FILE NAME: Oil Industry and American Petroleum Institute (API)

DATE: 1961 July

DOC#: API167

DOCUMENT DESCRIPTION: The Medical Bulletin Article - Industrial Hygiene Aspects of Mechanical Operations in a Petroleum Refinery

THE MEDICAL BULLETIN

JULY, 1961

STANDARD OIL COMPANY (NEW JERSEY)
AND AFFILIATED COMPANIES

VOLUME 21 NUMBER 2

INDUSTRIAL HYGIENE ASPECTS OF MECHANICAL OPERATIONS IN A PETROLEUM REFINERY

W. H. MEYER and F. W. CHURCH

Esso Research and Engineering Company

Exposures to chemicals and physical agents by workmen in the mechanical crafts cover essentially the entire realm of industrial hygiene concern. Such problems range from the inhalation of and physical contact with vapors, dusts and fumes to excessive heat, noise and radiation.

Mechanical craftsmen may work either in a centralized shop or in the field. In general, the severity of exposure is greater with field work than with similar work in the shop. Many times field work must be done in confined spaces where the provision of adequate ventilation may be difficult. Under these conditions, for example, a welder may have higher exposures than normally occur in shop welding.

In many industries, as in petroleum, automation and mechanization have reduced the exposures to process operators. Proportionate reductions have not always been made in the mechanical crafts. In addition, new processes and materials of construction have tended to increase the already imposing list of hazards. As an example, in the relatively new field of petro-chemicals many solvents, catalysts and chemicals are used which were not previously encountered. Alloy metals and protective coatings are more and more in use which may produce quite toxic dusts, fumes and gases under heated conditions or when abrasive-blasted.

The importance and scope of industrial hygiene evaluation and engineering control of the environment in which the mechanical craftsman must work is further evidenced by the fact that roughly 50% of a refinery work force may be employed in the mechanical trades compared to 25% each for process and other employees.

In the attached listing are summarized some of the more important mechanical operations, the potential hazards and suggestions for control methods. While basically prepared for shop operations, the general principles can be translated to other conditions. Actual assessments of the environmental factors should be made by means of industrial hygiene techniques to determine the extent of controls required.

Medical Research Division
Esso Research and Engineering Company

INDUSTRIAL HYGIENE COMMENTS ON MECHANICAL OPERATIONS

This tabulation will not be complete for all refineries as some may have specialized mechanical work not covered here. Also in some locations certain mechanical jobs may not be done in the shops or departments shown in this listing. This is not important, however, since this listing is concerned with the job rather than where it may be carried out.

Area	*Hazardous Items*	*Comments*
BOILERMAKER SHOP	Noise Free Silica (see also welding)	Many of the operations in this area produce noise intense enough to damage hearing of attendant personnel. Cold riveting, chipping, and plate bending are examples of operations which might require reduction of noise level or personnel protection. During pipe bending the pouring of sand in and out, as well as the sand handling facilities, make the air dusty. If the sand used has a high free silica content, exposures to this dust must be minimized. If welding is done in this shop, the potential exposures listed under *welding* should be included here.
CARPENTER SHOP	Paint Solvents Sanding Dust Noise	Various solutions and solvents are used for loosening and removing paint from objects requiring carpentry. In most instances the solvents contain aromatic or chlorinated hydrocarbons and either general ventilation or local exhaust should be provided. Skin contact with solvents can produce dermatitis. Prompt removal of solvent contaminated clothing and the use of gloves and showers reduce the hazard. Sanding operations produce considerable dust. Often the work piece has been painted with metallic pigments, such as lead or manganese, which can add the air with extremely toxic materials. Local exhaust should be provided for this operation.

Area	*Hazardous Items*	*Comments*
		Circular saws, bandsaws, planers, shapers, and the like, can be noisy, particularly when working on hard woods. Efforts to isolate and enclose these operations should be considered.
ELECTRICAL SHOP	Solvents, i.e. Benzene Carbon Tetrachloride Trichloroethylene	Many electrical shops use carbon tetrachloride or similar toxic solvents for cleaning electrical equipment. These materials may be sprayed or used as a dip. Carbon tetrachloride in particular is highly toxic. If required for cleaning electrical equipment, special arrangements should be provided, such as ventilated hoods or booths, so that employees do not inhale the vapors. In some applications it is possible to substitute methyl chloroform (MAC 500 ppm) for carbon tetrachloride (MAC 25 ppm) thereby reducing the hazardous conditions.
FORGE and BLACKSMITH SHOPS	Smoke Fumes Cyanides Radiant Heat Noise	Most forges have only a canopy hood placed some distance above them. The draft caused by the heat of the forge and the stack effect of the hood is generally insufficient to satisfactorily control the smoke and fumes from forging. The hood should be mechanically exhausted to assist the natural draft to provide a satisfactory control velocity over the entire free face area between the forge and the hood. It may be expeditious to reduce this free face area by partial enclosure. Case hardening sometimes employs cyanide salts. The entire operation where cyanide salts are involved should be under mechanical exhaust. This includes preparation of the salts, dipping and sprinkling of the salts over the heated work-piece, and work-piece quenching. At forges or furnaces, shielding should be used to reduce the amount of radiant heat transmitted to the work place. This is particularly true for openings of the furnaces through which the hot interior surfaces can be seen, such as the door, pyrometer ports, and so forth. Several operations in the area can produce high intensity noise, i.e., drop hammers and furnace burners. Efforts to isolate and enclose these operations should be made.

Area	*Hazardous Items*	*Comments*
INSTRUMENT SHOP	Mercury Solvents, i.e. Benzol Carbon Tetrachloride Trichloroethylene	Mercury is often spilled when instruments are repaired and serviced. Accumulation of mercury droplets on tables, floors, and other working areas may easily result in excessive amounts of mercury vapor in the atmosphere of the work area. Careful techniques should be followed to avoid spillage of mercury, properly

particularly into the openings of the furnaces through which the hot interior surfaces can be seen, such as the door, pyrometer ports, and so forth.

Several operations in the area can produce high intensity noise, i.e., drop hammers and furnace burners. Efforts to isolate and enclose these operations should be made.

Area	*Hazardous Items*	*Comments*
INSTRUMENT SHOP	Mercury Solvents, i.e. Benzol Carbon Tetrachloride Trichloroethylene	Mercury is often spilled when instruments are repaired and serviced. Accumulation of mercury droplets on tables, floors, and other working areas may easily result in excessive amounts of mercury vapor in the atmosphere of the work area. Careful techniques should be followed to avoid spillage of mercury; properly designed stands for tearing down and servicing meters help toward this end. In addition, good housekeeping and immediate cleaning of spilled mercury does much toward eliminating this hazard. (See attached drawing "Suggested Features for Mercury Meter Repair Stand" MRD-N2-53). If solvents are required for cleaning instruments parts, exposure to their vapors may occur. Some solvents, such as benzol, or chlorinated solvents like carbon tetrachloride, are extremely hazardous. These solvents should be handled with care and used only in well ventilated areas. If routine use of these materials is required, special facilities should be installed for the handling and application.
INSULATORS	Asbestos	If the insulators reclaim old insulation by shredding, the shredding device or machine should be provided with mechanical exhaust ventilation to prevent the dissemination of asbestos into the breathing zone.
MACHINE SHOP Metallizing	Cadmium Lead Nickel Zinc Noise Chromium Fluorides	The spraying of molten metals and alloys on heterogeneous metallic objects introduces fumes into the workroom atmosphere. Control of these fumes is necessary and is accomplished through local mechanical exhaust ventilation. Fumes of lead, lead alloys, cadmium and beryllium are extremely toxic and complete respiratory protection must be provided for the operator and other workers in the fume area.
Degreasing	Solvents	Occasionally solvents are required for cleaning work-pieces. These solvents should be handled carefully and used only in well ventilated areas. If routine use of these materials is required, special facilities should be installed for their handling and applica-

Area	*Hazardous Items*	*Comments*
		tion. Many satisfactory commercial units are available for this purpose. Skin contact must be avoided. Such solvents as benzene and carbon tetrachloride have a high order of toxicity and special caution is required.
Babbitting	Lead Cadmium Arsenic	Babbitt metal is the name originally given to alloys of tin, lead, and antimony. Newer materials may also contain cadmium and arsenic. Health hazards due to melting of babbitts depend upon several factors such as: pot size, temperature of melt, drossing procedure and disposal methods, frequency of melt disturbance by ladling and level of housekeeping. Good industrial practice requires thermostatic control of temperature, careful drossing and disposal of dross in a separate covered receptacle. The need for mechanical exhaust depends primarily on the frequency of the operation and quantities handled. Exhaust ventilation is recommended for large pots used for melting metal on a production basis.
Tool Grinding	Cobalt Beryilium	Grinders for sharpening tungsten-carbide tools should have local mechanical exhaust ventilation to prevent the inhalation of cobalt by the men. This cobalt dust comes from the cement used to bond the cutting tip to the shank. The wheels for grinding and sharpening non-sparking tools should have mechanical exhaust because these tools are made of a beryllium alloy. Sometimes such grinding and sharpening equipment is placed inside the tool crib and all operations are restricted to this area.
MASONS	Free Silica Radiant Heat	High silica content fire-bricks may be cut or ground to special shapes and sizes. The brick masons should have a cut-off saw containing an integral exhaust system to keep the dust away from their breathing zone. Furnaces lined with fire-brick must have the lining removed periodically. This operation subjects the workers to high concentrations of dust. As the work is usually intermittent, approved

Area	*Hazardous Items*	*Comments*
		air-line respirators should be worn while the work is in progress. In the event air-line respirators are impracticable, the filter-type respirator approved for protection against pneumoconiosis-producing dusts will provide adequate protection. Work [illegible] sometimes exposes the masons to high

Area	Hazardous Items	Comments
MASONS	Radiant Heat	High silica content fire-bricks may be cut or ground to special shapes and sizes. The brick masons should have a cut-off saw containing an integral exhaust system to keep the dust away from their breathing zone. Furnaces lined with fire-brick must have the lining removed periodically. This operation subjects the workers to high concentrations of dust. As the work is usually intermittent, approved air-line respirators should be worn while the work is in progress. In the event air-line respirators are impracticable, the filter-type respirator approved for protection against pneumoconiosis-producing dusts will provide adequate protection. Work within furnaces sometimes exposes the masons to high heat loads. Since most of this heat is from radiation, it cannot be easily controlled. Reflective, air cooled clothing may help in withstanding the high temperature. Often, the best that can be done is to limit the length of work time so as to control the duration of exposure.
PAINT SHOP	Pigments Solvents Thinners Paint Removers	Paint is applied by either brush or spray gun. The hazards of the work come from toxic pigments, solvents, thinners, and removers. Pigments may contain lead or other materials having toxic properties. Aromatic materials, such as benzol, toluene, and chlorinated materials, such as carbon tetrachloride and trichloroethylene may be employed as solvents or thinners. Both benzol and carbon tetrachloride are popular materials for paint removers. Inhalation of these materials may take place around painting operations. Good paint removers are also strong skin irritants. Paint shops should have well ventilated drying areas so that the solvent vapors being emitted during the drying process do not contaminate the general work area. An exhaust hood with a turntable mounted in front of it can provide a means of control when spray-painting small objects. For isolated spray painting, personal protective equipment should be used and any group of painters should be placed under medical supervision.
SANDBLASTING	Free Silica Noise	The health hazard of sandblasting is the inhalation of free silica dust possibly leading to silicosis after prolonged exposure. Both the sandblaster and his helper are exposed to this type of dust while blasting. There are generally two types of sandblasting, and both of these require protection for the worker. The first is sandblasting in one central location to which the parts are brought to be cleaned.

Area	*Hazardous Items*	*Comments*
		Commonly this work is done in a room or cabinet. The other type of sandblasting is done in field locations since the work is too large to move. In this type, the operator moves over the entire structure. The methods of controlling exposure to dust in these two situations are different. Where sandblasting is done in a room or cabinet, it is usual to supply these structures with exhaust ventilation. Where the operator stands on the outside of a cabinet or booth, the ventilation may be designed as to preclude the wearing of a sandblasting helmet. However, where the operator stands inside of the cabinet he must wear an approved blasting helmet. Where sandblasting is done in the open or on process equipment, structures, and the like, about the only method of protecting the individual is for the operator to use an approved sandblasting helmet. Dust type respirators may be adequate for the helper. The actual exposure to silica dust can be evaluated only by dust counts. Near the nozzle where the blaster himself stands, it is obvious that the exposure would be extremely high. Therefore, the counting of dust in such a situation is useless as it is not needed to reveal a health hazard. On the other hand, where it is observed that other workers are being exposed to silica dust, it may be desirable to determine the level of exposure. This should be done by an individual trained in the industrial hygiene techniques of collecting and counting dust samples. Exposed personnel should be placed under close medical supervision.
TIN SHOP	Lead Fluorides Cadmium Zinc Chlorides	(1) *Tin-Lead.* The heating of tin-lead solder to the flow point so that it will bond with other metallic surfaces when cooled is usually performed with a hand soldering-copper or tinning pot. The temperature of the melt is usually not high enough to produce injurious concentrations of lead fumes. However, during the "shake off" of soldered parts, finely divided particles of lead may be dispersed to the general room atmosphere. Control of the "shake off" exposure where large parts are involved, is through mechanical exhaust ventilation.

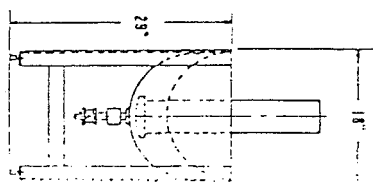
Area	*Hazardous Items*	*Comments*
		Fluxes and various cleaning solutions contain chlorides or free hydrogen chloride. A hood with mechanical exhaust should be provided in any acid-cleaning area. (2) *Silver Solder.* The process of silver soldering, sometimes known as hard soldering, involves the use of an oxyacetylene or city-gas torch to melt the silver solder in the presence of a flux. When borax or boracic acid is used no health hazard is presented by the flux. However, some types of [illegible]

placed under close medical supervision.

Area	Hazardous Items	Comments
TIN SHOP	Lead Fluorides Cadmium Zinc Chlorides	(1) *Tin-Lead.* The heating of tin-lead solder to the flow point so that it will bond with other metallic surfaces when cooled is usually performed with a hand soldering-copper or tinning pot. The temperature of the melt is usually not high enough to produce injurious concentrations of lead fumes. However, during the "shake off" of soldered parts, finely divided particles of lead may be dispersed to the general room atmosphere. Control of the "shake off" exposure where large parts are involved, is through mechanical exhaust ventilation. Fluxes and various cleaning solutions contain chlorides or free hydrogen chloride. A hood with mechanical exhaust should be provided in any acid-cleaning area. (2) *Silver Solder.* The process of silver soldering, sometimes known as hard soldering, involves the use of an oxyacetylene or city-gas torch to melt the silver solder in the presence of a flux. When borax or boracic acid is used, no health hazard is presented by the flux. However, some types of work call for the use of a flux containing fluorides. These fluorides are hazardous if breathed in appreciable quantity. Workers also should be cautioned not to get fluoride flux on the hands. Some silver solders contain appreciable quantities of cadmium which can be vaporized into the worker's breathing zone. Control, when required, is through mechanical exhaust ventilation. If welding operations are conducted in this shop potential exposures similar to the list under *welding* should be considered.
WELDING and CUTTING	Fluxes Fluorides Chlorides Metals Cadmium Chromium Lead Manganese Zinc Nickel Other Oxides of nitrogen Ozone Radiation Infra-red Ultra-violet X and Gamma	There are two classes of welding--gas and electric. The gas types are oxyacetylene, oxyhydrogen, and atomic hydrogen. Electric types are metallic arc, carbon arc and resistance. The newer methods such as gas-shielded arc, submerged arc, and magnetic arc, and magnetic flux, are electric also. The hazards incident to the operation are varied in their nature and severity. The requirements for health protection and ventilation in welding and cutting have been established by the American Welding Society on the basis of the three following factors which govern the amount of contamination to which welders may be exposed: 1. Dimensions of space in which welding is done. 2. Number of welders. 3. Possible evolution of hazardous fumes and gases according to the metals involved.

Area	*Hazardous Items*	*Comments*
		As a guide only, 2000 CFM welder should be supplied as general ventilation when welding or cutting mild steel in spaces of less than 10,000 cu. ft. welder or in a room having a ceiling height of less than 16 ft. Natural ventilation may be sufficient when these confined space limitations do not exist. Fumes from beryllium, cadmium, lead, chromium or mercury are extremely toxic and local exhaust and or supplied air respirators are generally required. Where local exhaust is used, a freely movable hood, intended to be placed by the welder as near as practical to the work, should provide sufficient air flow to maintain 100 linear ft. min. in the direction of the hood at its remotest distance from the point of welding. Eye protection must be provided; the density of color of the protective glass being dependent upon the intensity of the radiation. Flash shields should completely enclose the inert gas welding area to protect the eyes of workers other than welders. The bottom of the shields should be a short distance above the floor to help create natural convection currents. The newer welding processes produce around ten times the amount of ultraviolet radiation as does ordinary arc welding. Protection of onlookers in these cases is exceedingly important. X-ray machines and gamma ray sources are used to test welds. Film badges and direct reading pocket dosimeters should be worn during radiographic work. Short exposure times and the greatest possible distance from the radiation source are the most effective means of reducing exposures.

SUGGESTED



DIMENSIONS ARE SU
CAN BE CONVENIEN
TROUGH SLOPES TO
MOUNTING POSTS AT
WORKING LEVEL
TROUGH TO BE WASH
ALL CRACKS AND CRE
TO BE KEPT TO A M