FILE NAME: Exxon (EXX)

DATE: 1949

DOC#: EXX006

DOCUMENT DESCRIPTION: Internal Report - Industrial Hygiene Survey - Baton Rouge Refinery

IHF Baton Rouge
Sept 1949

Ralph

PLAINTIFF'S EXHIBIT
EXX 97

CONFIDENTIAL

INDUSTRIAL HYGIENE FOUNDATION OF AMERICA, INC.

4400 FIFTH AVENUE

PITTSBURGH, PA.

INDUSTRIAL HYGIENE SURVEY

of the

Baton Rouge Refinery

LOUISIANA DIVISION

ESSO STANDARD OIL COMPANY

Baton Rouge, La.

February - April, 1949

INDUSTRIAL HYGIENE FOUNDATION OF AMERICA, INC.

4400 Fifth Avenue
Pittsburgh 13, Pa.

****

INDUSTRIAL HYGIENE SURVEY

OF THE

BATON ROUGE REFINERY

LOUISIANA DIVISION

ESSO STANDARD OIL COMPANY

FEBRUARY, MARCH, AND APRIL, 1949

by

James F. Morgan

W. C. L. Hemeon

Industrial Hygiene Foundation of America, Inc.

By John F. McMahon
Managing Director

Date Submitted: MARCH 13, 1950

EM001606

TABLE OF CONTENTS

TABLE OF CONTENTS

(Continued)

TABLE OF CONTENTS

(Continued)

EM001609

LIST OF TABLES

INDUSTRIAL HYGIENE SURVEY

MADE FOR

ESSO STANDARD OIL COMPANY

BATON ROUGE, LOUISIANA

FEBRUARY 23 - APRIL 20, 1949

Arrangements for this survey were made in 1948 through the office of Dr. R. C. Page, General Medical Director, Standard Oil Company (N.J.). It is a part of a larger study which will include four plants of the Esso Standard Oil Company, Sarnia Refinery of Imperial Oil Limited, and the Aruba Refinery of Lago Oil and Transport Company. Field work at all the plants will have been completed before the submission of this report. The field work at Baton Rouge embraced the period February 23 to April 20, 1949. Mr. J. F. Morgan was present at the refinery for the entire period of the work, Mr. W. C. L. Hemeon spent two weeks at the refinery, and Mr. George F. Haines, Jr., of the Foundation staff, assisted during a period of two weeks.

Persons in Standard Oil Company (N.J.) directly concerned with the work are Dr. Joseph P. Holt and Mr. N. V. Hendricks; in the Esso Standard Oil Company headquarters, Dr. John S. Denholm and Dr. Clyde M. Berry. At Baton Rouge, the official contact was Dr. Howard Hansen.

During the course of the survey, close association was established with Mr. E. Stauverman, Jr., Mr. Roy E. Brady, and Mr. Stanley Day, of the Safety Department.

The important conclusions of the survey are highlighted in the "Summary" section of the ensuing pages.

SUMMARY

There are <u>four</u> principal classes of materials of significance in the present considerations.

(1) Materials which are known from experience to cause slowly developing toxic effects when workers are chronically exposed to atmospheric concentrations above certain levels, as lead dust, silica dust, benzol vapor, and the like.

The severity of exposure to this class in conventional manufacturing processes in factory buildings can usually be appraised quantitatively by analysis of the workroom air. Situations in the oil refinery where this could be done were few.

(2) Materials whose primary action is acute poisoning from short-time exposures. The acute poisoning may be effected by a single exposure incident. They usually have no chronic effects at lower concentrations. Carbon monoxide is an example. Asphyxiant or narcotic concentrations of carbon dioxide and aliphatic hydrocarbon vapors are in this category.

(3) Materials, as acid gases, which are irritating to breathe, repulsive, and hence, obvious in their presence; therefore, these warning properties tend to discourage exposures to injurious concentrations, except as they occur in accidents.

(4) Materials as PBN, C_9, and related aromatics which, because of their physical or chemical relationship to classes of known physiologically active materials, may be suspected of having deleterious health effects but about which there is no evidence from human exposures to permit of their accurate classification.

In the following tables, <u>exposures</u> of refinery employees to <u>materials</u> which are classified above are separated according to the evaluation arrived at in the course of the survey. Table I summarizes the exposures where it was possible to conclude that a definite health hazard existed.

Table II summarizes potential exposures to substances definitely known to be harmful, but where our observations indicated the intensity of exposure to be within safe limits.

Table III describes the largest and most important class of exposures where there is no experience to guide one to any definite conclusion, but wherein by inference (necessarily somewhat tenuous), we are led to suspect the possibility of hazardous conditions. In these cases, medical supervision of workers is indicated, so that by means of periodic examination of special design, any incipient health effects will be detected before widespread development occurs.

We have included in Table III the already recognized potential carcinogen hazards in exposures to the high boiling cut from catalytic cracking, wax pressing, OLA tars, and unknown substances from alcohol manufacture. Not heretofore recognized is the possibility of oil mist inhalation in various localities. Some measurements of oil droplet concentrations in atmospheric suspension have been made in various locations.

Table IV summarizes exposures to materials which are conservatively estimated to be innocuous or of negligible toxicity at the levels of concentration encountered in practice.

Table V summarizes recommendations for mechanical improvement of conditions in several locations.

In general, and to the credit of the executive attitude at this refinery toward safety and health, many of the hazards discussed in this report had already been recognized. Corrective measures have been instituted widely.

Table I

HAZARDOUS EXPOSURES TO MATERIALS OF KNOWN TOXICITY

Operation or Location	Substances or Conditions	Employee Group Affected
Paracril Plant	Acrylonitrile--by inhalation in vicinity of latex and coagulation pots.	One or two process men.
Catalyst Plant	Chromic oxide, various other raw materials and products--by inhalation and skin contact.	The 13 catalyst plant workers.
Sandblast Sheds	Silica dust--by inhalation.	Sandblaster helpers
Pipe Shop in Chemical Products Division	Metal fumes have produced symptoms of metal fume fever.	Boilermakers, welders, and burners.
Brick grinding Shed.	Silica dust enters shed from sandblast.	One man of Mason Department.

Table II

EXPOSURES TO HAZARDOUS MATERIALS JUDGED TO BE WITHIN SAFE LIMITS

Operation or Location	Substances or Conditions	Employee Group Affected
Butyl Rubber	Methyl chloride in vicinity of reactors and in finishing building. Safe usage by reason of process control, ventilation, and daily air analysis.	Process and mechanical workers in these areas.
Butyl Rubber Finishing Building	Talc dust at packaging.	Packers
Butyl Rubber Reactors	Aluminum chloride exposure is controlled by wearing respirators.	Process workers in the reactor area.
Alcohol Plant	Inhalation of acetaldehyde is at present prevented by use of respirators.	A few process workers in alcohol denaturing.
Anti-freeze production in Alcohol Area.	Methyl alcohol exposures are controlled by informed personnel and natural ventilation.	Process workers and pipe-fitters assigned to the area.
Paracril Plant	Acrylonitrile--in control rooms and in finishing building beyond coagulation pots.	Machinists, process workers, except attendants at latex and coagulation pots.
Light Oil Treating Plant	Lead--mist at ground level from aeration in doctor regeneration.	Process workers at ground level.
Shell Still Batteries No. 16 and No. 17.	Hydrogen sulfide exposures slight in receiving houses.	Still operators and helpers at the units.
No. 2 D. & S., Hydrogen Sulfide Recovery Unit	Leakage of hydrogen sulfide is effectively prevented in the process equipment.	
Tetra Ethyl Lead Blending Plant	Tetra ethyl lead--satisfactory control measures are practiced.	Blending plant employees, machinists, pipefitters, and laborers.
	Gasoline anti-oxidants--skin contact is unlikely in present mode of handling.	

Table II
(Continued)

Operation or Location	Substances or Conditions	Employee Group Affected
Wax Presses--Plate Repair Shop	Method of removing suspected carcinogenic material from plates before repair acts to prevent skin contact.	Plate shop personnel
Wax Presses--Refrigeration Unit	Paraffin Distillate, Foots Oil--no important exposures occur.	Process workers
Grease Manufacturing Plant	Dust of dry grease ingredients. Not significant by reason of low toxicity or infrequent occurence of exposures.	
Light Ends Plant and Gas Compressor Houses	Hydrogen sulfide is generally not a chronic toxic hazard at those places where it occurs in the process streams because of the degree of confinement and the ventilation of such places.	
Machine Shop	Metal spray and nitrogen oxides, safe by reason of infrequent use of toxic metals and outdoor location.	Machinists
Lead Melting Pot (portable)	Insignificant exposure by reason of low frequency.	1 Boilermaker helper.
General, at Process Units	Mercury, with reference to skin contact with liquid.	M. & I. workers
Underground Lead-sheathed conduits	Lead fumes. Infrequent occasion for fume evolution.	Electricians
General, in furnaces of process units and boiler houses.	Silica dust in furnace breakdown and repair.	Masons, Laborers
Underground Pipes where digging is required to locate leaks.	Heavy aromatics boiling above 700°F, skin contact.	Laborers--exposures are fairly well eliminated by present control practices.
Barges, repair of	Lead fumes from welding.	Welders
Tanks in Tetra Ethyl Lead Service	Tetra Ethyl Lead and residues.	Laborers
Refinery Lab.	Aniline. Mercury vapor.	Lab. personnel
Printing Standards	Volatile solvents and process liquids.	Machine operators

Table III

EXPOSURES CLASSIFIED AS SUSPICIOUS BUT ABOUT WHICH EXPOSURE AND/OR TOXICITY DATA ARE INCOMPLETE OR NON-EXISTENT. MEDICAL SUPERVISION INDICATED.

Operation or Location	Substances or Conditions	Employee Group Affected	Nature of Possible Effects
Paracril Plant	Acrylonitrile, in sampling at reactors.	Process men	Unknown
Chemical Products--Steam Cracking	Benzol in aromatic distillate.	Process workers at OLA-1 and OLA-2.	Upset of urine sulfate ratio in simple exposure cases; blood changes in cases of intoxication.
	Aromatic tars in Bottoms fractions, skin contact questionable.	Process workers; pipefitters assigned to the area.	Cancer (?)
Diolefin Extraction Unit	Benzol in aromatic distillate.	Process workers	See above description for benzol.
Butyl Rubber Finishing Building	Sublimation of PBN from extruders	About one-half of the workers in the finishing building.	Bladder tumors are caused by β-naphthylamine.
Iso-propyl alcohol plants	Skin contact or inhalation of suspected carcinogenic agents of unknown composition may occur.	Process workers and pipefitters in the iso-propyl alcohol plants.	Cancer (?)
Flare Stack at No. 2 D. & S.	Exposures to hydrogen sulfide from the base of the stack are uncertain by reason of variableness of output, winds, and work habits.	Process workers at new light ends plant and mechanical workers called occasionally to this area.	Irritation of eyes and respiratory tract.
Light Oil Treating Plant	Litharge--possible exposures at ground level to mist from aeration.	Process workers of the treating plant.	Increased lead in urine and blood after exposure.

Table III
(Continued)

Operation or Location	Substances or Conditions	Employee Group Affected	Nature of Possible Effects
Wax Presses	Wax, Paraffine Distillate, Foots Oil, Pressed Oil--as liquid or in the form of mists.	Lube and Paraffine employees, machinists, and pipefitters assigned to this area.	Cancer (?)
Wax Presses--Refrigeration Unit	Paraffine Distillate, a suspected carcinogen.	Machinists and pipefitters in repairing coolers.	Cancer(?)
Crude Scale Wax Sweaters	Crude scale wax and oil, possibly carcinogenic, depending on prior treatment of the stock.	Pipefitters.	Cancer(?)
Solvent de-waxing (MEK) Plant	Vapor of benzol, - occurs in low concentrations in working areas.	Process workers, machinists and pipefitters assigned to the unit.	Upset of urine sulfate ratio in simple exposure cases; blood changes in cases of intoxication.
Grease Manufacturing Plant	Inhalation of mists and skin contact with grease ingredients and products.	Grease Plant employees.	Unknown
Lube Oil Treating	Sulfur dioxide or sulfuric acid mist.	The problem of irritation may be critical in employees in agitator area having unusual pre-disposition.	Abnormal tooth decay; upper respiratory irritation.
Phenol Treating Plants	Phenol vapor	Workers at Phenol Plant, especially sample takers and pipefitters.	Unknown
Thermal Cracking Units	Oil mist and vapor, including clarified oil from catalytic cracking.	Sample takers and other process people, pipefitters assigned to the units.	Cancer (?)

EM001618

Table III
(Continued)

Operation or Location	Substances or Conditions	Employee Group Affected	Nature of Possible Effects
Steam Cracking Units in Petroleum Products	Aromatic distillate because of benzol content.	Sample takers and other process people, pipefitters assigned to the units.	The same signs of exposure and intoxication outlined for benzol previously.
	Aromatic tars and clarified oil from catalytic cracking.		Cancer (?)
Catalytic Cracking Units	Clarified Oil and slurry oil when encountered either as liquid or as mist at hot oil pumps.	Process people and mechanical crafts assigned to these units, especially pipefitters.	Cancer (?)
	Silica-alumina catalyst--dust inhalation, also entry into eyes.	Significant for pipefitters, welders, masons, and laborers.	Eye irritation; lung abnormalities (?)
Power and Boiler Houses	Noise	Full-time employees of these places.	Impairment of hearing
Barisol Plant	Carbon tetrachloride, ethylene dichloride.	Former process workers and pipefitters and machinists formerly assigned here.	Liver abnormalities
Machine Shop. Disassembly to re-assembly Shop	Aromatic tars and oils boiling above 700°F, spilled from undrained equipment and accumulating on the ground.	Machinists.	Cancer (?)
Pipe Shop in Petroleum Products Division	Lead fumes may be encountered in future work on bonded lead pipe.	Boilermakers, welders, and burners.	Increased lead in urine and blood as evidence of exposure.

Table III
(Continued)

Operation or Location	Substances or Conditions	Employee Group Affected	Nature of Possible Effects
Lead Burners Shops at No. 3 Acid Plant and in Chemical Products Area	Lead fumes, especially from bonding.	Lead burners and helpers.	Increased lead in urine and blood as evidence of exposure.
Main Electric Shop	Varsol and Xylenes	Shop electricians	Irritation of eyes and nose, nervous and digestive disorders.
General, throughout refinery	Solvent vapors from cements for insulating materials.	Insulators.	
Disposal Dump	Oil smoke, fumes, and mist. (Heavy aromatic wastes)	Laborers	Cancer (?)
Bubble Towers throughout refinery	Hydrocarbons from gas oil to heavy tar. Skin contact.	Laborers	Skin effects. Cancer (?)
Tube Cleaning, general	Coke dust	Laborers	Respiratory disorders
Vertical Soaking Drums at Thermal Cracking Units	Skin contact with tar and coke from thermal cracking.	Laborers	Skin effects. Cancer (?)
Condenser Boxes at Thermal Cracking Units	Skin contact with tar.	Laborers	Skin effects. Cancer (?)
Paint Shop	Inhalation of benzol in use of paint remover. Frequency is unknown.	Painters	Upset urine sulfate ratio in simple exposure cases.
General	Benzol occurring in other paint products.	Painters	Upset urine sulfate ratio in simple exposure cases.
Asphalt Processing	Mists and vapors	Asphalt workers	Cancer (?)

Table IV

EXPOSURES OF LOW INTENSITY TO MATERIALS OF A LOW ORDER OF TOXICITY

Operation or Location	Substances or Conditions	Employee Group Affected
Paracril Plant	Butadiene vapor	Process and mechanical.
Butadiene Extraction Unit	Mono- and di-olefins	Process and mechanical.
Isoprene Extraction Unit	Butylenes	
Diolefin Extraction Unit	Acetone	
Butyl Rubber Plants	Zinc sulfate, stearic acid, and zinc stearate.	Process workers in reactor group.
Alcohol Plants	Hydrocarbon feed stocks and low-molecular weight products and by-products.	Process and mechanical.
Light Oil Treating Plant	Petro Green D Dye.	Treating Plant porters.
Tetra Ethyl Lead Blending Plant	Petroleum dyes	Blending Plant workers.
Propane de-waxing, de-oiling, de-asphalting.	Propane	
Wax Filter Plant	Bauxite	
Lube Filter Building	Dust of Attapulgus clay.	
Specialty Stills (1929 Plant)	Petroleum vapors	
Generally, throughout refinery.	Welding fumes	Welders and burners
Generally, throughout refinery.	Fumes from burning coke deposits. Good ventilation is provided.	Welders

TABLE IV
(Continued)

Operation or Location	Substances or Conditions	Employee Group Affected
Catalytic Cracking Unit	Asbestos	Placed in this table with reference to exposures at turnaround for welders, masons, laborers.
M. & I. Shops	Varsol vapor	
UOP Poly Plant	Hi Sil Dust	Laborers
Railroad Car Unloading	Brick Dust	Laborers
Bricklaying sites	Brick Dust	Masons

Table V

RECOMMENDATIONS FOR MECHANICAL IMPROVEMENT OF CONDITIONS

Operation or Location	Substances or Conditions	Remarks	Type of Mechanical Remedy Applicable
Paracril Plant	Acrylonitrile vapor		Improved hood over coagulation pot.
Butyl Rubber Plant	PBN	Inhalation of dust during preparation of solution.	Dust respirator on exposed worker.
Butyl Rubber Finishing Building	Talc dust.	At packaging of finished product.	Improved hoods to capture dust at scales.
Catalyst Plant	Dust of chromic oxide and a variety of other materials.	Multiple dust sources throughout the building.	An extensive exhaust ventilation system for the plant.
Tetra Ethyl Lead Blending Plant.	Gasoline dyes.	Dusty for short periods during preparation of solution.	Use of respirator by the one person who shovels dry dye.
Grease Manufacturing Plant	Mist of grease ingredients and products.		Improved hoods over heating, saponification, and mixing kettles.
Lube Oil Blending	PX 441	Disagreeable odors and mist at solution preparation.	Exhaust hood.
Machinists' αD Pump Sh Disassembly and Reassembly Shop	Liquid material spilled from pumps, etc., some of which may be carcinogenic		Installation of floor drain beneath disassembly location.
M. & I. Shops	Spilled mercury	Exposure not hazardous at present. Chance for future accumulation.	Improved floor surfaces to facilitate cleaning.
Main Electric Shop & 9	~~Varsol and~~ Xylol vapors Steam Oakite		Exhaust hood for spraying.

Table V
(Continued)

Operation or Location	Substances or Conditions	Remarks	Type of Mechanical Remedy Applicable
Sandblast Sheds	Silica dust.	For protection of sandblast helpers and others in vicinity.	Confinement of silica dust.
Paint Shop	Paint removers likely to contain benzol.		Exhaust booth.
Pipe Shop, Chemical Products Area	Metal fumes.	Welding non-ferrous alloy pipes.	Local exhaust system.
Catalytic Cracking Units	Catalyst	With reference to welders' work at turnaround.	Respirator should be worn beneath welder's hood.
Lead Burners Shops; at No. 3 Acid Plant and in Chemical Products Area	Lead fumes	General room ventilation does not effect dilution of fumes between torch and burner's nose.	Local exhaust system.
Refinery Laboratory: Gas Analysis Room	Mercury vapor		Improve floor surface to facilitate cleaning.
Old Boiler Shop	Fumes from pre-heating Hastelloy D tubes.	Question of nickel carbonyl formation.	Extension of hood over furnace.

PROCESS WORKERS

CHEMICAL PRODUCTS DIVISION

CRACKING DEPARTMENT

Paracril Plant.

The principal process involved here is the polymerization of butadiene and acrylonitrile. Other substances besides the reactants are:

Daxad 11
PX 441 (di-tertiary-butyl-para-cresol)
Caustic soda
Acetic acid
Lorol mercaptan
Hydroxylamine hydrochloride
Candellila wax
Superloid

Number of Employees and Their Principal Stations. In the finishing building, three or four men per shift spend most of their time at the station alongside the drying oven. One or two men are active at the conveyor line where rubber enters the drying oven. Three or four men are engaged fairly steadily at the packaging end of the conveyor. One man intermittently tends the control panel behind the coagulation pot. It is estimated that he is in this locality approximately half of the time.

Reactor Control Room. One man per shift works here fairly steadily.

Control Room Over Strippers. One man works here full-time per shift. In addition to the above locations, there is intermittent attendance by the personnel already mentioned to the reactors, pumps, refrigeration unit, feed drums, storage shed, etc.

Exposures Incident to Normal Operation. Attention was directed principally to the possibility of inhalation of vapors of acrylonitrile. This was done for two reasons: First, the probable toxicity of acrylonitrile to man, as indicated by animal experiments, is greater than with other materials present in this plant; secondly, the properties and the quantities of acrylonitrile, and the conditions of its use in the process, indicate a greater chance for absorption of this substance by the men than for the other substances used.

Appreciable concentrations of acrylonitrile are most likely in the vicinity of the coagulation pot in the finishing building, because at this point the product and reactants first reach an unenclosed vessel. An exhaust hood stands several feet over the top of the pot.

Measurements of acrylonitrile vapor on the platform near the control panel showed 90-180 parts per million in samples collected over a period of several hours on two different days.

Samples collected in the following locations showed negligible or trace amounts of acrylonitrile vapor in air:

(1) control room at reactors

(2) control room over strippers

(3) entrance end of drying oven in finishing building

(4) operator's desk in finishing building

Concentrations at other outdoor locations, such as the vicinity of recycle pumps, charge pumps, knock-out drums for compressors, and charge drums would also be expected to be negligibly low. The question of the possibility of fairly high exposures at repeated intervals in the act of sampling the reaction mixture for completeness remains open. Sampling commences at the reactors about four to five hours after the start of reaction and continues thereafter for the duration of the reaction. Samples are taken with increasing frequency until the rate of once every 20 minutes is reached. We obtained an estimate of an average frequency of approximately once an hour. There is undoubtedly some vapor exposure at sampling, as evidenced by the strong odor in the vicinity of the sampling lines.

Information is lacking on the effects of prolonged or repeated inhalation of acrylonitrile in known concentration ranges by man. The published maximum allowable concentration for this substance is 20 parts per million. This figure was arrived at after animal experimentation by the U. S. Public Health Service. Guinea pigs and other species showed kidney damage. An observation was made that the action of acrylonitrile resembled that of inorganic cyanides for which 20 p.p.m. had previously been accepted as the limit.

We conclude from our observations at this plant that there is some possibility of chronic intoxication from prolonged work in the vicinity of the latex and coagulation pots. Extension of the exhaust hood face to the level of the top of the pot would effectively reduce acrylonitrile concentrations on the working platform. Close medical supervision of men working in this area is advisable.

Steam Cracking Plants, No. 1 and No. 2.

Materials and Processes. Gas oil is cracked in the presence of steam to produce ethylene, propylene, butadiene, an aromatic distillate containing isoprene, aromatic tar, heavy fuel oil, gas oil, and some residual gas. A clay treating plant at OLA-2 removes a gummy polymer from the aromatic distillate.

Exposures. In the routine operation of these units, exposures to inhalation of vapor are infrequent. The men spend most of their time in and around the control houses which are isolated from process materials. The necessity for collecting samples, making valve adjustments, inspecting equipment, and making changes in operation takes the men to areas where vapors may occur. This process equipment is out-of-doors. Time spent in such areas is of short duration. Vapor exposures are of short duration and infrequent.

Skin contact with the process material does not occur in normal operation. Unusual events may cause spills and leaks necessitating contact, principally with the hands and feet.

Significance of Exposures. The aromatic distillate is important toxicologically because it contains benzene, toluene, and xylene to the extent of approximately 29 volume per cent. Another 12 per cent of the fraction consists of aromatics boiling between 302°F. and approximately 450°F. It is impossible to obtain a knowledge of concentrations of these substances in air which may be encountered in those infrequent occasions when exposures occur because of their transitory nature. Since benzene is the most toxic and most volatile compound in this group, evaluation of exposures to it is of paramount importance. Evaluation under the supervision of the medical department, on the basis of urine sulfate ratio determinations for the group of process people most likely to be exposed is recommended. A discussion of this evaluating technique occurs in the appendix.

The aromatic tars produced at these units are included in the program for control of suspected carcinogenic materials. Pumps, vessels, and lines containing the tars have been labeled and precautions have been put in force. Contact with these tars by process people is infrequent, according to our observation of normal processing activity.

Butadiene Extraction Plants.

Materials and Processes. A product stream from steam cracking containing C_4 mono and diolefins goes to butadiene extraction units 1 and 2 for removal of butadiene. The process includes the preparation of cuprous ammonium acetate, its reaction with the hydrocarbons, and the subsequent separation of butadiene. One ammonia refrigeration unit serves the two extraction plants.

Tertiary butyl catechol is added to butadiene as it goes to storage in the following manner: The inhibitor is removed from the can or fiber drum in which it is received; it is melted in a pressure drum, dissolved in butadiene to make a concentrated solution, and is then metered into the butadiene on its way to storage. A control house for the extraction plant is isolated, materials of great toxicity are not present, and exposures of men by skin contact or inhalation are not frequent in normal operation.

Isobutylene Extraction Units Nos. 1, 2, and 3.

Materials and Process. Butylene streams from the petroleum products division and from the butadiene extraction units undergo sulfuric acid extraction. Isobutylene and butylene are the products.

Exposures. Prolonged vapor exposures do not occur in the normal operation of this plant.

Significance of Exposures. The feed stock and products are simple asphyxiants and anesthetics. Very high concentrations for a prolonged period would be necessary for the anesthetic effect to be noticed. Health hazards at these plants consist only of the accident hazard connected with the handling of sulfuric acid. Extensive precautions are taken.

Diolefin Extraction Unit.

Aromatic distillate disc.ssed under the heading "cracking plant" is treated at this unit for the removal of isoprene. It will be recalled that in this stream, benzene, toluene, and xylene make up a fraction amounting to 29 volume per cent of the total. Opportunities for exposure are approximately the same as at the cracking plant. Similar medical control is recommended for the men who work here. Vapor concentrations in the air at breathing level of workers at the unit are too transitory to permit appraisal of the hazard on the basis of

BUTYL RUBBER UNITS

There are three similar polymerization units, two of which are operating. One finishing building is in operation.

Materials and Process. Isobutylene and isoprene are polymerized to form butyl rubber. Aluminum chloride is used as a catalyst. Spent catalyst is hydrolized, neutralized, and discarded (2,000 pounds of aluminum chloride are received and used every 10 days).

Methyl chloride: This solvent finds large scale use as a carrier for the reactants and as a solvent for the catalyst. Methyl chloride is stripped from the polymer slurry, purified, and reused. (Loss of methyl chloride is in the range of 12,000 to 15,000 pounds per day. Of this amount, 4,000 pounds represents the unaccounted-for loss.)

Caustic solution: Caustic is used in neutralization of hydrochloric acid.

Zinc stearate: Zinc stearate is formed at the plant from stearic acid, zinc sulfate, and caustic. Its production is on a small scale, amounting to six batches in a 24-hour period. Zinc stearate for both polymerization units is formed in one location.

Phenyl-beta-naphthylamine is added as an inhibitor. It is received as a dry powder and about six times a day, a solution containing six shovelfuls of powder is prepared. Its use amounts to about 180 pounds a day.

Xylyl mercaptan is used as a plasticizer. It is made up in kerosene solution and is added to the rubber at the extruders in the finishing building.

Talc is dusted onto the finished product prior to packaging.

Exposures.

1. Control houses for the two polymerization units are isolated from the process units. The 12 men per shift who control the polymer units spend the greater part of the time in and around the control houses. They are, therefore, isolated from exposures to vapors escaping from the units. Instruments in the control house are of the receiver type except for the spectrophotometer room in each house, which has stream lines bringing small amounts of the volatile reaction mixture into the instruments. These rooms are well-ventilated by both exhaust and supplied air systems.

2. Manufacture of zinc stearate. This batch-wise process is performed twice a day by one man. Technical stearic acid and zinc sulfate are added by shovel to a reactor. Stearic acid is non-toxic and non-dusty. The technical grade contains other fatty acids as impurities. They are likewise non-toxic. Zinc sulfate is a material of low toxicity. The actual time spent in moving it to a reactor is so short that,even if dust arose, exposure time would be practically negligible.

3. Preparation of PBN solution. Twice per shift one man moves six shovelfuls of the powder into a solution drum. It might be expected that in so doing there would be some contact between the material and the skin, and that he might inhale some dust. PBN itself has not caused any acute toxic effects at this installation. The possibility that one or more of its cancer-forming homologues might be present as an impurity is sufficient to make advisable the use of a respirator during the time the material is being transferred.

4. Preparation of aluminum chloride solution. This irritating and dusty operation, for which a respirator is worn, is performed by one man in about 10 minutes every third day. Handling this material is a nuisance, but not a health hazard.

5. Supervision of reactor performance requires periodic visits several times per shift on the part of the process men to the pump and reactor areas. The pump areas have roofs, but no side walls. The reactors were formerly enclosed in a building. These buildings have had a section of the side walls removed for increased ventilation. At the time when we were searching for areas of possible high methyl chloride concentrations, there was great air movement through these reactor buildings, which precluded the possibility of accumulation of high concentrations.

6. Finishing building.

(a) Attendants at Oliver filters and vibrating screens: This is the location where one would expect most intimate association of men with the vapor of methyl chloride. Vapor concentrations are controlled by proper vacuum on strippers preceding this step in the process, and by exhaust ventilation over each filter and screen. Two men per shift spend part of their time at a distance of about 30 feet from the line of filters and screens. Occasionally each day, men mount the platform at each of the units. Routine spot checks by the chemical products laboratory and our own analysis of the samples collected over one and one-half hour periods showed less than 10 p.p.m. in the immediate area of screens and filters.

We are satisfied that the efforts which were made to control methyl chloride vapors, after the poisoning cases of 1943-44, are effectively operating today.

(b) Tunnel dryers. These are exhausted and vapors discharged outside the building. In our experience, men are seldom close to the dryers.

(c) Extruders and milling machines. There is full-time attendance by several men at these machines. Visible atmospheric contamination probably consists of water vapor, oil mist, PBN fumes, and possibly kerosene and xylyl mercaptan.

A deposit of scum was observed on the overhead roof structures in this vicinity, representing the accumulation since the plant was put in operation. Examination of the scum by the chemical products laboratory showed it to consist essentially of phenyl beta-naphthylamine. To obtain an estimate of the amount that might be put into the air by sublimation from the extruders in the course of a day, we learned that 180 pounds per day are used. Of this amount, the major portion leaves the product in water drainage to the sewer from water-rubber slurry and by separation of fine particles for subsequent burning. The loss by sublimation is considered by the process heads to be minor, probably less than 1 per cent of the amount added, or 1.8 pounds per day--equivalent to 500-700 milligrams per minute. Considering the vastness of the room, the exhaust ventilation at some points of escape, and the convection currents from the hot machinery and materials that would tend to remove sublimed material from the breathing zone of workers, it is difficult to believe that vapor exposures are significant. Yet the demonstrated carcinogenicity of several aromatic amines closely related in structure and physical properties to phenyl-beta-naphthylamine, specifically B-naphthylamine, and the possibility that some of these may occur as impurities in the commercial product, make it advisable that this situation be carefully evaluated. In medical examination of workers from this section, particular attention should be directed to detection of cancerous or pre-cancerous manifestations of bladder abnormalities, until it is finally clear that no such hazard exists.

(d) Talc dusting and rubber packaging. About five men work full time on the packaging line. There is a dust exposure on the part of the men who remove slabs of rubber from the conveyer to the paper cartons. Concentrations were found to be in the range of 9 to 16 million particles per cubic foot. Hoods provided for this job are ineffective because of their size and contour; for example, each man must weigh each package as it is filled. The scale is not enclosed in the hood. He must frequently add a piece of rubber to the package on the scale. Talc dust is dispelled into the air by this operation and is not captured in the exhaust line. The results of dust counts from samples collected at the breathing level of each of the packagers are tabulated in the Table.

Table 1

DUST CONCENTRATION--TALC DUST IN BUTYL RUBBER FINISHING BUILDING

Sample Designation	Elapsed Time	Sampling Location	Concentration Million particles per cubic foot
63	8 min.	At breathing zone of 3rd packer in line of 3, packing at normal rate.	16
64	5 min.	At breathing zone of 2nd packer in line of 3, packing at normal rate.	12
65	6 min.	At breathing zone of 1st packer in line of 3, packing at normal rate.	8.6
66	4 min.	At breathing zone of man dusting cut slabs of rubber for re-run through extruder, dusting by means of broom dipped in dust. There are 4 men working together, dusting and sawing slabs of rubber. This is about 60 feet from the talc dusting machine.	8.5
67	5 min.	General air sample throughout the area described in 66.	2.6

It is probable that concentrations of talc dust which were found in this locality constitute only a nuisance. It is true that there have been reports of pneumoconiosis from inhalation of dust in talc mining and milling, but concentrations responsible for these occurrences were in a much higher range than those we found. Some state codes require that concentrations of talc dust be kept below 15 m.p.c.f. Elimination of the nuisance by improvement in ventilation

(e) Utility men. Several men work at such jobs as preparing stock for re-run. They are frequently in the immediate vicinity of the talc dusting and milling machines.

(f) Miscellaneous groups of supervisors, physical and chemical testing men, etc., work at various places around the west end of the finishing building. Their exposures to dust, mist, and vapors would be infrequent and of short duration because most of their time is spent in areas remote from the processes.

ALCOHOL PLANTS

Complete protection of the health of workers in the production of ethyl and propyl alcohol requires that three separate and distinct problems be recognized, evaluated, and controlled.

Accident Hazard. The first of these is an obvious accident hazard connected with the use and handling of large quantities of sulfuric acid. This problem is well understood at the plant. Effective controls are practiced. They consist of provision of protective clothing, safety showers, and certain mechanical features of process units.

Blending Agents. The second problem is connected with the use of certain toxic materials as blending agents and denaturants. Acetaldehyde is the principal denaturant for ethyl alcohol produced at this plant.

It is irritating to the mucous membranes when inhaled as a vapor and, for this reason, will not be tolerated by men for periods long enough to give any evidence of systemic damage.

Denaturing with acetaldehyde takes place in a building under government supervision. We did not see the denaturing process during the course of our [illegible], as it is not continuous. We [illegible] for use in the building, which has only natural ventilation. We believe that use of respirators is sufficient precaution against inhalation of acetaldehyde vapor.

Methyl alcohol is used occasionally as the denaturant for ethyl alcohol and is used quite frequently as a blending agent with iso-propyl alcohol in manufacture of antifreeze.

Continued exposure to vapors of methyl alcohol may lead to chronic poisoning which is characterized by irritation of the mucous membranes, possibly leading to bronchitis and pulmonary affections which may be associated with headache, tinnitus, tremors, local and multiple neuritides, and more or less severe visual disturbances (Flury and Zernik, 1931).

The toxicity of methyl alcohol is well-respected in this plant. We saw the precautions which are provided at the blending site and at the loading racks. Most of the work connected with blending and loading of methyl alcohol takes place out-of-doors. The possibility of prolonged inhalation of significant concentrations of methyl alcohol is remote.

The hydrocarbon feed stock for both alcohol plants and the principal products of these plants are toxicologically in the class of narcotics. Inhalation of concentrations necessary for narcotic action does not occur. There is no evidence of systemic poisoning from ethylene and propylene or from the alcohols and ethers which are derived from them.

Carcinogenic Problem. The third problem at these plants is one which has risen in the Bayway alcohol plant and in the plant of one other company manufacturing iso-propyl alcohol from propylene. Statistical studies have revealed an abnormally high incidence of cancer among men who have worked in these plants for more than ten years. Cancers of larynx, pharynx, and nasal sinuses have occurred. The locations of these lesions suggest that there might be some air-borne material responsible for the occurrences. Investigations are under way in this company and in one other company to determine, if possible, what substances in the occupational environment may be the carcinogenic agents responsible for these lesions. Without going into details of these research programs, it will suffice to mention that the possibility of air-borne nickel carbonyl having its origin in some of the nickel alloys in the process equipment is being investigated. Another path of the investigation leads to an attempt to identify certain poly-cyclic hydrocarbons which are known as carcinogenic agents in the by-products of the action of sulfuric acid on propylene. The current problem at the Baton Rouge alcohol plant is to determine, if possible, whether the same conditions which give rise to atmospheric contaminants in the working environment at the Bayway alcohol plant exist at Baton Rouge. Several notable differences are readily apparent. For example, the propylene stream coming to the Baton Rouge alcohol plant is much purer than the stream processed at Bayway, at present and in the past. Secondly, a lower concentration of sulfuric acid is used at Baton Rouge. This results in a lesser amount of high molecular weight side products. Thirdly, the physical arrangements of the plant at Baton Rouge, which is a new modern plant incorporating all improvements in design up to seven years ago, are completely different from Bayway's plant. The matter of the enclosure of process equipment is the most striking difference. Whereas at Baton Rouge we find a minimum of enclosure, Bayway has all processing equipment following the hydrolysis step indoors. At Bayway, the control rooms and stations for performing tests on product and reactants are in much closer proximity to stripping stills than at Baton Rouge. Maintenance at Baton Rouge is more successful in keeping the process materials in closed systems because of the newness and improved quality of the equipment.

These remarks serve only to illustrate the kind of differences that might be significant in the final determination of whether two plants have a common problem.

If, indeed, the cancer problem at Bayway has an occupational origin, the conditions which permitted its occurrence may have existed in the earlier years of alcohol operations at Bayway, and changes in equipment and process material over the years may have eliminated the causative factors. Occupational cancer more frequently than not requires a long period of time to reach the stage where it is recognized clinically. Even if there are conditions at Baton Rouge favorable to the development of cancer, it cannot be expected to be recognized clinically at this time. Investigation now for possible causative factors is aimed at the prevention of illness in future years. Success, even if completely attained, will not be known.

On the basis of our observations at both Bayway and Baton Rouge, we can suggest that certain steps be taken:

First, that investigation of alloys in use at the plant, their products of corrosion, and the possibility of air-borne nickel carbonyl be carried on simultaneously at Baton Rouge.

Second, we recommend that close attention be paid to the manner of drawing samples at the various sampling locations at the alcohol plants. Because of the frequency of drawing samples and the obvious splashing that occurs, we consider the sampling act to be one of the most important sources of contact between operating personnel and the materials that are being processed. High temperatures and obvious splashing suggest the existence of mist and vapors at the sampling locations.

Third, frequent physical examinations of all the employees at the alcohol plants and selective placement of men are essential. What is apparently a localized site of attack suggests that persons with upper respiratory affections and chronic sinusitis are unacceptable for work at the alcohol plants.

The fourth suggestion is that the medical department establish close cancer problem would have been greatly facilitated had the medical department, upon becoming cognizant of the problem, had recourse to a log of process and equipment changes over the course of the years. At Baton Rouge, it is still early enough to establish a system whereby all important changes which might have a bearing on future health problems can be made available for joint study by the medical department and the process heads.

CATALYST PLANT

This plant is engaged in the batchwise production of a variety of solid, granulated, powdered, and pellet products for catalysis of reactions carried out in several refineries. The type of product depends upon current demand. Production of a specific catalyst may last for several days, several weeks, or several months. About a dozen men are employed in the plant.

A list of chemicals and other raw materials used at the catalyst plant during the last five years appears as Table 2, below. A brief discussion of the toxicity of several of these compounds follows.

Toxicity of Some Chemicals Used in the Catalyst Plant.

Molybdenum Trioxide, powder: Ingestion, injection, and inhalation experiments have indicated that acute toxicity of molybdenum compounds, including molybdic oxide, is appreciable, but fairly low. Its toxicology in industrial use has not been sufficiently well studied to warrant an assumption that it is non-hazardous. Uncontrolled dustiness of this compound should not be permitted.

Tungstic Acid: Ingestion and injection experiments with animals have led to the conclusion that this metal is more toxic than molybdenum. Toxicological data from industrial dust exposures to tungsten compounds is lacking. Uncontrolled dust exposures should be avoided on the basis of uncertainty of effects.

Table 2

CHEMICALS AND OTHER RAW MATERIALS USED AT
CATALYST PLANT DURING LAST FIVE YEARS

Material	Approximate Weight of Materials Used
Activated Alumina, 2-4 Mesh	1,500,000 Lbs.
Iron Oxide, Powder	400,000 Lbs.
Chromic Acid, Flakes	30,000 Lbs.
Chromium Nitrate, 50 Percent Concentration	50,000 Lbs.
Activated Carbon, Pellets	100,000 Lbs.
Molybdenum Trioxide, Powder	200,000 Lbs.
Superfiltrol Clay	100,000 Lbs.
Ball Clay	60,000 Lbs.
Nickel Nitrate, Crystals	80,000 Lbs.
Nickel Carbonate, Powder	20,000 Lbs.
Tungstic Acid	100,000 Lbs.
Hydrofluoric Acid, 60 Percent	15,000 Lbs.
Magnesium Oxide	15,000 Lbs.
Phosphoric Acid, 85 Percent	15,000 Lbs.
Cobalt Sulphate, Crystals	80,000 Lbs.
Naphthenic Acids	130,000 Lbs.
Nickel Sulphate, Crystals	150,000 Lbs.
Anhydrous Ammonia	50,000 Lbs.
Sulphuric Acid, 98 Percent	75,000 Lbs.
Sodium Hydrosulphide, 45 Percent Solution	450,000 Lbs.
Potassium Fluoride, Crystals	500 Lbs.
Caustic Soda, 100 Percent NaOH	25,000 Lbs.
Copper Nitrate, Crystals	7,500 Lbs.

Nickel Salts: Animal experiments have shown definite toxicity of nickel salts. They cause inhibition of growth of young animals, changes in the pancreas, effects on the respiratory and cardiac nerve centers, and liver and kidney damage. On the basis of minimum lethal doses in injection experiments, nickel is about 50 per cent more toxic than cobalt.

Cobalt sulphate: Cobalt salts are recognized as skin irritants. Toxic manifestations following ingestion include abnormalities in the blood-forming organs. Effects of prolonged exposure to cobalt dusts free from other toxic metals have not been sufficiently well studied to be understood. No per-

<u>Chromic Acid</u>: Dermatitis, chrome ulcers, and perforation of the nasal septum have long been recognized as being incident to exposures to hexavalent chromium compounds. Recently, a high incidence of lung cancer was discovered among workers in a plant manufacturing these compounds. Exposures for prolonged periods to low concentrations of dust and short-time exposures to high concentrations are to be scrupulously avoided. The maximum allowable concentration on the basis of injury to the nasal tissues has been established at 0.1 milligram per cubic meter of air.

There is good evidence in the recent occurrence of nosebleed among several employees that the catalyst plant is in need of effective dust control equipment. At the time of the nosebleeds, the plant was engaged in the production of a converter catalyst from chromic acid flakes and iron oxide powder. The principal dust sources are the dry grinding and mixing vessel on the third floor, the ball mill in which imperfect pellets are ground for re-extrusion, and the various operations of drying and screening the pellets. In the case of the chromic acid, the irritant effects became apparent in a matter of a few weeks after the production of this catalyst was begun.

Effects of inhalation of dust of other chemicals over a period of a few weeks or a few months may not always be so apparent as in the case of the chromic acid. More subtle effects could go undetected until serious illness and disability resulted.

Additional evidence of the need for a permanent exhaust ventilation system for dust control is the amount of settled dust on overhead structures throughout the building. The present use of propeller fans in wall installations is ineffective. The use of respirators is impractical because of the discomfort associated with continued wearing through the often prolonged cycle of a dust-producing operation.

Skin Contact. Irritation of the skin of workers by chemicals used in this plant has occurred in the past. Effective dust control will greatly reduce the amount of skin contact with these materials. At the present time, skin contact occurs even in the locker room used by these workers because of the invasion of dust into all quarters of the building. The use of protective gloves and jackets is effective in preventing skin contact while actually transporting materials.

PETROLEUM PRODUCTS DIVISION

REFINING AND OIL MOVEMENT

Distillation.

This department operates pipe stills and two shell still batteries; 96 men are employed in crude distillation and some 68 on re-run. There is no indication of any potential health hazard in the routine operation of refinery pipe stills.

Attention was drawn to the possibility of petroleum vapor or hydrogen sulfide exposure on the part of the operators of Still Batteries No. 16 and No. 17. Three or four men per shift operate each of these batteries. At these locations, product streams flow through the still house which is the principal station of the operating personnel. Look boxes are provided for each stream. There is a possibility of leakage of vapors from the look boxes or their lines. On two occasions, we were unable to detect the presence of petroleum vapor with a sensitive combustible gas indicator. Details of these tests are given in the following Table.

Table 3

PETROLEUM VAPOR MEASUREMENTS IN NO. 16 AND NO. 17 BATTERY STILL HOUSES

Date	Location and Operations	Concentration (p.p.m.)
4/6/49	No. 17 Battery Still House. No. 1 system charging after turnaround; No. 2 system running crude; No. 3 system running mixed gas oil. Several measurements made.	Less than 10
4/6/49	No. 16 Battery Still House. No. 1 system running mixed gas oil from separators. No. 2 and No. 4 systems handling low octane distillate feed; No. 3 system running heating oil. Tests made at 6 locations among the look boxes.	0 - 10

Plans are underway and work has already started on providing an enclosure for operating personnel separate from the location of the look boxes. Side walls will be removed from the present enclosures. This is in keeping with the general tendency to open up buildings where there are sources of leaks from process equipment. Other examples are various pump rooms that have been opened up and some gas compressor houses from which the side walls have been removed. In the case of No. 16 and No. 17 Battery Still Houses, execution of these plans should result in complete elimination of any potential health or safety hazards from vapor or hydrogen sulfide.

No. 2 D. & S. and Hydrogen Sulfide Recovery Unit.

These two units are under the direction of the same operators. Hydrogen sulfide comes to the recovery unit from various sources. From this unit, tri-potassium phosphate solution is pumped to No. 3 D. & S., operated by the Light Ends Department, for use there in scrubbing gas.

The hydrogen sulfide-laden solution is sent back to the recovery plant for regeneration. There is no pump handling the spent solution, therefore, leakage at pumps does not put hydrogen sulfide into the air. This scrubbing unit is exceptionally tight. No odor of hydrogen sulfide was detected.

At the base of the flare stack, there is a water seal drum to prevent flash back. Under the operating conditions that we saw, there is some spillage and leakage from this water-seal drum, permitting an appreciable escape of hydrogen sulfide at ground level. This was formerly in an isolated area, but now the new Light Ends Plant stands in close proximity to the source of leakage. A high local concentration of hydrogen sulfide seems possible under weather conditions producing little air movement. We consider this the most important potential site in the refinery for acute accidental or chronic exposure to hydrogen sulfide gas. Accidental exposure to high concentrations might be suffered by persons entering the immediate vicinity of the flare stack base to perform mechanical work. Sub-acute effects, such as conjunctivitis or upper respiratory irritation might be suffered by process people constantly in the nearby Light Ends Plant.

Oil Movement.

Oil Movement has control of pumps, gauges, pipe lines, storage tanks, barge loading, car loading, lead tetra-ethyl blending, use of inhibitors, and dyes.

Tetra-ethyl lead blending. This operation is performed under safe practice rules, prescribed by the suppliers of tetra-ethyl lead. Medical control by the refinery Medical Department is rigid. Protective equipment and clothing, as well as facilities for personal sanitation, are provided the employees. Two men are employed per shift. Aside from the normal routine of blending lead tetra-ethyl into gasoline, there are periodic calls for cleaning of tanks, pumps, and pipe lines. These jobs are done under the supervision of the suppliers' safety people. Equipment is routinely flushed with lead-free gasoline before it is turned over to the mechanical department. We know of no additional precautions or changes in procedure that are necessary in the handling of tetra-ethyl lead.

Addition of Dye to Finished Gasoline. Two men work on each shift. A dye solution is prepared from the dry dye about three times in 24 hours. The dye is removed from the drum in which it is received by means of a scoop. It is weighed and scooped into the solution drum. It is a dusty job, as shown by the deposit of dye on all structures in the room. Infrequency and short duration of the dust-producing job suggests the use of dust respirators for the prevention of dust inhalation. Prevention of inhalation is desirable, since the exact effects of such inhalation, where a variety of dye materials are used, are difficult to predict.

<u>Addition of Inhibitor to Finished Gasoline</u>. The inhibitors that are currently in use are UOP-5 and DuPont-5. Inhibitor is drawn by vacuum from the drum in which it is received into mixing and metering drums and from there is bled into the streams. This procedure offers only the remotest chance for a man to come in direct contact with the inhibitor.

<u>Light Oil Treating</u>. This includes acid and alkali treating, calcium hypochlorite treating, and doctor sweetening. Of these processes, only the doctor sweetening involves the use of materials or processes that are of interest from the standpoint of employee-health.

<u>Litharge Handling</u>. Fresh litharge is added to regenerated doctor solution by dumping directly from drums into the open regenerator tanks. The size of the tank and the location of the platform and crane prevent free movement to the windward side while dumping. Respirators are worn by men doing the dumping for the prevention of inhalation of fine lead dust. All litharge dumping is done by two porters on "A" shift, with a frequency somewhat less than once a day. These men are on the Medical Department's schedule for twice-yearly examination.

Doctor solution regenerator tanks are in a crowded area in this refinery, differing in this respect from the situation at Aruba. With the thought that employees in the treating plant, other than those who actually dump litharge may be exposed to toxic amounts of lead as dust or as a mist from tanks being aerated for doctor regeneration, we sought to learn the concentration of lead in the mist escaping at the top of the tank. The opportunity to make such measurements presented itself at Sarnia. The results showed that two samples of air, collected in the heaviest concentration of mist at the tank top on the downwind side during aeration following litharge addition, contained 0.17 and 0.27 milligrams of lead per cubic meter, respectively. If we consider lead in a range of 0.1 to 0:5 milligrams per cubic meter to be present at the tank top, we may safely assume that, with dilution occurring before it reaches ground level, and with variation in wind direction, that no men are constantly exposed to concentrations of lead likely to produce symptoms of lead poisoning.

The validity of this assumption might be tested by performing urinary lead determinations for the group of exposed persons. Such measurements will serve to indicate, far better than atmospheric sampling and analysis at this outdoor location,-whether lead absorption is occurring in these individuals.

Addition of Dye to Tractor Fuel. The treating of tractor fuel includes the addition of a dye known as Petro Green D Dye, which is a product of Patent Chemicals Company, Patterson, New Jersey. The same two porters who handle litharge and doctor sweetening occasionally make up two-pound packages from the bulk dye in drums. A lack of dye deposit on the floor and structural members of the room in which this packaging is performed indicates a low order of dustiness in the performance of the job.

LUBRICATING AND PARAFFINE DEPARTMENT

Wax Presses.

The fact that there is a statistically significant high incidence of cancer among wax press cleaners was demonstrated in another refinery. Cases of scrotal cancer have been discovered among the press cleaners at Baton Rouge. Investigations are now underway by the company to identify a specific carcinogenic agent or agents in the material which enters the presses. Immediate steps were taken to prevent any further contact with the material that may be responsible for the pathologic changes in the men.

The first step was logically to prevent the obvious contact between the skin of the pressmen and machinery or implements on which there was a deposit of paraffine distillate, paraffine wax, or foots oil. One particular zone of contact to which attention was directed is the anterior surface of the thighs and the pubic region. This was based on the observations that pressmen sometimes lean forward against a waist-high, horizontal bar that runs the length of each press on both sides, and that some of the cancers occurred on the scrotum.

To prevent such contact, all press cleaners are now provided with clean work clothes and aprons for each shift and are required to take a shower daily before leaving the plant. These precautions are effective in preventing this particular type of contact. A shower room for press men is conveniently located and maintained in a sanitary condition.

Other skin contacts with wax and pressed oil must have taken place in past years, in the cellars where press cleaners go daily to clean the floors, remove sawdust, etc. preparatory to the entry of pipefitters and machinists.

In spite of the precautions taken to date, there remains full-time opportunity for absorption of materials through the skin of the press cleaners' hands. Such absorption cannot be ruled out as a mode of entry of the suspected carcinogen. Its prevention has not been effected because of an inability to find a satisfactory glove material that will exclude the contaminant from the hands and, at the same time, permit efficient manipulation of the flat steel blade with which wax is removed from the presses. Frequent washing and wiping with clean cotton waste are temporary, but not wholly satisfactory, precautions.

Another mode of entry of carcinogenic material into the body of man is by absorption through the lungs following inhalation. Following inhalation of chromic acid, cancers were formed in the lung itself. Inhalation of beta-naphthalamine results in the formation of bladder tumors. Skin cancers have occurred in workers with arsenic, where at least a part of the exposure has been to inhalation of arsenic compounds as dust. With this thought in mind, an effort was made to learn whether oil mist might be present in the air in wax press rooms in sufficiently fine particle size to permit of passage to the deeper portions of the lung. Samples of the air were collected by means of the midget impinger with water as the collecting medium. Microscopic examination of the water suspension definitely showed the presence of oil droplets of less than 5 microns diameter.

Table 4, which follows, shows the locations where samples were collected and a rough approximation of quantities present, on the basis of counts that were made in a manner analogous to that used in making dust counts. As shown in the Table, mist was discernible in rooms with both doors closed and filtration in progress, and also in rooms with doors open and actual press cleaning taking place.

A demonstration of the presence of oil droplets in the air in wax press rooms is significant of the fact that inhalation of a potentially carcinogenic material occurs. The importance of this occurrence in relation to the present cases of illness and to the prevention of future cases is a matter that can be evaluated only by a broad investigation into the reasons for mist formation, the

Table 4

OIL DROPLET COUNTS -- PARAFFIN PRESS BUILDING

Sample Number	Sampling Time	Location	Evaluation (Particles per cubic centimeter of air)
77	10 min.	In "hot" press rooms Nos. 5, 4, and 3, in which the pressure is on. No men working in these rooms during the sampling time. Sample taken while walking around the filter presses.	11.3
78	10 min.	In "hot" press rooms Nos. 13 and 14, pressure on. No men working.	21.2
79	8 min.	In "cold" wax press rooms Nos. 30 and 31, pressure on. No men working. At conclusion of sample period, two pressmen entered for the purpose of cleaning the presses.	0.0
80	11 min.	"Cold" press rooms Nos. 30 and 31, during beginning stage of press cleaning, starting when pressure is withdrawn and ending with four minutes of actual press cleaning.	6.4
81	7 min.	Outdoor sample in vicinity of lube agitators directly north of tank 331, wind of moderate velocity from the south-east.	7.8
68	10 min.	In "hot" press room No. 11. Pressure on.	7.1
69	10 min.	In "hot" press room No. 9. Pressure on. Many visible oil-wax leaks.	2.8
70	10 min.	In "hot" press room No. 6, shortly after presses have been cleaned. Both doors open.	0.0
71	10 min.	In "cold" press room No. 18. Pressure on.	1.4
72	10 min.	In "cold" press room No. 24. Pressure on.	7.1
73	10 min.	In "hot" press room No. 9 during cleaning of the filter presses. Both doors open.	2.8
74	10 min.	Outdoor sample in vicinity of lube oil agitator tanks.	0.0

nature of the material in droplet form, its carcinogenic activity under experimental conditions, and methods of eliminating exposures to inhalation of the mist.

Some observations were made at the wax presses in the Bayonne Refinery for the purpose of comparing conditions there with those at Baton Rouge. It was noted that maintenance efforts at Baton Rouge are more successful in preventing leakage of material from the presses. Gross leakage, in the form of voluminous sprays against the press room walls and ceiling were seen at Bayonne, but not at Baton Rouge. The nature of the wax-containing stock and the percentage recovery of wax that is desired have, of course, been the factors that govern the extent of the maintenance effort and may account in whole for this observed difference in performance. Handling of San Joaquin distillate, responsible at Bayonne for most of the press room contamination, has not been undertaken at Baton Rouge.

Another notable difference in the operations at the two plants is the fact that Baton Rouge has but one press per room, while Bayonne has some multiple installations. This may mean that Bayonne press cleaners experience a contact with material as a mist, spray, or leak from presses adjoining the one on which they are working which is lacking in the Baton Rouge operation.

These differences, both of which would seem to indicate less intimate contact of men with material at Baton Rouge, may or may not be significant when applied to forecasting cancer incidence. They may assume some meaning when the identity of the carcinogenic material and its mode of entry are better understood.

Plate Shop.

Across the road from the wax press rooms is a shop consisting of one room in which plates and filters are cleaned by means of steam, and two other rooms in which repairs are made to the canvas filters. About 8 men work in this shop on day shift. Filters are brought by the press cleaners to the cleaning room. They are placed on a rack, the room is closed, and live steam is turned onto the filters on the racks and left on overnight. As each filter is put on the rack for cleaning, the others which have been exposed to steam are pushed down toward the far end. In this manner of rotation, by the time a filter reaches the end of the rack it has been cleaned and is ready for repair. The time actually spent in the cleaning room is only the time required to remove a clean filter from a rack and the time required to turn on or shut off the steam line. Exposure of men to the vapor and mist arising from the steam cleaning is, therefore, infrequent. The actual work of repairing filters occasions no contact with contaminating wax or oil.

Refrigeration Unit.

At this unit, actual contact with the materials being handled is limited to the machinists and pipe fitters. No hazardous exposures on the part of the process operators can be foreseen.

Crude Scale Wax Sweaters.

Feed for the crude scale wax sweaters consists of wax and oil after pressing has removed some oil, flash-topping at No. 1 vacuum pipe still has removed still more oil, and acid treating and caustic neutralization has improved it. Men are not exposed to the mixture in the sweating room during actual operation. Maintenance men do come in contact with the material when effecting repairs. These will be discussed elsewhere.

Refined Wax Sweating.

This process is similar to that described above but handles wax with much lower oil content.

Propane De-waxing, Propane De-oiling, and Propane De-asphalting.

These three processes of the lube and paraffine department appear to have no health significance. There is intermittent exposure to propane in unknown concentrations. Non-volatile materials at these units consist of lube stocks for further treatment and the residues which are wax, oil for cracking feed, and asphalt for fuel. Occasions for skin contact with these materials are infrequent in normal operation. There is no evidence of danger from skin contact, however frequent.

MEK Plant.

Processing materials. The solvent employed in this process consists of methyl ethyl ketone 50%, benzene 30%, and toluene 20%. The solvent is stripped from the oil and returned for reuse. The separation of precipitated wax from the oil solution is accomplished in six large rotary filters. Since this is a low temperature process, the filters are enclosed as completely as possible and surrounded by insulating material. The refrigerant is propane.

Personnel. This unit is operated by five men per shift. One of these men spends his full time in a small room in the filter building. The remainder divide their time between the isolated control house and various parts of the plant.

Control of Exposures. The extremely toxic character of benzene and its volatility make its complete control a prime concern in the operation of this plant. Protection against accumulation of solvent vapor was built into this plant by design engineers. Storage tanks and pumps stand in the open air, leaving the filter room as the only enclosure for benzene vapors. A phase of operating procedure which is of great significance in the control of solvent exposures, although it probably had origin in precautions against fire the draining of units prior to repair or replacement and their flushing with inert gas prior to disconnecting.

The ventilation system in the filter building has recently been made the subject of a thorough investigation by the Petroleum Technical Service. The survey indicated that solvent vapor concentrations (as measured with the MSA Benzol Vapor Indicator) in excess of 100 parts per million could not be detected and that the most commonly encountered value was 20 parts per million. In view of these results, and our own which are similar and appear in Table 5 (following), we conclude that in the present mode of operation of this plant, loss of solvent to the atmosphere in the places where men work does not result in excessively high concentrations in the breathing level.

Table 5

MEASUREMENT OF SOLVENT VAPOR IN MEK PLANT

Date	Location	Result *
4/5/49	Lower level of filter building, 10 feet inside the S.W. door.	20
4/5/49	On steps of West ladder to upper level.	0
4/5/49	Beneath Filter No. 1.	Less than 20
4/5/49	On steps of East ladder to upper level.	Less than 20
4/5/49	In filter room control room where the filter operator spends most of his time.	15 - 20
4/5/49	Lower level; over drain to sump.	30
4/6/49	Beneath Filter No. 2, near sump	Less than 10
4/6/49	At pump handling wax-solvent from No. 2.	20
4/6/49	Beneath Filter No. 2. At southernmost sump.	0
4/6/49	At sump beneath No. 5 filter.	0
4/6/49	On upper level. West side.	10
4/6/49	Inside operators shack.	0
4/7/49	At 10 locations on lower level beneath filters.	0 - 20
4/7/49	At base of pipe discharging waste to sump, not at man's breathing level.	100 - 200

* Total vapor, in ppm.

Urine samples from a group of five process men were examined during our survey and showed normal values for the sulfate ratio. The results are given in Table 6, which follows:

Table 6

RESULTS OF URINE SULFATE RATIO MEASUREMENT FOR MEK PLANT WORKERS

Sample Number	Ratio of Inorganic Sulfate to Total Sulfates	Organic SO_3 gm/liter
12007	0.85	0.259
1541	0.84	0.269
5940	0.90	0.110
11374	0.84	0.400
12279	0.90	0.273

The high degree of toxicity of benzene and the fact that leakage of solvent does occur, requires that continuing checks be made on the concentrations in the air. The PHS proposal that routine measurements with the Benzol Vapor Indicator be made is a sound one. The frequency of the measurements should be fixed through correlation with the production schedule and results obtained. The instrument itself is satisfactory, provided that it is checked about once a month against known concentrations of the solvent mixture in a test chamber.

It is desirable also to periodically examine the urine of the 21 process people at the unit and mechanical people regularly assigned to the unit to detect any variation of the ratio of inorganic to total sulfate from the normal range. Such a variation will be detectable in advance of symptoms of poisoning, should excessive exposures occur and will supplement the atmospheric tests as a method of measuring exposures. A discussion of urine sulfate ratio determinations as a means of evaluating benzene exposures is included in the Appendix.

Wax Filtering.

In this process of filtering wax through bauxite and bauxite roasting, a dust source is the base of the regenerator tubes, where the heated bauxite falls to a conveyor belt and is carried to the hopper. The only excursions into this dusty area are for the purpose of replacing wooden pegs on the shake-out apparatus and for loading fresh bauxite from sacks to hopper. The former requires about five minutes several times per shift, possibly hourly. The latter is done infrequently and requires relatively few minutes. Occasional inspection of the operation and replacement of belts accounts for other trips into the dusty places.

The regenerator runs 24 hours to fill one charge. Two 24-hour regenerator periods may follow one another closely and then not again for the remainder of the week.

About seven or eight men are present at this unit during a 24-hour period. They spend most of their time in the room on the northwest corner of this building, ground floor. This room is closed off from the dusty area of the building, but some dust enters to settle on desk, ledges, instruments, etc.

Typical dust counts are:

1. At base of bauxite chutes during regeneration: 23 m.p.c.f.
2. In control room, immediately after blowing out the chutes with compressed air: 4 m.p.c.f.
3. In room containing hopper to receive new bauxite, during regeneration: 1 m.p.c.f.

This dust contains no crystalline free silica, therefore, no silicosis hazard exists. Dust concentrations where the men spend the major part of their

Lube Filter Plant.

Filtration of lube stocks through fixed beds of Attapulgus clay and the regeneration of the clay by the downward passage through a kiln is a process which has no industrial health significance. Clay dust occurs in some parts of the buildings which house the two filter plants and the clay regenerator. This dust contains no crystalline free silica. There is no silicosis hazard. Our observations and dust counts made in the plant show a low degree of dustiness most of the time. Concentrations are not sufficient to constitute a nuisance. Results of the dust counts are given in the Table that follows.

Table 7

DUST COUNTS AT LUBE FILTER PLANT

Sample Number	Sampling Time	Location	Dust Counts (m.p.c.f.)*
79	5 min.	Sample taken at level of elevator motor in regenerator building. No men working in this area at this time, except two carpenters at a lower level.	1.0
80	10 min.	On floor level beneath regenerative furnaces, around the base of No. 2 furnace.	0.0
82	8 min.	General air sample on level around top of filters. No visible dust sources.	0.1
83	6 min.	General air sample on level around base of lube oil filters. No visible dust sources.	0.0

Phenol Plant.

At the Phenol Plant, adequate precautions for the prevention of skin contact with phenol are in effect. They consist of provision of all the necessary protective clothing and emergency showers. The personnel at the plant are aware of the accident hazards. Our attention was drawn to the existence of phenol vapor in certain areas of the plant, as evidenced by the odor. Chronic phenol poisoning from prolonged inhalation of low concentrations of vapor has been demonstrated in animal experiments. It results in respiratory difficulty, digestive disturbances, and central nervous system disorders. Damage to liver and kidney also occurs. Toxicological data for man from industrial exposures are lacking. It is difficult to say, on the basis of available information, what concentrations of phenol in the air of work places can cause chronic illness.

The principal sources of phenol vapor are leakage at pumps handling fresh phenol feed, de-phenolizer feed, etc., and a tank which collects drainage from all sources of liquid leakage. The need for heating the leakage as it is collected and drained from the units, in order to keep it liquid, causes greater vaporization than would be expected from cold phenol. These sources of phenol leakage are outdoors. Two rows of pumps which serve these plants are in open areas adjacent to the control room. Eight men per shift operate the two phenol plants. They spend approximately equal time in areas where phenol vapor is noticeable. In all cases, the time amounts to approximately no more than one hour per shift. Most of their time is spent in the control rooms which have fresh air supplies and in outdoor locations around the plant, remote from the sources of phenol vapor.

The following table shows the results of measurements of phenol vapor in the air in various locations.

Table 8

PHENOL MEASUREMENTS

Sample Number	Location	Date	Phenol Concentration (parts per million in air)
66-64	South pump group No. 2 plant.	4/4/49	
71-67	At drain to sump. No. 1 plant.	4/4/49	< 4
73-72	Control room. No. 1 plant.	4/4/49	
1	South pump area. No. 1 plant.	4/8/49	11
2	Same as 1.	4/8/49	6

In air samples collected at a point between two pumps which were visibly leaking hot phenol mixtures, concentrations were found to be in the range of 6 to 11 parts per million. These concentrations exist in the area where the greatest amount of phenol would be expected. On the basis of these results, one can reason that in the control house, where the men are present for most of the working day, the concentration of phenol vapor will not exceed 1 or 2 parts per million. The occurrence of detrimental effects from continued inhalation of this range of concentration would not seem possible when one considers the ability of the normal human body to detoxify phenol by means of sulfates and glycuronic acid. However, it is advisable that close medical supervision of these men be exercised. Any nervous disorder or history of chronic digestive or respiratory difficulties among the phenol plant workers should be sufficient to raise the question of occupational origin.

Lube Oil Treating.

The plant area containing acid agitators, sludge kettles, caustic wash, and water wash vessels is noted for the presence of sulfur dioxide and sulfuric acid mist. It is evident that the treaters' exposure is the greatest of all personnel, for they must supervise the treating and sludge hydrolysis. They are required by these duties to mount several times a day to the top of the agitator vessels. In so doing, they cannot always remain to the windward side. Their reaction is typical of personnel at operations of this kind. They become inured to irritant concentrations that would offend persons not constantly exposed. As a group, if there are effects on their health, these might be expected to manifest themselves as increased incidence of tooth decay and upper respiratory affections of an acute nature superimposed on predisposing conditions, such as asthma, catarrh, etc. Permanent systemic damage from such exposures are not known.

The other category of exposed persons, those who work in the neighborhood and are intermittently exposed to somewhat lesser concentrations, are more apt to be irritated by occasional high-exposure incidents. These exposures are nuisances rather than health hazards, except in cases of individuals made highly susceptible by predisposing illness affecting the respiratory or heart functions. Such individuals are known in other refineries. They can suffer respiratory difficulties and distress bordering on prostration. Their transfer to plant areas uncontaminated by acid gases is the simplest solution to their difficulties.

Lube Oil Blending.

The manner of transfer of lube oil additives from tank car, to storage, to blending tanks by pumps does not furnish occasions for intimate contact of these substances with the men. An exception is the weighing and addition of PX-441 to small batches of heated oil to make a concentrated solution. The high temperature causes fume evolution which is disagreeable. Installation of a canopy exhaust hood over the mixing tank would eliminate the obvious cause for complaint in this operation, which is performed frequently.

Grease Manufacture.

Exposures on the part of the five to eight men per shift who operate the grease manufacturing plant consist of: (1) inhalation of mists rising from heating tanks, and with steam from saponification kettles, and mixing kettles; (2) inhalation of dust during the receipt, storage, and addition of dry ingredients; (3) skin contact with grease ingredients and products. The evaluation of these exposures must take into consideration the fact that many products are produced only occasionally and with great variation in amounts.

Inhalation of Mists.

Much of the mist arising from heating of the starting materials in grease manufacture is traceable to tanks containing purified vegetable oils and animal fats. For such exposures, there is no indication of hazard. The saponification reactants likewise are regarded as insignificant. At the mixing tanks, there is occasion for entry into the air of some of the large variety of chemicals and additives. In many cases, these are harmless. An exception if that of the suspected carcinogenic agent whose presence is known to the medical department. These exposures are so unpredictable in duration that medical experience with the men involved will have to be the basis for their evaluation.

It is a fact, as illustrated in other grease plants within the company, that mist escaping from saponification and mixing kettles can be effectively captured by properly designed and well-maintained exhaust ventilation systems. Where such systems exist, inhalation of mist becomes negligible in the plant.

Inhalation of Dust.

Dust exposures in grease manufacture are of minor importance because the dusty material which is handled most constantly and in greatest amount (lime) is non-toxic in quantities absorbed as dust and other materials of higher potential toxicity (lead, asbestos, mica) are handled either in small amounts with negligible frequency or in a manner that does not cause the dispersion of great quantities in the atmosphere. Asbestos, for example, after receipt and storage, is added to grease batches with a frequency that was estimated at 6 to 8 times per month. Its handling does not require violent tearing apart in the dry state with consequent dispersion of dust. Occasional exposure to the moderate dustiness of normal handling is not the type of exposure that is known to have caused asbestosis in workers of other industries.

Red lead comes in small cans and is added infrequently to grease batches. The act of dumping from the can into the mixing vessel is the only dust dispersing operation in its handling. It is difficult to conceive of toxic amounts being absorbed by any workman in this manner.

Skin Contact.

Contact of the ingredients and products with the skin of the hands, arms, and faces of the workers in the plant occurs frequently. Its occurrence is due chiefly to deposits of these materials on equipment from misting. Deleterious effects from such skin contact cannot be predicted merely from a knowledge of the effects of the individual compounds on the skin of man for, in the case of a grease mixture, the inclusion of the additives and chemicals in a matrix of soaps and oils makes the chance of their unobstructed contact with the skin questionable. Evaluation of the dermatitis hazard rests, therefore, in the record of incidence of skin effects among grease plant workers seen by the medical department. In the absence of any evidence from this source, it is safe to assume that no problem exists and that the company meets its responsibility to its workers by providing them with adequate cleansers and washing facilities.

CRACKING DEPARTMENT

Thermal Cracking

1,000 pound Coils: No. 21 and No. 22 Units.

Materials and Process. Feed stock is gas oil from various sources, clarified oil from PCLA, and pitch bottoms (from pipe stills). Products are gas (C-1 to C-4), naphtha, cycle gas oil, and tar.

Exposures. Exposures to inhalation of vapor and mist from the materials that are being processed can be expected to occur in the act of sampling process material, in the neighborhood of pumps where leakage occurs, and in the neighborhood of pumps which give rise to oil mist. Such exposures are significant health-wise when the material consists of clarified oil or the tar produced from cracking clarified oil. These are suspected carcinogenic agents. The control of oil mist inhalation in a program for complete prevention of occupational tumor formation is discussed in the section dealing with Wax Press Rooms.

Collection of oil mist in an impinger and evaluation of the results by a procedure analogous to that used in dust counting gave the following results:

Table 9

CONCENTRATION OF OIL MIST IN VICINITY OF PUMPS AT THERMAL CRACKING UNIT

Sample Number	Sampling Time	Location	Droplets per Cubic Centimeter of Air
64	8 min.	No. 21 - 1,000-pound cracking coils, in doorway to control house near hot pitch feed pump.	1.59
65	4 Min.	Adjacent to hot pitch feed pump, two feet from shaft which appears to be chief source of oil mist.	0.0

These evaluations serve only to demonstrate the presence of oil mist in the location cited.

Number of Men. Operating personnel consists of six men per shift.

Location and Features of Control House. The control house in which the men spend most of their time consists of two rooms adjacent to one another and close to pumps. Mist from hot oil pumps can enter through open door on west side of control room. Pump site is covered by a roof and enclosed on two sides. Reflux pumps handling light fractions (naphtha) have fair amount of leakage, but are located good distance from control house and are not enclosed. Materials for measurement are brought into the control house (no transmitter-receiver type instruments here). Activation of recorders is by means of natural gas. Brown and Foxboro instruments in shop bleed tests showed escape of 0.02 and 0.32 cubic feet per minute respectively. There is an estimated total of 15 such instruments for the No. 21 and No. 22 units. Tests with benzol vapor indicator gave no deflection around the instrument panel. Full scale reading was obtained when the intake was placed at the meter face.

The location of hot oil pumps just outside the door of this enclosed control house affords the opportunity for the entrance of fairly high concentrations of oil mist and vapor of varying composition and of unknown significance health-wise. Escape of vapor and gas from instrument lines inside the house is thought to be of insignificant importance because of the small amount of leakage that can be tolerated from the standpoint of process control.

Sampling. Helper at the unit takes a sample from the "hot bottoms" line about four times per shift. The line must be bled for several minutes before drawing the sample. The person drawing the sample cannot always stand to windward side because of the location of the draw-off pipe over the drain to the sewer.

The three-sided shed where the gravity test is made, effectively encloses vapors from the hot oil being tested, causing increased concentrations in the operator's breathing level.

The location of the end of the draw-off line, with respect to the opening to the sewer line and to the position that must be taken by the man prior to and during sampling, affords too great an opportunity for splashing and volatilization of the material that is being drawn. Less confinement at the site of gravity testing is desirable.

Since sampling and testing are the acts providing the most intimate contact of process men with the material, an effort towards improvement of these arrangements is suggested.

750-pound Coils: No. 19 and No. 20 Units.

Process. Feed stock and products are similar to those of No. 21 and No. 22 units. (Note: When clarified oil from PCLA is used as feed, it is supplied under sufficient pressure by pumps at PCLA. We have inferred from this that there is no pump here handling unaltered clarified oil--hence, no mist of this substance as received.)

Number of Men. About nine men per shift operate 17, 18, 19, and 20 cracking coils.

Location and Features of Control House. The control area is not as completely enclosed as that at No. 21 and No. 22. Instrumentation is the same. Proximity of pumps and invasion of mist from hot oil pumps through open doorway is about equal. Results of oil mist counts are as follows:

Table 10

CONCENTRATION OF OIL MIST IN VICINITY OF PUMPS AT THERMAL CRACKING UNIT

Sample Number	Sampling Time	Location	Droplets per Cubic Centimeter of Air
66	10 min.	No. 20, 750-pound cracking coil, near hot oil pumps handling gas oil from various sources.	7.44
67	8 min.	No. 20, 750-pound cracking coil, adjacent to pump handling cold gas oil and another running pitch bottoms. Wind is from north-east and some mist from hot oil pumps may reach this position through the open doorway.	1.23
68	7 min.	No. 20 unit, in doorway between hot oil pump room and control room, directly down-wind from hot oil pumps.	7.44

Conclusions Regarding Exposures of Men.

Exposures by skin contact and inhalation of mist or vapor is possible at sampling locations. The sites were not inspected, nor was the frequency noted; this is, therefore, an inference from observations at other units.

Mist from the hot oil pumps to the north was found to invade the space (semi-enclosed) where process men spend most of their time reading instruments and filling out charts and data sheets. This is not a continual exposure, depending on wind from the northern quarter or lack of wind.

Unusual situations, one of which we witnessed, such as a broken valve, occasionally will cause spillage or leaks that result in skin contact before repairs can be effected by the pipe fitters.

Steam Cracking

Process.

Feed stock for this process is virgin heavy naphtha. The products consist of a dilute butadiene stream, an aromatic distillate, residue gas, aromatic tar, fuel oil, and a C_5 cut which goes to isoprene extraction. Clarified oil from PCLA is used as a quenching agent.

Number of Men. Three men per shift spend most of their time in the control house which is closely associated with the feed and water pumps.

Association with Toxic Substances. The substances at this unit which deserve closest scrutiny are the tar bottoms, clarified oil, and the aromatic distillate.

The tar fraction and the clarified oil are included in the suspected carcinogenic materials for which special precautions against skin contact have been planned. They are discussed separately.

The aromatic distillate is described as containing 56 per cent aromatics. Initial boiling point of the fraction is 300°F. and final boiling point, 475°F. Leaving the cracking coils, this distillate is handled by a pump near the control house. It undergoes fractionation at No. 4 D & S; after separation here, it is put through a clay treating process similar to that at CLA 2, in the chemical products area. It finally goes to Tank 961 on the western side of the rundown tank area. The boiling range of this fraction includes the boiling points of C_9 and higher mono-nuclear aromatics. Any problem of toxicity of this fraction would be of the order of toxicity of cumenes, etc. and not of the type of benzene, toluene, and xylenes. Observations at this unit and at Tank 961 failed to disclose any occasion for prolonged breathing of this fraction.

There are several reasons why the operations at these units are of

EM001668

interest to those concerned with the maintenance of employee health:. (1) Chron toxic effects of C_9 and related aromatic hydrocarbons are not sufficiently well-understood; (2) the exact extent of occasionally repeated vapor exposures of me at these units could not, of course, be determined in the course of this survey; (3) the process is similar to that at OLA-1 and OLA-2. There is no assurance th changes in feed stock or processing conditions will not result in the production of the more volatile aromatics of the type of benzene.

Catalytic Cracking

Three catalytic cracking units are operated. No. 1 is the first fluid catalytic cracking unit to be put in operation anywhere and differs radically in design and operation from No. 2 and No. 3, which are identical.

Materials and Process.

Feed stocks for the catalytic cracking units include reduced crude fro end-fired stills, virgin gas oil from crude distillate, various residual stocks from the production of lubricating oil, and cycle gas oil from thermal cracking. Products are gas (to C_4), light naphtha, heavy naphtha, and heavy cycle gas oil. A finely-powdered silica-alumina catalyst is handled as a fluid.

Number of Men. 90 persons are employed on three shifts in the operatic of the three catalytic crackers.

Significant Exposures.

(1) Catalyst dust: Unloading of fresh catalyst from the cars in which it is received is a relatively dust-free job. Twenty-seven to thirty carloads of catalyst per month are received. Removal from storage and return of regenerated catalyst are all handled in closed ...

units themselves when the high velocity of the catalyst stream causes corrosion in pipe lines. This occurrence is not infrequent, especially on the No. 1 PCLA. When leakage occurs, exposure to the dust is suffered mainly by maintenance men who are called upon to repair the lines.

The toxicological information now available indicates that this material is unlikely to cause silicosis. This may be due to its being so lean in very fine dust fractions compared with naturally produced dust; or to its relatively high rate of solubility. In any case, we conclude that any exposures we learned about are of no significance health-wise.

(2) Heavy catalytic cycle gas oil: This fraction occurs in two forms at the unit. The first is known as slurry oil and contains catalyst in suspension. The second is clarified oil which is the same oil stock after removal of catalyst. These substances are the principal materials involved in the program for control of skin contact with carcinogenic oils. This phase of their activity is discussed in a separate section.

Two other factors concerning the handling of these oils are worthy of consideration. The first is the existence of fine mist in the vicinity of hot oil pumps carrying either slurry or clarified oil. We demonstrated the existence of such a mist and observed that there is occasion for men to spend at least short intervals of time in areas where mist is present.

An air sample collected by means of an impinger at PCLA No. 1, three feet from the shaft of a pump handling hot clarified oil was evaluated in a manner analogous to dust counting and showed 21.3 droplets per cubic centimeter. At the time of sampling, there was a visible mist arising from the shaft of the pump with each stroke. Mist also arose from the cylinder block upon which oil had been spilled from a sampling line.

Inhalation of oil mist affords equally good opportunity for contact as

ioes actual spillage or

carcinogenic agent that may be present into the body of a man. A careful review of all the localities where such misting occurs and the correlation of this occurrence with the presence of men seems to be warranted.

The remaining consideration is the immediate formation of blisters upon skin of men where spillage of slurry oil has occurred. It is true that in many cases, these blisters would appear to be thermal blisters from hot oil. There is good evidence, however, that some of the properties of the oil may be responsible. In those cases where heat can be ruled out as a cause of blister formation, question arises as to whether this is a unique effect of slurry oil or whether it is a manifestation common to several other petroleum fractions, notably kerosene. An associated question is whether this occurrence of blisters may be related to the irritant effects on eyes and respiratory system following exposure to catalyst dust, a possible relationship lying in the adsorbed oil on spent catalyst.

UTILITIES AND LIGHT ENDS

Light Ends

Petroleum Vapor.

The principal effect of the inhalation of vapors of saturated and unsaturated light hydrocarbons is narcosis from prolonged breathing of concentrations in the range of a few thousand parts per million. We know from refinery surveys that such concentrations do not prevail for prolonged periods in areas where men work. However, industrial hygiene codes of some states and the National Conference of Governmental Industrial Hygienists include tolerable limits of 500 or 1,000 parts per million as definitive of good working conditions. It is a matter of interest, therefore, to obtain some estimation of concentrations that are encountered in the light ends plant of this refinery. For this purpose, the 1929 Gas Absorption Plant, whose units are now used as specialty stills, was chosen. The control house of this plant was described to us by personnel of the light ends division as the most "gassy" in the refinery, the reason being its location in the midst of the process units.

The fractionation towers at the 1929 Gas Absorption Plant handle principally virgin heavy naphtha, separating C_3 and C_4 from C_5 and heavier; they also were handling propylene polymer, separating a small amount of C_4 from the remaining heavier polymer. Readings in the range of 25 to 50 parts per million were obtained downwind from a sewer opening beside water cooling coils with a sensitive combustible gas indicator. Elsewhere about the plant, in the control house, at the base of No. 4 Specialty Still, at No. 3 Rectifier, and downwind from a leaking valve 50 yards from the control house, readings were essentially zero. These readings show the effect of the mild breeze, which was blowing on the day the measurements were made (April 12, 1949), in diluting the vapor soon after it

The examples typify our findings of petroleum vapors around outdoor process equipment.

Hydrogen Sulfide.

In the compression and distribution of gases containing hydrogen sulfide and their subsequent recovery for use, the hazard has been recognized and effective precautions to prevent its escape in places where men work are generally quite good. A fairly recent development has been the removal of sections of side walls at No. 1 and No. 2 Gas Compressor houses. Ventilation thus provided is in addition to the local exhaust ducts at the compressors.

At the various units of the light ends plant, when men encounter hydrogen sulfide it is most often as a barely perceptible amount in outdoor pump locations where natural ventilation and lack of confinement prevent its accumulation. If we disassociate from our consideration the necessary precautions against accidental inhalation of amounts sufficient to cause immediate symptoms of acute poisoning, such as would occur in equipment failure, it would seem that there is no problem of hydrogen sulfide poisoning. No areas where men work for prolonged periods in amounts sufficient to cause chronic poisoning could be noted in this survey, except as noted in the discussion of the flare stack adjacent to the new light ends plant.

Acid Recovery Plants.

The processes of hydrolyzing acid sludge, recovering weak acid, and concentrating this acid to 85-90 per cent by vacuum distillation is associated with the obvious possibility of accidental acid burns for which the proper precautions have long been practiced. There is nothing else significant to employee health about this type of work.

Boiler Houses and Power Houses.

The best approach to the question of possible damage to hearing in places where high noise levels exist, such as the power houses, is to make a hearing inventory among the men who are exposed, in order to detect any changes with the passage of time. Measurements of noise levels in the work places do not give a satisfactory basis for predicting damage to hearing. Satisfactory standards do not exist, chiefly because of great variation in response between individuals at given noise levels. The matter can be resolved by determining the state of a person's hearing in a pre-placement examination and determining in subsequent yearly examinations any changes that occur.

MAINTENANCE AND CONSTRUCTION

PIPE DIVISION

The Pipe Division of M. & C. Department was subjected to careful study in the course of the survey because personnel of the division forms a numerically large segment of the plant population and because the performance of the functions of the division places its men in intimate contact with process material. Pipefitters comprise 23 per cent of M. & C. employment and about 9 per cent of the total refinery personnel. After the General Labor Division, it is the next largest M. & C. division.

The Pipefitters enter into nearly every phase of processing from the initial installation of a unit through its normal operation, routine maintenance and general inspection, turnaround, dismantling, or change of design. In their work of blanking off lines for removal or repair of pieces of equipment, they can suffer an exposure to whatever material is in the unit. The magnitude of the exposure is dependent chiefly on the effectiveness of draining or flushing by the process people before the unit is released to the pipefitters. Typical exposures of this nature range from the short-time breathing of gasoline vapors in an instance where a pump or valve on a gasoline line is removed from service to an occasion where pipefitters render prolonged assistance in removing a large number of heating tubes from a crude reboiler in acid service at the alcohol plant. The former is typical of an exposure where the hazard to health is of a low order of magnitude, the latter, one of doubtful or uncertain magnitude.

Of the 765 men employed in Pipe Division, close to 200 are regularly assigned to process units. These men have fairly steady assignments and are subject to fairly steady environmental conditions. Turnaround work and shifting demands of building and reconstruction gives to most of the men in the Division a

Environmental studies, as a part of the protection of the health of pipefitters, can do no more than describe the nature of materials encountered, their toxicity, rough estimates of exposure time and frequency of exposure, and number of men involved or affected. In most cases, nothing can be said about the range of concentrations of an atmospheric contaminant prevailing in a given exposure incident. The random occurrence of pipefitters' jobs makes sampling an measurement impractical except as part of a long range program.

Protection will depend on keeping a complete medical inventory of all men in the Pipe Division who have occasion to spend part of their working time i areas where exposures that are difficult to classify may occur. This inventory should include periodic medical examinations, recording of occupational historie and application of clinical laboratory analyses for the early detection of signs of exposure. An example of the latter is the urine sulfate test for pipefitters who work about the MEK Plant, to detect exposure to benzene vapor before sympto of poisoning occur.

Some typical examples of pipefitters' exposures are reviewed below.

Catalytic Cracking Units.

Catalyst dust is encountered in fairly-frequent repairs to the catalys line from the Cottrell precipitator to the regenerator. Eye irritation occurs. Its total effect after repeated exposures can only be determined by medical super vision of the pipefitters and boilermakers who have been longest exposed. Exposure during repair of leaks above the ammonia feed should also be studied.

Heavy aromatics boiling over 700° are encountered in replacing slurr heat exchangers while the unit is in operation. Flushing cannot be accomplished in the procedure currently in use. Removal of steam generators at turnaround is another occasion for possible [illegible] flushing. These occasions require consideration of mechanical changes to improve the method of flushing and draining (if it has not already been solved), and close scrutiny of the men involved, to detect any early pre-cancerous skin changes.

Alkylation Units.

Vapors of light hydrocarbons and possibly hydrogen sulfide are encountered in breaking lines prior to pump, valve, and pipeline repairs. Infrequency of the job and inertness of most of the materials encountered suggest that these are harmless exposures. Accumulation of a body of medical experience with the men who work in this area should conclusively put it in its proper classification.

Wax Manufacture.

Pipefitters have three men full time in the area which includes the wax press rooms, crude scale sweaters, and refrigeration units. Their opportunity for skin contact with suspected carcinogenic substances probably exceeds that of press cleaners in the wax press rooms and cellars. At the sweaters and coolers, repair work requires contact which the process people never experience. These men should be included in the provision of protective clothing and frequent medical examination.

Phenol Plants.

The two pipefitters who work full time in this area have occasion for infrequent exposures to concentrations of phenol vapors in work at the hot pumps. The net result of such exposures over an extended period of time on the health of the workmen can only be determined by paying careful attention in routine medical examinations to respiratory, nervous, or digestive disorders.

Equipment for protection against skin contact with phenol and first-aid facilities are provided. The accident hazard is well-understood at the plant

Barisol Plant.

Almost full time attendance at this plant was required of pipefitters. Since operation has been discontinued, the pipefitters who spent the greatest amount of time here should be watched by the Medical Department for sequelae of exposures to carbon tetrachloride. It is a matter which will require careful study as the literature is lacking in reports of prolonged follow-up of acute or chronic carbon tetrachloride exposures.

Lube Treating Area.

Four pipefitters are present full time in the area including weak acid recovery and lube agitators. Their exposures to acid mist and sulfur dioxide is potentially great enough to warrant medical supervision aimed at ascertaining whether excessive tooth decay occurs and whether there is abnormal occurrence of upper respiratory affections.

Alcohol Plants.

The large scale use of sulfuric acid in alcohol manufacture and its recovery at this plant requires constant combating of effects of corrosion. It is a place of intense activity on the part of pipe fitters. About fifteen men spend all their time at ethanol production, propanol production, and acid recovery. The entire group is likely to encounter all substances at this plant from raw materials fed to these units to finished products. As pointed out in the discussion of process men at the alcohol plant, most of these substances cannot, on the basis of present knowledge, be directly implicated as detrimental to employee health. The possibility of the presence in this area of one or more carcinogenic agents dictates the necessity for careful medical supervision of the pipefitters and other mechanical craftsmen and laborers who spend most of their time in the area. The examinations of such employees can be specialized along lines indi-

M. & C. Machinists

The total number of men in the Machinists Division is 474, making it the third largest M. & C. Division after General Labor and Pipe. Like the pipe-fitters, they are fairly stable in assignment to fixed locations. Shop men number 121, the remainder, with a few exceptions, are outside machinists assigned to a given area or process unit.

Outside Machinists.

The general character of the machinists work at process units is to perform routine duties of inspection and oiling, to move in to a pump in need of repair, replacement, or cleaning after the pipefitters have completed blanking off the line and to perform special tasks of installation or repair, again after the pipefitters have been there. In qualitatively evaluating their exposures to process materials, it is apparent that the sum total of outside machinists encounters everything in the refinery, and individual members of the group experience repeated contacts with the materials within their own area or unit. The frequency, intensity, and duration of such contacts enters into the quantitative appraisal. For purposes of comparison, it appears to be less frequent than similar exposures of the pipefitters, less intense, and about equal in duration. With awareness that exceptions to this rule occur, any accurate appraisal of pipefitters' exposures to process materials should be applicable in judging the exposure of outside machinists.

Examples of certain machinist activities in which there is opportunity for repeated exposures to materials processed in the unit follow.

MEK Plant.

EP001679

Ever since operation of this unit was started, two machinists have been employed consistently, realigning the foundation of the filter tanks.

These men have probably had a greater exposure to the solvents than any of the process people or other mechanical crafts. At the conclusion of this job, they should be given a physical examination related to symptoms of benzene poisoning. The results of these examinations will be useful in evaluating the exposures of those who are regularly employed at this plant.

Two other machinists spend 30 to 50 per cent of their time performing regular maintenance duties at the MEK plant. We have no indication that they suffer excessive exposures to solvent vapors.

Phenol Treating Units.

Our observations at the phenol plants lead to the conclusion that the two machinists who work full-time at these plants and at the Kellogg pipe stills are not exposed to phenol vapors for prolonged periods of time. The low vapor concentrations that exist during normal operation of the plants suggests an extremely low total exposure for machinists. Machinists are in possession of protective clothing for prevention of skin contact. Showers are provided for use after accidental contact.

Paraffin Wax Presses.

Two machinists spend about 90 per cent of their time on wax press maintenance. We consider that their opportunity for skin contact with paraffin distillate, wax, and pressed oil exceed that of the filter press cleaners. There is contact with various parts of the presses themselves and with the freezers in the refrigeration building. Repair of the stirrers and other parts of the freezers requires entry into the unit through a manhole. This job requires assistance from other maintenance machinists.

The two men who are now assigned to the wax press maintenance and those two who were formerly assigned (those with the longest tenure can be identified by the machinist foreman) should be given the routine physical examination required of the press cleaners. Equal facilities for the practice of personal hygiene are necessary for the maintenance machinists.

Butyl Rubber Reactors and Finishing Building.

There is a low incidence of exposures to methyl chloride by the machinists. In the reactor building, natural ventilation through the open side walls is usually good. In the finishing building, routine greasing of the screen shakers and the filter mechanisms requires exposures of short duration. Repair work on these units is performed while the flow of materials is shut down and while the ventilation system is still operating.

Paracril Plant.

Exposure of machinists to acrylonitrile and other volatile substances in the paracril plant do not exceed those of the operating personnel, which were shown by air analysis to be within acceptable limits, except in the vicinity of the latex pot and the coagulating pot.

Gas Compressors.

Since maintenance of gas compressors in various parts of the Petroleum Products Division and the Chemical Products Division accounts for a large part of the total time spent by maintenance machinists, there is a certain degree of importance attached to the possibility of gas inhalation at these units. In our examination of the compressor buildings, we failed to see any localities where accumulation of amounts of gas sufficient to produce chronic intoxication was a likely occurrence. There undoubtedly have been some exposures in the past and may be occasionally at the present time. Most of the obviously dangerous exposures have been eliminated, either by providing exhaust systems over the escape points or by opening up the building to permit natural ventilation. Methyl chloride and hydrogen sulfide concentrations have been reduced by these two methods, respectively. A review of all such installations from the standpoint of chronic exposures to low concentrations of gas is recommended.

Contact with Heavy Catalytic Cycle Gas Oil and OLA Tars.

The machinists are among the crafts which have had and will continue to have opportunity in the daily performance of their duties at the process units which handle these materials and at field tank pumps for contact with these substances. Future contact is regulated as a part of the general program. No unusual or unforeseen incidents relating to contact were observed in this study.

Machine Shop

Main Shop.

The main shop was found to be without any apparent industrial health problems. Lighting and sanitation facilities are excellent. Use of solvents is limited to Varsol, which is handled in such a way that, even though its toxicity and volatility were great, exposures would not be significant.

Disassembly and Reassembly Shop.

Pieces of equipment come to this location directly from the process units or from an Oakite cleaning in the tanks of the heat exchanger cleaning shop. Those pieces of equipment which have been in service at units handling the heavy catalytic cycle gas oil, OLA tars, or re-run tars bear a special identification tag. When they are disassembled, some of this suspected carcinogenic material may be released. We saw slurry oil spill out of a slurry pump which had been through the Oakite cleaning. There is a problem of its disposal. The nearest drain to the sewer is about 60 feet from the place where heavy equipment is disassembled.

Metal Spraying.

About 15 different types of metal are sprayed in a shed with open sides near the machine shop. Stainless and mild steel wires are most frequently used. The amount of lead spraying seems to be too small to be of any importance toxicologically. It was described to us as consisting of about one small job a month for a part of acid service at the Chemical Products Area. Bronze is no longer used.

Incidents of poisoning by nitrogen oxides generated by the heat of the spraying torch, that are described in the literature, have occurred in enclosed spaces where it has been possible for concentrations of these gases to accumulate over a prolonged period. It is safe to assume that such accumulations could not occur in this open shed.

BOILERMAKER DIVISION

Riggers.

The work of the riggers, who numbered 67 in the entire plant, did not come in for close scrutiny in this survey. It was adjudged that in the performance of their mission of moving and erecting heavy equipment, their exposures to toxic and hazardous material are slight. Riggers are not active on a job until after process men have taken a given piece of equipment off stream and pipefitters have blanked it off from the flow; actual close work with the equipment is of short duration.

Opportunity for skin contact with acids or high-boiling aromatic hydrocarbon exists. For protection, riggers are furnished protective clothing, which they carry with them to a job. Contaminated riggers' clothing is laundered by the refinery in accordance with the general program for prevention of prolonged contact with substances implicated as possible cancer-formers.

Welders and Burners.

106 welders include 98 electric welders and 8 gas welders. All of these men are first class mechanics and their work is limited to welding. Fitting of parts to be welded is done by other crafts.

The burners number 66, consisting entirely of first class mechanics. Work inside drums, towers, etc. amounts to a considerable percentage of the total work of welders and burners. An important aspect of this inside work is that pieces of equipment in which inside work must be done are routinely cleaned by sandblasting before the welders and burners enter. This practice effectively limits their inhalation of atmospheric contaminants to those products of the welding or burning process, i.e., fumes or gases from the base metal, welding rod, or coating:

Welding on ordinary structural grades of steel with coated electrodes results in the escape to the atmosphere of fumes containing iron oxide and oxides of several metals found in the electrode coating. Manganese, titanium, and silicon are common. The gaseous products consist of carbon dioxide, carbon monoxide, water, and nitrogen oxides. These fumes and gases originate in the extreme heat of the arc and are thus given an initial velocity upwards that tends to disperse them to less than harmful concentrations in any but the most confined spaces. Given a fair sized enclosure and some natural movement of uncontaminated air from outside the contaminants will disperse in a satisfactory manner. In cases where the welding is performed in a confined space with no ventilation the symptoms are primarily those of nose and throat irritation, and cough.

In welding on galvanized steel, the proportion of zinc oxide in the total fume is greater than that of iron oxide. Metal fume fever may result unless total fume concentrations are kept at a much lower level than is necessary in the case of welding on uncoated steel. Good ventilation of the space is effective in preventing the occurrence of metal fume fever.

Welding on lead or cadmium-coated base metal may constitute major health hazards. Cadmium fumes are not believed to constitute a chronic poisoning hazard, but do represent a very serious accident hazard where concentrations are high due to poor ventilation. Exposures of only a few hours duration are sufficient to cause serious lung involvement and even death. Protection may be provided either in the form of local exhaust ventilation or the wearing of a fume respirator beneath the welder's face shield. No instances of these types of welding were noted in the refinery.

Welding on stainless steel involves exposures to fluorides from the rod coating. Excessive exposure to these fumes causes irritation of the nasal passages, and not infrequently nosebleed. This is generally believed to be caused by the formation of hydrofluoric acid. In our opinion, there is no [illegible]

EMOO

fluorosis from such exposures. Fluorosis is a development of bone abnormalities resulting from many years exposure to large concentrations of fluorides.

We were unable to obtain a first-hand impression of fume conditions in any of this welding work. However, the exposure being basically of nuisance type, scientific evaluation is not required and ordinary inquiry will suit all purposes.

Ventilation for inside welding work is provided by Lamb "air siphons" furnished by the boilermakers and installed by pipefitters. An estimated 30 or 40 "siphons" are available in the entire refinery.

Surfaces painted with red lead are encountered in minor repair work on barges, an infrequent job, and on new structural steel, also infrequent. An electric blower is provided to furnish local exhaust on the barge work. Red lead is removed from new structural steel by burning and brushing prior to welding. The short duration of these jobs and their lack of frequency make it unlikely that there is any hazard to burners or welders from inhalation of lead fume from work on steel that has been painted with red lead.

Protective clothing is provided for work in acid areas. It is stored in division tool rooms or kept personally by individual welders.

Coke deposits are sometimes cut from inside equipment by burners' torch. Ventilation equipment is called for and used because of the smoke and heat in confined quarters.

Cutting and melting of lead scrap is done by one man with a portable lead pot, working occasionally at various locations. Several efforts to witness this job failed because of its discontinuous operation. This man should be included in physical examination schedule for lead burners.

The Pipe Shop (Petroleum Products Division) is operated jointly by pipefitters and welders. Pipe welding is done in a structure having open sides. An estimated 95 per cent of the work is on new pipe, limiting fume exposures to the innocuous type of black iron welding. Lead-lined pipe is not ...

shop. Fume exposures are not serious at this shop at this time, although certain positions may put a welder's head for a time in the region of heavy fume from the arc. This might assume a more serious nature if in the future the new pipe containing a bonded lead lining, which was described to us at the acid plant, should be brought to this shop for cutting or welding of flanges. Provision of local exhaust equipment for removal of the fumes from their point of origin to a distance from the welder's breathing zone would then become necessary.

Boilermaker Shop, 572 Area, in Chemical Products Division north of No. 4 Finishing Building, employs one welder and one burner. There was nothing in the layout of the shop nor in the description we obtained of its work to suggest the existence of occupational disease hazards.

Pipe Shop, Chemical Products Division.

At the welding shop, Chemical Products Division, west of No. 1 Alcohol plant, five welders and three burners, all on "A" shift, are employed at fabricating and repairing pipe sections. Fume exposures are limited mainly to fumes from the metal being welded and the rod and coating. No estimate could be obtained of the relative proportions of work on new and used pipe. It was ascertained that residual material in used pipe was removed by burning at a point remote from the shop and in a manner that results in no fume or vapor exposure to the man doing the burning. In this shop, welders complained of illness from welding on certain types of alloys described as "Red Copper," "Red Brass," and "Everdur." In welding such material, heat is applied by means of a carbon electrode in the usual welder's electrode holder. Pipe sections undergoing this process are of such sizes and shapes that it is impossible for a welder to always stay out of the zone of most dense fume from the arc.

The illness they described is suggestive of metal fume fever, being an acute illness having its onset several hours after work has ceased, and being characterized by chills, fever, vomiting, and headache.

The Everdur alloys contain copper, 95 to 98 per cent; silicon, 1.5 to 4 per cent; and about 1 per cent manganese.

Red Brass usually contains 85 per cent copper and 15 per cent zinc.

There are no chronic effects from metal fume fever. The acute illness can be prevented by installation of a local exhaust system in this shop to carry away the fumes from their points of origin.

Boilermaker Shop. "Old Boiler Shop."

Activities in this shop consist of:

Electric welding--one or two arc welders perform various repair jobs.

Burning--three machine burners work in this shop full time. A variable number of hand torch burners are present.

Gas welding--the gas welding shop in this building is the site of employment of the eight gas welders included in the employment list for the Boilermakers Division. The work consists of oxy-acetylene welding of non-ferrous alloy parts, using principally un-coated rods of composition similar to the base metal. A considerable proportion of the work load consists of effecting repairs to Hastelloy D heating tubes used in acid service at the alcohol plants, ILA units, and acid concentrating plants.

The shop is provided with a local exhaust system for removal of fumes from the actual welding. Hastelloy D tubes which contain 85 per cent nickel must be pre-heated to about 600°F. in a furnace at the shop before welding. Some 20 heating tubes per month are handled here, and three is the maximum number in any one day. When these tubes come to the shop with a coating of some residue of carbonaceous material from the unit from which it was removed, there is an evolution of fumes, at least in the first stages of heating to the correct temperature for welding.

The possibility of the formation, under these conditions of combustion, of nickel carbonyl has been raised. Nickel carbonyl, a volatile material posessing a high degree of acute toxicity, has been responsible for the development of lung cancer in the nickel refining industry. We are not in a position to comment on the possibility of its presence in the fumes from heating these tubes. Inhalation of these fumes can be greatly diminished by the installation of a hood over the furnace port.

Welders at Catalytic Cracking Unit Turnaround.

At turnaround of catalytic cracking units, the services of welders and burners are required for about 3/5 of the turnaround period. Welders work three shifts a day, six days a week, and burners on two shifts, 6 days a week. An estimated sixty per cent of the work is inside work and of this, forty per cent is considered dusty work. A high proportion of the work inside is on stainless and chrome steel. Dust sources are residual catalyst, especially in the precipitators where it is easily disturbed from its resting places on the shakers, refractory and insulation dust in the regenerators, and settled dust remaining after sandblasters have left the tower. Dust elimination efforts have gone a long way toward cleaning up the vessels for the turnaround mechanics. Additional protection from inhalation of these dusts can be offered these welders and burners by providing them with a filter-type respirator designed for dust and fume. Types that will fit beneath the welder's hood are available.

The danger of contracting illness from inhalation of these dusts in the concentrations prevailing during the turnaround is thought to be rather small for the following reasons:

(1) Exposure time for an individual welder or burner over the course

of a year will amount to probably no more than one month. (There are about four turnaround periods of about 15 days normal duration on the three units.) All boilermaker crafts are rotated on catalytic cracker turnaround;

(2) Catalyst dust and most of the refractory dust that is encountered is relatively non-hazardous by reason of its composition and particle size.

Lead Burners

Lead Burner Shop at No. 3 Acid Plant.

About four men work part-time in a shop which is open on three sides. This affords good natural ventilation and prevents accumulation of lead fumes in the lead shop. It does not prevent the inhalation of fumes rising directly from the burning or bonding torch. Measurements of atmospheric lead during burning and bonding at Aruba showed that concentrations in air at the nose of the man can exceed the recommended limit even in outdoor locations, because of the proximity of the man's nose to the source of fume. With this experience and with the results of the urine lead determinations that were made at Aruba, we recommend that some exhaust ventilation be provided for lead burning in this shop.

Lead Burning Shop in Crafts Building in Chemical Products Area.

Three men work about half-time in this shop. This room has fairly good natural ventilation. The same remarks regarding inhalation of fumes coming directly from the torch apply here.

Outside Lead Burning and Bonding.

About half of the time of the seven lead burners and seven helpers is spent performing jobs at the process units. Many of these jobs require work in spaces somewhat more confined than the shops themselves. Examples are re-boilers at the alcohol plants.

Medical Control Measures.

Lead burners and their helpers are examined twice yearly by the Medical Department for symptoms of lead poisoning. We suggest that the examinations be supplemented with urinary lead determinations, so that evidence of absorption may be detected before symptoms of poisoning occur. As a part of this survey, we obtained urine specimens from 12 lead burners and helpers. As a group, these men showed normal excretory values. The results are shown in the following Table.

Table 11

RESULTS OF LEAD DETERMINATIONS IN URINE
OF LEAD BURNERS AND HELPERS

Name	Sample Number	Amount (Cubic Cent.)	Specific Gravity	Concentration (Milligrams of Lead per liter)
Chapman	3016	230	1.020	.170
Christof	3249	110	1.028	.097
Elkins	1830	155	1.025	.120
Fisher	3093	115	1.027	.132
Kelley, B. A.	328	380	1.010	.055
Kelley, B. F.	1030	295	1.012	.058
Kelley, O. D.	251	295	1.023	.098
Martin	844	175	1.030	.153
Nettles	1372	180	1.020	.115
Thomas	3012	93	1.026	.192
Whittey	3464	95	1.026	.102
Williams	134	475	1.004	.095

Periodic urinary lead determinations will reveal any changes in the exposures, which at the present time are not excessive.

Utility of Lead Urinalysis.

The measurement of the amount of lead excreted in the urine is a useful means of evaluating exposure to lead and, therefore, a valuable adjunct to medical techniques in supervising the health of lead workers. It [illegible] respiratory systems of the members of the group of exposed persons as collecting devices for the lead in the atmosphere. By its mechanism of collection it eliminates any forms of lead in air that do not contribute to actual lead absorption, such as coarse dust particles. Furthermore, it averages out exposure with time, eliminating the intermittent high or low concentrations that might be found in sporadic air sampling and analysis. The amount excreted in the urine is proportional to the amount absorbed within certain limits of individual variation.

The influence of individual variation makes it necessary to use urinary lead concentrations as measures of group exposures rather than as measures of individual exposures. The knowledge of exposure obtained from urinary lead determinations can be utilized to point out the need for environmental control of the contaminant, and for indicating the frequency of, or even need for, medical examinations in the detection of early signs of lead poisoning.

Normal urine, from persons with no industrial exposure to lead, contains 0.02 to 0.10 milligrams of lead per liter, dependent largely on the dietary intake. Amounts of lead in the range 0.15 to 0.20 milligrams per liter are considered indicative of exposure at a borderline level of actual toxicity, with a probable degree of safety.

Extensive experience indicates that the collection and analysis of "spot" samples of urine, containing about 100 ml., is a satisfactory procedure for determination of exposure. It has an advantage over the collection of 24-hour specimen in that its collection can generally be closely supervised and the danger of contamination of the sample lessened.

Precautions against contamination are the use of chemically clean vessels and stoppers and scrupulous cleanliness during voiding of the sample. In a 100 ml. sample, containing 0.15 mg. of lead per liter, the analyst will have to work with only 15 micrograms of lead. The possible influence of dust or other foreign matter in the sample is obvious.

We were told at the acid plant of the contemplated use of steel pipe with bonded lead lining. The use of this pipe may introduce increased exposure to lead fumes because it will not be possible to remove the lead lining at will, prior to making changes in the shape or length of pipe sections, as can be done with the lead inserts now used. The urinary lead determinations will be valuable in determining whether this expected increase of exposure actually occurs.

METER AND INSTRUMENT DIVISION

Shops.

The shop men routinely overhaul, clean, and repair meters and instruments. There is a main shop in the Petroleum Products Area and a shop in the Crafts Building of the Chemical Products Area. Smaller shops are located in the East and West Esso Laboratories Areas, and in the ELA Mechanical Shops.

In the shop work, mercury is the principal hazardous material encountered. Measurements were made of the concentration of mercury vapor in the air of each of these shops, except the ELA Mechanical Shop. In none could we find concentrations as great as 0.1 mg. per cubic meter of air, a concentration considered a safe upper limit for 8-hour daily exposure. Results of all measurements are shown in Table 12 (page 71).

The main Meter and Instrument Shop, which handles the greatest volume of mercury, has a system for collection and recovery of spilled mercury, the effectiveness of which is shown by the absence of visible deposits on the benches or floor and by the extremely low atmospheric concentrations found.

The trial of this system in the main shop is expected to lead to similar installations in the other shops. There is need of such a system in the Chemical Products Area Crafts Building and in the East and West Esso Laboratories shops. Although low atmospheric concentrations were found in these places, the difficulty of removing spilled mercury from this type of floor makes it appear that sufficient accumulations may occur to give rise to higher concentrations with the passage of time.

It is well to remember that the occurrence of mercury vapor in hazardous concentrations in laboratories and shops is more likely to result from evaporation of spilled mercury having extremely large surface area, than from the actual manipulations with liquid mercury in the shop or laboratory work.

Table 12

MERCURY VAPOR MEASUREMENTS--
METER AND INSTRUMENT SHOPS

Sample Number	Location	Air Volume (Cu.Ft.)	Mercury Concentration (Mg./cu.m.)
1	Main Meter and Instrument Shop. In vicinity of meter racks. Sample intake near floor.	20	0.08
2	Main Meter and Instrument Shop. In room used as office and storeroom. Visible deposits of spilled mercury on floor. Sample inlet at clerk's desk.	26	0.08
3	Shop in East Pilot Plant Area. New location for this shop. No visible deposits on this rough concrete floor. Sample intake on top of work bench at workers' breathing level.	15	trace
4	Shop in West Esso Laboratories Area. Shop located here for 3 months. Signs of spillage around mercury reservoir under bench. Rough concrete floor. No floor drain. Sample intake moved during sampling to three locations at breathing level.	10	trace
6	Shop in Crafts Building in Chemical Products Area. Visible deposits of spilled mercury on rough concrete floor. Floor drain has no trap for recovery of mercury.	20	0.08

The use of Varsol for cleaning purposes in these shops is not considered hazardous in view of the ammounts used and low volatility of this product.

Outside Men.

The principal duties of the outside men are inspection of thermocouple wells and orifice plates, trouble shooting at instrument locations, including repair at the site, and inspection and repair at time of turnaround.

These routine duties take the meter and instrument men into areas of exposure to process material of highly diversified character. Quantitatively, their exposures are considered somewhat less than that of process operators at the respective units. They are furnished protective clothing to prevent skin contact with heavy aromatic distillate, acids, and alkali. That they are sometimes exposed accidentally to high vapor concentrations is evident from the account of a "fainting" incident that occurred in the MEK plant and the fact that cases of poisoning with methyl chloride occurred among meter and instrument men when its use was new.

Exposure to mercury vapor in confined spaces by outside M & I men is not steady enough to cause any concern.

Skin contact with liquid mercury occurs on meter and instrument repair jobs. The frequency of its occurrence was not ascertained. It is not a serious potential source of industrial disease, because (1) the supervisors and the men know that it should be avoided and do so as much as is possible; (2) washing facilities are available and are used after encountering liquid mercury on the job.

Shift Men.

Shift men of the Meter and Instrument Division work out of the main shop and the Chemical Products Area Craft Building Shop and on the current turnaround jobs. Their work does not differ from that of the straight day men in the same area.

ELECTRICAL DIVISION

The greater part of the time of these men is spent away from the proximity of process material. Repair of refrigeration units, as in drinking fountains and air conditioning equipment, wiring and lamp replacements in the offices, maintenance of power lines overhead and beneath the ground are jobs that require no consideration in a review of health factors.

In work at the units, such as installation of lamps, maintenance and replacement of motors, temporary power and light wiring at turnaround, etc. the electricians' contact with process material is generally neither intense nor prolonged.

They work out of the main shop and way stations. Two or three men at a unit turnaround is the usual number.

<u>Line Gang</u>.

The line gang is composed of 13 rated men and one laborer. The work is mostly outdoors on overhead lines. Occasionally they are employed at pulling cable in underground conduits and, in bad weather, they may be employed at lamping in and around process units. Their employment is non-hazardous from the industrial health standpoint.

<u>Electricians Assigned to Process Units, Laboratories, and Offices</u>.

Five men are regularly assigned to process units, two at the catalytic cracking units and three at butyl rubber polymerization.

Twelve electricians are assigned to laboratories and offices. They may be excluded from consideration of health hazards.

Main Electrical Shop.

Four men are present full time at the main electrical shop. Their work is primarily that of motor cleaning and repairing. Approximately 100 motors per month are handled in this shop. Varsol is the regularly used cleaning agent. Its use in this shop is probably the greatest opportunity that exists in the refinery for toxic manifestations from repeated daily inhalation and skin contact, should there be any such manifestations from this substance.

According to a description furnished by the Refinery Laboratory, Varsol consists of a narrow cut fraction boiling between 300 and 400 degrees Fahrenheit. Its aromatic content was given as follows:

Varsol B (105)	15.5%
Varsol C (106)	15.5%
Hi Flash Varsol (107)	13.0%

This boiling range would indicate that benzene, the most toxic of the aromatic hydrocarbons, is absent and that toluene and Xylenes are also absent. Aromatic substance in the analysis would presumably consist of ethyl benzene, propyl benzene, isopropyl benzene (cumene), ethyl toluene, etc.

These compounds are in a class about which little is known toxicologically, except for the acute effects of single large doses. It would seem that the low aromatic content, low volatility, and natural ventilation at the shop would result in a toxic vapor exposure of a low order of magnitude. Determination of just what the exposure amounts to and what its effects may be on the men as determined by close medical observation would be desirable undertakings.

Pedigree Products No. 150 Thinner is used in the shop to the extent of about five gallons per week as a thinner for insulating paints and varnishes which are sprayed, for cleaning spray equipment, and for cleaning the hands. This product is described by its manufacturer as consisting of commercial xylenes. Its use constitutes an exposure of undetermined toxicological significance. Although the toxicity and volatility of xylenes are low, spraying of paints containing them as a thinner and intimate skin contact in washing the hands may produce undesirable effects in the men. Respiratory protection for the operators of spray equipment and substitution of a less irritant skin cleansing agent are logical starting points for elimination of any hazard that exists. In periodic medical examinations of these workers, attention should be directed at discovering any eye irritation, dermatitis, or central nervous system changes.

Skin Contact with Suspected Carcinogens.

Skin contact with heavy aromatic oils and other petroleum products from handling contaminated extension cords and floodlights that have seen service at process units is avoided by routine cleaning with steam by one man on "B" shift at the electric shop.

The regular duties of electrical maintenance men do not subject them to contact with acids or heavy aromatic oils and tar. Any contact is accidental, involuntary, and infrequent.

Underground Lead Work.

Lead sheathing in underground electrical conduits is relatively scarce in this refinery, being used for one voltage. Maintenance work on lead sheathing in underground conduits is done by one man. It was estimated that he is engaged for no more than one week per year at this type of work.

Because of its infrequent occurrence and the nature of the work, no lead poisoning hazard can be forseen in this work.

Occurrence of Nitrogen Oxides.

Vacuum tube rectification at the catalytic cracking units eliminates the possibility of exposure to nitrogen oxides, which is said to occur in other plants.

MASON DIVISION

This division includes 63 brick masons, 56 concrete and sandblast workers, and 72 insulators.

Masons.

The tearing down and removal of furnace brick at the No. 22 thermal cracking unit was observed in order to determine the degree of intensity of dust exposure in this type of work. Four dust counts made in the breathing zone of man performing this work showed concentrations ranging from 0.4 to 2.5 million particles per cubic foot, which are beneath hazardous levels. In work of this kind, there is usually some degree of natural ventilation. The work is intermittent. Some unit turnarounds require a minor amount of brick replacement. Dust encountered in this work would be expected to contain free silica to the extent of 25 to 30 per cent, as found in the Aruba survey. The job, therefore, is not considered to constitute a positive silicosis hazard.

Laying of new brick requires some cutting to shape at the site. For this purpose, the division has three clipper saws. They are equipped with dust exhaust but no collectors. The dust is discharged to the air at the rear of the apparatus. This effectively prevents the prolonged inhalation of dust by the operator. Persons in the area are, of course, exposed to the discharged dust. Their exposure is occasional since the saw is portable. The new type of saw with wet dust suppression, which is on order, will effectively prevent this nuisance practice of discharging dust to the air.

The replacement of brick in the catalyst regenerators in fluid catalytic cracking units is known as a dusty job. The greatest source of dust is the disturbance of residual catalyst in the chamber. Of secondary importance is asbestos dust, which is present to an unknown extent. It is probably minor because there is no process whereby the asbestos is broken down to fine particle size. The overhanging "Jointless" firebricks used in this installation can be excluded from consideration as an important source of dust for the method of installing them is not dust producing. The longevity of the brick in this service, and the normal frequency of four turnarounds per year serve to classify this dust exposure as occasional.

Replacement and laying of brick in acid areas constitutes a large part of the brick masons' employment. The brick has a low free silica content. Cutting and shaping is done mainly outdoors. The dust exposure is not considered hazardous. Use of Basalite adhesive can result in exposure to irritant fumes, unless precautions are taken. The irritant property of the fume is so intense that chronic exposures are necessarily avoided by the men themselves.

Concrete and Sandblast.

There is an interchange of men between concrete and sandblasting jobs which makes it difficult to determine just how many persons in the course of a year spend sufficient time in the vicinity of sandblasting to require physical examination by the Medical Department. The tendency toward increasing requirements for sandblasting inside process equipment prior to mechanical work at unit turnarounds makes it necessary that a continuing check on exposed personnel be kept by or for the Medical Department.

At units where we observed sandblasting inside towers, drums, or other equipment, the dust was well enough confined so that only the man handling the blasting hose was in a high concentration. He is, of course, protected with an approved supplied-air mask and helmet. There may be, and probably are, occasions where escape of dust is in the direction of attendants at the sand blast machines.

This is a situation which can only be evaluated by repeated observation and measurements at the scene.

At the sandblast shed next to the salvage yard, blasting of small parts from the process units, such as bubble caps, is done almost daily. The open sheds provided for this work provide no confinement of the dust. The shed where men must stand to attend the machines is sufficiently close to the blasting to receive at most times a high dust concentration. The attendants use no respiratory protection. Dust counts in this area, as shown in Table 13, which follows, ranged from four to 14 million particles per cubic foot. These concentrations are excessively high for free silica dust. Attendants at these units should be required to wear dust respirators during the whole time that sandblasting is being done. A more satisfactory long-range solution to the problem will be to provide a modern enclosed sand-blast shed with dust recovery system at the proposed new location at the Mechanical Crafts new buildings.

Table 13

DUST CONCENTRATIONS IN VICINITY OF SANDBLAST SHED

Sample Number	Sampling Time	Location	Dust Count (Million particles per cu.ft.)
68	5 min.	Around perimeter of brick-crushing shed.	7.4
69	5 min.	At entrance to shed just east of sandblasting shed. This is the regular station of the man tending the machine for the sandblasters.	14
77	5 min.	Inside the shed mentioned in No. 69.	14
78	7 min.	Same location as No. 77.	7.3
82	5 min.	Along side the eastern-most sandblast shed. No blasting being done in this shed at this time. Dust comes from two sandblasters working in the other shed.	4.2

EM001703

Brick and Asbestos Grinding.

Check

no long done

In a shed adjacent to the sandblast shed, a crushing machine is used several days each month to provide ground brick to be used as aggregate. Its use for grinding asbestos was described to us as very infrequent. Although an exhaust fan and duct are connected to this machine, there is considerable escape of fine dust within the room during its operation. Another important source of dust at this location is the sandblast shed next door. We feel that even in times past, when brick grinding was a continuous daily job to keep the polymer plant catalyst tower supplied, the high silica dust from sandblasting could have been a more important health factor than the occasional asbestos dust and brick dust in this shed. Use of a dust respirator in the brick grinding shed should be required.

Insulators.

We saw no operations in the refinery where insulators would be exposed to high concentrations of dust, harmless or otherwise, from the material with which they work. They do use a large variety of cements, thinners, solvents, and adhesives of unknown composition. There are some occasions where high concentrations of volatile constituents of these products will be encountered. The Medical Department should have some means of acquiring knowledge of the particular products that are in use and what the principal constituents are, so that proper medical control can be exercised.

GENERAL LABOR

Refinery Disposal Dump.

Fourteen men are employed and the majority have worked here more than ten years. All types of liquid and solid wastes from refinery processes, to the extent of 100-150 truckloads daily are disposed of here by open pit burning of combustibles. Since combustion is only of bon-fire type, considerable smoke results, and there is undoubtedly opportunity for major vaporization of materials surrounding the area of the actual fire. Dumping of heavy aromatics is said to be one of waste materials, and this suggests the good possibility of exposure of men to smokes containing injurious materials in vapor or mist form. Obviously, the men will attempt to take advantage of wind direction to avoid smoke, but this redeeming feature was minimized by our informants. At the time of our inspection, the wind was favorable for avoidance of smoke. The variety of waste materials handled and atmospheric conditions makes it impossible to appraise these conditions on a scientific basis, beyond the suggestions outlined above. General Labor supervisors rate the occupation as one of the worst problems they have.

Ethyl Lead Tanks Cleaning.

This hazard is recognized and precautions taken to comply with requirements and recommendations of the Ethyl Corporation (as well as duPont), which includes gas testing before entry into tanks, use of special protective clothing, supplied-air respirators, and periodic medical examination.

Exposure to Powder Catalyst Dust. Cleaning Reactor Chamber (PCLA).

A number of men are exposed for an estimated average of three months per year. The dust is very irritating to the upper respiratory tract and to the eyes.

It was generally agreed that men wear the respirators provided, faithfully, and this is a good index of the irritating qualities of the dust--since voluntary wear of respirators is only done where discomfort it imposes is of lesser extent. Goggles provided are worn but not as faithfully as respirators and, frequently, minor eye injury cases are reported to the Medical Department.

Cleaning Bubble Towers.

Inspectors, as well as laborers, cannot totally avoid skin exposures to various deposits in bubble tower and plate cleaning and inspecting, even though they wear rubber suits. These men literally must lie in the material where space is often no more than 15 inches deep. Some examples of this type of exposures are in the bubble towers of Cracking units 17, 18, 19, 20, 21, and 22, Pipe stills 1-8, PCLA 1, 2, and 3, ALA 1, 2, and 3, etc.

The deposits encountered in such places consist of a wide variety of materials from gas oil and naphtha used for flushing prior to entry to heavy polymers and coke deposits of unknown composition.

Exposures of this type to skin contact with materials of unknown composition and toxicity constitute one of the category of exposures of questionable importance. Fuller understanding of the effects of such exposures can only come with continued medical observation. The desire for complete health protection of refinery personnel dictates the necessity for avoidance of such exposures as much as possible and limiting the occurrence of possible ill effects by restoring cleanliness of person and clothing immediately following each exposure incident.

Cleaning Reactors, Light Ends Plant.

Renewal of polymerization catalyst occurs at a rate of about once in three months and lasts for about two days. The job is performed by a group of ten men at an out-of-doors location. The material they encounter is coarse and granular, hence non-dusty. No significant exposures can be seen in the performance of these duties.

Tank Cleaning.

A certain amount of unavoidable skin contact occurs when laborers enter a tank to remove sediment remaining after pumping out the tank. These exposures are in the same category with those described in the section above, entitled Cleaning Bubble Towers. Respiratory protection is afforded by the use of hose masks. Spent clay from the lube filters is used to "dry up" the last of the sediment to facilitate its removal by wheelbarrow. This practice constitutes no dust hazard by reason of the granular form of the material used.

Tube and Soaker Cleaning.

An important segment of the duties of general labor consists of cleaning tubes at the furnaces of the various refining units. Some eighty men are employed on this job over three daily shifts.

There is no doubt that this is a dust-producing operation.

It is likewise evident that there is no accumulation of dust concentration at the breathing level of the cleaners, because their position is open to the outside air on three sides and above. There is usually a fair amount of air movement about their position. When dust production ceases, dust at the breathing level is quickly dissipated. The production of dust is fairly constant after the tubes have been opened and cleaning equipment has been put in place. Total exposure time, as for most M & C operations outside of shops, is variable and, hence, unknown. The effects on health from inhalation of these dusts, if and when it occurs, are likewise unknown.

Cleaning Soaking Drums at Thermal Cracking Units.

Cleaning out vertical soaking drum at cracking coil No. 22 was done by means of a mechanical auger inserted from the bottom. Water wash flows down through the drum. This cleaning rig is used on 19, 20, 21, and 22 coils. Four laborers comprise its crew.

There is no dust exposure because of the use of water. There is opportunity for skin contact with materials in the drum while fitting the bit and while cleaning the sludge and coke away from the rig. We were told that one man is sometimes put into the drum from the top for scaling with a hand tool.

These contacts would be an important exposure in cases where the unit has been feeding clarified oil from catalytic cracking. There is an opinion in some quarters that the aromatics boiling over 700°F. are not destroyed, but concentrated, in the heavy tar fraction when clarified oil is fed to thermal cracking coils. This opinion should be tested by means of some animal toxicological experiments.

Dismantling Condenser Boxes.

Four laborers were engaged in dismantling a condenser box on the No. 22 unit. There was a copious flow of heavy tar from the coils as end-connections were removed. Skin contact was plentiful. Some pipefitters were also involved in this occurrence, which was described as unusual by the pipe-fitter foreman, as gas oil is usually encountered in dismantling these coils. In this instance, the tar may or may not be considered potentially carcinogenic, depending upon its source and prior treatment. The occurrence serves to point up the necessity for establishing some procedure whereby every unexpected incident that results in prolonged contact of material over a large area of men's bodies shall be reported to the Safety Department or some other responsible agent for determination of whether the regulations concerning clothing, showers, and medical examination for potential carcinogens shall be applied.

Exposures to Heavy Aromatics.

General Labor foremen have given earnest consideration to the problem. A question was raised that, in digging ditches to uncover pipeline leaks, the men may encounter a deposit of aromatics seepage. Alertness to this occurrence, which obviously exists in the division, is essential to success of the program for prevention of contact. Actual supervision of the use of protective boots and gloves that are provided for such occurrences is the other essential for success.

Another question is that of replacement of work clothing which men will wear for long periods in normal practice. This is one of the many details that must be worked out in the plan for providing clean work clothes when there has been contact with suspected carcinogenic material.

Skin contacts with heavy aromatics, on the part of general yard labor, has been considerably lessened by the provisions for flushing out lines before work is done on the catalytic cracking units. Similar provisions are being arranged at thermal cracking units where clarified oil is cracked.

CARPENTER AND PAINTER DIVISION

Paint Shop.

The use of paint remover for stripping office furniture and other items occurs with sufficient frequency to require precautions against injurious inhalation of vapor. It is urged that special ventilation be provided for this work. It can be arranged by installation of a large propeller exhaust fan, e.g., 24" to 30" diameter, and placing of all paint remover work immediately adjacent to this fan. The present system of placing furniture outdoors for removing paint is not an assurance of safety against inhalation of the vapors of benzol, toluol, or chlorinated hydrocarbons which may be present because it depends on the vagaries of the winds and is not at all practical during extended rainy periods.

Painters.

The relatively minor role of painting by refinery personnel is indicated by the fact that about 32 men actually do painting. Of this number, five or six men are part-time spray painters. (Major paint jobs on new construction, tanks, and process equipment is done by contractors.) Respirators are provided for all indoor spray work, which is very infrequent. No red lead is sprayed by refinery personnel.

An item of major interest to the Medical Department is the possibility of the occurrence of benzol in some of the formulations used. Since the sources of paint products, and even the composition of products from the same source, are subject to variation, a check on benzol exposures can best be obtained by random application of urine sulfate measurements to the members of the group.

M I S C E L L A N E O U S

LABORATORIES

Refinery Laboratory

Aniline.

Daily routine aniline point tests are made. We could see no practice in the conduct of these tests that would result in breathing appreciable amounts of aniline vapor or any skin contact with aniline, except, perhaps, accidentally. The amount of aniline required for a test (approximately 10 c.c.) is drawn from a reservoir in an exhaust hood. It is mixed with material being tested on a laboratory bench away from the hood. After the test, used aniline is discarded, there being no facilities for re-distillation. Our only suggestion regarding the protection of workers from aniline is that the physical examination of these people be increased in frequency from once to twice a year, to conform to practice in the other refineries that we have seen.

Mercury Vapor.

Those laboratories in which metallic mercury is used were visited in company with Mr. Day, of the Safety Department, for the purpose of observing the extent and manner of use and the disposition of spilled mercury. Hygienic practice in the use of mercury consists of controlling accumulations of vapor or dust in the working environment. This can be accomplished by providing a reasonable amount of room ventilation and in keeping the floors and work benches free of spilled mercury. Evaporation takes place from finely divided droplets dispersed on a floor surface at a much greater rate than it will from mercury reservoirs on laboratory apparatus, because of the greater surface exposed to the air. The American Standards Association has adopted the value of 0.1 milligram per cubic meter of air as the maximum permissible concentration. It constitutes a good bench mark for control of mercury vapor exposures. It expresses an easily attained level of control.

The results of measurements made in the various laboratories are known to the Safety Department. They are summarized in the Table below (page 88) for convenience.

Only the Gas Analysis Room of the Refinery Laboratory showed a concentration bordering on the level of what constitutes good practice. In this instance, replacement of the contaminated floor mats and cleaning and painting of the contaminated floor will effectively reduce the atmospheric concentration to the level prevailing in the other laboratories. The Gas Analysis Room of the Chemical Products Laboratory is in a much worse condition as regards spilled mercury on the floor and beneath the work benches, but accumulation of concentrations in the air is prevented by the excellent ventilation system.

Table 14

MERCURY VAPOR DETERMINATIONS--LABORATORIES

Sample Number	Location	Mercury Concentration (Mg. per cu.m.)
5	Refinery laboratory. Gas Analysis Room. Fairly smooth concrete floor. Rubber mats. Not much ventilation. Sample intake at breathing level in two locations.	0.18* Greater than 0.1
7	Plancor 572 Lab. Sample at breathing level near POD apparatus. No visible spilled mercury.	Less than 0.02* 0.0
8	Refinery Laboratory. Leonard's Lab. Small use of mercury. Good ventilation. No visible deposits.	0.0
9	Distillation Group Laboratory: (a) Near vacuum still (b) Near glass still	 0.0 0.0
10	Fuel Products Lab. Mercury is washed here for use in test at treating plant. Sample taken near washing apparatus in open cage locker.	0.0
11	Chemical Products Main Laboratory: (a) Analytical Lab. In vicinity of Polarimeter at breathing level (b) Gas Analysis Lab. Visible deposits of spilled mercury on the floor, on rubber mats, underneath laboratory benches. Six exhaust ducts with intake one foot off floor, good air supply to room. Sample taken at breathing level. (c) Special Problems Lab. B. Small use of mercury; good air movement. (d) Special Problems Lab. A. Small use of mercury.	 0.0 0.0 0.0 0.0

* Results obtained by a chemical method utilizing absorption in iodine and a colorimetric determination. Air volume 20 cubic feet. All other results were obtained by use of the General Electric Mercury Vapor Detector.

PRINTING STANDARDS

The shop, design section, and office of this division employ about 33 persons in a one-story frame building.

Materials Handled.

The use of AzO dyes in the Ozalid process and of photographic chemicals constitute possible sources of dermatitis in susceptible individuals with which the Medical Director is fully aware. There are several solvents and process liquids in use which are of interest because of the likelihood that these, and similar preparations that may come into use from time to time, contain substances of known toxic properties, such as methyl alcohol and carbon tetrachloride.

Those currently in use are:

Ditto Direct Process Liquid
Multilith Blankrola
Multilith Repelex
Multilith Repelex
Multilith Platex
Multilith Decxit

Ventilation.

Besides the doors and windows which are usually open, ventilation of the working space is furnished by a 48-inch attic fan, a wall exhaust fan at the location of the photographic reproducer, and the exhaust fan connected with the hood over the Ozalid Process. It is estimated that the ventilation rate exceeds 12,000 to 15,000 cubic feet per minute. This ventilation rate will suffice to keep concentrations of vapor of liquids commonly used in formulations of this kind below 100 parts per million in the air, should the total evaporation rate amount to as much as 2.5 gallons per hour. According to our observations of the processes, the evaporation rate of liquids in this shop is much below this figure. Concentrations of vapor in the air are thus maintained at a level safely below that which would cause harm to the personnel.

If there were acute exposures to high local concentrations of harmful solvents at any of the machines, these would have manifested themselves by symptoms of nausea, dizziness, or irritability.

ASPHALT PLANT

Need study

We did not make a study of the facilities at this refinery for oxidizing, blending, and packaging asphalt. In view of the experiences at other refineries within the company, it would be advisable to examine these facilities from the standpoint of production of vapors or mists in oxidizing, aromatic vapors in cutback blending, and asphalt mist at drum filling, wherever such atmospheric contaminants may prevail for extended periods in areas where men are at work.

APPENDIX

PREVENTION OF EXPOSURE TO HIGH BOILING AROMATICS

We have reviewed the basic information which indicated the necessity for a program of control of exposure to catalytic cracking or steam cracking fractions boiling above 700°F.; we are also acquainted with the exposition of this program to employees on February 23 and 24, 1949, and with the general rules for personal conduct and hygiene with respect to persons encountering these fractions in the course of their duties. We have reviewed the Safety Department's survey of exposures to high boiling aromatics in the refinery, which includes recommendations for further action and additional precautionary measures.

These studies indicate that the Refinery is in a favorable position with respect to prevention of skin contact with these oils by employees and early detection of any skin changes brought about by contact. The first and most important favorable point is that the employees are fully informed of the reasons for precautions. They have thus been put in a questioning frame of mind. Possibilities for exposure that were overlooked in the original directives and survey have been suggested and will continue to be brought out by the several hundred alert supervisors and workers that are affected. The list of proposed improvements in the Safety Department's survey contains several examples, notably the necessity for providing better means for flushing out slurry heat exchangers and steam generators at the catalytic cracking units, especially those that must be worked on while a unit is in operation. Some details of procedure still remain to be accomplished. Slurry pumps, in present practice, are not satisfactorily drained of the oil before removal to the machine shop for disassembly. There seems to be a chance for small parts from service in heavy aromatic oils to reach the sand blast shed for cleaning without warning labels.

With widespread knowledge of the problem, the prospects are excellent for the development in time of totally effective procedures.

The adequacy of facilities for taking showers and for provision of protective clothing assumes a great importance in this program for prevention of skin contact. We find that the refinery is well-equipped with shower rooms and that they are well-distributed for easy accessibility by those who may be in need of such facilities during a working day or at the end of the working day. Any tendency toward further centralization will have a detrimental effect on the ready accessibility of the rooms after the occurrence of a spill or a splash of the oil fractions that are to be avoided. Maintenance of these shower rooms in a clean and sanitary condition is generally quite good. There are a few exceptions:

(1) The colored room at the road oil stills. The location of this washroom under a water tank makes light and ventilation a difficult problem but maintenance on a par with facilities elsewhere could still make it a good place to take a bath.

(2) The colored room beneath tank No. 291 (next to No. 2 boiler house) is likewise ill-kept.

(3) The colored room at the Plate Shop suffers from overcrowding.

General Labor foremen say that 99 plus per cent of Negro laborers take showers on their own time at the end of the working day. This habit should be encouraged in every practical way. Good maintenance of the shower rooms is most important.

In the matter of dividing potentially exposed personnel into <u>frequent</u> and <u>infrequent</u> groups, we question the inclusion of nearly all process employees at PCLA units, QBLA, and OLA in the <u>frequent</u> category, while the number of Mechanical employees is minimized. In our experience, the process employees spend more time at places where these oils are handled but experience less skin contact than Mechanical employees who may less frequently be in areas of exposure but more often are exposed. A simple time study on these groups should clarify the respective exposures.

In addition to what has been done to lessen skin contact with these high boiling aromatic oils, we propose that a complete program for prevention of exposure should include the prevention of inhalation of vapor or mist of these fractions. We were able to demonstrate the presence of oil mist in the vicinity of hot clarified oil pumps at the catalytic cracking units. We feel that there should be a concerted effort to identify and evaluate every occurrence of oil mist in places where men work and where the stock consists of oils that are presently included in this program for prevention of skin contact. The toxicological potentialities of inhalation of a mist of a substance that is potentially carcinogenic cannot at present be adequately defined but seems to deserve a great degree of important consideration. Initial efforts should be directed to the areas of slurry and clarified oil pumps at catalytic cracking units; feed pumps at thermal cracking units receiving clarified oil; quench oil pumps at steam cracking units; the tar product pumps of steam cracking units; and the use of steam lines for flushing away surface deposits that have resulted from spills or leaks.

All sampling locations at units handling these oils should be examined for the purpose of ascertaining whether the person who draws the sample can accomplish his mission without suffering exposure to mist or splashes of the stock he is sampling.

BENZOL EXPOSURES

While potential exposures to benzol in various locations (summarized below) may have been over-emphasized, the uniquely toxic character of the vapor warrants special attention.

Various investigations in the consuming industries, especially in coated fabrics plants, where enclosure of equipment and ventilation were thought to be good, disclosed cases of benzol poisoning at concentrations of 75-100 p.p.m. The action is particularly insidious; many fatalities from chronic exposure to low concentrations are known.

Time for the survey did not permit detailed appraisal of this hazard in the several possible exposure locations. We did not feel that any were particularly significant, especially for average individuals in good health. The possibility of unfavorable developments, however, in an occasional susceptible individual could not be ruled out, and this is the reason for the general recommendation for medical supervision for workers potentially exposed.

Urine Sulfate Test.

This test provides a convenient method for measuring the degree of a worker's exposure to benzol vapors during a given day, and is particularly applicable to appraising the exposures of workers in the listed locations.

Summary of Potential Benzol Exposure Areas.

Solvent De-waxing (MEK) Plant
Steam Cracking Plants No. 1 and No. 2
Diolefin Extraction Unit
QHLA Steam Cracking Coils
Paint Shop