ELEMENTS OF AN EFFECTIVE
INDUSTRIAL HYGIENE ENGINEERING PROGRAM
WITH SPECIAL CONSIDERATIONS FOR THE
MONTANA MINING DIVISION

THE ANACONDA COMPANY
MONTANA MINING DIVISION
BUTTE, MONTANA

INDUSTRIAL HYGIENE ENGINEERING REPORT

from The Travelers Insurance Companies

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CHEMICAL, ENVIRONMENTAL AND PRODUCTS SAFETY UNIT

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I N D E X

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APPENDICES

I. INTRODUCTION

The control of employee industrial health exposures is vital to all industry. The provisions of a number of laws, including the Metal and Non-Metallic Mine Safety Act of 1966, the Federal Coal Mine Health and Safety Act of 1969, and the Occupational Safety and Health Act of 1970, have placed increased emphasis on the providing of a safe, and for purposes of this discussion, healthful, place to work.

The Anaconda Company, Montana Mining Division, through its Director of Safety Mr. David L. Watts, has a desire to evaluate the existing Industrial Health program of the division, and, where appropriate and desirable, to increase the effectiveness of the program. A request was directed through Travelers' Field Engineering representative in Montana, Engineering Supervisor David W. Ardiana, to assist in evaluating the present program and provide recommendations for any changes or improvements to the current program.

This report is a first step in this evaluation. The writer has a minimum of knowledge of specific activities related to Occupational Health within the division. It is intended in this discussion to provide Mr. Watts and the Montana Mining Division an outline of the principle elements of a program, to discuss the importance of many of these elements and how they apply, and to outline areas of specific information which are required by Travelers personnel in order to carry out the intended objective. Once this information is assembled and can be evaluated, then Anaconda and Travelers personnel can proceed with the next step, program evaluation, physical inspections, difinitive consultation, and recommendations for program changes and improvements.

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM

A. Scope

The effective control of Industrial Hygiene exposures involves application of five (5) distinct elements. Each element is of relatively equal importance in its own way, but must be taken in a logical progression. These five (5) elements are:

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

A. Scope (continued)

1. Exposure Recognition
2. Exposure Evaluation and Quantification
3. Medical Monitoring of the Occupational Environment
4. Exposure Controls
5. Education and Training

B. Exposure Recognition

1. General

The first element in control of the occupational Environment health hazard is recognition. It is important to recognize there are some exposures existing in every occupational environment. The specific exposures, actual and/or potential, must be discovered and set forth for each unique job and environment.

The most frequently encountered causes of Industrial Health exposures are:

1. Chemical Causes (Liquids, dust, fume, mist, vapor or gas)
2. Physical Energy (electro magnetic and ionizing radiation)
3. Noise, Vibration, and exceedingly great temperature and pressure extreames.
4. Biological (in the form of insects, mites, molds, yeasts, fungi, bacteria and viruses).
5. Ergonomic (monotony repeditive motion, anxiety and fatigue, etc.)

These stresses must all be evaluated in terms of their danger to life and health, as well as their influence on the natural bodily functions.

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

B. Exposure Recognition (continued)

2. Theoretical Evaluation

The first step in Exposure Recognition is a theoretical evaluation of potential exposures. All operations should be considered to try and determine what logical kinds of exposure might exist. This is very preliminary, not intended to be complete, but to provide a basic guide, and preparation for step two (2) of exposure recognition. A guide to many exposure potentials is given in Appendix "A".

3. Elementary Survey of Operations

The second step in exposure recognition is the elementary survey of operations. The scope and general requirements of such elementary surveys is covered in more detail in Appendix "B"

C. Exposure Evaluation and Quantification

Once the exposures have been recognized, the actual degree of exposure to each worker must be evaluated and quantified. This can only effectively be done by sampling and testing the work-place.

Sampling and testing can take many forms. Most important are personal samples on individuals to evaluate exposures to the many chemical causes. Personal sampling can be supplemented as necessary and appropriate by breathing zone and general area samples.

Physical energy exposures can be evaluated using a number of instruments on a general area basis (for the most part), with use of personal dosimeters and film badges for the various ionizing radiation forms. Noise and vibration and other physical extremes can be evaluated by surveys with noise meters and octave band analyzers, and other instrumentation, usually on an area basis, supplemented in some cases with personal monitoring (such as audiodosimeters).

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

C. Exposure Evaluation and Quantification (continued)

The Biological became increasingly difficult. Required are trained studies of the work places to see if these exist, make judgemental values on degree and effect, and monitor the actual health effects on workers.

The Ergonomic stresses are very difficult since their effects are very individual. Time and motion studies, individual evaluations, studies of accident and medical records are necessary to establish possible trends and situations where ergonomic stresses might exist.

D. Medical Monitoring of the Occupational Environment

Somewhat simultaneous with Exposure Quantification is the need for an effective Medical Monitoring Program. It is important to realize that every individual worker is different, that generalized approaches such as those expressed in "Threshold Limit Values for Chemical Substances and Physical Agents in The Workroom Environment" do not account for these unique differences. It is expressed that within the current noise standard 90 dbA -8 hour exposure, that some 15% of workers will still suffer some degree of hearing loss. Medical Monitoring of the Occupational Environment serves to close this gap and make industrial health a personal thing.

Effective medical monitoring is neither easy nor inexpensive. It is essential, however, to effective Industrial Health control. Appendix "C" gives a more detailed explanation of what and how an effective Medical Monitoring Program is, and functions.

E. Exposure Controls

1, General

The control of exposures to occupational health is a major subject within itself. It is a science and art all its own. Some general thoughts on control in major areas are given here, others will have to be individually developed to fit the specific conditions.

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

E. Exposure Controls (continued)

2. Atmospheric Contamination

Exposure controls for airborne contaminants include ventilation, substitution, isolation, process change, housekeeping and maintenance, or respiratory protection. A more detailed discussion of these is given in Appendix "D". It is also briefly included in Appendix "A".

3. Noise Exposures

Exposure controls for noise include hearing protection, administrative control, and engineering based reductions. A more detailed discussion of these is given in Appendix "E". A typical Hearing Conservation Program is presented in Appendix "F".

4. Other Physical Hazards

a. Heat Stress

Control is gained by employee selection, aclimatization, and control of the work/rest regimin, protective clothing can also be effectively used, along with heat shielding.

b. Non-Ionizing Radiations

Highly dependent on wavelength. Ultra violet radiation, such as from welding, requires primarily protective clothing and special glasses. Infra red, such as furnaces, requires heat shielding, protective clothing, and, for some applications, glasses.

c. Illumination

Installation of adequate illumination foot candle levels at all working and access areas, with consideration of light quality also.

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

E. Exposure Controls (continued)

4. Other Physical Hazards

d. Ergonomic

Redesign tools and equipment to minimize stresses in use. Design jobs to minimize time in most boring and stressful portions, trade off between workers so each gets a little.

5. Training and Education

Training and education must be considered as an important facet of control for all Industrial Hygiene exposures.

F. Education and Training

1. General

Education and Training is a major factor in Industrial Hygiene exposure control. It can be logically divided into two (2) broad areas. Each is important in its own way. First is that of supervisors and special personnel who will administer and carry out an effective Industrial Hygiene program. Second is of supervisors and workers, down to the last person, who are affected by the exposure potentials, and whose Industrial Health we are primarily trying to protect and guard.

2. Industrial Hygiene and Supervisory Personnel

Training of special personnel to handle the Industrial Hygiene exposure control program takes on many possible facets. These people must receive special training in exposure recognition, sampling and evaluation techniques, engineering control methods, and many other facets. Education can, and should be, both formal and informal.

Formal training can be obtained many places. The National institute for Occupational Safety and Health, Cincinnati, Ohio, offers a number of week to two (2) week programs in many facets of Industrial Hygiene. Included are sampling, Engineering, analytical methods, occupational health and many others.

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

F. Education and Training (continued)

2. Industrial Hygiene and Supervisory Personnel (continued)

Other programs are offered by several universities. The university of Cincinnati is particularly active in this area.

The Travelers is also active in training for its customers. The chemical unit offers a week long course in the Home Office several times per year. The regional Chemical Specialists are also available to do training at our various district Engineering offices, and, in special cases, at customer plant locations. Appendix "G" provides a brief synopsis of four (4) such programs currently available from the author in the west coast area (including Montana).

One thing must be emphasized with respect to this facet of training. Some of the broad survey courses, especially such as Travelers "Introduction to Industrial Hygiene", and "Medical Monitoring of the Occupational Environment", should be attended by top company management personnel. It is vitally important that this top management, while they will not do the actual work of carrying the program through, be fully aware of what such programs are and what they entail. This will put them in a position that when programs are formulated and submitted for approval to implement, when funds are requested for engineering changes to control exposures, when additional evaluation equipment is requested, when funds for additional formal training are requested, that they will understand the needs and ramifications and respond with informal decision.

3. Operating Personnel

Training of the actual work force is a must. These people must understand the industrial health exposures to which they are subjected, and how to prevent adverse effects on their health. A number of facets need be considered, including these few:

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

F. Education and Training (continued)

3. Operating Personnel (continued)

a. How excss noise affects hearing and the consequent need to have and wear hearing protection.

b. The adverse effects of various atmospheric contaminants, how they affect the body, and why personal protective equipment must be used.

c. Care and maintenance of personal protective equipment to maximize effective control of exposures.

d. How to recognize the onset of adverse effects of all Industrial Hygiene exposures so that prompt help can be obtained.

e. Principles of good personal hygiene as a control for occupational health exposures.

f. How an effective company medical monitoring program can help them in control of their exposures.

g. Basic principles of sampling for atmospheric contaminants so that when taking personal samples (particularly) they can help assure the best possible sample.

h. Exposure recognition principles so they can intelligently inform supervisors and Industrial Hygiene Program personnel of exposures that might be missed because of lack of intimate familiarity with each job and workplace.

j. The company Industrial Hygiene Exposure control Program so they can understand what the company is doing to insure their health, safety and well being.

II. ELEMENTS OF AN EFFECTIVE INDUSTRIAL HYGIENE PROGRAM (Continued)

F. Education and Training (continued)

3. Operating Personnel (continued)

These training programs can be carried out in several ways, and best is probably a combination of these ways. Some will require virtually one to one contact with individual workers. Others can be effectively handled by group, area, shift, department or similar size unit meeting, either special or as part of regularly scheduled safety meetings. Others can be covered with large group meetings such as a whole plant. Written approaches are also good for some, either special mailings to employees, or in company newspapers. Not to be overlooked is possible involvement of union management and facilities in some portions of training.

III. APPLICATION TO MONTANA MINING DIVISION

A. General

The writer is not familiar with the nature and extent of such programs as may exist in the Montana Mining Division to control employee industrial health exposures. Surveys of several entities of the division have generated some casual discussions of employee oriented safety programs, but, since Travelers does not provide Anaconda with workers compensation coverage in Montana, such discussions have not been detailed, nor specific. Such discussions as have been held have indicated that some Industrial Hygiene sampling is carried out, but the nature, extent and validity are unknown to the writer.

Bearing this in mind, the remainder of this section will be devoted to analyzing what is known about the operation of the Division, evaluation of potential exposures, and providing an outline so that the division management and The Travelers can jointly evaluate the present program, and develop recommendations for the implementation, upgrading and improvement of the program as proves necessary, based on the evaluation.

III. APPLICATION TO ONTANA MINING DIVISION (Continued)

B. Required Information

1. General

The making of an intelligent evaluation of the Division program requires that certain information be available regarding each of the elements of an effective control program. This, generally, includes the following areas.

2. Exposure Recognition

The first step in exposure recognition is to develop a complete organizational structure, starting with the Division, the next sub-units of the division, and on down to the smallest sectional unit of employees and a supervisor. Once this is accomplished, a detailed evaluation of the work activities and work place for each employee is necessary. This is the basics which are outlined in Appendix "B", "Elementry Survey of Operations". This information gathering should be started at the desk, using basic knowledge on company structure, section code numbers, and anything else which will lead to understanding of operations. It is then completed by a physical inspection and evaluation of each section, department, division, etc. To verify information already developed, and to develop and refine additional information.

During the course of both the theoretical evaluation and the on-site physical evaluation, constant thought and attention must be given to finding exposures and what controls are applied to control of exposures. The writer has made brief consideration of potential exposures, which is presented here:

Pit Miners - Dusts, free silica (silicosis) in ore, copper oxide/sulfide dust, carbon monoxide from powered equipment. Other fumes from burning fuel, lead from TEL in fuel, noise, heat stress (especially during summer), cold stress (in winter), vibration (drilling, jack hammers), diseases from organisms in the soil.

III. APPLICATION TO MONTANA MINING DIVISION (Continued

B. Required Information (continued)

2. Exposure Recognition (continued)

Haul Drivers - Noise, vibration, carbon monoxide fumes, various ergonomic stresses.

Underground Miners - Most of those of pit miners, plus dampness, methane gas, explosive conditions.

Maintenance Personnel - Dusts; free silica; copper oxide/ Sulfide dusts; (all from equipment bearing same), carbon monoxide in shops; exhaust fumes; fumes and mists from pickeling, degreasing and other cleaning operations; welding fumes; Ultra-Violet light from welding; flammable solvents; noise; dermatitis (oils and materials used in cleaning);

Leaching Plant - Dusts, free silica, copper oxide/sulfide dusts, acid mists, noise.

Primary crusher - Dusts, free silica, copper oxide/sulfide dusts, noise, vibration, radiation (Bin level indicators).

3. Exposure Evaluation and Quantification

Some what simultaneously with developing recognition of exposures, will be finding out what has been done to actually evaluate and quantify the extent of exposures, which includes not only data showing existence of excessive employee exposures, but also testing which shows absense of exposures. Such testing and evaluation can have been done in many ways and by a number of agencies. This could include sampling and evaluation by Anaconda Montana Mining Division Personnel, that done by Anaconda Corporate or other Anaconda operating entities for and on behalf of Montana Mining Division, by the State of Montana Health Department, local health Departments, OSHA, The Travelers, hired outside consultants, colleges or universities in connection with research projects, and possibly others.

III. APPLICATION TO MONTANA MINING DIVISION (Continued)

B. Required Information (continued)

3. Exposure Evaluation and Quantification (continued)

This data should be assembled at a central location, and catalogued and analyzed by a knowledgeable individual to determine extent and quality of data, validity, adequacy, and to, in turn, formulate a program for additional testing and sampling.

It must be kept in mind that in assembling data and formulating programs for acquiring additional data, that we must consider the entire gamat of potential exposures. These include not only the entire range of atmospheric contaminants as listed on the booklet "Threshold Limits for Chemical Substances in the Workroom Air", by ACGIH, but also physical exposures to noise, light, ionizing and non-ionizing radiation, heat stress, ergonomic stress and others.

4. Medical Monitoring

Again, somewhat simultaneously, should be developed what medical monitoring programs exist in the Division. Are pre-employment physicals given? If so, what do they include? Are audiometric testing, chest x-ray, vital capacity/pulmonary function tests, blood chemistry included? Is there a respiratory case history, evaluation of off-work activities, anything that might contribute to Industrial injury? Are the doctors fully knowledgeable of the potential exposures of employees that the pre-employment physicals can be tailored to them?

What periodic physicals and tests carried out? How often is there a repeat physical, chest x-ray, audiograms, and so on? What action is taken in response to deficient findings? All of this must be assembled into a central place and evaluated and compared to other available data.

III. APPLICATION TO MONTANA MINING DIVISION (Continued)

B. Required Information (continued)

5. Exposure Controls

At the same time as the extent of exposures are being evaluated, application of controls should be determined. Where airbourne contaminants exist, it should be determined if there is local exhaust ventilation, use of respirators, gas masks, self-contained breathing apparatus? Are administrative controls used? Is personal protective equipment approved by proper agencies (MESA, NIOSH, other)? Is substitution, isolation, maintenance, housekeeping used as a control? What engineering changes have been made? What controls are applied to noise exposure, other physical stresses, radiation, etc?

6. Education and Training

The final aspect of the program which needs evaluated is education and training. Determined should be what qualified personnel exist in the division to carry out an effective program. Are there any certified Industrial Hygienists, in the division or available from corporate or other corporate entities? Are there any para-professionals in Industrial Hygiene? What education do these people have, and what additional education could they use to improve their abilities?

Supervisory and employee training programs must also be determined and evaluated. Are employees aware of the Industrial Hygiene exposures and how to protect against them? Have they been instructed in good personal hygiene? Are supervisors aware of potential hazards, how to protect against them? Are rules set forth on use of personal protective equipment, with appropriate administrative corrective procedures for failure to comply?

III. APPLICATION TO MONTANA MINING DIVISION (Continued)

C. Application to An Effective Industrial Hygiene Control Program

Once all the required information is assembled, the effectiveness of the existing program can be assessed. It can be anticipated that some deficiencies will exist, possibly extensive deficiencies. Based on this information, a plan of action and priorities can be established.

The first and most important priority, should be the application of personal protective equipment to all jobs and locations where available data indicates problem, or where visual evaluation leads to a conclusion of problem, and such controls are not already in effect.

The second priority, primarily because it can usually be quickly implemented, is to initiate or reinforce, as required, the medical monitoring program. Such physicals, testing, evaluation as determined appropriate by qualified medical personnel should be applied to all personnel commencing immediately.

Third priority should be a monitoring program for airbourne contaminants, plus such physical hazards as noise, radiation, etc. This should be put on a priority basis based on the preliminary evaluation of facilities, catching the worst apparent exposures first, and working down.

Fourth priority is effective permenent controls wherever possible on all exposures found to be in excess of allowable standards, or where medical monitoring shows problems not found by sampling or testing.

Fifth in priority is education and training. Parts of this, of course, should be initiated almost immediately. Present personnel should be selected for more advanced training and upgrading to insure the best professionalism among them. Additional para-professionals should be trained to expand the testing and sampling program.

Programs of training and education should be initiated over and above those already in effect to cover employees and supervisors, appraise them of the hazards, controls, use of control equipment and personal protective equipment.

III. APPLICATION TO MONTANA MINING DIVISION (Continued)

D. Systems Approach

The scope of the program outlined is great considering the size and magnitude of the Montana Mining Division. All things cannot be accomplished at one time. A systems approach can help get parts of a program going while other parts are under development. It can also enable going after the worst exposures first.

The system approach is primarily looking at the various aspects of an effective industrial hygiene control program for only a small operational aspect. This may be one operating unit of the division, or maybe just one entity within that operating unit. It should orient to discovering all exposures in that unit, quantifying those exposures. medically monitoring personnel for specific exposures found, applying controls to exposures, and Educating and Training personnel on that operating entity.

This approach serves several valuable purposes. First, it makes the magnitude of the program seem not quite so insurmontable. Second, it allows familiarization with the entire range of an industrial hygiene program rather than carrying one part through, then another. It also permits trying out various approaches to customize to the pecularities of the division rather than be stuck with a division wide program which ends up quite rough around the edges. It also permits attacking "hot spots" quickly and completely so that the worst is controlled first.

IV. HOW THE TRAVELERS CAN HELP

The participation of The Travelers can be only limited, yet can be effective. One major area where some direct assistance can be provided is in Education and Training. Our Home Office training programs are available to selected personnel through Anaconda's Insurance Department at corporate and Travelers Special Accounts Engineering contact. Further training can be provided by Travelers field staff and regional chemical specialist. A synopsis of currently available seminars is in Appendix "G" of this report. Other kinds of training can also be arranged from time to time.

IV. HOW THE TRAVELERS CAN HELP

The other areas are strictly the responsibility of Montana Mining Division. This is primarily because only the Division management has the thorough and intimate knowledge of operations and personnel to make the collection and evaluation of data possible. The Travelers can, however, assist and support your personnel in evaluating data obtained, and in making recommendations for program improvements. Assistance can also be provided in training personnel to gather this data and perform such as the elementary survey of operations.

Travelers can also advise and guide in establishing or strengthening sampling and testing programs, advise on equipment, procedures, analyses, laboratory facilities, and many other facets of a program.

V. SUMMATION

Anaconda Montana Mining Division is interested in evaluating and upgrading its industrial health program. Travelers can assist in evaluating, and making recommendations for improvement.

An effective program involves five (5) elements. Each must be evaluated. Since Division personnel are in a much more knowledgeable position to understand division operations, it is appropriate that they participate in initial assembledge of all available information to permit management evaluation, with the assistance of Travelers.

Initially, as complete an evaluation of existing potential exposures should be recognized and made. This should be followed by assembly of all data showing what quantification has been applied to each exposure. It should also include knowledge of instrumentation used to measure exposures, procedures used, sampling frequency, instrument calibration, etc. Thirdly, should be assembled detail information on the nature and extent of the medical monitoring program. A complete delineation of exposure control measures is necessary. Finally, is a survey of educational and training programs being used. A system approach to this is desirable.

APPENDIX "A"

EXPECTED CONTAMINANT EMISSIONS

FROM TYPICAL INDUSTRIAL PROCESSES

Operation	Contaminant	Control
Acid Dipping	Acid mists - Sulfuric, Hydrochloric, nitric; oxides of nitrogen, hydrogen fluoride	Personal Protection - Face Shields, Local Exhaust
Annealing	Carbon monoxide, toxic metal oxides - lead	Local Exhaust
Automobile Body Repairing	Lead, solvent vapors, flammable vapors, carbon monoxide	Personal Protection, Exhaust Ventilation
Brazing (welding)	Carbon monoxide, fluoride, cadmium, chromium, oxides of nitrogen, ultraviolet radiation, zinc, infrared radiation	Local Exhaust Ventilation
Casting (non-sand casting)	Beryllium, brass-lead, zinc, copper cadmium, magnesium fluoride, and sulfur dioxide	Ventilation
Cementing (rubber or plastics)	Benzene, perchloroethylene, methyl ethyl ketone, ethylene dichloride, toluene, flammable vapors	Ventilation
Coating (barrel, blade, or hand brush spraying)	Benzene, methyl ethyl ketone, naptha, xylol turpentine, flammable vapors	Ventilation

APPENDIX "A"
(Continued)

Operation	Contaminant	Control
Cold Tinning	Lead, Mercury	Ventilation
Decarbonizing	Creosote, ethylene dichloride, kerosene, flammable vapors	Ventilation
Degreasing (metal cleaning)	Benzene, trichloroethylene, xylol chloroform, flammable vapors	Slot Ventilation
Duplicating Machines	Methanol, flammable vapors	Substitution
Electroplating	Ammonia, copper, zinc oxide, chromic acid, arsine, cyanide formaldehyde, flammable vapors	Ventilation
Etching	Alkali	Ventilation
Foundry (abrasive blasting, tumbling, casting, grinding, core making, melting and pouring, shakeout)	Silica dust, acrolein, carbon monoxide, chlorinated hydrocarbons, fluorides, lead and zinc oxide, sulfur dioxide, magnesium, manganese	Ventilation, Personal Protection
Gas Burner	Carbon monoxide	Ventilation
Hardening (heat treat)	Acrolein, carbon monoxide, lead, oil mist	Ventilation
Instrument Filling	Mercury, benzene, flammable vapors	Closed System
Lacquering	Butyl acetate, benzene, flammable vapors	Ventilation
Lead Burning	Lead	Ventilation
Metal Cleaning	Benzene, tetrachloroethylene, flammable vapors, chlorinated hydrocarbons, acid and alkali mists	Ventilation, Substitution
Metallizing on Metal	Oxides of metals, zinc, lead, nickle, copper	Ventilation

APPENDIX "A"
(continued)

Operation	Contaminant	Control
Microwave (heat sealing or cooking ovens)	(Heating of internal body organs, eye cataracts)	Isolation, Maintenance
Mining	Silica dust carbon monoxide, flammable gases	Ventilation, Personal Protection
Painting (spray & brush)	(See Coating)	
Pickling	Acid dripping	Ventilation, Personal Protection
Radioactive Static Eliminators	Alpha particles, beta particles, gamma rays, radon gas	Isolation, Housekeeping, Maintenance
Reclaiming and Refining Metals	Lead, arsenic, chlorine, beryllium, sulfur dioxide	Ventilation
Soldering	Lead, cadmium, copper, zinc fluoride, aniline	Local Exhaust Ventilation
Stripping (paint)	Methanol, methylene chloride, toluene benzene, flammable vapors	Ventilation, Personal Protection
Tunneling	(see Mining)	
Welding and Cutting	Cadmium, chromium, fluorides, infrared radiation, ozone, ultraviolet light, nitrogen dioxide, lead, zinc.	Personal Protection, Local Exhaust Ventilation
X-Ray	X-Ray machines, depth gauges, radiography	Isolation, Personal Protection

APPENDIX "B"

ELEMENTARY SURVEY OF OPERATIONS

A. Introduction

An initial survey should be made of each facility and operation and the various processes within each facility and operation to evaluate existing and potential hazards. The person performing this survey should receive cooperation from various departmental personnel. His duties should include gathering information about the industrial processes in the plant, activities of the employees, materials used, and control and monitoring devices used. The basic purpose of a preliminary or elementary survey is to determine where the hazards are and to decide what should be done to control the exposure after proper investigation.

B. Evaluating Operations

Each operation and process used throughout the work place must be evaluated for the hazards it presents. Unfortunately, in many industrial situations the number of processes and operations being used are varied and large. Because of this situation, the investigator should be familiar with:

(1) The type of equipment used
(2) The specific function of the equipment
(3) Maintenance of equipment and schedule of maintenance
(4) Control measures used (if any) to protect the worker
(5) Controls that are needed
(6) Length of employee exposure
(7) Any physical or mental impairment that could be traceable through medical assistance or observation.

C. Work Areas

A knowledge of the work area is desirable. The investigator surveying the area should know:

(1) The dimensions of the area being surveyed
(2) The location of the equipment
(3) The types of controls used in the operation (ventilation, explosion-proof equipment, etc.) and machine hazards.

ELEMENTARY SURVEY OF OPERATIONS

D. Work Outline or Procedures

The investigator conducting the preliminary survey should be familiar with each worker's procedures. Therefore, he should have the following information:

(1) A job description of each worker
(2) The location of each worker
(3) The location of each job
(4) The amount of time each employee spends in the work area, including his work periods and his own time (such as coffee breaks, lunchtime, etc.).

E. Materials Encountered

Once the person conducting the survey is familiar with the physical environment of the facility, he should become familiar with the materials used and encountered in that operation. He should ask the following questions about materials in or about the operations:

(1) What type of raw materials are used?
(2) What products are made?
(3) What waste products are produced?
(4) How are they handled?
(5) How are they disposed of?
(6) What is the toxicoligical data relating to the materials used? This includes threshold limit values of other avialable information.

APPENDIX "C"

ELEMENTS OF AN EFFECTIVE MEDICAL

MONITORING PROGRAM

A. Introduction

The traditional definition of Occupational Medicine is:

> "That branch of medicine which deals with the relationship of man to his occupation for the purposes of prevention of disease and the promotion of optimal health, productivity, and social adjustment".

How the individual worker reacts to his environment depends partly on the composition of the environment and partly on the man himself - his physical makeup, heredity, and previous exposure to toxic materials. To understand the effect of an environment on an individual, the physician or medical department should know how materials enter the body and what effects they might produce in the body. The employee comes into contact with the working environment in four major areas:

> The special senses (eyes, ears, nose, mouth)
> skin
> Digestive tract
> Respiratory system

A good Medical Monitoring Program is important to any effective Industrial Hygiene Program. Effective use of physicals, and doctor examination can provide an important adjunct to inplant monitoring of atmospheric contamination and other physical hazard exposures.

The physician can use the human body, can monitor the work environment in many diverse ways. There are a number of important indicators which can be used which include:

- Skin
- Special Senses
- Gastrointestinal
- Internal Organs
- Blood
- Respiratory tract

B. Company Physician

The company physician or medical director must first be aware that workers are subject to many materials which can cause disease. It is unfortunate that many physicians and industrial medical personnel do not know, or have the knowledge of, materials and processes used in the industries they serve. The biological effects of industrial machines, processes, raw materials and finished products are myriad. Therefore, it is recommended that the physician become acquainted with the actual and potential problems in the industries with which he comes in contact.

C. Environmental Monitoring by the Physician

1. General

The physician has several approaches to monitoring the work environment, by observing the worker in his environment. There are a number of indicators which can be used to alert him to employee disease.

2. Skin

The skin is an excellent mirror of the compounds with which it comes into contact. Contact dermatitis reactions, flushing of the skin, sweating, depigmentation, and other manifestations can indicate exposures to very diverse substances, such as gases, chemicals, metals, and physical agents. Thus, the environment can be monitored by observing the reaction of the individual worker's skin.

3. Gastrointestinal System

The environment can affect the worker's gastrointestinal system. Although motion sickness involves more than this system, the diagnosis is primarily a gastrointestinal one. Reactions to lead poisoning can involve various parts of the gastrointestinal tract with such manifestations as metallic taste, nausea, vomiting, abdominal colic, and constipation. By inhibiting the enzyme system (cholinesterase), organic phosphate poisoning can result in diarrhea, nausea, and vomiting. In general, noxious odors tend to produce gastrointestinal upsets.

C. Environmental Monitoring by the Physician (Continued)

4. Systemic Reactions

a. General

Although general systemic reactions to environmental hazards are more difficult to define, the blood, bone marrow, urine, sputum, feces, and other materials can be examined to ascertain malfunctions in the internal body environment as well as to identify toxic materials or their byproducts in the body.

b. Blood

The blood is composed of formed elements, which are white cells, red cells, and platelets, and also the serum.

The white cells injest and destroy bacteria. They also appear to have functions relating to immune and hypersensitivity reactions, for example, the tuberculin skin reaction or an attack of hay fever.

The red cells contain hemoglobin, which includes a ferrous radical for binding oxygen to the heme. This is the manner in which oxygen is transported from the lungs to the body cells. Exposure of these to oxidizing agents, such as cyanide, will convert the ferrous iron into ferric iron, forming methemoglobin, which, when present in the body causes the skin to take on a dusky discoloration.

Carbon monoxide reacts with hemoglobin to form carboxyhemo globin. The increased affinity of hemoglobin for carbon monoxide reduces the oxygen-carrying capacity of the blood, thus decreasing the available oxygen for tissue use. Anemia, a lack of hemoglobin, can result from poisoning by certain aromatic hydrocarbons.

Blood serum also can be used for monitoring. The functions of blood serum are not completely understood, however, it is known that the quantity of certain enzymes present in the blood serum is changed by exposure to organic phosphate ester insecticides and chlorinated hydrocarbon solvents. Toxic organic phosphate esters can cause cholinesterse depression and eventual death.

C. Environmental Monitoring by the Physician (Continued)

4. Systemic Reactions (Continued)

b. Blood (continued)

The serum can also dissolve toxic agents such as lead. A positive test by the industrial physician examining the blood would indicate what materials or processes the employee should avoid.

Evaluation of the blood by the plant physician could, by detection of plant materials present, indicate what materials the worker should avoid. A bone marrow examination will also permit evaluation of deliterious materials to the worker.

c. Urine

Urinalysis can provide knowledge about the type and extent of exposure to some toxic materials. Heavy metals, such as lead and arsenic, may be excreted in the urine.

Certain organic compounds are detoxified by the body. These detoxification products, or metabolites, are excreted in the urine. In interpreting the results of urinalyses, especially with regard to heavy metals, remember that absorption can take place without poisoning and that access to the body may be non-occupational in origin.

d. Sputum

When pneumoconiosis is suspected, sputum examinations may be used to rule out other infections. An increased number of ambiguous and suspicious cells in the sputum is associated with underground uranium mining.

5. Nervous System

The effects of various toxic compounds on the nervous system vary from such non-specific generalized manifestations of disorder as headache, dizziness, giddiness, and silliness, to deaths due to the inhalation of massive doses of DDT and, to wrist drop, a form of lead palsy with atrophy and weakness of the extensor muscles of the forearm. Personality changes, often difficult to recognize, have been caused by methyl chloride poisoning. Carbon monoxide can produce a whole gamut of neurological and psychological disorders.

C. Environmental Monitoring by the Physician (continued)

6. Special Senses

a. General

Special senses include vision, hearing, touch, taste, smell, and others which are less generally recognized. The physician can use these senses to get an indication of conditions in the industrial environment.

These special senses are useful indications of plant conditions. Physicals are important. They give a base line at the start. periodic reevaluation shows any changes that might occur to the employee. Records of pre-employment and periodic examinations can be particularly important in regard to eye injuries caused by radiant energy and to hearing loss.

b. Eye Damage

Eye damage has been related to wave length of radiant energy and the resulting tissue damage. The involved area of the eye varies with the different wave lengths. For example, long wave lengths such as infrared, produced by diathermy machines, and radiant heat, tend to penetrate less. These wave lengths tend to penetrate the lens, and will usually result in such as cataracts.

On the other hand the visual or near visual wave lengths produce blind spots. Short wave lengths tend to produce lesions, cataracts, and conjunctivitis.

The onset of effects can be immediate with the longer wave lengths. If we encounter shorter wave length it may take hours to days before any onset of effects may show up. The plant physician must be prepared to treat all kinds of injury immediately and expeditiously.

c. Hearing Loss

Another special sense affected by the environment is hearing. The relation between noise exposure and deafness is continually undergoing review and experimentation.

C. Environmental Monitoring by the Physician (continued)

7. Respiratory Disorders

a. General

The environment can contribute to a whole series of respiratory disorders from mild, cold-like catarrh, to pneumonia, pneumonocconiosis, and cancer, as well as many others. Obviously it is difficult to delineate where a cold, pharyngitis, bronchitis, or cancer begins.

With respiratory disorders the symptoms can include: cough, phlegm production, chest pains, shortness of breath, and spitting up blood as well as irritation in the respiratory tract.

Afflictions of the respiratory tract cannot always be specifically located anatomically. The effect of arsenic has been reported to be a painless perforation of the nasal septum and also to produce lung cancer. Irritations of the nasal passages and bronchial linings are common manifestations of exposures to certain chemicals. Other lung cancer agents are beryllium, asbestos, and ionizing radiation including the radon daughters.

b. Respiratory Case History

When evaluating a case where the respiratory tract is involved is is essential to have a respiratory case history. This case history should go way back, and cover all kinds of exposures which the employee may encounter to such things as gas; smoke, including cigarettes; and other fumes and materials that may contribute to the development of lung disease.

c. Pneumoconioses

Pneumoconiosis is the fiberous hardening of the lungs caused by irritation created from inhalation dust.

The major pneumoconioses are, first, a disease known as silicosis, which is from free crystalline silica. A second important one is asbestosis, which is from silicates, which are asbestos materials.

C. Environmental Monitoring by the Physician (Continued)

7. Respiratory Disorders (continued)

C. Pneumoconioses (continued)

A third major pneumoconiosis is known as Talcosis, which is from silicate of the talc form. A fourth is the one known as Coal Miners' Pneumoconiosis, or black lung, which originates from cold dust.

There are a number of minor lung afflictions that have similar effects. The first of these is Anthracosis, which originates from soot and carbon. Another one is Diatomaceous earth pneumoconiosis which is from amorphous silica materials.

A third one is Silicatosis, coming from mica, clay, and feldspar. These are basically silicate type materials similar to what we have encountered before. The fourth is beryllium disease, which comes from beryllium metal in its various forms.

Vegetable dust can also produce similar kinds of diseases. Included are mill fever, Byssinosis, bagassosis, Farmers Lung, grain asthma, Tamarind asthma, and Weaver's cough.

There are also a group of materials that have a relatively benign effect, but are nonetheless recognized lung diseases of the type. These include Baritosis, ($BaSO_4$, BaO), Siderosis, (Fe_2O_3), Stannosis, (SnO_2), Titanosis, (TiO_2), Graphosis and Chalicosis.

It is important to realize that pneumoconioses can run from seriously disabling ailments such as silicosis, to a group of very poorly defined disease effects such as byssinosis, and that there can be a complete range of problems and effects in between these various problems.

Because of the necessity for using a battery of investigative tools, it is apparent that no single test is completely diagnostic. There are definite correlations between pneumoconioses and age, and other correlations also with many as yet unknown factors. These correlations do not necessarily indicate a cause and effect relationship. Even though some pictures are consistent with pneumoconiosis and the worker has a positive occupational history, the findings are not this clear cut. In these situations it is possible to make only very general retrospective or prospective statements about individual employees in terms of means, notes, or trends.

D. Physical Examinations

Physical examinations of all employees is a major part of any effective medical monitoring program. This should include, as minimum, a pre-employment physical, along with periodic re-examinations.

The pre-employment examination should consider two (2) things. First, naturally, is the general health of the prospective employee, and his general capability to perform the work required. Second should be special emphasis on potential occupational exposures to chemicals and physical agents. Visual acuity tests should be made, audiograms made, vital capacity and other long tests performed, body chemistry performed for chemical exposure possibilities where biological TLV's exist. On this latter Biological TLV's exist for:

Urinary:

- Aniline
- Antimony
- Arsenic
- Arsine
- Benzene
- Boron Trifluoride
- Calcium arsenate
- Chlorinated benzenes
- Cyanide
- Fluoride
- Hydrogen bromide
- Hydrogen cyanide
- Hydrogen fluoride
- Hydrogen selenide
- Lead Arsenate
- Mercury
- Molybdenum
- Nickel
- Nickel carbonyl
- Nitrobenzene
- Nitrogen trifluoride
- Parathion
- Selenium
- Selenium hexafluoride
- Stibine
- Sulfuryl fluoride
- Tellurium
- Tellurium hexafluoride
- Thallium
- Uranium
- Zinc chloride
- Zinc oxide

Blood TLV's are more applicable than excretory limits for:

- Cadmium dust
- Cadmium fume
- Lead
- Manganese
- Methylbromide

D. Physical Examination: (continued)

Blood and/or Breath TLV's should be applicable for:

- Carbon monoxide
- Nitric oxide
- Sulfur hexafluoride

Breath analysis is good for many:

- Alcohols
- Aliphatic hydrocarbons
- Chlorohydrocarbons
- Ketones

The physical should also include a complete Epidemological History, plus a respiratory case history where exposures include the lung.

APPENDIX "D"

EXPOSURE CONTROLS FOR AIRBOURNE CONTAMINANTS

A. Introduction

Contamination can be controlled by ventilation, substitution, isolation, process change, housekeeping and maintenance, or respiratory protection. These methods of control are described in the following paragraphs.

B. Ventilation

When materials are released from a process into the plant, the worker in that operation may be exposed to dangerous levels of contaminants. These contaminants should be removed from the work space at the point of operation by using proper ventilating procedures, such as hoods connected to ducts or exhaust fans. Ventilating systems should always be kept in operation while contaminants are being generated or released.

While industrial ventilation is usually the best method of control, other control methods for protecting the worker should be considered. Some of these methods can still produce a safe working environment and can be put into operation faster than designing and installing a ventilation system. The following paragraphs outline other methods for controlling contaminants in a work place.

C. Substitution

Substitution is a simple method of protecting the worker. A toxic substance is replaced by a substance of lower toxicity. This will reduce the employee's exposure. Substitution is used several ways. For example, the silica-bearing materials in grinding wheels are being replaced by aluminum oxide, a less toxic material. Steel shot has generally replaced sand as an abrasive in blasting. Lead, which has been a common paint pigment for years, is being replaced by the less toxic pigment, titanium dioxide. Substitution as a method of control has many uses if we realize that it can protect the worker. Be aware, however, that it is not always possible to substitute less hazardous materials for toxic ones.

D. Isolation

Frequently, it is not possible to operate a process in the middle of a working environment. By isolating the process, exposure is limited to the workers directly involved in the hazardous operation. These workers can then be adequately protected from harmful contaminants by using personal protective equipment. This is more economical than either protecting the entire work force or designing a ventilation system for a whole floor.

Isolation should be considered not only in relation to space, but also in relation to time. For example, when a dusty operation is occurring in a work place and there is only one work shift needed to perform that operation, it could be run during the second shift when fewer people are exposed. Of course, the people performing this operation should have adequate local exhaust ventilation or personal protective devices.

E. Process Change

A process change is no more than developing different ways of doing an operation to reduce the exposure. For example, after paint or lacquer has been applied by brushing, the brushes can be hung in closed containers to prevent evaporation of the solvent into the work space. These containers will then hold the solvent vapors within the closed environment. By using approved safety cans rather than open containers scattered throughout the plant, the process is changed from a hazardous operation to a less hazardous operation; the opportunity for volatile solvents to escape into the work space is greatly reduced. An assembly line welding operation occurring in several areas of a plant can be changed. All the welding lines can be combined into one assembly line and vented. This is a process change which economically uses only one ventilation system instead of having several hoods for several different lines. Before combining systems, however, a preliminary investigation and process review should be conducted to determine if combining these operations will reduce their safety.

F. Housekeeping and Maintenance

It is extremely important for a plant that handles materials in a particulate form to use good housekeeping and maintenance. This is important because toxic dust or particulates that settle on the floor or ledges can be redistributed into the air by vibration or air movement within the building. These materials can then be inhaled. A suitable vacuum cleaning system, rather than a compressed air system, should be used to clean equipment, floors, and ledges. Dust should not be swept up dry since this will also redistribute toxic materials into the air.

Contamination can result from leaks in equipment. For this reason, equipment should be maintained in good working condition. Tanks, pipes, valves, pumps, gaskets, and ventilation equipment should be inspected frequently. Damage to any of this equipment should be immediately repaired so that leaks which could release extremely toxic materials into the work place can be prevented.

G. Respiratory Protection

Generally, there are two classes of respirators:

Those that remove the contaminant from the air
Those to which air or oxygen is supplied

The first class of respirators is further divided into chemical types, including canister gas masks and cartridge respirators, and into mechanical filters for removing dust, mist, and fumes. The second class of respirators is divided into hose masks which may or may not be attached to blowers or air lines, self-contained compressed air, and oxygen masks.

This type of control should not be used in lieu of other control measures. It should be used to protect a worker in emergency situations and/or until proper engineering controls, such as local exhaust ventilation, can be designed and put into working operation.

When using respirators, it is important to determine the correct type. (Refer to the manufacturer's directions for specific contaminants the respirator is designed to protect against.) The type of respirator depends on the contaminant to be removed and on the size of the particles distributed in the air. For example, filter type respirators are designed to protect the wearer from silica dust, toxic dust, mist, and fumes while canister gas masks and cartridge respirators absorb gaseous contaminants. These canister gas masks, cartridge respirators, and filter respirators cannot supply the wearer with sufficient oxygen in an oxygen deficient atmosphere. In this case, oxygen must be supplied.

G. Respiratory Protection

It is strongly recommended that respiratory protection devices used in the plant be approved by the National Institute of Occupational Safety and Health or U.S. Bureau of Mines. If they do not have this approval, the devices should not be used.

Respiratory protective devices should be properly maintained. They should be kept clean and sanitary and the filters or cartridges should be replaced frequently. The frequency should depend on the concentration of contaminants to which it comes in contact and the amount of time they are used. It is also recommended that one person or department be responsible for maintaining all respiratory protective equipment. Cleaning, repairs, and maintenance should not be done by the individual user.

H. Conclusions

The following questions should be asked to determine the proper type of control for the plant:

What type of particulate matter is the individual exposed? What form is the contaminant? Gas, mist, fume, vapor, or dust?

How long has the individual been exposed to this contaminant? (To evaluate a worker's exposure, it is not enough to know how much contaminant he is receiving. How long he is in that work place in relation to the contamination level must be determined.)

APPENDIX "E"

VIII. EXPOSURE CONTROLS FOR NOISE

A. Immediate

The first basic approach to noise control is immediate control. This is necessary immediately upon discovering that a noise exposure problem exists. The two immediate controls which can be applied are:

- Use of hearing protectors to reduce and noise level exposure of the employee.
- Administrative controls to also control the employee exposure.

The immediate control approach of using hearing protectors is satisfactory only as an interim measure. Hearing protectors consist basically of two items, these being ear plugs and ear muffs. These can be used independently, or can be used in combination where necessary. Ear plugs take a number of different configurations. They also must be carefully selected to control the kind of noise encountered, and different items will control noise differently.

B. Long Term

The long term controls which are necessary to apply can consist of two basic approaches. The first of these is engineering reduction, wherein the noise is eliminated; or again the use of administrative controls to control the time of exposure of the employee.

As engineering reductions noise levels can be lowered at the source by reducing the metal contact, applying dampening material to reverberant surfaces, applying shock mounts, isolating mounts, etc. Another possible solution is to remove the employee from the noisy area. This can be done by providing the employee with a soundproof chamber where he can escape from the noise. In some cases, this method should be considered because it may be more economical.

B. Long Term (continued)

If such an approach is taken, adequate lighting and some type of air change mechanism and comfort control are required. Another solution to noise control is to isolate the individual noise source. This includes baffles or total enclosures around loud areas. The type of enclosure required depends upon the frequencies and the intensities involved. Curtains of acoustically high transmission loss around the machine noise source may be a partial cure. However, curtains are frequently bought without knowing how they should be installed or their effectiveness to the particular frequencies involved. Simply placing a curtain around a machine may result in little noise reduction and could increase the noise level near the machine where the employee is located. Application of shock mounts on the machine will be of little value unless the machine is also enclosed. Sometimes considerable reduction of noise can be accomplished with a combination of shock mounts and a total enclosure.

C. Administrative Controls

Administrative controls are equally applicable as both immediate and long term exposure controls.

Administrative controls are basically the control of exposure by limiting the time of exposure of the employee. The allowable exposures permit an employee to experience 90 dBA for 8 hours, 95 dBA for 4 hours, 100 dBA for 2 hours etc. Thus if we administratively limit the employee to working in a noisey area, say at 95 dBA, to no more than 4 hours per day, and then place him in a quiet area for the rest of the day, we have effected administrative controls. The essential thing to remember in the application of administrative controls is that it must be absolute and invariant. It must be a finitely scheduled matter, and nothing, not even emergencies, should permit a worker to be in the noisey area for longer than the scheduled period of time. The OSHA rules and regulations require strict control and accurate documentation of this fact.

D. Hearing Conservation Programs

Whenever high noise levels are to be encountered, and we are talking about noise levels in excess of 90 dBA, it is essential that a hearing conservation program be applied. The basic essentials of a hearing conservation program are:

- Annual audiometric testing of every employee. This should also include some follow-up testing where hearing loss is suspicioned or encountered.

- Periodic assessment of the area. A periodic noise level survey should be run to continue documentation that the exposure exists and the extent of the exposure.

- The use of hearing protectors should be instituted, mandated, and enforced. Remember that the use of hearing protectors is only a short term approach, and should not be regarded as a long term solution

- Administrative controls should be applied where practical and necessary.

- Engineering reductions should be effected to control all noise exposures.

NOte: A copy of Travelers Hearing Conservation Program is included in this report.