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REPORT ON

"SUMMARY OF THE PLANT INDUSTRIAL  
HYGIENE PROBLEMS"

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SUMMARY OF THE PLANT INDUSTRIAL HYGIENE  
PROBLEMS OBSERVED IN SEVERAL REFINERIES  
ESSO COMPANY

C. M. Berry, Ph.D.

In the time allotted to me, I should like to discuss the industrial hygiene problems in the Esso Company on the basis of broad groupings into the type of exposures. I believe that this approach, rather than by operation, will point up more clearly the responsibilities of the industrial hygienist. The following is a partial list:

1. Exposure to toxic gases, vapors, and mists
2. Exposure to toxic fumes and dusts
3. Industrial dermatitis
  - a. Primary irritants
  - b. Sensitizing agents
4. Exposure to carcinogens
5. Excessive heat
6. Excessive noise
7. Inadequate illumination
8. Inadequate ventilation
  - a. General
  - b. Local exhaust
9. Vibrating tools
10. Atmospheric pollution
11. Sanitary facilities
12. Special problems

Toxic gases, vapors, and mists occur quite generally throughout the refineries; from hydrogen sulfide in the processing of sour crudes, to mercury vapor in the instrument shops; from sulfur dioxide in sludge cooking,

to carbon monoxide in synthesis gas, and from benzol vapors in solvent dewaxing, to the mists associated with drum painting. Other potential exposures are to oxides of nitrogen, mercaptans, ammonia, chlorine, toluol, xylol and other aromatics, acetone, methyl ethyl ketone, methyl propyl ketone, methyl chlorido, carbon tetrachloride, boron trifluoride, aluminum chloride, hydrogen chloride, sulfur trioxide, lead tetraethyl, phenol, sulfur trioxide, aliphatic hydrocarbons both saturated and unsaturated, vaporized lube and grease additives, vaporized and sublimed plasticizers, alcohols from methyl to iso-octyl, ethers, esters, and others.

Fumes and dusts are encountered almost as widely. There are welding fumes in maintenance operations and occasional heavy exposures to siliceous catalyst dusts, coke dust from equipment cleaning and litharge dust in Doctor sweetening, asbestos dust in insulating operations and talc dust in rubber manufacture. Catalyst manufacture offers a wide variety of dust exposures. Lube and grease manufacture offer exposures to diatomaceous earth, several types of clays, graphite, metal stearates, lime, asbestos, mica, and others. Metallizing operations, lead burning, sand blasting and pipe reconditioning -- all present potential industrial hygiene problems.

The problem of industrial dermatitis is like the poor -- always with us. The problems vary from those associated with defatting of the skin, as would occur on intimate contact with certain petroleum fractions, to those accompanying the use of harsh abrasives and detergents in hand cleansers. There are plant exposures to primary skin irritants, such as the mineral acids and alkalis, and to more serious substances, as the chromates. Cutting oils, gasoline, lube, and grease additives present opportunities for contact with primary irritants, as well as sensitizing agents.

Exposure to carcinogens, known and suspected, dips heavily into the time and energy of the industrial hygienist. All of us are familiar with the problem associated with wax pressing. The control of this problem, however, may not be sufficiently complete as statistical evidence is mounting that the incidence of systemic manifestations among this group of employees is out of line with that for the general refinery population and the population at large. The control program must be continually observed and reviewed to insure that maximum worker protection is provided.

Animal experimentation has indicated that certain heavy fractions from catalytic cracking are potentially carcinogenic to man, as are the tars from steam cracking and thermal reforming. The control programs for these materials have been discussed in detail and need not be reviewed at this time except to indicate that they represent a significant effort on the part of industrial hygiene personnel, past and present, and there is every reason to believe that even greater industrial hygiene effort will be required before all groups concerned with the problem are sure that a satisfactory control program has been evolved, inaugurated, and is running smoothly.

Excessive heat exposures cannot be solved for plant personnel as easily as for office employees where the latter can be sent home in the middle of the afternoon if it gets too hot. Such exposures, directly associated with the work, occur in such widely varied activities as pipe bonding and furnace thermocouple servicing, certain boiler house activities, and working in confined areas where the equipment has not cooled down entirely. During certain seasons, any physical labor of a strenuous type, and especially if it is performed in direct sunlight, may represent an occupational exposure of no mean significance.

A medical opinion has been expressed in certain of the refineries that hearing impairment is relatively common among certain groups of workers, such as the boilermakers. However, high noise levels are encountered in other parts of the refinery as well. Potentially undesirable noise levels might be encountered in the vicinity of high-speed pumps, in compressor rooms, in generator rooms of the power houses, to mention only a few.

Inadequate illumination is a problem that affects clerical personnel as much and as often as process workers. Satisfactory illumination must be considered in close conjunction with the job to be performed and is a composite of a number of items -- the intensity of the light, its color, contrast, amount of glare, and angle of incidence. Potential difficulties arising from inadequate illumination may be encountered in any area of the refinery but is most likely to arise from clerical activities.

Fortunately, the open type of construction employed in petroleum refining reduces the number and variety of general ventilation problems with which the industrial hygienist must contend. On the other hand, there are numerous instances where enclosures have been constructed for the shelter of men and/or equipment, and the ventilation of these spaces then becomes a problem. Pump houses frequently offer exposures to hydrogen sulfide; compressor houses may provide exposures not only to hydrogen sulfide, but also to methyl chloride, ammonia, or some other refrigerant.

In many cases local exhaust ventilation is required for specific operations. Each of us is familiar with the spray paint booth and the laboratory hood, but the need for this type of ventilation can be demonstrated for metallizing operations, permanent welding locations, degreasers, and driers, calenders, and dusting machines in rubber manufacture.

As in the case of illumination, each operation must be considered on an individual basis. If no ventilation is provided, then the need for such control must be demonstrated and assistance provided to be sure that the system will be of the correct design and of suitable capacity. Because ventilation for health protection is so poorly understood, every industrial hygienist must be conversant with hood and duct design, fan types, and the proper collector to use for the specific contaminant. The capital outlay for a satisfactory ventilating system is far too large to permit unconcern over its future performance by the industrial hygienist.

Vibrating tools are in use throughout the plants and their effects are of interest from an occupational standpoint. These instruments range from electrically driven star drills, to jackhammers and pavement breakers; and from the use of chipping chisels, to riveting operations. These need to be scrutinized from the standpoint of frequency and duration of use, the number of cycles per minute, and features peculiar to the activity that may have significant medical implications. Since the smog incident at Donora, Pennsylvania, currently being investigated by the Industrial Hygiene Division, U.S. Public Health Service, the specter of atmospheric pollution has haunted the industrial hygienist. This individual is trained and experienced on the evaluation and control of atmospheric contaminants within a plant and it is only a small step, and a very logical one, for him to be called upon for similar functions related to the discharge of undesirable contaminants into the atmosphere of a community. All of the Esso refineries are located in urban areas, and it is not unlikely that the work load of the industrial hygienist will be augmented by being called upon in some degree to assist management in this field of endeavor.

With respect to sanitary facilities, it would be desirable to be assured that all governmental requirements are met and exceeded and that any control program, as in the case of the carcinogens, will not be impeded by the lack of lavatories and showers. In certain of our establishments, the lack of suitable facilities, their location, or their physical condition, is a very real problem. On the other hand, this condition is being steadily alleviated, and the next few years should find the situation much improved.

In addition to the industrial hygiene problems and activities previously enumerated, there are others, real or alleged, that require investigation. Yesterday we heard of the cancer problem associated with the manufacture of isopropyl alcohol at the Bayway Refinery. This problem, considered acute by the local management because of the employee relations aspect, has entailed a tremendous amount of effort and the end is not in sight. Developing incidence figures for the Chemical Products area alone utilized all available personnel from the Medical Department of the Jersey Company and our own for several weeks, and incidence figures for the alcohol plant are just now being completed. The etiologic agent is not known but no effort is being spared to identify it. Only after the problem has been well defined will it be possible to set up an intelligent control program. The facts evolved at Bayway must then be translated, insofar as they are comparable, into a program at Baton Rouge.

Several studies of a similar type may be in order in other refineries, inasmuch as statements relative to the incidences of certain medical entities have been made and should either be substantiated or disproved.

CMB  
April 11, 1949

EM003124



INDUSTRIAL HYGIENE PROBLEMS OBSERVED IN THE BAYTOWN REFINERY

J. W. Hammond, M.S.

 In 1948 a survey of the Baytown Refinery and the Specialty Plant was made with the assistance of Mr. N. V. Hendricks. The purposes of this survey were to determine the materials and conditions of health significance and acquaint the Industrial Hygienist with the technical operations, materials, and products which are handled in the Refinery and the Specialty Plant. These operations and the nature of the materials were investigated for the purpose of locating any problem associated with refinery operations that might have an adverse effect on the health of the employees. Some of the questions that were studied which seem to be the most outstanding are presented in the summary attached. The subjects shown are by no means a complete list of observed industrial hygiene problems associated with refinery operations and the manufacture of petroleum specialties.

On page one of the Summary the sanitary phases of the industrial hygiene survey are briefly presented. The question of protection of the drinking water supply and the method of bacteriologically checking this for unsuspected sources of contamination were investigated. As a result of this investigation several weaknesses were brought out. The method of collecting samples was changed to include samples every three months from the foremost ends of the water mains in addition to collecting samples at a point very near the well site. This new program has disclosed, on one or two occasions, minor contamination which has resulted in a more careful control over the entire system. It was observed during this survey that there were several fountains and other places where employees obtained their drinking water that did not meet with the minimum standard from the standpoint of sanitation. A program is now underway with the orders being issued from the manager of the refinery to replace all unapproved type of fountains, thus to eliminate any

cross infection of the personnel by this means. The old type of drinking water cans are being replaced by a sanitary type which keeps the water and ice separated. Until the new type of cans can be substituted in every instance, chlorine tablets are being used to sterilize the drinking water mixture in the insanitary type of cans.

The refuse and sewage disposal methods were studied. The good sanitary program such as, the construction of the sewage disposal plant, installation of sewerage lines to separate the storm and industrial waste drains from the sanitary sewers, and replacement of all the open-type privies, has been greatly accelerated since this survey. This survey pointed out through the report that communicable diseases were easily transmitted by various insects under the existing conditions in the Refinery.

The washing and sanitary facilities available to the employees were reviewed. Recommendations for the increase in the number of these facilities were made and in many cases the needed changes or additions have been secured. This program has been well underway since before the connection of the Industrial Hygienist with the Company, but due to the bringing to light of many industrial hygiene problems which would dictate the need for the expansion of the facilities, this program has now reached the stage that the approval of requested facilities from top management is assured if they are essential in the medical program. By the beginning of the year 1950, the facilities which were seen to have been needed will be completed or under construction. In a few locations where toxic materials were being handled and the nature of the work made it necessary for the employees to get badly soiled, hot water has been added to the present washing facilities. The presence of toxic materials was brought to the attention of the Management to justify the added expense of installing hot water.

It will only be possible in the few minutes that have been allotted to me to cover the most outstanding hazards associated with toxic materials.

First, from the standpoint of the number of employees exposed and the general presence of the material throughout the Refinery, one would have to list hydrogen and organic sulfides. Prior to this survey, several cases of serious eye irritation came to the attention of the Medical Division from a low grade exposure of rather long duration to sulfides. At another location this survey disclosed that there was a rather serious possibility of eye irritation from the presence of hydrogen sulfide. Before any action was taken on the recommendation, such as instigating a detailed study of this location and recommending adequate ventilation, several eye cases reported to the hospital for treatment from this unit. There still exists the need for a detailed and quantitative investigation of these sulfides in many other units. This gas has been responsible for very serious, acute poisoning and some cases have resulted in fatalities. Under the existing conditions, the precautions used, and the concentrations of sulfide that are now found, it is the opinion that the danger is not only eye irritation, but possibly chronic systemic poisoning from low concentrations. The currently used sulfide detector is not sensitive enough to pick up concentrations of these gases which will produce physiological effects. An adequate appraisal would depend upon using absolute quantitative chemical methods and integrated samples.

There are at least five skilled crafts where possibility of plumbism exists. To date no investigation of this problem in the nature of either atmospheric samples or lead excretion values of body fluids has been carried out. This latter will soon be undertaken by the analytical laboratory.

Mercury is extensively used by the laboratory analytical group, the research engineers, and handled in large quantities by the Instrument Men.

This potential problem has received a great deal of attention from the Medical Division through having employees with the greatest exposure report to the hospital so that urine specimens could be collected and submitted to the analytical laboratory for analysis. More than 60 samples have been collected and checked for mercury so far. This study is continuing. In several locations mercury vapors have been found by atmospheric sampling. In some of these locations where mercury is regularly used, a weekly check is being made and a record kept by the operating personnel or the analytical laboratory at the request of the departmental supervisor. Other heavy metals which have been located and we know present enough exposure that they should be studied are zinc, chromate, cadmium, and to a lesser degree, beryllium. Up to the present time no quantitative values are available on these materials.

Silica and asbestos are both extensively used in the Refinery by a limited number of employees. To date the only quantitative study we have made dealt with the composition of contact clay. The free silica content of these clays has been determined by a careful chemical analysis assisted by x-ray spectograph. It is felt that a study on the atmospheric concentrations on silica and silicate dust associated with relining the furnaces is of immediate importance. Silica bricks are commonly used in lining the furnaces used in the Refinery. Even where silicate bricks are used, it is known that in high temperatures these silicates decompose to form very dangerous forms of silica, cristobalite, and tridymite.

The exposure to asbestos under normal operating conditions in the Refinery is not extensive but frequently it is necessary for an insulator to do work inside of a closed space with limited ventilation, making it possible that a high concentration of asbestos dust may be engendered. Also, the

asbestos insulations are saved by power saws which give off rather heavy clouds of dust. This problem should be studied.

The analysis for free silica in contact lube clays disclosed that the average concentration is about five percent. This is valuable information in view of the fact that the Public Health Service has on record an analysis of a similar type clay which they claim to have contained 20% free silica. It further behooves us to make fairly complete surveys of the locations where silicate is apparently being handled, including the Rubber Plant where talc is applied to the finished rubber. Such a detailed study, with complete dust counts at various locations and exposures, will be invaluable for our records should we later be confronted with complaints and claims from former employees who might have worked at these locations. No doubt the dust counts will disclose some unnecessarily dusty operations that can be controlled by mechanical means.

At the Acid Plant and at the SO<sub>2</sub> Plants, low concentrations of sulfur dioxide and trioxides are potential problems. Many complaints have been received at various times from the Acid Plant, and it was observed that various operations carried out there involve irritating concentrations. As a happy result of an active department management's attempt to improve these conditions, the current situation is much improved. The proof of these improvements was recently brought to our attention when it was reported that employees are now requesting to be assigned to the Acid Plant rather than trying in every way possible to get transferred away. Not all of the problems have been solved, but much money for the purpose of improving this area has been spent and even more has been requested.

In connection with the sulfur oxide problem, not only in the Refinery proper but in the surrounding community, a study has been instigated to take

atmospheric samples at various distances from the Refinery to establish information pertaining to the concentrations that may exist under varying weather conditions. It is planned that this study will be prolonged over a period of years, if necessary, to establish enough factual analytical data that a decision can be reached as to the extent of the problem with waste gases. A preliminary investigation as to the extent of vegetation damage in the vicinity of the Refinery has already been started. It was observed during this survey that fairly high concentrations of nitrogen dioxide existed in four small buildings associated with the Acid Plant. Atmospheric samples disclosed that the nitrogen dioxide exposure was a very serious problem to anyone having to enter the building even for a short period. Warning signs have been placed in this area and Management has ordered that the engineers design adequate ventilation to reduce the concentrations of nitrogen dioxide to those that are recognized as harmless.

Concentrations of benzol were detected in the atmosphere at the Mel. Plant, in some of the laboratories, and at the Bottle Laundry which were believed to be excessive for prolonged exposure. As a result of the casual work accomplished through this survey, the MEL Plant supervisor has initiated the removal of benzene and the substitution of toluene in its stead. This substitution does not control the problem entirely, but it diminishes the seriousness of it.

Other aromatics, including toluene and xylol, cumene, and others are manufactured in large quantities. These exposures are considered in many cases to be within accepted limits, but there is no way of being sure as to the effect that they may produce on the health of the employees without making sufficient atmospheric examinations to establish the range and duration of exposure.

It is a common practice to use chlorinated hydrocarbons to clean electrical motors and various instruments in two or more departments of the Refinery. This problem is being currently studied in detail with the assistance of the safety engineers. This study will include not only the Refinery and the Specialty Plant, but also the Production Department and Humble Pipe Line Company's operations.

Varcol was found being used freely without regard to the 15% aromatics it contains.

In a few units heat, which has been the cause of various fatigue cases as well as the source of many complaints, was observed. Time has not permitted any detailed study of the problems associated with heat and noise, but it is felt that it is important enough that such a study is justified.

In most cases, these studies have been carried out by the operating personnel in charge of the various departments with the assistance of the laboratories which are available to them. The Medical Division has served as consultant on making available approved type analytical methods to be used in atmospheric testing, analysis of urine samples, and to interpret the results that the analyst reports. In some departments the supervisor has not felt that they had qualified personnel, supplies, equipment, or the time to make these indicated surveys. In these cases, when possible, the Industrial Hygienist has carried out the chemical and engineering services. In some instances the equipment and time were not available to the Industrial Hygienist and he has turned to the industrial hygiene services of the Texas State Department of Health for assistance on a quantitative appraisal of the toxic materials known to be present in the atmosphere. These public officials have been very cooperative in every way in trying to further the general well-being of the Humble employees.

Time does not permit me to touch on many of the other problems, some of which are as major as these, that have been uncovered, nor is this the meeting to report on the sanitary engineering aspect of the work which has been carried out in close cooperation with the civil engineers of the Company. It is sufficient to say that, as a result of these activities, the various engineering standards and guides have been rewritten with the view in mind of making it possible for the uninitiated engineer to supervise construction of adequate water and sewage facilities to protect employees' health. This phase of the problem seems to have met with complete approval of Management.

JWH  
April 12, 1949



APPENDIX

SUMMARY OF PRELIMINARY INDUSTRIAL  
HYGIENE SURVEY AT BAYTOWN

| <u>Condition and Facility</u>         | <u>Potential Diseases</u>                           | <u>Department or Craft Affected By Recommendation</u> |
|---------------------------------------|-----------------------------------------------------|-------------------------------------------------------|
| Drinking Water, Fountains and Coolers | Twenty-one Communicable Diseases                    | Turnaround and Labor Gangs, and Twenty or More Units  |
| Sewage Disposal                       | Ten Communicable Diseases                           | All Units and Personnel                               |
| Washing and Sanitary Facilities       | Skin Irritation (dermatitis) and Systemic Poisoning | Mechanical, labor, Processing and Others              |

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SUMMARY OF PRELIMINARY INDUSTRIAL  
HYGIENE SURVEY AT BAYTOWN

| <u>Material or Condition</u>          | <u>Potential Diseases</u>                            | <u>Departments or Crafts Affected By Recommendations</u>                            |
|---------------------------------------|------------------------------------------------------|-------------------------------------------------------------------------------------|
| Hydrogen and Organic Sulfides         | Eye Irritation and Ulceration.<br>Systemic Poisoning | Distillation, Light Ends, Cracking, Treaters, Pumping, Gauging, Mechanical & Others |
| Lead                                  | Plumbism                                             | Labor, Painting, Welding and Burning and Machine Shop                               |
| Mercury                               | Mercurialism                                         | Instrument, Laboratory, Warehouse and Pilot Plant                                   |
| Zinc, Metal Fumes                     | Purge Fever, and Systemic Poisoning                  | Mechanical                                                                          |
| Chromates and Beryllium (Slight Exp.) | Lung Cancer and Skin Tumor                           | Painting, Mechanical & labor                                                        |
| Silica and Asbestos                   | Silicosis, Fibrosis, Erythema & Cancer of Lungs      | Brick Masons & Helpers, Insulators, Laborers and Pipe Fitters                       |

SUMMARY OF PRELIMINARY INDUSTRIAL  
HYGIENE SURVEY AT BAYTOWN

| <u>Material or Condition</u>              | <u>Potential Effects</u>           | <u>Department or Craft Affected by Recommendations</u>      |
|-------------------------------------------|------------------------------------|-------------------------------------------------------------|
| Silicates and Coke Dust                   | Fibrosis, and Possibly Lung Tumors | Contact, Straining and Blending, Cracking Coils and Labor   |
| Sulfur Dioxide and Trioxide and Acid Mist | Irritation, Asthma, and Poisoning  | Treaters, Acid Plant, Batteries, and SO <sub>2</sub> Plants |
| Nitrogen Dioxide                          | Edema of Lungs                     | Acid Plant and Welding                                      |

SUMMARY OF PRELIMINARY INDUSTRIAL  
HYGIENE SURVEY AT BAYTOWN  
(Continued)

| <u>Material or Condition</u>      | <u>Potential Effects</u>                 | <u>Department or Craft Affected by Recommendations</u>        |
|-----------------------------------|------------------------------------------|---------------------------------------------------------------|
| Benzol                            | Blood Disease and Cancer                 | MEK Plant, Laboratory and Bottle Laundry                      |
| Toluol, Xylol and Heavy Aromatics | Blood Disease                            | MEK, SO <sub>2</sub> Plants, LEFU, NRU, and P & G Units       |
| Varsol and High Aromatic Naphtha  | Dermatitis and Blood Disease             | Generally Used Throughout Refinery                            |
| Chlorinated Hydrocarbons          | Cirrhosis of Liver                       | Instrument & Electrical                                       |
| Heat and Noise                    | General Malaise, Exhaustion and Deafness | Maintenance Crews, Pumpers, Boiler and Power Houses Personnel |