not found in the dusty operations sampled elsewhere in the plant.

Attention is called to the practice of burning lead containing materials in the yard of the plant. Such work may give rise to lead exposure, as may the removal of accumulated ashes from the burning. Analysis of the ash pile showed it to contain from 5-10 per cent lead, even after passage through a 325 mesh screen.

The burning out and scraping of pots contaminated with lead containing varnish may give rise to a significant lead exposure. Workmen engaged in scraping these pots should wear respirators of proper design.

The general lead exposure in this plant, while not bad, could be appreciably reduced without undue expenditure of money.

General exhaust ventilation should be installed inall lead using departments and local exhaust hoods supplied for very leady operations. Better wash room and locker room facilities should be provided for lead workers. The company should insist upon workmen completely changing their clothing before leaving the plant, and supply overalls to be worn in the plant if necessary. Under no circumstances should the consumption of food be permitted in lead using departments.

LEAD PROBLEMS

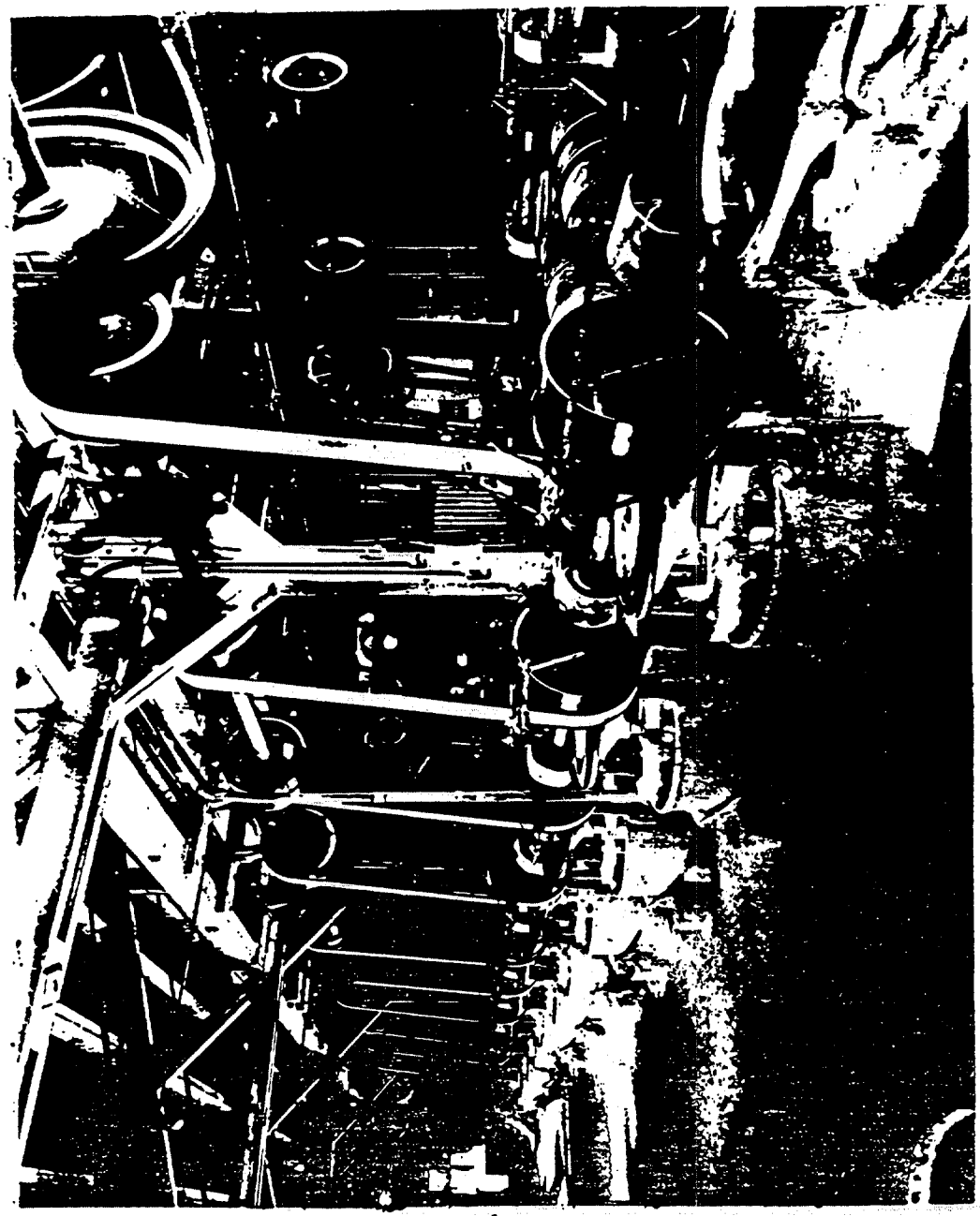
On a qualitative basis, lead may be found in almost every portion of this plant. It is found in raw material warehouses, in mixing departments, in varnish departments, in connection with the making of aluminum paint, in the stone dressing room, in the lacquer department, on the waste pile, in connection with paper baling work, on stairways, etc.

This statement is of relative unimportance. Lead has been used in this plant for approximately 42 years. It has been tracked from lead using departments to remote container cleaning operations, in small quantities it has been wafted by winds through the various yards until inescapably precise tests made for lead anywhere would disclose some of this substance. However, the quantity present, except for a few localities, is unimportant in appraising practical lead poisoning exposures.

Two other sections of this report are devoted respectively to atmospheric analyses for lead and examination of blood of workers for evidence of lead absorption. As noted elsewhere, only one worker is at this time suspected of having any degree of lead poisoning, although not every worker in the plant has been examined.

That section devoted to lead analyses in truth reports several places where lead concentration in the atmosphere well exceeds tolerable limits, but this fact in itself does not serve as a guarantee that lead poisoning will arise. Offsetting this high concentration of lead are the facts that respirators are fairly faithfully worn by exposed workers, also the operations leading to lead in the air are so intermittent as to preclude continuous exposure.

Now after these preliminary statements, an attempt is made to answer the self-imposed questions - "Can lead poisoning arise in this plant?", "Are numerous cases eminent?", "At what points may cases be expected?", "What steps may be introduced to avoid lead poisoning?". The answers now follow:



Section of Dry Mix Department both White and Colored. Operation Lead to Mineral Dusts in Atmosphere Including Lead Dust. Dustiness Favored by Vibration from Overhead Shafting. See Discussion under "Lead Analyses."

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

(1) "Can lead poisoning arise in this plant?"

"Yes. So widely distributed is lead throughout this plant that in spite of elaborate precautions, it would not be surprising that at rare intervals sporadic cases of genuine lead poisoning would arise. It would not be the least surprising if the drum washer developed typical lead poisoning, or that the woman paster of terne plate cans developed lead poisoning, or that the post agitator tank cleaner developed this disease. In short, and to resort to vernacular 'The makin's of lead poisoning are about this plant'".

(2) "Are numerous cases eminent?"

"There will be found under present and unimproved conditions only rare cases of lead poisoning. The reasons for this are apparent. The human body is able to stand the action of day by day small intakes of lead without injurious manifestations. Furthermore, lead, while everywhere present about this plant, is not taken into the body in appreciable quantities under ordinary circumstances. The mere fact that a mixer is coated two inches thick with hardened lead and oil does not constitute exposure. It is only when such lead finds entry into the body either through the lungs or the gastro-intestinal tract that difficulties may arise.

In spite of the absence of prospective large numbers of lead poisoning cases, a few persons at all times probably may be proved to be absorbing lead."

(3) "At what points may cases be expected?"

"If lead poisoning cases arise at all they are most likely to appear at the following work points, in order of importance:

(a) Yard work, if this includes burning of refuse or baling of leaded paper bags

(b) Janitor work in enamel or house paint departments

(c) Cleaning of post agitator tanks after burning

(d) Dry mix room of paint department

(e) Dry mix room of enamel department

(f) Manipulation of terne plate cans

(g) Drum and container cleaning

(h) General janitor work in factory

(i) Stone dressing

(j) Varnish making

(k) Maintenance department because of repair jobs on leaded machinery

(l) Paint recovery section, including small order section for dry colors."

(4) "What steps may be introduced to avoid lead poisoning?"

"(a) The use of lead in paints, except for color purposes, is definitely on the wane, being replaced by such other minerals as lithopone, titanium, etc. This trend should be encouraged, and one of the steps in any program of lead control in paint mills should center about the diminishing use of lead.

(b) Personal hygiene of workers brought about through education is a definite factor in the avoidance of lead poisoning. Workers should be taught that lead is poisonous, that its general source of entry is through the lungs in breathing, that the wearing of respirators serves as a barrier, that lead may be transferred to the mouth in connection with eating, tobacco chewing, smoking, etc., that constipation favors lead poisoning, that the use of alcohol promotes lead poisoning, that the drinking of milk in some measure diminishes the likelihood of lead poisoning, that personal cleanliness is a factor -- that is, the avoidance of clothes dusted with lead, the removal of lead from hands and forearms, etc.

(c) Small tricks in the handling of leaded raw material in this plant play an important part in connection with lead exposures. As shown in another section, some lead in barrels is dumped on to the floor near mixing machines, then is shoveled into the mixers. This practice produces more lead dust than found under any other circumstances in this plant. This practice should be stopped once and for all time, and promptly. Conversely, the careful dumping of lead from bags resting on the lip of mixers leads to comparatively little dust. Some workers, in emptying bags having contained lead, bang and slap the bags about producing excessive lead concentration

in their immediate vicinity. Others achieve to empty the bags with very few motions and very little scattering of lead. Obviously, the latter is preferable and should be encouraged.

(d) Every worker should be trained to wear suitable respirators at all times when lead is being stirred up as a dust. This applies to mixers, janitor workers and on occasion to yard workers. The two types of respirators here in use are both commendable but neither type are well serviced, and particularly the Willson respirators are neglected. Some one person, and an intelligent person, should be given the duty of inspection, cleaning and testing respirators. The few in use in this plant calls for no elaborate cleaning equipment or any great amount of time expended in this work. Soap and water are the best agents for cleaning solid parts of respirators and carbon tetrachloride is a good detergent for the felt type of respirator after these have been blown in reverse direction. Some few respirators in use in this plant are so neglected as to present shaggy whiskers, in part representing an accumulation of dust on the felted surfaces.

(e) Accumulations through the years from faulty janitor work has lead to encrusted machinery, floors and other portions of the plant. Day by day some lead is ground off by walking and hand trucking and this lead is tracked in all directions. Lead as a constituent of general dust settled on stock, machinery, unused portions of floors, rafters, etc., so that whenever any draught is present lead dust is stirred up and endlessly blown about. Fire hazards are increased by accumulations on equipment, floors, walls, etc., so that altogether it is desirable that increased effort be made to get rid of at least 75 per cent of the accumulated lead bearing incrustation widely present in this plant. This statement applies particularly to the enamel department and the house paint department.

(f) No workers in definite lead areas should be permitted to consume food in these areas, or anywhere, without proper hand cleansing. Some states prohibit the consumption of food in lead using departments and conversely such states require the providing of suitable eating places. This commendable law does

not exist in Michigan so that the elimination of eating must be left to the control of the manufacturer, along with the intelligent cooperation of his workers. Very definitely no food should eve. enter the top floor of the two department doing dry mixing.

(g) Not a great deal of any sort of janitor work has been observed around mixing departments, except for the laying down of puddles of paint remover and spent lacquer for the purpose of softening up floor incrustations. Dry sweeping has been observed and wet sweeping has not been observed, although this may exist. It would be very helpful if janitors sweeping up lead accumulations such as in the mixing department might wear respirators during this operation, the wetting down with water or a solution of epsom salts might be used to allay the dust,and further, if careful avoidance might be carried out not to stir up unnecessarily any lead bearing dust.

(h) No need for elaborate dust collections has been found in this survey. At least, up to the present time this need has not been demonstrated. If the very simple remedies discussed in this section are carried out, and faithfully so, it is believed that lead concentrations may be kept within safe limits.

(i) From a hygienic point of view, no objection should be made toward the use of chewing tobacco by lead exposed workers, provided the tobacco is introduced into the mouth with clean hands. The reason for favoring tobacco chewing is that workers involved will invariably spit out tobacco juice that may contain lead, whereas in the absence of tobacco in the mouth, saliva might be routinely swallowed, thus introducing some lead into the system.

(j) From time to time batches of workers should be subjected to blood examinations for lead as a test of the efficacy of preventive measures. If workers present positive basophilic aggregation tests, something is wrong, either with the worker or his work conditions in relation to lead exposures. The finding of consistent positive R. A. tests should lead to additional remedial steps.

(k) With respect to those workers handling turn plate containers, it may be pointed out that the lead on turn plate, which is oxidized

on the surface, rubs off on to the hands of workers in the form of lead oxide. Every worker handling these leaded cans may show you his or her blackened hands. This lead is then transferred to the mouth and some portion of it inescapably is swallowed. Small traces of lead from these cans is thrown into the atmosphere as the cans are bumped about in connection with filling and labeling, etc. This atmospheric lead is not enough to produce lead poisoning. The hand transferred lead is the important matter in this situation. These workers should be encouraged to exercise extraordinary care against in putting fingers into or about their mouths when they are coated with turn plate lead oxide.

(l) Workers with dry color materials often fail to realize that these substances, particularly the yellows, oranges, lemons and greens may be rich in lead. The wearing of respirators and the same precautions named in this general discussion should be exercized by color workers.

(m) Inasmuch as women are likely to be affected more seriously by lead poisoning than men because of their child bearing function, many states prohibit the use of women on any lead work. It is not known that any such law exists in Michigan. The contrary is believed to be true. This question might, however, be brought to the attention of Mr. McGregor, the resident attorney. In any event, no women workers should be called upon to carry out duties involving definite lead exposures. The handling of turn plate cans is not regarded as constituting a definite exposure.

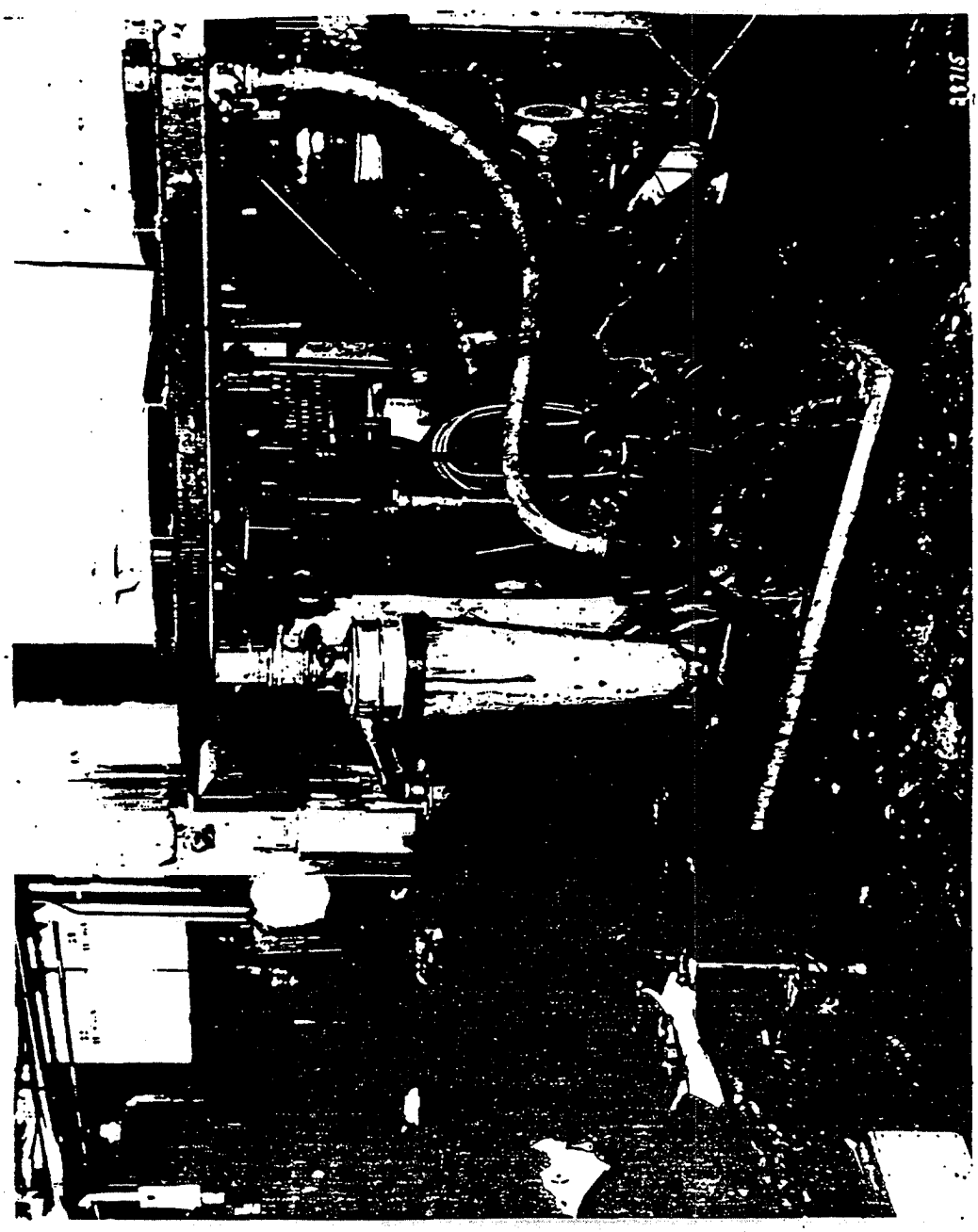
(n) Summary -- What this plant needs more than anything else in the control of lead exposures is a first class clean up, followed by day by day cleansing measures that will avoidthe accumulations now present. During the extensive clean up period, added exposure will be brought about. This is inevitable. Second, the more careful wearing of respirators at the immediate time of temporary exposure to lead would go far in preventing actual lead poisoning cases. Third, the education of workers is needed in regard to the best type of practices in handling materials to obviate lead dusts or other lead exposures.

VAPOR DETERMINATIONS

This phase of the investigation was carried out by Dr. Fredrick and is not strictly divided into special departments, such as lacquer, varnish, etc. The suggestions and recommendations made by Dr. Fredrick are here typed, just as prepared by him, but in some instances in later sections Dr. McCord has modified the recommendations made by Dr. Fredrick as not being practical at this very time.

No fixed standards may be set for all chemicals giving rise to vapors, but a few may be mentioned. For benzol, toluol, xylol, solvent naphtha, wood alcohol, chlorinated hydrocarbons and butanol, the threshold of danger is about 100 parts of the vapors per million of air. In mixtures such as found in thinners, which may contain some toluol and xylol, along with various acetates, alcohols and naphthas, the threshold of beginning possible injury is believed to be about 200 parts per million. For petroleum distillates, including gasoline, kerosene, mineral spirits, naphtha, Stoddard's solvent, without admixtures with more dangerous substances, the threshold of beginning danger is perhaps higher, on the order of 300 parts per million.

Dr. Fredrick's data and comment now follow:



Lacquer Department. Portable Centrifugal Machine. This Operation Gives Rise to Disturbing Quantities of Mixed Vapors. See Text for Discussion of Remedial Measures.

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Testing and Sampling Conditions

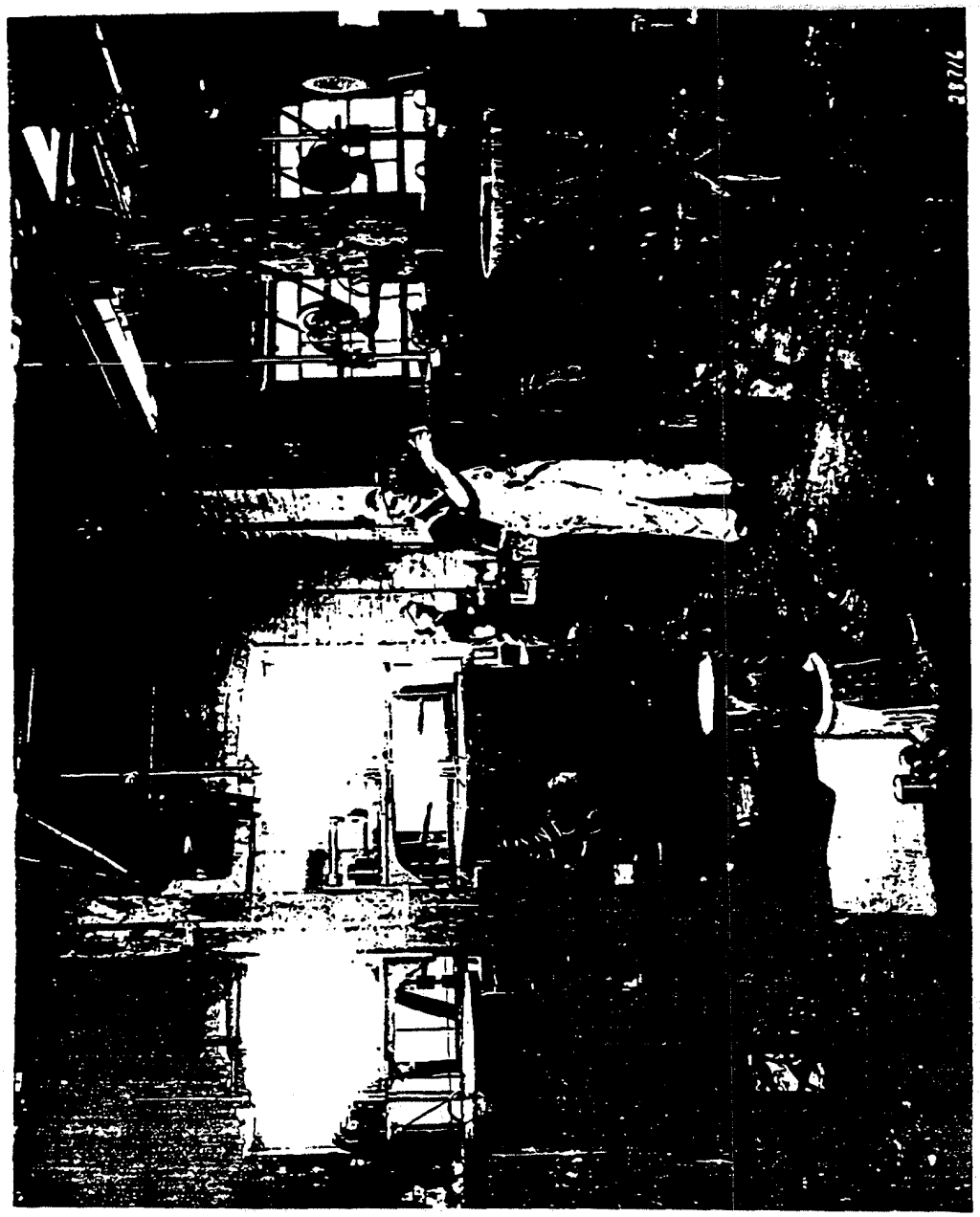
All tests for organic vapors were made with a Mine Safety Appliance Company Combustible Gas Indicator, an instrument capable of expressing in terms of its lower explosive limits the concentration of any flammable gas for which proper calibration has been made. A knowledge of the lower explosive limit of the gas under consideration makes possible the calculation of its concentration. Approximate information may be obtained about any combustible vapor providing the composition is known, even though the instrument has not been precisely calibrated for that material. Obviously only very general data may be deduced from the scale deflections produced by complex mixtures such as lacquer solvent fumes.

In order to minimize errors in sampling due to air currents, dilution and intermittent release of high concentrations of vapor, numerous readings were taken about each work area investigated. The values reported show the average range of gas concentrations encountered. All samples were taken at the nose level of workmen engaged in the operation under study, and as close to his face as possible.

At the time these samples were taken, all windows and doors were open and the natural ventilation so provided was good. With the exception of spray booths, virtually no mechanical ventilation in the form of hoods, exhaust fans, etc. was provided. It may be reasonably predicted that tests taken under winter working conditions with doors and windows closed would show substantially higher results.

General Findings and Comments

The general vapor content of the atmosphere in both the first and second floor lacquer rooms was found to be near 500 p.p.m., probably the upper limit of concentration which may be tolerated for long periods of time without marked harm to the workers so exposed. Windows were open and natural ventilating conditions good. Vapor concentrations about lacquer tank cleaning operations and lacquer clarification with centrifuges were found to be as much as ten times



Lacquer Department. Portion of Post Agitator Tank Section. These Tanks Emit Fairly High Concentrations of Mixed Vapors at Breathing Level of Workers. This Picture also Typifies the General Unsightliness Characteristic of Several Portions of this Plant.

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the probable safe value.

Nitro cellulose-carbon black mixing and milling produces enormous concentrations of denatured alcohol vapor (2500 - 7000 p.p.m.) to which the worker is exposed for periods of several hours. It should be pointed out that the methanol concentration in the vapor is probably higher than that in the liquid owing to its higher volability.

Excessive vapor concentrations (300 - 1000 p.p.m.) were found near the agitator tanks in the D4F Enamel Thinning and Filling Department.

The manufacture of paint remover, composed as it is of benzol, methanol and acetone, all highly volatile and toxic materials, produces a serious exposure to dangerous vapors. Although windows and doors were open, from 200 to 10,000 p.p.m. of vapor were found. A safe concentration would not exceed 100 p.p.m.

Vapor concentrations about the varnish filter presses (100 - 300 p.p.m.) were not spectacularly high, but due to their highly irritating character possibly create a condition dangerous to the health of the exposed workers, especially men engaged in cleaning the presses. The possible presence of phthalic anhydride and other phthalic acid derivatives should increase concern over conditions in this area.

Concentrations in other areas were not alarmingly high during the period tests were made. It must, however, be considered that ventilation conditions were probably at their best. Similar tests made under winter conditions with windows and doors closed will show much higher values.

Attention is called to the practice of cleaning floors and machinery with the paint remover described elsewhere in this report. Observations made in the Enamel Mixing Department showed paint remover vapor to be present in concentrations of from 100 - 500 p.p.m. in the general workroom air. The condition existed throughout

Spray Booths Wherever Found in the Plant Require Modification in Order to Obtain Complete Protection from Injurious Exposures.

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the entire working day. The widespread use of lacquer thinner for hand washing and miscellaneous cleaning is not praiseworthy and leads to undue exposure to these vapors. The extended use of shellac in hand labeling and color card preparation may lead to methanol intoxication.

It has been observed that practically without exception exhaust stacks on spray booths are inadequate and permit the return of exhausted material into the buildings through open windows. These stacks should be raised to at least five feet above roof level.

The blowing of fish oil, and to a lesser extent linseed oil, results in the formation of highly irritating products, probably unsaturated aldehydes such as acrolein and croton aldehyde. These vapors are exhausted into a short stack. Unless unusual wind conditions prevail, excessive concentrations of these materials become distributed in the several work areas.

An appropriate exhaust system should be provided for the centrifugal clarifiers on the first floor Lacquer Department.

The nitrocellulose mixing and milling machines are producing a serious exposure to alcohol vapor. Their enclosure in exhaust hoods similar to those on the enamel roll mills will successfully reduce this exposure.

Installation of individual exhaust hoods of proper design on the varnish filter presses is advisable. It appears that an unusual amount of leakage of hot varnish takes place in the filtration process.

In order to reduce the general winter time level of solvent vapors in the various work places, it is suggested that adequate floor level exhaust fans be installed throughout these areas.

(All tests made Tuesday afternoon, July 13, 1937 and Wednesday, July 14, 1937)

Lacquer Department, second floor.

General room air average-500 p.p.m.

Cleaning tanks with thinner, a common practice - 4000 - 5000 p.p.m.

Lacquer Department, first floor

General room air - 200 - 400 p.p.m.

Filling cans - 400 - 600 p.p.m.

Centrifuge clarification - 2000 - 4000 p.p.m.

Tank cleaning with thinner - 4000 - 6000 p.p.m.

Paste Color Tube Filling (3 or 4 girls) - 200 p.p.m.

(Carry over from Lacquer Department)

Around grinders in color tube filling area - 200 p.p.m.

(Carry over from Lacquer Department)

Color card spraying - 100 - 200 p.p.m.

Some spray carries back to operator.

Small batch mixing room

Mixing table 100 - 400 p.p.m.

At spray booth - 100 p.p.m.

Shellac filling - denatured alcohol - 125 p.p.m.

Lacquer solvent storage (large tanks in an unventilated shed) - 100 p.p.m.

Nitrocellulose-carbon

Department D4L - Lacquer - Second Floor

General room air average - 500 p.p.m.

Cleaning tanks with thinner, a common practice - 4000-5000 p.p.m.

Department D4L - Lacquer - First Floor

General room air - 200-400 p.p.m.

Filling cans - 400-600 p.p.m.

Centrifuge clarification - 2000-4000 p.p.m.

Tank cleaning with thinner - 4000-6000 p.p.m.

A Department

Past color tube filling (3-4 girls) - 200 p.p.m.

(Carry over from Lacquer Department)

A Department

Around grinders in color tube filling area - 200 p.p.m.

(Carry over from Lacquer Department)

Color Card Spraying Department - 100-200 p.p.m.

(Some spray carries back to operator)

Department 21 - Small Batch Mixing Room

Mixing Table 100-400 p.p.m.

At spray booth - 100 p.p.m.

Department D8F - Varnish

Shellac filling - denatured alcohol - 125 p.p.m.

Field Tanks

Lacquer solvent storage (large tanks in an unventilated shed) 100 p.p.m.

Department D6

Nitro cellulose-carbon black mixing - denatured alcohol - 3500-7000 p.p.m.

Department D6

Nitro cellulose-carbon black milling - Average - denatured alcohol - 2600 p.p.m.

(Process lasts 4-5 hours at a time)

Department D4G - Stone Mills

Enamel grinding - not over 100 p.p.m.

Unhooded roll mills - 100-200 p.p.m. Vapors very irritating.

Hooded roll mills - well below 100 p.p.m.

Grinding with lacquer solvent - 100-600 p.p.m.

Department D4

House paint mixing tanks at one end of enamel grinding room - below 100 p.p.m.

Department A (little) House Paint - Second Floor - 100-200 p.p.m. largely lacquer fumes from Lacquer Department next door.

Department B House Paint Grinding - First Floor - no vapors in measurable concentrations.

Labelling Department nearby also showed no vapors.

Department D4F - Enamel - Thinning and Filling

General air conditions - 100 p.p.m.

Around agitator tanks - 300-1000 p.p.m.

Girl straining box car paint - 200-400 p.p.m.

The solvent vapors in this Department are quite irritating and in general are not lacquer thinners.

Paint Remover Department

50% benzol and 50% of a 75% methanol - 25% acetone solution used as solvent. Some crude paraffin added to retard evaporation of the remover on work.

Emptying benzol drums into tank from second floor, windows open - 280-700 p.p.m.

Same for "methyl acetone" drums - 1000-10000 p.p.m.

Filling 1 gallon cans on first floor - 200-10000 p.p.m., 1000 p.p.m. being most frequently encountered.

Department D10

Filling drums with "synthetic" varnish at synthetic storage tanks - 200-400 p.p.m. of lacquer thinner vapor

Department D-10M

Cleaning varnish filter press - 200-300 p.p.m.

Vapors are very irritating, especially to the eyes.

Filtering varnish on filter press - 100-200 p.p.m.

Department D8F

Filling spar varnish - no vapors

Filling lacquer thinner - 200-400 p.p.m.

Varnish labelling near lacquer thinner filling room - 100 p.p.m. or less. Is said to be much higher at times.

Department D8M

Varnish cooking - no measurable concentrations.

Varnish cooling - no measurable concentrations.

Varnish thinning at pits - traces - below 100 p.p.m.

Spray Booths

Numerous spray booths were tested and were found to be virtually free from vapor leakage at their throats.

All tests were made afternoon of Tuesday, July 13, 1937 and Wednesday, July 14, 1937.

VARNISH MANUFACTURE

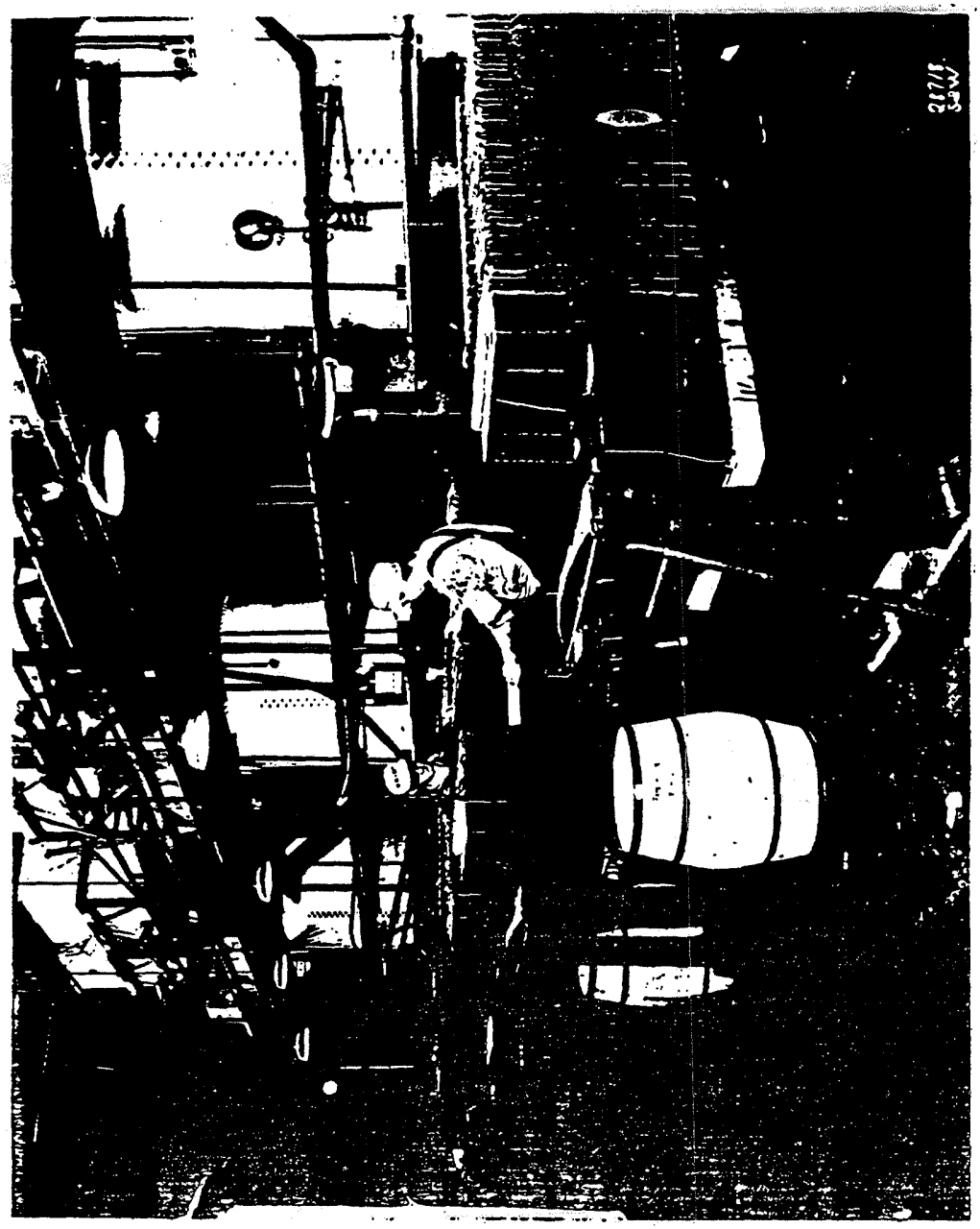
An outstanding portion of this plant's operation is represented by the Varnish Department. Here practically all classes of varnishes are manufactured, using vegetable, fossil and synthetic gums. In addition, there are a number of ancillary operations conducted, such as the manufacture of paint and varnish remover, the preparation of nitrocellulose carbon scale, etc.

From our investigation, we are impressed that a number of objectionable conditions exist, calling for some remedial action. These deficiencies may not be rated as constituting gross exposures. On the other hand, they are of such severity as to be reckoned as practical exposures. As some proof of the actuality of these conditions, we are noting that there now are employed in this department two workers with double pterygium, which disease of the eyes may well have been caused by the irritant action of materials used or created in this department. It is impossible flatly to state either that the condition of these eyes was or was not caused by the materials in use. Legally the answer is in the affirmative. Further, there appear to be a number of persons with chest diseases, one of whom now is in the Hospital, one recently has been in the Hospital and several are said to be working but complaining of chest affections. Third, widespread complaint exists among the men as to the injurious effects growing out of work at various points. This is notably true of the manufacture of glycerol phthalate, the filtering of varnishes, and the blowing of fish oil.

In the following listing, these injurious practices and operations are described, discussed and insofar as possible remedies are suggested.

1) Varnish Filter Presses

This section of the Varnish Department makes use of six filter presses. When these are in operation, a fair amount of leakage takes place, the quantity of which varies somewhat with different types of varnishes. All lead to some leakage, some to more than others. In the



Filter Section in Varnish Department. High Concentrations of Noxious Vapors Were Found in this Workroom.

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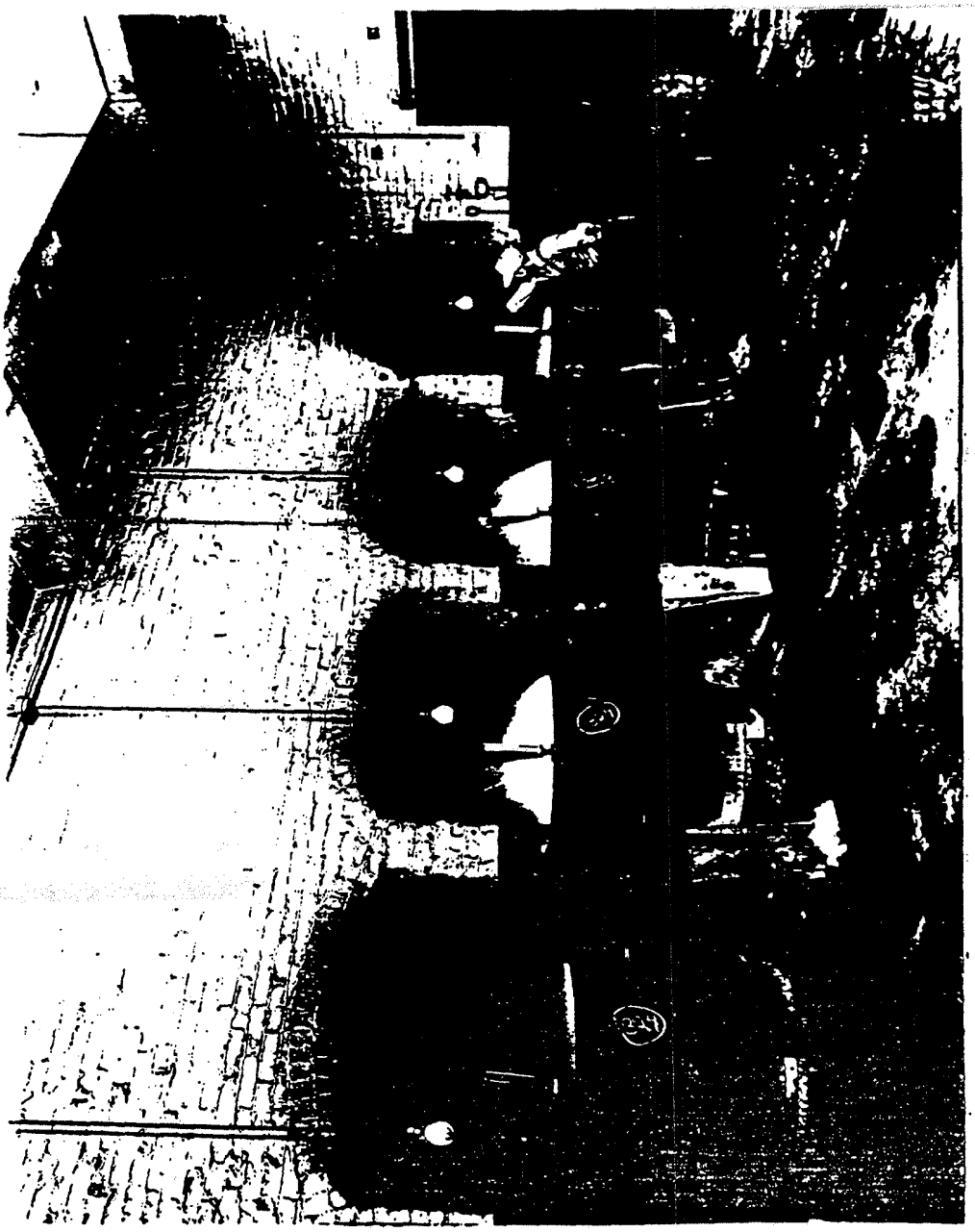
process of knocking down these presses, additional vapors enter the air. As a general result, this room, in spite of its very high ceiling, is thoroughly contaminated with vapors of whatever constituents go into varnishes, but chiefly naphtha and related petroleum derivatives. By actual testing, the concentration of vapors was found to be high. These tests are reported in a special section devoted to the measurement of vapors of lacquers, varnishes, thinners, solvents, etc. It is in this room that one of the two workers with petrygium is employed. The superintendent of this department agrees with these investigators that this room constitutes one of his most objectionable work points.

In the opinion of these investigators, it is desirable that hoods be installed in this workroom. Conceivably general ventilation might be introduced. This, however, will call for the removal of so much air per minute as to be expensive. It seems preferable to recommend that an individual hood over each filter press be installed, that these hoods be fitted with suitable conduits leading to a central stack which in turn should lead to the roof. This central stack should be equipped with a blower and the individual conduits should be equipped with dampers so that when only one or two filters are in use, others may be dampered off as may be required. This installation probably will call for the introduction of increased heating facilities because of the continuous removal of air from this room.

2) Cold Cut Room

This room, which is located in Building 41, houses a variety of operations of somewhat dissimilar nature, but all giving rise to high concentrations of dangerous vapors. Roughly the vapor concentration is 1000 parts per million of air, when not more than 200 parts per million may be regarded as permissible. Not only do workers in this particular room complain, but nearby women workers, labeling varnish and similar duties, complain of vapors from this workroom. After due consideration, these investigators have come to the conclusion that so many changes would be required in order to protect all operations in this room, that the cost



Natural Stack Action Connected with Varnish Cooking Kliminates High Vapor Concentrations about Stack Rooms. This Statement Does not Apply to Phthalic Anhydride Work.

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would be prohibitive and perhaps would cost more than the creation of a new work place to house these operations. Accordingly, the suggestion is made that all of these operations be re-established in some other better suited place and that at the time of such installation, there be installed suitable exhaust systems as will keep the vapor concentration level within permissible limits. No attempt is here made to indicate a new location, type of arrangement or other facilities leading to acceptable results.

One of the worst features in this room is the lack of safeguards for belting. For example, in one location an unguarded belt runs up directly over a series of steps so that the workman must climb under an unguarded belt in order to reach the work platform.

3. Tank Storage Problems.

This department is provided with an unusually large array of storage tanks. It is gratifying to note that already a fair number of these tanks are equipped with carbon dioxide gas overblankets and at this very time an installation is being made that will provide such gas for a larger number of tanks. The use of this protective procedure is to be commended in all ways and at all times. Those tanks that do not lend themselves to the application of carbon dioxide should as rapidly as is expedient be replaced by others that do. At this time there appears to be no way of measuring whether or not carbon dioxide actually is present in a tank. This uncertainty should be removed through procedure to be devised by the Chemical Department. A very simple test may be devised for this purpose.

Inasmuch as fatalities and severe accidents connected with storage tanks for varnishes and raw materials are associated with entry into tanks, it seems desirable to discuss in some detail protection against such accidents. We are therefore copying into this report a similar discussion chiefly derived from an investigation in another plant. So far as known, this material is applicable to all varnish and similar storage tanks.

"The type of asphyxiation or acute intoxication that may arise varies from substance to substance. In the case of benzol, benzol vapors themselves are responsible. Sufficient benzol vapors to produce

death may be present in a tank that has been treated over a period of days by [illegible] steam, hot water and air blowing. In the case of linseed oil, the damaging agent may be carbon dioxide, possibly with a trace of carbon monoxide, or there may be an oxygen deficiency. In the case of varnishes, vapors from the various volatiles, through their combined action, may lead to asphyxiation. The following statements may be pertinent to the situation:

1. No workmen should enter tanks unless absolutely necessary.

2. No workman should enter a tank unless previously it has been freed, as far as possible, of its contents.

3. No workman should enter a tank unless closely guarded by another workman making observation from the manhole or equivalent opening.

4. No workman should enter a tank unless fitted with safety rope with which he may be withdrawn if asphyxiated.

5. No workman should enter a tank unless wearing a positive pressure respirator of proved suitable type. The all-service cannister type is not regarded as suitable. Breathing through a hose in the absence of positive pressure is regarded as objectionable and insufficient.

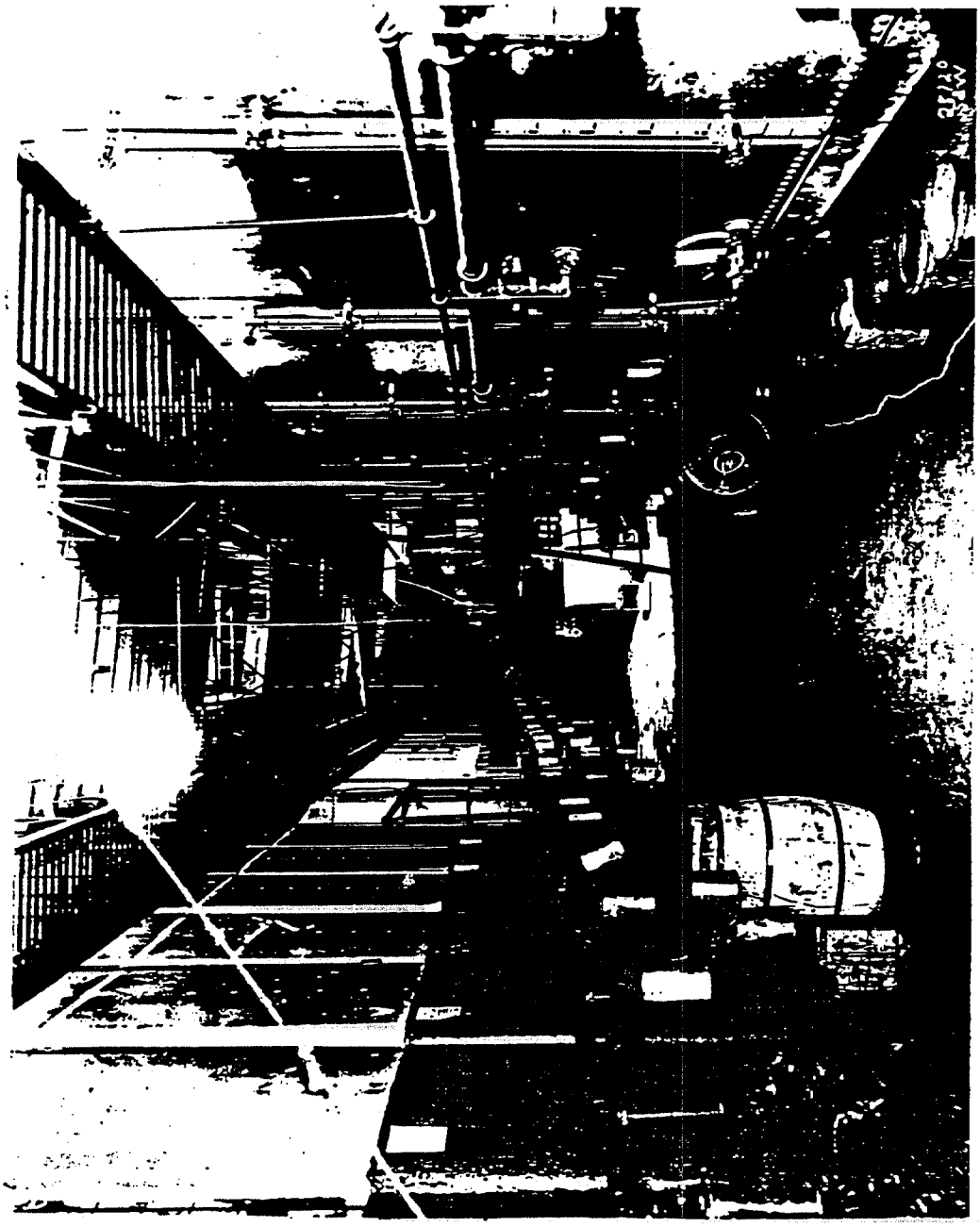
6. No workman should carry ordinary electric light into a tank and no type of light other than those approved by fire and explosion regulations.

7. In case two men enter a tank, each should be guarded by a separate individual on the outside and each should wear a separate safety line.

8. Under no circumstances should workers remain for prolonged periods in tanks. One half-hour is the maximum without emerging for a short period.

9. In most instances, a positive pressure respirator device should be of such type as to also provide eye protection.

10. Due consideration should be given to the possibility of static electricity sparking or other sources of ignition in connection with work in tanks.



The Storage of Raw and Finished Liquid Materials
May Introduce Serious Exposures Connected with Leaks,
Entry of Tanks, etc. See Discussion in Text.

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It is observed in the Acme Plant that a fair number of small leaks are continually present about tank areas. This statement applies not only to tanks themselves, but to valves, pumps, pipe joints, etc. While no one leak was observed to be serious, in the aggregate considerable material is lost and eventually a disaster almost inevitably will arise. On the day that this item was written up, it was observed, in connection with the emptying by pumping of a tank car that continuous leaking was taking place in the pump itself and from the flexible hose entering the storage tank. It was estimated that during the period of emptying the tank as much as 20 gallons may have been discharged on the ground. In one place, bucket had been placed under the leak, but unfortunately the bucket likewise leaked. This criticism is not made of any individual or any branch of the management, but is simply the observation that the way is being paved for explosions, fires, asphixiation, incrustation of machinery and general unsightliness.

4. Fish Oil Problems.

In another section of this report, one of these investigators has introduced some discussion of the difficulties attending fish oil and particularly blown fish oil. In small measure, the present discussion is a duplication of the comment there made.

Among the workers of this plant, the one thing that is known to all as offensive are the vapors created in the process of blowing fish oil. The condition appears to be worse at some little distance from the point of operation than it is at that point. Those persons describe the offensive odor as being in part animal odor, fishy in nature, and a somewhat pungent irritating substance which it appears possible to disassociate from the fish oil odor. In short, one disagreeable agent is an odor, the other is an irritant. The important item, from a health point of view, is the irritant, as odors do not themselves create diseases. They may foster nausea, loss of appetite, create neuroses, but they do not lead to organic disease.

Weather conditions influence the disagreeable features of fish oil processing. On occasion the vapors are blown back to the varnish area with the result that practically all workers may be observed with

irritated eyes as indicated by profuse lacrimation. This vapor or gas would very well serve as a powerful lacrimator for military purposes. This irritant is believed to be acrolein or some acrolein-like body. At least it appears to be an unsaturated aldehyde. Because of offensive properties, the blowing of fish oil is now conducted at night and only on occasion.

In addition to worker discomfort, when workers are present during the blowing process, some complaints are arising from fairly remote sources. During the present week workers at the Dodge Plant, approximately six blocks away were complaining of the disagreeable action of fish oil from some source. Most of the workers were unacquainted with the source of the objectionable odor encountered.

It is believed, but not proved, that it may be a rather simple procedure to get rid of the odoriferous portion of this exposure. At the present time the vapors created are discharged through a conduit up on to the roof of an adjoining building, where there is a short stack. If near the point of origin of this conduit, fairly near to the blowing tank, minute traces of chlorine may be introduced and dispersed, it is probably that the offensive odors may be eliminated. This method has been introduced into tanneries, where similar offensive odors are produced by flesh, hides, skins and other animal organic material.

Wallace and Tiernan manufacture chlorine deodorizing equipment, but it is not known that any elaborate equipment be necessary, at least during experimental stages. It is believed that as little as one part of chlorine per million of vapors may prove effective. Certainly the quantity will not be over three or four parts per million. The cost therefore would be negligible and conceivably all that may be necessary is a small cylinder of chlorine with the type of valve that may be cracked in such a fashion as to discharge minute traces of the gas. The quantity of gas discharged readily may be measured by the Chemical Department. This procedure should be tried out as an experiment, since practically no money is involved. If the odor is eliminated, approximately one-half of the problem will have been solved.

The above mentioned procedure will probably not eliminate the presence of the irritant acrolein or similar body. In fact the chlorination of acrolein may enhance its irritant qualities. Some consid-

eration should be given to the possibilites of eliminating the irritant fraction of this vapor mixture by washing with appropriate solvents, such as dilute alkalies, sodium bisulphite, or otherwise. Since there are already on hand large numbers of tanks, it might prove to be practical to rig up a spray washer in some tank now on hand which is unsuited for other purposes.

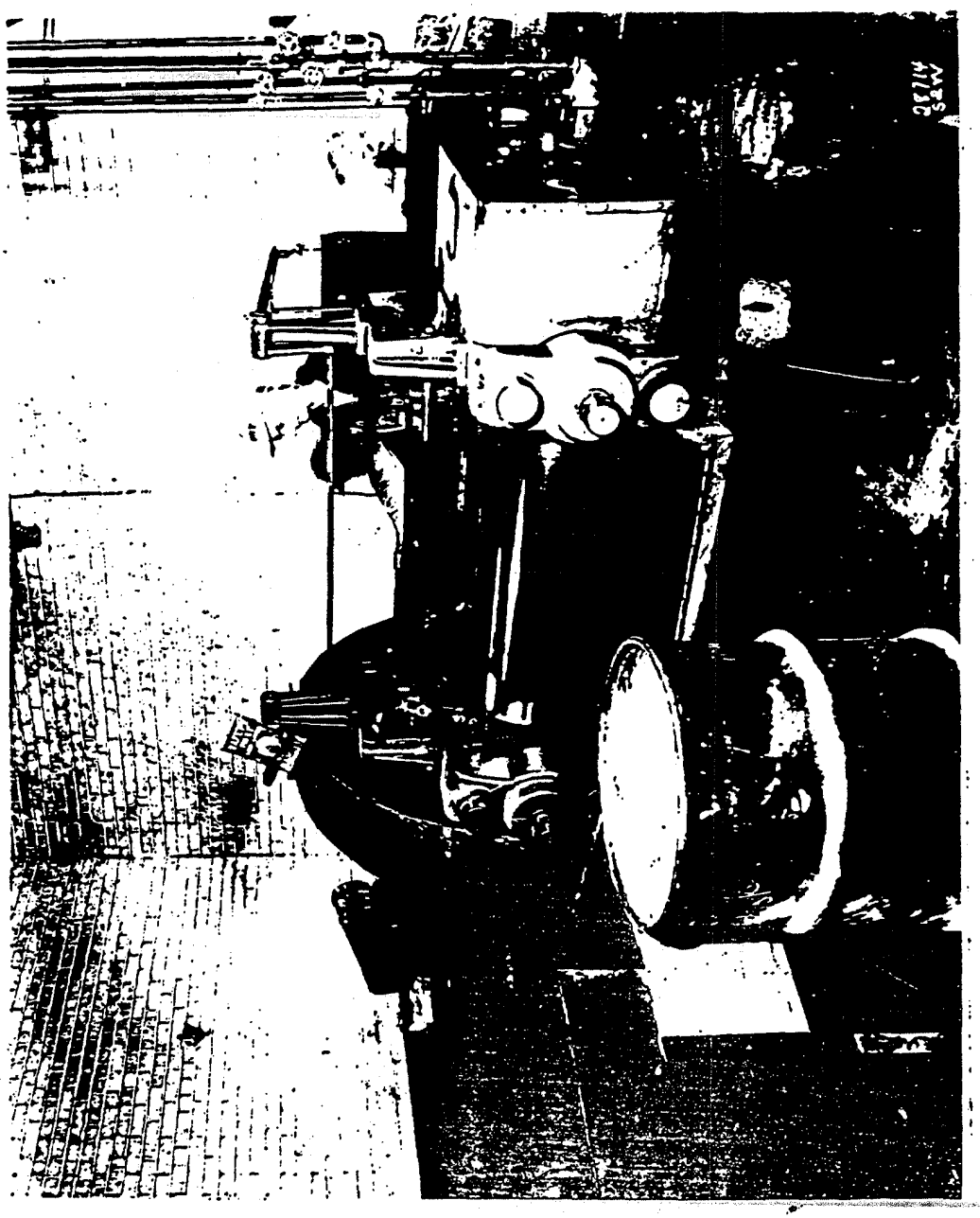
Equipment to control this problem is on the market, but is only available at a high price. The local chemical group, well qualified as it is, should be able to create a spray method or some method for the elimination of this marked irritant.

5. Carbon-Nitrocellulose Milling and Mixing.

One activity in this department apparently is unrelated, at least so closely, to varnish manufacture as to the making of lacquers. This is the mixing and rubber milling of carbon with nitrocellulose. A troublesome exposure is provided not by the carbon and not by the nitrocellulose, but by the alcohol which is used to wet the nitrocellulose. This alcohol primarily is ethyl alcohol, denatured at least in part with wood alcohol. The percentage of wood alcohol is, however, so low as not to constitute the foremost exposure. The exposure is a mixed one of ethyl and methyl alcohol.

The operations involved are 1) mixing and 2) milling. A separate nearby operation is that involving the use of the Banbury machine, using somewhat dissimilar materials. The problem involved with the Banbury operation is mentioned in a later paragraph within this section. Four times daily, for approximately two hours of the work day, material is being removed by the workmen from the mixing machine. Two such machines are present, but only one may be in use. At times both are in use. Correspondingly, two milling machines are present, but only one may be in use at any one time.

It seems necessary that the worker or workers in this room be protected against excessive alcohol vapors. For the milling machines, it is suggested that an appropriate hood be designed and installed immediately



Roll Mill for Nitrocellulose Carbon Paste. High Concentration of Alcoholic Vapors Continually Present during Operation Call for Exhaust System.

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above each milling machine and that the vapors be conducted at least five feet above the roof level with the aid of a blower. This hood should be located as low as possible on to the machine and if at all possible below the breathing level of the workman.

For the mixing machine, the problem of exhaust is difficult, owing to possible explosion hazards because of the dry carbon and nitrocellulose. Almost inevitably fires or explosions may be expected in flues connected with any exhaust system. Any general ventilating system is likely to be somewhat ineffective, inasmuch as worker projects his head and shoulders well into the mixer in process of removing the batch. It seems the best method to meet this problem may be to equip this workman with a positive pressure mouth and nose piece instead of the usual positive pressure hood of larger size. This will provide complete protection. Perhaps somewhat less expensive may be the use of an organic vapor respirator with cannister, which cannister is good for approximately eight hours of service. Least expensive of all would be the use of the ordinary cartridge type of respirator, the cartridge of which contains activated charcoal sufficient for about one-half hour's continuous use. This last mentioned device, while cheapest, is difficult to control in that the effectivity of the respirator at any given moment is somewhat uncertain and the cartridge must be replaced three or four times daily, depending upon the amount of use. If the choice of these three methods is the positive pressure face and nose piece, due consideration should be given to the matter of source of supply. The taking of positive pressure air for breathing purposes off of the usual plant pressure line offers some risks because of the high pressure likely to be provided in the plant pressure line.

The thought underlying this entire discussion is that this small operation is a rather dangerous one and calls for some remedial action.

The Banbury operation, and to some extent the operations just discussed, involve more than usual fire risks. Already the Banbury machine has been well fitted with protective devices against fire, but not against explosion. The experience of the company is that fairly frequent fires are expectable, but explosions are not expected. The stand here taken is that explosions are not out of the question.

It is suggested that the management consider enlarging the two windows not present to include the area between the two windows and so to construct the window installation that this constitutes an explosion wall. This may be done at low expense and may prove to be both economic and a life saver should there be an explosion.

The results from fires may not be limited to fire damage, but instead may involve injury to workmen from the inhalation of the deadly nitrous fumes produced on the burning of nitrocellulose. These nitrous fumes involve series of oxides of nitrogen which are without warning properties and bring about no immediate damage, but after a few hours' interval fatalities may arise due to pulmonary edema.

On the assumption that there may be fires, all workers in this immediate area, including nearby buildings, should be duly warned to leave this portion of the plant even though the fire appears to be a small one. The burning of as little as 10# of nitrocellulose may give off sufficient fumes to kill all persons within the breathing zone within a distance of 100 feet. While this report does not contemplate fire protection and fire procedure, it is strongly urged that the possibility of fires and the production of nitrous fumes be considered and a program for avoiding exposure be created before any fires arise.

Already there are on hand two all service masks which so far as known are suitable for rescue purposes should the need arise in these two rooms. It is noted in passing that these all service respirators should not be warn on the inside of a tank where an adequate supply of oxygen is missing. These respirators merely filter out noxious gases without at all supplying oxygen when oxygen is lacking.

What is here recorded with reference to nitrocellulose fires around the Banbury machine and milling operation also applies to any other portion of the plant where nitrocellulose fires may arise.

6. Glycerol Phthalic Anhydride Resins

This type of resin manufacture is the source of a fair amount of apprehension among workers in this department. Just what the irritant

involved is is somewhat uncertain. This may be limited to the phthalic anhydride or conceivably to the heated glycerine and more conceivably is the little known compound produced by the combination of glycerine with phthalic anhydride under these circumstances. It is possible that more than one irritant is produced. It is a well established fact that some irritant is produced which leads to irritatibn of the eyes, nasal passages and bronchi. There is apprehension that more serious damage may be done, leading to susceptibility to tuberculosis, pleurisy, chronic bronchitis, pneumonia and other such affections. This is not proved.

The process leading to irritation is probably not just one but a combination of mixing, cooking, thinning, filtering and subsequent handling. The superintendent of this department believes that stack action is sufficient to take care of the vapors produced in the process of cooking. Of this these investigators are not equally certain. They are inclined to believe that the installation of fans within the stack for booster action under unfavorable weather conditions may be desirable. This may benefit the workers in the cooking department, but possibly may lead to the distribution throughout the plant area of increased quantities of phthalic anhydride "snow". Without any definite recommendation, it is pointed out that certain other plants have installed booster blowers to augment stack action. The recommendation is made that the management give due thought to the merits and demerits of this sort of installation.

The thinning of this type of varnish offers greater exposure than the cooking. Although the superintendent is convinced that the present installation is adequate and takes care of all vapors, it is readily discernible that such is not the case. The hood over the varnish pot is only about one-half the area of the pot itself. Visible fumes are observed not to be taken up through this hood. The stand has been taken by the superintendent that the hood must be smaller than the pot in order that the condensation drainage will be returned to the pot. This is a tenable position as the control of the condensate without wastage readily may be brought about. If the hood be made as large or somewhat larger than the pot, the lower edge may be rolled inward and upward to constitute a gutter which at some one or two points may be perforated for drainage purposes into the varnish pot,

through one or more suitable spouts.

This type of thinning is complicated by the fact that hydrocarbon solvents, toluol and xylol, are introduced into the varnish while hot. The toluol and xylol boils due to the heat of the varnish. Enormous quantities of dangerous vapors are given off from these hydrocarbons, which are in addition to the irritation from the glycerol phthalic anhydride compounds.

A third problem connected with phthalic anhydride work is in the small room housing the filter presses for this type of varnish. As observed by us, conditions in this room were exceedingly bad. One of our own workers, spending only a few minutes in this room, acquired a minor pulmonary condition. Even though it be granted that improvement should be made, it is a bit difficult to offer any arrangement that will be entirely practical. At once the question arises as to the advisiability of moving this filtering operation to the general filtering area, for which certain recommendations already have been made. It is understood that this is not likely to be practical owing to the necessity for filtering this varnish hot and because of the desire to keep this troublesome varnish confined to one area. If we be wrong in this assumption, possibly the filtering of this varnish in the general filtering section, when improved, will be adequate.

If the above assumption be correct, consideration should be given to three possibilities: 1) general ventilation, 2) a hood immediately over the filter press and 3) the wearing of positive pressure helmet by the operator. Inasmuch as the varnish pot is present in the room containing hot varnish, and inasmuch as this filter is of the portable variety, it seems more practical to these investigators to favor the provision of positive pressure equipment for this one operator. If decision be made to use this type of equipment, such apparatus should be bought as will not be damaged by the varnish itself. By this is meant that rubber equipment might be softened up by the toluol vapors. Painted equipment likewise might be quickly made unsightly. It is believed that an all aluminum face piece or synthetic rubber may be found available.

Please note that no definite recommendations have been made

beyond the recommendation that consideration be given to this one or two man work place.

7. Paint and Varnish Remover Manufacture.

This small operation is located in Building 18, in a lead-to shed of ancient vintage. Paint and varnish remover consists of the following formulae:

Paraffin Wax	3.30%
Benzol	50.25
Methyl Acetone	46.45
	100.00%

In this mixture, the benzol is the most dangerous substance. The methyl acetone, which is not a true methyl acetone, but a mixture of methanol and acetone is second in importance. In another section of this report, reference is made to the concentration of vapors in various localities including the one under discussion. At times the vapors in this varnish remover work place ran as high as 10,000 parts per million, but the average was only 1000 and the minimum 200. Not all of this may be considered to be either benzol or methyl acetone. Obviously a mixture exists. On the floor above, at the time the drums of benzol and methyl acetone respectively were emptied, the concentration ranged from 280-700 on benzol and 1000-10,000 on methyl acetone. It is to be understood that these concentrations were not general and not continuous. However, one workman was present in close proximity to these high concentrations.

The outstanding difficulty connected with the manufacture of this product is connected with the filling operation. This paint remover automatically fills into an open trough from which four more or less siphon units lead off to run into small containers. Inescapably, a fair amount of spillage takes place and evaporation is constant during the filling operation.

The temptation is to recommend that this manufacturing operation be moved out of the present quarters, owing to general dilapidation. It is, however, understandable that there may be good reasons for utilizing that space as it is. It does seem scarcely warranted that any elaborate exhaust equipment be installed in so worn out a workroom. Perhaps the underlying thought in this situation is this--that if any plans are contemplated

for moving this operation, the moving should take place now, prior to the installation of any exhaust or other type of protective equipment.

Before making any recommendations, it is here observed that a complete blood count was made upon the one worker at this operation. The results are here appended:

Hemoglobin (corrected Sahli)		90%
Erythrocytes	4,600,000	
Leucocytes	6,200	
Polymorphonuclears		65%
Large lymphocytes		2%
Small lymphocytes		33%

No pathology of red blood cells.

The outstanding laboratory evidence of benzol action is to be found in diminution in the number of white blood cells present. The normal and usual number approximates 7500 per cubic millimeter of blood. This worker shows 6200, which is not necessarily below the normal range, but at least is borderline. A second test is that recently described as the urine sulphate test, which was developed by the Bureau of Mines. A sample of urine was taken and tested and was definitely positive, indicating a benzol intake.

Although these investigators may possibly be charged with a benzol phobia, it is recommended that this operation be modified so as to provide no concentration of the mixture of vapors present in excess of 200 parts per million. This may be accomplished in any one of several ways. The dumping of the drums above the floor level requires only about ten minutes and thus is comparatively unimportant, even though the exposure be high. On the floor level, the filling operation may be made automatic or instead the filling operation may be carried out in the equivalent of a spray booth; that is, immediately in the vicinity an exhaust fan may be installed within a booth, in which zone the filling may be performed. One worker in this department exhibits a trivial dermatitis, which may be ringworm or may be caused by benzol or other ingredients of the paint remover. A third possibility, and the cheapest of the lot, may be found in doing away with the open trough siphon system now in use, substituting for this filling directly from the closed tank and providing suitable respirators for the operators.

The dilapidated shed, favored with the number Building 32 really should be torn down, as no useful purpose is being served by it. The materials now housed there appear to be of as little value as the building itself. If this building space is truly needed, rebuilding should take place.

On the southeast corner of Building #12, there is situated a low metal stack, approximately ten feet high, with which is connected a series of conduits from the varnish thinning department and nearby operations. The greater portion of vapors work their way upward toward this stack and are condensed before reaching the stack itself and drain back into their respective conduits. This is not entirely true for a fair amount of complaint has been encountered that under certain weather conditions vapors are blown down from this stack and unfavorably effect workers in that region. The question is raised, but may not be practical, and advantageous, to increase the height of this stack by twenty feet and possibly more.

Miscellaneous Items:

Another section of this report discusses skin hazards in the plant, including the varnish department.

Many of the pumps and similar equipment in this department is in need of ordinary cleaning. Compared with certain other plants, the machinery in this department may be classed as filthy.

In the resin warehouse, a considerable amount of dust is present and some of these dusts are explosive. Theoretically, a fair amount of skin disease should be present, but we do not possess sufficient evidence to condemn operations in this room.

It seems to be justified that we maintain that throughout this department there is a fair amount of disorder, accumulation of unused objects and materials. One portion of the yard area is particularly bad, but this is said to be due to repair operations now in progress.

Resin dust has a way of plugging up the ears of workers

leading to functional deafness without any organic disturbance of the hearing apparatus. One man, working with resins in the warehouse, appears to be hard of hearing in his right ear. Nothing is known about this man's condition, but it may be well to send this man to Ford Hospital to have his ears freed of accumulated resin if in fact his partial deafness is due to this cause.

COMMENT AND RECOMMENDATIONS FOR LACQUER DEPARTMENT

As elsewhere observed, a considerable portion of the Lacquer Department work is done elsewhere. The nitrocellulose paste is prepared apart from this plant. The milling of carbon nitrocellulose scale is here carried out in the Varnish Department. The milling of lacquer materials is here carried out in the Enamel Department.

Thus the Lacquer Department largely becomes one of thinning, tinting, filling and labeling.

Notwithstanding this restriction of operations here carried out, this lacquer department presents higher concentrations of vapors than any yet investigated by us where actual measurements were carried out. In another section of this report details are provided as to various tests made of vapors, gases, etc. throughout the plant. Also, certain limitations are there shown as to the accuracy of the method used by us. Even though the method employed possesses an error of 50% as a deviation from accuracy, there still is much too much vapor material in the Lacquer Department.

It appears demonstrated that the high concentration of vapors about which complaint is being made is due to four sources, as follows:

1) almost continuous cleaning of large and small utensils, including tanks, immediately on the two lacquer floors, but particularly the first floor, using lacquer thinners as cleaning agents.

2) the free use of lacquer thinner or paint remover for floor cleaning, cleaning of work utensils, hands and forearms, etc.

3) the use of centrifugal machines.

4) the almost total lack of any air exhausting equipment in this area.

In that earlier section, dealing with vapor determinations, Dr. Fredrick has made various suggestions as to ways and means of controlling vapor concentrations. Dr. Fredrick's comment should be considered, but in the last analysis this final comment is to be regarded

as taking precedent over comment made in other places.

It is distinctly recommended that within the Lacquer Department there be installed an isolated room, well exhausted, for all cleaning of containers, portable tanks, etc. used in this department. This installation seems to be imperative. In this small room there should be installed a sufficient number of cleaning tanks for the holding of such fluids as may be necessary for cleaning purposes. All tanks, save those containing cold water, should be thoroughly exhausted. Due consideration should be given to spark proof lamps. It seems likely that this room should be installed on the first floor, as the use for it is greater there. However, plans should be made for the use of this cleaning room in connection with the work on the floor above.

It has been represented to us by Mr. Hutchinson that extensive alterations shortly will be instituted in the Lacquer Department. If this be true, it is undesirable that major installations be made at the present time as regards vapor control. Whether or not these innovations are introduced, provision should be made to maintain the vapor concentration level throughout this area between 200 and 500 parts per million of air with a preference for the lower figure. It is possible that the centrifugal machine or machines will require an exhaust system, as this operation is a considerable offender. Conceivably the centrifugal machines might be made more or less stationary in order to provide opportunity for the exhaust installation.

The rather free use of lacquer thinner for all types of washing purposes in open areas should be discontinued by being centered in the lacquer utensil cleaning room above mentioned. On the second floor, it may be sufficient merely to introduce exhaust fans at about the floor level for the evacuation of accumulated vapors to the outside.

Since extensive changes are in order in this department for production purposes, and since it is understood that these workers will spend a few days in this plant about six months hence, no further recommendations are made at this time. However, this section closes with the emphatic statement that at the time of our testing, vapors were unusually high in this department.

ENAMEL DEPARTMENT

In many other sections of this report activities in the enamel department are discussed. Some comment may be found in connection with lead analyses, vapor determinations, dust counts, blood examinations, illumination tests, etc. In two sections some recommendations are made by Dr. Fredrick in connection with his own examination of these premises.

All this being true, no reason exists for lengthy discussion of hygienic conditions in this department. Two items stand out with definiteness:

(1) No major mechanical installations are required for this department under immediate operating conditions.

(2) This department, like many others, is badly in need of better janitor work, one good wholesale cleaning and considerable brightening up of unsightly places.

More important comment is made in separate sections, such as "Lead Analyses."

HOUSE AND SPECIAL PAINT MANUFACTURING DEPARTMENT

Already in other sections practically every consideration connected with this department has been included. These other sections refer to lead analyses, dust counts, blood determinations, illumination tests, observations as to noise, janitor work, special means for the control of lead, etc. On this account, it is preferable not to repeat a record of these observations, but instead to refer to other special chapters.

Two or three small items are here made in connection with this department:

(1) A fair amount of lead is being carried into the dry aluminum room and the mixture of these two substances conceivably may increase the inflammability of the aluminum, even though the lead be present only in traces. If practical, this aluminum work should be removed to less exposed quarters, in view of the fact that two women work in this department. This suggestion is by no means urgent.

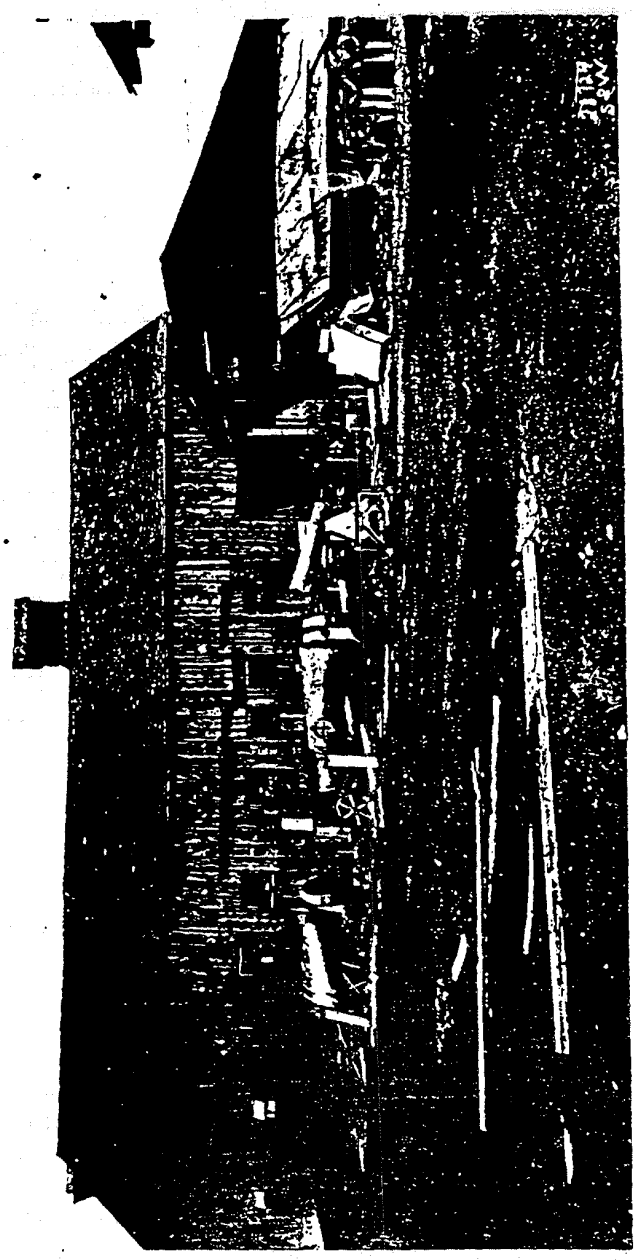
(2) Just outside the door of the aluminum room there is an acid soda water type of fire extinguisher which apparently is intended for use in the aluminum room in case of fires. If this were done, the intensity of the fire would be greatly increased. Instead, there should be located directly in the aluminum room two buckets full of fine sand for use in smothering metallic aluminum fires.

WAREHOUSE AND STORAGE

In the Northeast section of the plant area are a series of buildings used for warehouse storage and for antiquated machinery storage. In part these represent left-over buildings from the horse and buggy period of the life of the plant. Some of the buildings are now devoted to garage purposes. More centrally located in the plant area are the old calcimine building, the dry color building and the dry color warehouse. Considering this entire group of buildings as a unit, it may be pointed out that from the point of view of industrial hygiene, this series of buildings are relatively unimportant. In special sections of the report, reference may be made to special items, such as illumination.

In those buildings devoted to raw material storage, there are certain minerals of dangerous nature such as lead in various forms, silica, etc. Since movement of these materials takes place intermittently and infrequently, such as at the time of unloading cars, no hazards may be said to persist. No visible dusts are present, no mechanisms for stirring up dusts are ordinarily operated and altogether no reason is known for taking any stand against practices as now carried out.

In that group of buildings representing the very old type, such as Building #14, the old barn building #39 and possibly one or two others along the East wall, it is believed that they serve very little useful purpose at the present time. The stored antiquated machinery does not appear to have a great deal of value other than for scrap purposes. Although the retention of these buildings has little or nothing to do with health problems, their presence is of some significance in that it brings about an appearance of disorderliness in that area. Without any definite recommendations, the question is raised as to the value of tearing down at least the old barn and shed and possibly other buildings. It is not known to be a fact, but possibly some tax saving may be accomplished by this step. These statements do not apply to that portion of Building #18 devoted to the manufacture of paint and varnish remover.



This Venerable Establishment Retains Some Antiquated Buildings of a By-Gone Period. Although Constituting No Distinct Health Hazard, the Removal of Some of These Buildings would Greatly Add to the Sightliness of the General Plant Appearance.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

WASTE DISPOSAL

Due investigation has brought out a number of potentially important facts concerned with the disposal of refuse in this plant. Three items are now enumerated:

1) The wooden waste, chiefly derived from barrels, at the present time is turned over to the City of Hamtramck, which, in turn, distributes this burnable material for fuel to indigent families. The underlying idea involved is commendable, but wherever lead, chromium and other dangerous materials are involved, considerable risk is run in that poisoning may become the lot of persons not employed in the plant. Conceivably a legal risk may be involved, but this is a matter for the Legal Department to decide.

2) Paper bags, previously having contained lead or other minerals, are picked up by waste collectors not connected with the plant, who are permitted to enter the plant for this purpose. What becomes of this paper waste thereafter is not known, but theoretically, at any rate, a widespread exposure may be provided, including the waste collectors, paper balers, paper sorters, etc. Again the question of legal responsibility arises.

3) On the premises, considerable material is burned. In the burning operation, highly inflammable solvents and thinners are thrown on to less burnable material. The temperatures provided are such that inevitably there enters the air a mixture of all sorts of volatilized materials. These are spread over the nearby residence area. It is believed that no real intoxicants are thus disseminated, but if any complaints were to arise, it would be costly to defend claims that might be involved.

All of this leads to the recommendation or at least the suggestion that waste materials be disposed of on the plant premises. The basic reason for this recommendation, supplementing the foregoing enumerated items, is the fact that chemical analyses made on the ash pile where burning

The Disposal of Waste and Waste Containers Introduces Possible Exposure for Workers and Possibly for the Public. The Construction of an Incineretor with Stack for the Disposal of all Waste on Premises is Suggested.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

is carried out yielded a percentage of lead which in the highest instance was 14.86% and in a sifted sample 5.7%. In this connection, it may be pertinent to inquire if too much material is not reaching the waste pile, but no stand is taken in this respect.

By accident the period of this investigation coincides with the period that the accumulated waste heap was being carted away and loaded on to flat cars (or a flat car). By actual observation this process was noted to be distinctly dusty. The tender of this present dump heap appears to have a very mild lead poisoning. In view of a 14% lead content, the wonder is that more lead poisoning is not present in this man who constantly works around this refuse pile.

After due consideration of this problem, a decision has been reached to suggest to the management that an incinerator be built for the disposal of waste. No attempt is made to pick out a location for such an incinerator. This incinerator should not be elaborate, but should be enclosed at least as to walls and should be furnished with a stack. It should be so constructed that ashes and residual mineral material may be thoroughly wetted before handling in order to obviate dustiness.

The operator of the incinerator, when handling dusty materials such as bags, barrel staves, etc. should be required to wear a filter type of respirator. In view of the fact that the materials burned include spent lacquer thinners, solvents, oily materials, pigments, etc., a variety of hazards may arise unrelated to lead. Two examples are cited:

1) The hydrocarbons entering liquid vehicles, when evaporated are distinctly toxic.

2) Various coloring materials, but particularly ultramarine blue, may give rise to oxides of nitrogen, which are extremely dangerous even in traces. The filter type of respirator will not provide protection against vapors or gases which means that the incinerator tender should continually be alert to his protection by avoiding close proximity in the process of disposing of essentially all waste materials. Stack action ordinarily will entrain these unwanted gases.

DRUM AND TANK CLEANING

One of the most troublesome features of paint manufacture from the point of view of worker protection is the inevitable department devoted to the cleaning of drums, tanks, buckets, etc. Some of these containers reach the cleaning department smeared with lead containing substances and other materials of injurious nature, including skin irritants. This is a minor hazard compared with exposures that may arise from the materials used in cleaning. The exact composition of the chemicals employed is rarely determinable, being trade secrets. It is known that these materials are strongly alkaline, that they contain caustic alkalies, tri-sodium phosphate, sodium carbonate or similar agents. These substances do not evaporate under ordinary circumstances, but when heated the created steam does contain these irritant materials which as such or when precipitated into the general atmosphere may become harmful. Furthermore, this process is commonly a hot one. The presence of heat augments the irritant action of alkalies. Altogether this type of work is to be accepted as necessary, but rated as troublesome insofar as health of workers is concerned. In certain other plants, x-ray examinations made on the chests of workers have revealed evidence of increased fibrosis in the lungs which, while not disabling, represents a low-grade disease state of the respiratory tract. On this account, three workers from the Department were subjected to x-ray examination at the Henry Ford Hospital. The results furnished by that Hospital are now shown:

REDACTED

"The x-ray of this man's chest was entirely negative for any pathology."

"This man's chest x-rays show some calcified hilar glands on the right side with a calcified lesion in the right base, probably an old tuberculous process. No other parenchymatous involvement could be made out, and there is nothing to suggest any active process in the lungs now."

"The x-ray of this man's chest yesterday showed calcified glands in the right hilus area and marked increase in the bronchovascular markings, but no definite evidence of involvement in the lung parenchyma itself to suggest any tuberculous involvement or other serious pathology. It is possible that he, at one time, had an infection which healed, and hence would give the markings mentioned."

Alkali Cleaning of Drums and Other Containers.
Alkali Vapors Continually Present. Situation
Calls for Extensive Improvement, Including one
or More Exhaust Systems.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

From the foregoing, it does not appear established that the lungs of these workers have been harmed to a measurable extent. This is fortunate, but does not free the plant from responsibility for bettering work conditions in this Department. A number of suggestions are now made, seeking improved work conditions for these employees.

First, over the alkali tanks now installed, an exhaust system should be provided for the purposes of entraining and discharging alkali vapors and excessive heat created by these tanks. At once it is pointed out that this will not be easy to do, because of the fact that the containers to be cleaned are loaded into cradles and are handled by small block and tackle crane devices. On this account, the entraining hood will have to be constructed in such a fashion as to swing upward and backward to provide clearance for the cradles. In lieu of this arrangement, possibly the entire intake of steam heat, vapors, etc. may be accomplished through the use of hoods, situated only at the back of the tanks. Still further the possibility exists that lateral suction may be introduced on three or four sides of the tank through which the steam, etc. may be drawn first downward and eventually upward to be discharged above the roof level.

In any event, due consideration must be given to protecting workers in the nearby Printing Department, to which Department these discharged vapors may be carried under ordinary circumstances.

The withdrawal of large quantities of air through this venting system will lead to the necessity for an increased number of heating units in this Department during winter months.

Whatever is done in the way of an exhaust system will probably require the installation of a fan system rather than the placing of dependence upon natural venting. Of this, however, these investigators are not precisely certain.

That portion of the work now devoted to drum cleaning already is fitted with natural stacks and is enclosed, except at the filling and discharge ends. These two portions are in fact enclosed, but necessarily are

frequently opened up for the introduction and discharge of drums. The type of stack present is not conducive to the best removal of irritants and heat, but for the time being no recommendations are made for changes.

In addition to the installation mentioned, it is believed that there is a need for the general exhausting of air in this building. It is noted that a spray booth is present in this room for use in conjunction with the painting of drums. When this hood is being operated, the air in at least some portions of the workroom is frequently changed. The question arises if it may not be advantageous to operate this fan at all times in order to bring about frequent changes of atmosphere. This, however, will place increased loads on heating units during winter months.

This entire building is somewhat ramshackled and dilapidated. This very fact introduces no especial health hazards except possibly cold in winter. No less, it seems desirable to suggest that this building be repaired in order to make it more livable. This applies in some measure to the antiquated wooden platforms located about cleaning tanks. Some of these are broken up, partly submerged in water and altogether are unsightly.

Appropriate examination of these workers disclosed no evidence of lead poisoning.

Is there any known system of carrying out these cleaning operations with cold solutions in order to eliminate excessive heat?

SKIN EXPOSURES.

Of all occupational diseases, 65 per cent, or thereabouts, are skin diseases. In a general paint plant the percentage of skin diseases should run higher. Primarily this is due to the nature of the raw, intermediate and finished materials. If reference be made to the long list of raw materials in this report, it may be observed that not less than one hundred are rated as being capable of producing skin diseases. In particular, such substances as benzol, toluol, xylol, solvent naphtha, naphtha, mineral spirits and their combination leading to thinners, solvents, etc. are capable of inducing skin diseases. Therefore many of the mineral materials entering paints and their coatings may induce skin diseases. The chief offenders are those compounds containing chromium, particularly the chromates and oxides of chromium. Many resins, but chiefly synthetic resins are well known as sources of skin diseases.

These divers substances act to create skin diseases in different fashions. Some are direct irritants, such as chromates, others injure skin by solvent action, thus depriving the skin of its natural protective fatty coating. The greater number are both irritants and solvents. Still others sensitize the skin and pave the way for chronic skin diseases. A few substances may produce low grade skin diseases by mechanical action. For example, carborundum used in stone dressing may abrade the skin as well as abrading the stone. Actual burning of the skin with caustics may account for occasional extended skin injuries. Apart from actual work exposure possibilities for skin diseases are enhanced by the practice of many workers to wash up at the end of the work period in irritant solvents. All in all, a provocative source of skin diseases is legion in this paint plant, but not more so than in other paint plants with similar operations.

It is a common truism in medicine that "whatever is looked for is apt to be found." The management is likely to express doubt that any skin disease is now present in this plant.

These investigators, without any search, have spotted several cases of skin diseases, not all of which are known to be traceable to work as their direct or indirect cause. The paint and varnish remover maker exhibits a dermatitis of one finger which is believed to be ringworm aggravated by contact with benzol and methyl acetone. One dry mixer has a definite skin disease of the face which probably is of non occupational origin. The two workers with double pterygium technically might be listed as suffering from skin disease, since the overgrowth of tissue in the eyes represents an extension from a contact layer of the skin. It is prophesied that a careful survey of all workers would lead to the detection of not less than 25 instances of skin disease at this very time.

Skin diseases in the paint industry are prone to become more severe through complications resulting from invasion by fungi (ringworm). The combination is a bad one. The chemical action of various liquids provides a suitable bed for the growth of fungi. In turn the growth of fungi prevents healing of the skin and a vicious cycle is established.

Since it is unthinkable that the scores of causes of skin diseases in a paint plant may be eliminated from the raw materials, it is pertinent to inquire as to appropriate ways for prevention and control of skin diseases. A number of suggestions are now made.

(1) Personal hygiene is the key to the avoidance of industrial skin diseases. Workers should avoid washing in solvents and thinners beyond the most meager necessity. Soap and water is preferable, but not always entirely efficacious. If it be necessary to wash up with defatting agents, it is desirable that workers, at the end of the wash period, rub into the skin of the hands and forearms, and at times their faces, some bland emolient to replace the natural fat that has been lost. Lanolin, cocoa butter, cold cream or even vaseline may be used, although mineral fats are much less desirable than either animal or vegetable materials.

(2) The choice of soaps is fairly important. No soap is entirely harmless to all skins. Soaps containing free alkali are most objectionable. Lifebuoy soap is irritant to many skins and more so perhaps than any other of the better known varieties of soap. Frequent washing is preferable to wholesale rough washing one or two times during the day.

(3) Workers upon the first sign of a dermatitis should not be permitted to continue work that involves additional exposure. These afflicted ones should either be removed to non-hazardous work for a few days or else should be stopped from work altogether.

(4) Self medication with irritant drugs naturally does more harm than good. Iodine, for example, commonly but aggravates skin diseases. If the condition is at all severe, medical services should be sought. In the absence of the necessity for professional care, bland treatment is preferable. Such bland treatment includes application of some one of such substances as the following:

10% zinc oxide in olive oil
calomine lotion
hot soaks in aluminum acetate solution
hot soaks in epsom salt solution

(5) Certain operations regularly providing exposure to irritants should lead to the wearing of rubber gloves. This statement applies peculiarly to drum and container cleaning work. However, after the inauguration of the skin disease the wearing of rubber gloves may aggravate rather than aid the skin disease.

(6) In some instances it may prove to be possible to use some one or more of the protective ointments manufactured by the Milburn Company of Detroit or Parke Davis & Company. The latter firm manufactures a protective coating called "Tar Dermament." This, when applied to the skin, serves as a

protective barrier against the action of a variety of irritant chemicals.

(7) Some few workers may so frequently break out with skin disease as to require elimination from all future work. This is more likely to be true for blondes than brunettes. By and large, in selecting new workers a preference should be extended, other things being equal, to dark skinned workers, since they are much less likely to acquire skin diseases. However they are not entirely resistant.

(8) Negroes are well suited for work requiring exposure to the skin of irritant substances.

(9) Education on the part of foreman and others of the workers under them in ways and means to avoid skin disease is one of the most helpful agencies in avoiding this unwanted, troublesome affection.

By no means are all skin diseases arising among industrial workers of work origin. From many observations the opinion has been formed that even in the paint industry not more than one third of the skin cases detected are traceable to work as the cause. Many workers suffer from acne which is a non occupational skin disease. A fair number of workers will present skin diseases due to the use of phenolphthalein laxatives of which there are many varieties on the market. Still other workers are sensitive to food, clothing, animal hair, flowers, etc.

Finally it is observed that no claim for compensation under the new occupational disease law, involving skin diseases, should be accepted for compensation purposes until a thorough investigation has been made by a qualified physician.

CARBON MONOXIDE

In this plant, carbon monoxide is likely to be produced only in connection with fires used for cooking varnish, gas heated drying ovens, cook stoves, laboratory heating appliances, etc. Since this gas gives no warning and is entirely insidious in its action, it was deemed appropriate to make a fair number of tests for carbon monoxide throughout this plant.

The type of instrument employed was the navy type, manufactured by the Mines Safety Appliance Company for commercial purposes. This highly sensitive instrument reads directly in parts per million of this gas. Tests were made in practically every known place in the plant where carbon monoxide might arise, but particularly about the varnish manufacturing department. No positive tests were found anywhere and the conclusion is reached that no carbon monoxide was present at the very time that the tests were made. It is observed that no tests were made around two blacksmith forges in the Maintenance Building, solely because these forges had not been discovered at the time of these tests. Inasmuch as stacks are over these forges, it is not believed that harmful quantities of carbon monoxide are present. It is noted that summer time rather than winter is the danger period for carbon monoxide. Some of the very appliances tested during these summer weeks might, in cold weather, show dangerous concentrations of gas. It is for this reason that a recheck is urged about six months hence.

At the present time, there is no reason to believe that any carbon monoxide hazard exists in this plant.

JANITOR SERVICE

The janitor work in this plant, as well as in most industrial plants, is a much neglected art. From time immemorial, it has frequently been the custom to turn janitor work over to handicapped persons, to superannuated workers or to other persons who, for one reason or another, may not be used on direct production employment. Still worse, janitor work in many places is carried out by the workers themselves in any given department. This practice sometimes eventuates in little or no janitor service when the department is pressed because of workers being too busy. Then when work is very slack little or no janitor work is performed because many workers are laid off.

Continuing to speak of janitor work in general, and without reference to this particular plant as yet, it is believable that neglect of janitor services readily may be the source of losses out of proportion to money necessary to employ such help. Even when good physical and mental types of workers are available for janitor work, poor results frequently arise because of lack of supervision and lack of training. In truth, the janitor should be above average in intelligence and should regard his duties as of technical nature rather than a mongering type of employment.

In this plant, many of its ills represent current or past low types of janitor work. The high concentration of vapors complained of in this report to a considerable extent grows out of the faulty practices connected with janitor work, in which paint remover is poured on to the floor in small lakes for purposes of softening up incrustations that have accumulated through the years. The faulty sweeping is in some measure responsible for the high concentrations of lead in the atmosphere found in various places. Failure to procure proper cleanliness through janitor work is likewise the source of some lead in the atmosphere.

Now after these complaining introductory remarks, a number of suggestions are made with reference to clean up services.

(1) Paint remover, lacquer thinner or kindred solvents should not be indiscriminately used for floor or wall cleaning purposes. The practice of pouring a gallon or two of paint remover or lacquer thinner

on to the floor in the midst of various workers going about their duties is definitely condemned. If it be desirable to use such materials for floor softening purposes, the application should take place after work hours, should be carried out by janitors or other workers wearing respirators, and further all windows should be opened up and the entire space should be well ventilated prior to the re-entry of unprotected workers.

(2) Dry sweeping should not be permitted in any portion of this plant except office areas, storage areas for finished products, and a few other substantially dust free places such as labeling rooms. The practice of wetting sawdust with lacquer thinner or paint remover is likewise bad. For wetting purposes successfully may be used water, sawdust wetted with water, dawdust wetted with oils or various chemical floor compounds in which sawdust or similar material is treated with deliquescent chemicals. In a few places actual hosing down of the floors and even the walls may be salutary. Sprinkling of floors with water in sprinkling cans, unless done judiciously, will in itself stir up considerable dust.

(3) In those areas in which lead is manipulated, or other dangerous substances such as chromium compounds, silica, magnesium and resins, janitors should be called upon to wear respirators. The two types of respirators seen about this plant are both good but they are not adequately serviced and some workers complain that the particular ones furnished them do not fit. This item is discussed in greater detail elsewhere.

(4) If janitors are called upon to pick up and bundle up paper bags that have previously contained dangerous materials, including lead, or if they are called upon to handle empty barrels that have contained such substances, respirators should be worn whenever any likelihood of dust production exists.

(5) It is presumed that janitors strictly devoting themselves to such work are not called upon to clean up the machinery or appliances. On the other hand, in those departments where workers themselves are expected both to do janitor work about their machines and to clean the machines as well, it may be pointed out that many of the suggestions here

made apply to machine cleaning as well as strictly janitorial work, floor cleaning, etc.

(6) As shown in another section, poor illumination is brought about in this plant to a considerable extent through the failure to clean lighting fixtures. Approximately 30 per cent of the effective power of a new electric lamp is lost if such a lamp is coated over with settled dust.

(7) Distinctly more janitor work is needed in the plant proper than is now being supplied. This does not apply to every single department but is certainly true for many.

The foregoing comment now leads to a definite recommendation. It is believed that the janitor work in this establishment should be more centralized than at present. All of the janitor work carried out in the factory should be under the direct supervision of one qualified person who may instruct, supervise, guide and condemn workers performing janitorial services. For purposes of administration it is probable that janitors working in the office area carrying out ordinary janitor work should report to some person having duties in the office section of the plant. In a subsequent section some comment is directed to the possibility of employing a supervisor for many types of employee in plant services. This matter of janitor work is there again discussed.

CUSTOMER PROTECTION

Year by year every paint manufacturer is the recipient of numerous complaints from dealers or ultimate consumers of paint products, either directly condemning some product as harmful or else seeking information as to safe procedures. While many complaints may be unwarranted, it still must be recognized that almost any paint product may lead to injury to human beings, if grossly ill-used. On this account, it may be well to bring together various items of information dealing with the protection of the ultimate user of paints.

First a number of typical formulae are presented in support of the contention that most all coating materials contain one or more well known injurious agents.

White Proxlin Lacquer #556

Zinc Sulphide	7.08%
Titanium Dioxide	7.12
Zinc Oxide	3.20
Zinc Stearate	.20
Raw Castor Oil	1.65
Dibutyl Phthalate	5.20
Damar Gum	4.10
Blown Castor Oil	.20
Toluol	16.55
Xylol	6.35
1/2 Sec. N/C	14.75
Ethyl Alcohol	10.20
Butyl Acetate	12.95
Butyl Alcohol	2.00
Isopropyl Acetate	6.50
Ester Gum	.20
Naphtha	1.75
	100.0%

Synthetic Varnish (2143)

Phthalic Anhydride	19.00%
Glycerine	11.00
Linseed Oil Fatty Acids	15.00
High Flash Naphtha	26.00
Xylol	26.00
Butyl Alcohol	3.00
	100.00%

Paint and Varnish Remover

Paraffin Wax	3.30%
Benzol	50.25
Methyl Acetone	46.45
	100.00%

Black Proxlin #66

Carbon Black	1.5%
Black Dye Solution	2.67
1/2 Sec. N/C	13.90
Ethyl Alcohol	11.02
Dibutyl Phthalate	5.29
Amberol 801	4.01
Toluol	20.10
Xylol	3.12
Isopropyl Acetate	5.50
Butyl Acetate	15.74
Butyl Alcohol	.75
Naphtha	16.00
6 Sec. N/C	.40
	100.00%

Chrome Yellow Lacquer #807

Lead Chromate	9.6%
Raw Castor Oil	2.3
Dibutyl Phthalate	5.0
Ester Gum	1.75
1/2 Sec. N/C	15.65
Ethyl Alcohol	6.67
Isopropyl Acetate	7.49
Butyl Acetate	15.20
Butyl Alcohol	2.32
Toluol	14.47
Xylol	11.50
Naphtha	8.05
	100.00%

Lacquer Filler #400

Powdered Soapstone	25.96%
Calcium Titanox	6.46
Lamp Black	.60
Blown Castor Oil	6.49
Amberol 801	12.97
Butyl Acetate	9.78
Ethyl Alcohol	5.27
Isopropyl Acetate	3.94
Naphtha	7.14
Toluol	13.45
1/2 Sec. N/C	6.29
Butyl Alcohol	.65
Xylol	1.0
	100.00%

Lacquer Polish

Paraffin Oil	8.52%
Methyl Salicylate	.35
Gum Tragacanth	.55
Water	75.72
Snow Floss Filter Cel	9.63
Glycerine	3.53
Formaldehyde 40%	.54
Neomerpin S.A. Conc. Powder	1.16
	100.00%

It is a well known fact that most old time professional painters have suffered from lead poisoning at some time in their life and most such painters show a few of the sequellae of lead poisoning. Some reason exists for believing that on the average, the professional painter who starts his trade early in life probably lives several years less than the average tradesman in dissimilar, non-hazardous employments. It is also known that many complaints arise from non-professional painters who assay some jobs of painting. Because of these involvements of these two classes of paint users, it seems desirable to set forth here a number of circumstances and practices that may lead to trouble and to complaints coming to this Company.

1) Lead does not enter the body through the skin in sufficient quantities to produce lead poisoning. This is not true of tetraethyl lead and other organic lead compounds. However, such are not known to enjoy any extensive use in the coating industry. All inquiries based on the assumption that lead so enters may positively be replied to in the negative.

2) Lead in itself will not produce skin disease, on the order of a dermatitis. Frequently, complaints arise intending to incriminate lead as a direct skin irritant. This is not true, although certain lead compounds may produce a dermatitis. Lead chromate, for example, possibly may produce a dermatitis. This, however, is due to the chromium component and not the lead component.

3) Among painters, the dry sanding of coated surfaces containing lead is the commonest source of lead poisoning. This statement may not apply to processes in which lead containing coatings are sprayed in the absence of suitable boothing. Otherwise, the statement as to dry sanding applies. The removal of paint by burning is less dangerous as a source of lead poisoning than sanding.

4) After lead is mixed with oil, or other vehicles, the hazard to lead poisoning is appreciably diminished. Lead does not evaporate in coated surfaces, nor in the course of painting does enough splashing ordinarily take place to the point of entering the mouth in adequate quantities to cause difficulty. This means that painters, neither pro-

fessional nor amateur, should undertake to make their own paints, starting with dry ingredients.

5) Painters, and particularly amateur painters, should not long work in closely confined spaces, such as closets, in the absence of ventilation. Professional painters frequently get into difficulties working in tanks in connection with painting operations. Almost any substance will evaporate or otherwise give rise to harmful vapors in close spaces to the point of injury.

6) Paint removers are almost universally trouble makers, either from containing harmful alcohol,s such as methyl, or dangerous hydrocarbons, such as benzol, which may lead to distinct poisoning, or otherwise the constituents of paint or varnish removers may lead to marked skin irritation. Paint or varnish removing is at best a dubious enterprise for the non-professional when carried out to any great extent.

7) Turpentines are rather definite irritants to the skin of many persons from direct contact and a minor irritant to the respiratory tract of some persons. Some turpentines are much more disturbing than others. In the experience of these investigators, turpentines are troublesome in the order now listed, the first being the most irritating and so on down.

1. Steam distilled wood turpentine.
2. Sulphate turpentine.
3. Destructively distilled wood turpentine.
4. Gum spirits turpentine.

As a general statement, and with some exceptions, the more turpentine is purified, the more irritating it becomes. This is not necessarily true of steam distilled wood turpentine, which now, by some manufacturers, may be so fractionated as to eliminate an irritant fraction. The thought in this discussion is that all persons making use of turpentine in paints should respect the irritant properties of turpentine.

8) Whenever linseed oil and possibly other vegetable oils are in process of drying, they give off or may give off appreciable quantities of carbon dioxide and probably carbon monoxide. The quantity that is created in one room is perhaps not serious, but in the case of large areas,

such as the hold of a steamship, practical hazards may be produced. The point is that persons should not remain and particularly should not sleep in rooms, buildings, or other spaces immediately after painting.

9) Indoor spray painting should not take place with or without a lead content in the absence of boothing, positive pressure respirators or other adequate protection. Spray painting is one of the great bones of contention on the part of painters. While the real reason for complaint may be economic, a case against spray painting is frequently brought out in connection with health exposures. The situation is fairly simple and is namely that spray painting calls for special protection of the painter and without such protection, spray painting is unwarranted and with good protection spray painting is laudable and commendable.

10) For the sake of the consumer, as well as the paint maker, benzol, wood alcohol, chlorinated hydrocarbons and substances of comparable toxicity should be kept out of all coatings to the fullest extent possible.

11) Although this Company does not manufacture waxes for coating purposes, it is here recorded that such products have led to disasters for consumers because of dangerous contents of such products.

12) In general, all users of paint should realize that practically without exception, all coating materials call for intelligent use. Every type of paint product and related product contains one or more substances which conceivably might lead to disaster if handled with utter abandon and complete recklessness. This statement is not meant to condemn in any way paint materials, but instead to emphasize that almost every substance about us, whether paint or otherwise, may lead to difficulties when improperly utilized.

It is hoped that out of the foregoing materials will be found useful facts for furnishing some information in response to the majority of inquiries related to complaints against your products.

MEDICAL DEPARTMENT

Medical work in this plant is on a fairly low level at this time. In any plant having as many as 746 workers, which is the work population of this plant, the genuine day by day needs for medical care far exceeds the services rendered on the plant premises or at the Ford Hospital. It is generally stated, and widely accepted, that in industry from 5 to 8 per cent of the work population will pass through the medical department daily with genuine affections of varying degrees. When the number visiting the plant's medical relief station markedly falls below that figure, ordinarily this reflects a lack of adequate facilities, lack of faith in the persons rendering the services or lack of knowledge on the part of the workers that medical services are available to them.

This argument does not maintain that this plant or any other industrial plant should make of its medical department a substitute for the family physician or the specialist. By no means does it urge that every condition affecting the health of workers properly falls within the domain of services to be rendered in an industrial medical department. On the other hand, it is emphasized that the maintenance of the health of the worker well serves the interests of the management as well as the worker himself. Day by day dozens of workers develop minor conditions such as headache, menstrual disturbances, gastro-intestinal upsets, minor cuts, bruises, abrasions, sprains, burns, eye inflammation, etc., which rightfully should not lead to the worker seeking the services of a physician or taking time away from gainful employment.

Daily in this plant some 30 or 40 workers should be ministered to by the medical department. Instead, practically no work is carried out on the premises, the total number of items of medical care rarely exceeding 12 including redressings, the average approximating 6. The need for medical service is somewhat obvious in passing through the plant when even external conditions

are in sufficient numbers to attract the attention of the passer-by.

These statements are in no degree to be accepted as an unfavorable criticism or condemnation of the arrangement with Ford Hospital or the nurse now in charge of the plant's first aid station. The services rendered by Ford Hospital in physical examinations and special examination of the unusual case and the rendering of emergency care in case of accident is of high order, but it has the same disadvantages as those attending "absentee landlordism." So far as known, no one in the Ford Hospital is familiar with the work operations in this plant, nor are they in a position to properly interpret disease states brought to their attention in terms of possible relationship to work at this plant. An example of this lack of contact with plant affairs on the part of Ford Hospital physicians may be found in the three workers sent from the drum cleaning departments during the period of this survey to the hospital for x-ray examination of the chest. It was thought by these investigators that the action of the alkilis in this work might very well lead to heavy trunk marking in the x-ray film, resulting from the irritant action of the alkilis. In truth, one of the three workers presented just such a condition which with fair certainty may be ascribed, at least in part, to the action of irritant work vapors, and yet in no known wise was work exposure on the one hand associated by the Ford physician with the x-ray condition found on the other.

The point is this, if Henry Ford Hospital physicians are to be accepted as this company's industrial physicians and advisors, and if one physician carries out most of the work, then this physician at least should be familiar with the chief operations carried out in this plant and the chief exposures potentially or actually existing here. Furthermore, the opinion is expressed that more supervision should be exercised by the Ford physicians, as this plant's industrial medical advisors, on the activities of the first aid station. These physicians should be concerned in the type of skin disinfectants used, the medicaments applied, all to the end that cases given first aid here prior to

being sent to the hospital may not be mistreated to the point that the work of the hospital physician becomes more difficult.

Now with respect to the first aid station and the present nurse in charge, the equipment on hand is meager and facilities for work are equally so. It is no wonder that workers have little interest in the administration of the first aid department except as emergencies arise where the injured parties must be furnished immediate first aid care. As a result of non attendance at the first aid station, the management develops the notion that no more cases exist and that the medical needs of the plant are being met. Such is not the case. With full admiration for many admirable qualities of the nurse now in charge, the fact must be faced that she is not qualified as an industrial nurse, she has long been out of nursing ~~care~~ and is only employed because of unfortunate family circumstances. This nurse is not qualified properly to interpret medical services that should be available in this plant to the workers of this plant. She is not qualified to make tours throughout the plant for the purpose of building up faith in the medical services and stimulating the reporting of obviously afflicted workers to the first aid station for conference. Nor is this nurse qualified to gain the confidence of large numbers of workers for the purpose of discussing more serious medical problems which should be referred to the family physician, for whatever ministration the family physician may deem advisable. In short, these investigators, without any ill will recommend that the present nurse exclusively devote her services to duties other than the chief nurse, meaning the continuation of duties she is already performing apart from nursing and that three steps be taken for the purpose of better safe-guarding the health of workers in this plant. These are, namely: (1) The removal of the first aid station to a larger and better equipped location. (2) The acquisition of the services of a skilled industrial nurse who may be responsible not only for the ordinary first aid services in the plant but who may serve as a health educator for the plant, and for the purpose of building up the first aid service here and (3) That close working relations

be established with physicians at Ford Hospital to the end that he or they may be more familiar with the plant's operation and the potential sources of injury to workers.

Under the existing circumstances, it is futile to attempt here a delineation of a proper first aid or educational program in this plant, or to supply lists of practical first aid medicaments, which to advantage might be in daily use. However, because of a more or less urgent situation, two items of comment are made.

It appears that the most used or perhaps nearly the most used drug in this first aid station is bromo seltzer, which is a proprietary medicament, believed to consist chiefly of acetanilid, which is a drug widely condemned by the medical profession because of the fact that addiction readily takes place. It is conceived but not claimed that this plant may be producing a fine lot of acetanilid addicts from the wholesale and unrestricted dispensing of this dangerous drug.

The second item here mentioned is with respect to the first aid treatment of burns, since burns are perhaps the commonest injury in this plant. Tannic acid should not be used on minor burns. This agent is of great value but this value is limited to burns of hospital severity. The 5 per cent tannic acid solution commonly used, if applied to minor blistering, does more harm than good, because it destroys little damaged epithelium. Lately commercial overtures have been made to the management to purchase an elaborate tannic acid kit containing a variety of appliances such as spray gun, bandages, tannic acid, etc. No objection can be expressed against this kit except that it is more elaborate than necessary in order to bring a high unit sale price. Instead, what this company needs is a very simple spray jar or even an atomizer, a small quantity of 5 per cent tannic acid solution, facilities for making up more tannic acid solution, which, however, may be obtained at any drug store all at a cost of approximately $2.00. The number of burns arising which will justify the use of tannic acid will not exceed one a month.

As a substitute for tannic acid for minor burns, greaseless ointments containing skin anesthetics such as "Anesthesin" or "Nupercaine" are preferable. Such ointments are widely used in the Detroit schools for minor burns of pupils. These anesthetic ointments may be purchased under a great variety of names. In this city the one marketed by the J. F. Hartz Co. called "Tan-Oxy-Caine" is regarded as satisfactory and is low in price. This type of ointment should be on hand in the first aid station, and since it is harmless should be placed in the varnish making department and other hot areas where burns may arise. Although the practice of lay treatment, particularly in departments, is regarded with disfavor.

Another argument for the building up of a better service in first aid grows out of a review by these investigators of experience with sick claims of the benefit association. A long list is provided which is said to cover the 12 month period from 1935 to 1936. It is true this long list of fairly serious conditions may represent a fair measure of neglect from not having reached some of these diseases in their very early stage. Taking at random one example, it is noted that a certain woman lost several weeks' time because of an infected eye. Nothing is known about the nature of this infected eye or its cause, but the general comment is made that there may have been a time at the very inception of this infection when judicious first aid rendered in the plant's first aid station may have obviated the entire situation, lost time and lost money.

The burden of this long discussion is that the minor medical problems in this plant of 746 employees are not adequately being met by existing medical facilities located on the premises.

MISCELLANEOUS ITEMS

Office Heat Problems

On the second floor portion of the office building, no ceiling is provided with the result that work is carried out directly under a hot roof. However, due recognition is given to the fact that this roof is situated at a high level above the floor. Already a number of overhead fans have been installed to evacuate accumulated heat and in addition overhead circulating fans are being used to produce improvement in air motion. Many complaints arise during very hot seasons from workers in these office sections, which sections are fairly crowded.

It is not easy to make a decision that these areas should be equipped with ceiling and insulation. Very hot spells in Detroit in any one summer do not aggregate more than fifteen or twenty days. During this time it must be true that a great deal of discomfort exists in these offices. For longer summer period, relative discomfort is the obvious lot of those workers assigned to duties in the areas under discussion.

The introduction of fans for the withdrawal of heated air already has accomplished much, but still complaints are reported to be numerous and appeals have been made to these investigators for consideration of the plight of these workers. On this account, the suggestion is made that the management determine the cost of introducing a ceiling, preferably of the sound ameliorating type, to be over-laid with suitable insulation material for heat abatement. Unless the cost is prohibitive, this installation should be made. However, overhead fans, evacuating the then attic air should be maintained and at the same time limited evacuation of the air in the work area should be provided owing to the considerable congestion of workers there.

Color Card Manufacture:

Building 41, a detached, small structure, is given over to the manufacture of color cards. In practice, color materials are

sprayed on to suitable cardboard whereupon these cards are racked and work is terminated until these cards are dry. Under favorable weather conditions two or three batches may be run through per week but conversely when wet weather is present, it is sometimes true that only one lot per week may be completed. This operation introduces a small but very distinct exposure. The large number of coated cards offer a high area of evaporating surfaces leading to the presence in the workroom of toxic vapors.

After due consideration, the conclusion has been reached that no new equipment of protective nature should be installed in this workroom, inasmuch as it appears that comparative safety may be attained if the spray booth fan is continually operated whether or not spraying is being conducted at all times when evaporation is taking place. This means that in this small room the concentration of vapors may be kept adequately low if the spray booth fan is operated as an exhaust system.

Blacksmith Shop:

In the Maintenance Building, building #24, and in the blacksmith shop, thereof, there will be found two black stacks over forges that are just about falling down and no longer serve the proper function of conducting smoke, carbon monoxide and other gases from the forge. These stacks should be repaired, to include cowls projecting over the fire area. These aprons or cowls apparently have existed in earlier days, but have worn out through much use.

Seating Facilities: (for women)

Apart from office workers and the Printing Department, the seats for women workers are distressingly bad. Women have been observed to work for their entire trek of duty seated on a discarded box or bucket. This statement does not apply to casual operation of temporary nature, but instead to operations where day by day women carry out substantially the same duties in sitting positions. See for example groups of women working respectively on the first floors of the enamel and lacquer departments. There are a few bad seats in the Printing Department, but the larger number are fairly satisfactory.

Drying Ovens:

In Building 13, a battery of drying ovens are in operation, heated by gas. The greater number of these are adequately vented, but four, apparently more recently installed, are not vented at all and discharge immediately into the workroom atmosphere. This should be remedied.

Seasonal Variation:

This work has been carried out during hot summer months with all doors and windows wide open. This provides a set of circumstances unlikely to apply in some respects to winter months. In all instances it may not be assumed that statements made in this report absolutely will be applicable to the winter season. Elsewhere the recommendation has been made that six months' hence a check-up study over a period of three or five days be carried out in order to bring out hygienic features in this plant peculiarly related to cold weather.

Spray Booths:

In various sections of this report mention is made of spray booths and at times specific recommendations have been made. Now, as a general item, it is noted that throughout the plant the majority of spray booth exhaust pipes merely lead through the window or building wall and discharge immediately in the proximity of the booth itself. Consequently it may be observed that vapors are occasionally exhausted through the booth to the outside, three feet away, and they immediately are blown back into the workroom. Those discharge pipes that empty upward or horizontally appear to be less efficacious than those discharging downward. As a general rule, but with some exceptions, it is quite desirable that these discharge pipes extent to the roof level and 5 feet beyond. The best example of the item under discussion may be found in Building 13.

Errors of Diet and Faulty Eating Habits Represent A Common Shortcoming in the Life of Industrial Workers. Industrial Cafeterias Should Make Studied Efforts to Supply Suitable and Appetizing Food for Higher Percentages of Employees.

Acme White Lead and Color Works
Hamtramck (Detroit) Michigan

Stone Dressing:

In one other paint plant, two deaths among stone dressers were ascribed to silica dust from stone. On this account, these investigators are somewhat alert to the possibilities of damage in this operation. In this plant it was found that stone dressing was carried out as a wet operation and that substantially no dust was produced, as shown in actual dust counts. This has led to the conclusion that if operations at all times are as they were when tested by us, no dusty lung disease is possible. Five men are said to work in this room, some of whom are "old timers". Undoubtedly some of these men have worked under other conditions where dust was produced. No less, it was deemed inexpedient to obtain x-ray pictures on these workers since it seemed well established that even though they have silicosis, nothing existing under present conditions would augment that condition.

Cafeteria:

As is usually the case, the company's lunchroom is not very popular. It is little patronized apart from the office group and even in this group many complaints are made about quality of food, dirtiness, difficulty in obtaining food, etc. It is well recognized that whatever may be done will not please all persons and that whatever is pleasing for the time being may become distasteful a few weeks hence. On this account, these investigators wish to sidestep any elaborate recommendations for improving cafeteria service. Three things, however, stand out as of possible significance: 1) The greater number of factory workers should be served under conditions satisfactory to themselves, either in this cafeteria or with food furnished by this cafeteria; 2) This cafeteria should not take responsibility for the furnishing of food to be consumed in lead using areas; 3) It appears reasonable to believe that much would be gained if the immediate management of the cafeteria was of a little higher intelligence order or if there might be a little more extensive supervision by the higher management. The chief point here made is that something is wrong with the cafeteria.

Use of Salt Tablets:

From observations made on several tours over the entire plant, the impression has been gained that the use of salt tablets for purposes of combating heat is not universal and further that where installations have been made, supplies of salt tablets are not always kept available. Inasmuch as this is the very season when salt tablets should be used and inasmuch as the worth of this practice is now well established, it is suggested that a little bit more attention be paid to the supplying of this helpful chemical agent. Heat exhaustion, abdominal cramps, muscle cramps and gastro-intestinal upsets, frequently resulting from work under conditions of high temperature, are all related to the fact that the body is partly deprived of its normal saline content through the loss of sodium chloride and other salts in perspiration. On a very hot summer day, in work associated with hard labor, most workmen may perspire from 4-6 quarts of perspiration, which may contain as much as 20 or 30 grams of sodium chloride derived from body tissues. The use of sodium chloride tablets is for the purpose of replacing this salt lost in the course of perspiration. The drinking of water alone merely increases the saline deficiency, produces increased fatigue and generally does not serve the interests of the desalinized workmen. However, the use of water and sodium chloride tablets adequately meets the physiologic requirements of the body, provided sufficient salt tablets are daily ingested. It is customarily stated that the tablets should be used with every drink of water. Since some workers drink much more water than others, this is not an infallible governing procedure. It is suggested that from 7-10 tablets per day is about the right number.

Marking of Toilets:

Dr. Fredrick, who has made several complete tours through the plant, reports that many of the toilets are not marked with such wording as "women", "ladies", "women's toilet" or "restroom". If this is true, those unmarked toilet places should be appropriately marked. In some states this is required by law.

Ignored Work Places:

In this report, several fairly large work areas are scarcely mentioned. The reason for this is simple, that no conditions have been encountered calling for modification of present practices, so far as health conservation is concerned. This statement applies to the entire laboratory section, which is only mentioned in connection with excessive noise, and various warehouse and storage sections, where no known hazards exist. This statement is equally true for the shipping department, where work conditions appear to be satisfactory.

FUTURE PROGRAM

The mere making of this survey will be of little value unless the majority of the recommendations are carried out. Some few of the recommendations made may prove to be impractical or incompatible with industrial requirements. Therefore, the first item relative to a future program centers about the introduction of some or all of the recommendations embodied in this report.

Apart from the foregoing, the question arises as to the desirability of future surveys, of additional examination of workers, of additional measurement of air conditions, etc. At once the opinion is expressed that there should be a follow-up inquiry by these investigators, or others if there be a preference for others, approximately six months hence for the purpose of appraising the worth of changes that may have been introduced. If the initial survey was made during the summer months, the check-up survey should be carried out during cold weather, as many differences naturally will arise due to the effect of seasons. The converse of this statement also applies. This check-up survey should be limited in character and perhaps will not extend over three or five days.

It is believed that it will not be necessary that this plant set up its own laboratory or purchase any elaborate equipment for the routine conduct of hygienic tests such as dust counts, vapor determination, blood examinations, carbon monoxide detection, etc. The reason for this stand is that in this plant there are no overwhelming exposures and no considerable number of cases of occupational diseases.

One great need in this plant is for routine inspection at short intervals, such as once weekly and certainly not less often than once monthly, of the entire premises by one or more persons who will see the entire lay out in terms of health exposures. In this plant there is no physician, and the nurse in charge is not sufficiently qualified for this operation. It

appears likely that the fire chief is not qualified, although possibly he may become suited to these requirements. At any rate, some qualified person should check over, at frequent intervals, the many scores of potential danger points brought out in this report. These inspections should not be perfunctory, but instead should be systematic. The records should be written up, orders should be issued, and if necessary the advices of these investigators or some other group should be sought on troublesome points.

At the present time the use of lead in coating materials is on the wane. To the extent that it is practical, this exodus of lead should be encouraged. As an item for future program, it is suggested that lead should be replaced whenever the choice between this and other minerals is equal. This statement also applies to benzol, wood alcohol and other highly dangerous solvents.

Year by year new materials are introduced into the paint industry. It is to be hoped that any future program will include consideration of new materials in terms of avoidance of health exposures on the part of workers in the factory and the consumers. It is conceivable that various chlorinated products may be proffered the paint manufacturer, that efforts may be made to increase the use of benzol, that arsenic compounds may enjoy some favor. Whenever highly dangerous substances such as these are brought up for consideration, due thought should be given to the new dangers that may be introduced because of their manipulation on the plant's premises.

In due time the extent of medical work on the premises should be increased. The section of this discussion devoted to the medical department is without any criticism of the expediencies of the present arrangement, but the fact must be faced that very little medical work is going on on the plant premises and conversely that there is a need for more. A future program should contemplate this extension.

It was not within the province of this present survey to handle safety hazards. No less, these investigators would be unfair to the management to omit the statement that mechanical safety at this plant is at low ebb and that many improvements would be justified. Therefore, a future program should contemplate increased safety activities, both of mechanical and educational nature.

This report includes much discussion of the occupational disease law as now exists and before it goes into effect. It is now said that plans are being made for the revamping of this law within the next few weeks by the Legislature in special session in Lansing. If, and when, this revamping is accomplished, there should be consideration of the then law by these investigators or other qualified persons in terms of the effects this law will have upon the operation of this plant. In further relation to the occupational disease law, it may become desirable that somewhat different types of physical examination be carried out by Ford Hospital physicians. This, however, should wait the appearance of the effective law.

It appeals to these investigators that if physicians at Ford Hospital are to continue to serve as the plant's industrial physicians that some one or more of these physicians, and particularly the one doing the greatest quantity of work, should visit the plant premises, should know of the operations involved, should read this report and otherwise increase his capacity to fit in with the medical needs of this plant.

It is difficult to disassociate any future program as projected here from the recommendations made in other parts of the report. It is therefore urged that for the time being a future program related to industrial hygiene center about this report in its entirety as a guide.

NEW PERSONNEL

After reviewing all of the discussion, data and recommendations made in this report, these investigators are impressed with the probability that the management should appoint some one highly qualified person, either now present in the organization or who may be employed, to be placed in charge of a variety of activities, chiefly falling into the category of employee service.

The need exists for a high type of supervision of 1) mechanical safety, which is at a low ebb in this plant; 2) personnel problems connected with employment and kindred matters; 3) first aid problems; 4) fire protection; 5) the carrying out of the measures suggested in this report; 6) routine plant inspection with respect to health and accident exposures; 7) janitors.

It is not argued either that all of these matters have been distinctly neglected in the past or that absolutely this type of service should be centered in one person. It is argued that in this plant one of the outstanding shortcomings is a lack of supervision of and consideration for a lot of matters not directly related to production. So much work is required that it may be doubted that these items may be added to the long list of obligations of one or two persons in the managerial group.

Without specific recommendation, the suggestion is made that much would be gained if a young, trained industrial hygienist or cub engineer might be given a chance to bring up to high order the types of services above discussed.

ERRATA

Undoubtedly in a typewritten report of this length many undetected typographical errors exist. These unwanted discrepancies are almost inevitable in elaborate reports of this character.

Of greater significance is the possibility of errors of omission and commission due to the short comings of these investigators, n t being entirely familiar with all angles of paint manufacture. These investigators wish to be the first to recognize that they manifestly cannot spend two weeks on the work premises and thus master every feature of intricate production operations.

This report, therefore, is just what it professes to be -- an appraisal by industrial hygienists only partially familiar with the complex manufacturing processes involved in a large paint producing plant.