OCCUPATIONAL HEALTH ASPECTS OF RISK MANAGEMENT IN ELKEM METALS COMPANY

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SUMMARY

The workplace environment in the ferroalloy industry requires greater management attention because of increased regulatory activity and increased medical knowledge on long-term effects of worker exposure to various contaminants. Minimization of future liability, together with responsible management decisions on acceptable risk levels, can be accomplished by a company Occupational Health Program comprised of the following steps:

1. Program Establishment
2. Risk Identification
3. Risk Assessment
4. Risk Management

Elkem Metals Company experience covering each of these steps is discussed, and specific ferroalloy workplace examples are cited.

INTRODUCTION

Before any civilization made significant advances, it always had a fundamental understanding of its past so that an orderly progression was made toward a more favorable future. Our future is the 1990's. If our future is to be an improvement upon history, it is up to us to pioneer a higher quality of work so that the business we are responsible for efficiently harnesses available technology in harmony with man and the environment. Our efforts toward better ways of producing commodities at an increased volume with minimal manpower may have deleterious effects.[1]

The chemical and physical agents detailed in Table I represent both potentially hazardous and toxic materials as well as valuable raw materials. Such items should be controlled. In an uncontrolled, unmanaged work environment, all these materials could cause injury and occupational disease.

*As of 1/1/89 Federation of the Norwegian Metallurgical Industry, Norway

TABLE I - Examples of Common Chemical and Physical Workplace Contaminants

Arsenic (As) and Compounds (solids)
Asbestos
Arsine (AsH_3) (gas)
Carbon Monoxide (CO)
Chromium (Cr) and Compounds
Coal Tar Pitch Volatiles (CTPV)
Heat Stress
Hydrogen Sulfide (H_2S)
Manganese (Mn) and Compounds
Noise
Polychlorinated Biphenyls (PCB's)
Radiation
Silica (SiO_2 Crystalline and Amorphous)
Sulfur Dioxide (SO_2)
Vanadium (V) and Compounds

The risks associated with toxic materials require adequate assessment before sound business decisions can be made. Information must flow through an established network of engineers, chemists, purchasing personnel, medical professionals, traffic managers, general managers, and lawyers to provide a data base which supports the actions of responsible managers. The information flow from this network will result in improved decisions.

Unless industry continues to recognize the hazards of the workplace, makes management decisions to control them and implements corrective and preventative measures, the quest for a better future for our industry will not succeed. Instead, complex health problems in an inefficient workplace will be encountered.

ESTABLISHING AN OCCUPATIONAL HEALTH PROGRAM

An Occupational Health Program is essential to establishing and maintaining a safe and healthful workplace. The Program will provide a mechanism for a company to identify occupational health risks, to inform employees of the hazards of their workplace, and to develop a minimum acceptable level of personal injury and monetary loss due to occupational illness.

Occupational diseases generally take time to develop. A repeated exposure for an extended period in a worker's life may precipitate a number of chronic illnesses. Alternatively, a short-term limited exposure may aggravate a pre-existing condition or may cause acute ill effects. It takes years to experience the deleterious effects of exposure to crystalline silica or asbestos, while it takes only minutes to feel the effects of lime (CaO) or CO. A good Program will encompass both types of contaminant but should focus more upon chronic effects. This Program will be aligned to monitor for long term trends and not isolated individual accidents. For example, thermal burns from molten metal would be addressed in a Safety Program, while heat stress would be the concern of an Occupational Health Program.

The foremost factors behind implementation of an Occupational Health Program are liabilities resulting from laws and regulations (see Figure 1). Laws, regulations and guidelines exist in the United States for many of the contaminants found in ferroalloy workplaces, as shown in Table II.

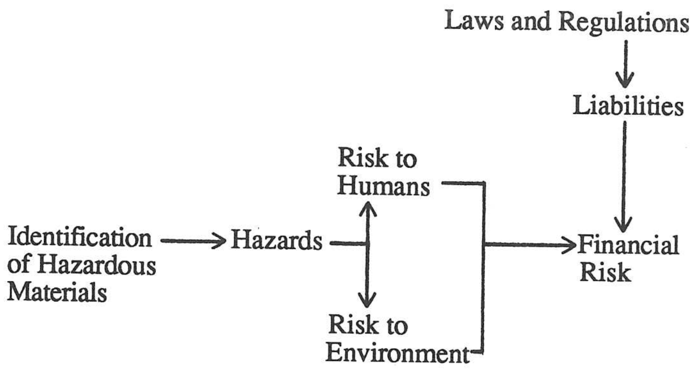

FIGURE 1 - Decision Process Based on Risks and Liabilities

TABLE II - Established Regulations and Guidelines for Maximum Exposure Levels to Contaminants in the Ferroalloy Workplace *

Contaminant	Laws and Regulations - Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (PEL)[2]	Guidelines -American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value[3]
Respirable Crystalline Silica (Quartz)	0.1 mg/m^3	0.1 mg/m^3
Asbestos		
Amosite	0.2 fibers/cc	0.5 fibers/cc
Chrysotile	0.2 fibers/cc	2 fibers/cc
Crocidolite	0.2 fibers/cc	0.2 fibers/cc
Other Forms	0.2 fibers/cc ceiling 1.0 fibers/cc (30 minute)[4]	2 fibers/cc
PCB's	1 mg/m^3 (skin)	1 mg/m^3 (skin)
CTPV	0.2 mg/m^3	0.2 mg/m^3
CO	35 ppm	50 ppm
Manganese (Mn)		
Compounds and Dust	ceiling 5 mg/m^3 as Mn	5 mg/m^3 as Mn
Fume	1 mg/m^3 as Mn	1 mg/m^3 as Mn
Manganese Tetroxide (Mn_3O_4) Compounds and Fume	1 mg/m^3	---
Chromium (Cr)		
Cr (II, III) Compounds	0.5 mg/m^3 as Cr	---
Metal	1 mg/m^3	---
Metal and Cr (II, III) Compounds	---	0.5 mg/m^3 as Cr
Cr (VI) Compounds	---	0.05 mg/m^3 as Cr
Chromic Acid and Chromates	0.1 mg/m^3 as CrO_3	---
Arsenic (As)		
Inorganic As and Compounds	0.01 mg/m^3 as As	---
As and SolubleCompounds	---	0.2 mg/m^3 as As

*Eight hour Time Weighted Average unless otherwise noted.

TABLE II - Continued

Contaminant	Laws and Regulations - Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (PEL)[2]	Guidelines -American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value[3]
Lead (Pb)		
Metal, Inorganic Pb Compounds and Pb Soaps	0.05 mg/m^3 as Pb	---
Inorganic Pb Dusts and Fumes	---	0.15 mg/m^3 as Pb
Lead Chromate	---	0.05 mg/m^3 as Cr
Calcium Oxide (CaO)	5 mg/m^3	2 mg/m^3
Vanadium (V)		
Respirable Dust and Fume	0.05 mg/m^3 as V_2O_5	0.05 mg/m^3 as V_2O_5
Nickel (Ni)		
Metal	---	1 mg/m^3
Metal and Insoluble Compounds	1 mg/m^3 as Ni	---
Soluble Compounds	0.1 mg/m^3 as Ni	0.1 mg/m^3 as Ni
Inert or Nuisance Dust		
Total Dust Fraction	15 mg/m^3	10 mg/m^3
Respirable Dust Fraction	5 mg/m^3	---
Noise	90 dBA	85 dBA

A law, regulation or guideline does not exist for every health or physical hazard, but a liability might. Examples of unregulated exposures could include the following:

- Low levels of asbestos below current PEL's.
- Levels of arsenic, lead, or various organic carcinogens below current PEL's.
- Heat stress
- Magnetic fields
- Tobacco smoke

In the United States, no government agency monitors the workplace because employees are exposed to the above examples. Standards and codes developed by independent or trade associations may cover these situations. In addition, generally accepted ferroalloy industry practices may furnish additional criteria. If not, there is insufficient information to support good judgement on how to handle these exposures.

Established company policies are necessary to organize and control the ever increasing amount of effort needed to ensure both legal and financial protection for a company. For example, Elkem Metals Company has deemed it necessary to have written policies on Occupational Health as well as Personnel Safety, Product Safety, and Environmental Affairs.

Using the policy statements as a basis, standards and practices can be developed to govern company occupational health activities. Table III lists the Elkem Metals Company occupational health issues covered either by a written policy or a standard.

TABLE III - Elkem Metals Company Occupational Health Standards/Practices

1. Audits
2. Contractor-on-Site
3. Exposure Standards
4. Hearing Conservation and Noise Control
5. Respiratory Protection
6. Industrial Hygiene
7. Medical Services
8. Medical Information Confidentiality
9. Informing Employees
10. Embryo-Fetus Protection

The implementation of such standards and practices forms the basis of an Occupational Health Program.

The remaining three phases necessary to achieve a functional Occupational Health Program require development of:

- Risk Identification
- Risk Assessment
- Risk Management

RISK IDENTIFICATION

The intricacy of Risk Identification is illustrated by the recognized trace elements essential to the human diet (copper, fluorine, iodine, molybdenum, manganese, nickel, selenium, silicon, vanadium, and zinc).[1] All are toxic when ingested in excess, and all are listed in the exposure limits that have been incorporated into regulations or guidelines. Some forms of several of these trace elements are classified as carcinogens. It should be emphasized that certain trace elements essential for survival are, under certain circumstances, capable of destruction.

The initial task required under Risk Identification is a hazard determination. Whereas hazard defines the potential to do harm, risk is an estimate of the probability that harm will actually occur.[5] For example, crystalline silica is listed as a carcinogen by The International Agency for Research on Cancer (IARC) [6] and is considered as a hazardous, toxic chemical. However, the mere presence of crystalline silica in the workplace may not constitute a health risk. Before a risk will occur, there must be an exposure above the PEL. The authors are not aware of any evidence of carcinogenic activity in ferroalloy workers due to exposure to crystalline silica.

A hazard determination starts with an extensive inventory of all on-site chemicals and materials. The degree of hazard associated with each item on the list should be established by a qualified professional. It is not surprising that some items previously thought to be "inert," such as amorphous silica, will be included because they have been classified by authorities as a health hazard.

The hazard determination will continue with a quantification of all exposures in the workplace. This quantification identifies high risk jobs or areas in which to concentrate future sampling. Also, sampling periodicity can be chosen based upon predetermined degree of hazard. The inventory, the exposure quantification and the sampling periodicity would require the input of a qualified professional.

Elkem Metals Company determines sampling periodicity under its Industrial Hygiene Sampling Program. To do this, a method has been established which allows an evaluation of both the contaminant's toxicity and its exposure level to arrive at an estimate for minimum sampling frequency. Table IV details the methodology to arrive at monitoring frequency.

TABLE IV- Minimum Sampling Frequency Determination

<u>Part A</u> - Exposure Level Multiplier	
≥50% of PEL	4
20% to <50% of PEL	2
<20 % of PEL	1
Maintenance Personnel	1
<u>Part B</u> - Health Hazard Multiplier	
High	2
Medium	1
Low	0.5

Part A Multiplier times Part B Multiplier = Annual number of workplace samples for a particular job class.

An example of the application of Table IV is a furnace tapper primarily exposed to amorphous silica fume. The Part A multiplier is usually 2 (<50% of PEL) with a Part B multiplier of 0.5 (low). At least one sample per year must be taken within the tapper job class to meet Elkem Metals Company standards. Another brief example of the appli - cation of Table III involves maintenance workers. All maintenance workers should be sampled at least once a year to meet Elkem Metals Company standards.

The results of the hazard determination will lead to the next significant segment of an Occupational Health Program - medical surveillance. A properly performed hazard determination will guide the medical program components. For example, the primary exposure route of contaminants in a ferroalloy workplace is inhalation. The target organ is generally the lung. A physical examination for a ferroalloy worker will definitely include a pulmonary function test (PFT) and a review by a physician in an attempt to detect occupational lung disorders at an early stage. Other components, as shown in Table V, may be chosen by a medical professional, depending on company requirements.

TABLE V - Basic Elements of a Periodic Physical Examination Within Elkem Metals Company

Medical History Questionnaire

Blood and Urine Analysis

Electrocardiogram

Blood Pressure, Height, Weight, Pulse

Pulmonary Function Test (PFT)

Audiometry

Vision Testing

Chest X-ray

Review by Nurse or Physician

Risk Identification is needed to maintain a consistent flow of accurate up-to-date information. The process should be supervised by an occupational health professional (physician, industrial hygienist, toxicologist, chemist, or engineer). Smaller organizations may have to rely upon consultants for this function.

RISK ASSESSMENT

The assessment of risk to human health due to occupational exposures is highly technical and complex, requiring a scientific methodology. The results of Risk Assessment are necessary not only for regulatory decisions regarding worker exposure but also for the evaluation of emissions and effluents, ambient air and water exposures, waste disposal sites, naturally occurring contaminants as well as worker protection. Risk Assessment furnishes the basis for arriving at sound conclusions on the extent of potential for injury, death, property damage or other loss to occur. This assessment provides managers with the following:[7]

1. A characterization of the types of health effects expected.

2. An estimate of the probability of occurrence of the health effects.

3. An estimate of the number of cases with these health effects.

4. A suggested acceptable concentration of a toxicant in the workplace.

The driving force for Risk Assessment in the ferroalloy industry in the United States is federal, state and local regulations. Since 1970, federal legislation has adopted "unreasonable risk" as the measure of safety in the United States. The United States Occupational Safety and Health Administration (OSHA), for example, uses an acceptable working lifetime risk of one in one thousand for developing cancer as a guide in determining exposure levels for carcinogens.[8] Table VI lists examples of materials documented as carcinogens by IARC, [9, 10] OSHA, [11] and the National Toxicology Program (NTP).[12]

TABLE VI - Examples of Materials Documented As Carcinogens (IARC, OSHA, and NTP)

Asbestos	CTPV
Arsenic and Inorganic Arsenic Compounds	Crystalline Silica (Quartz)
Lead and Lead Compounds	Chromium and Inorganic Chromium Compounds
Nickel and Inorganic Nickel Compounds	Tobacco Smoke

When occupational health professionals consider the elements of Tables II and VI together, they conclude that the health risk to workers in the ferroalloy industry is potentially very high. Assessment of this potential requires the use of fundamentals developed in Risk Identification. Through Risk Identification, the CONSEQUENCE of an occupational exposure was developed. The PROBABILITY of accident or injury must then be determined by a health professional. Considering the CONSEQUENCE of an occupational exposure in conjunction with its PROBABILITY comprises the final phase of Risk Assessment.

Elkem Metals Company has developed and utilizes the definitions in Table VII as an aid to Risk Assessment.

How the Risk Assessment relates to the legal definition of "unreasonable risk" will dictate the next actions taken. Since most Ferroalloy Industry CONSEQUENCES are category 2 Critical or 3 Marginal and PROBABILITY category 2 Less Probable or 3 Remote, management generally has an extended time for the next phase, the Risk Management process.

RISK MANAGEMENT

Risk Management is selection and implementation of the most appropriate action based upon the results of Risk Assessment, available control technology, cost versus benefit analysis, acceptable risk, acceptable number of cases, policy analysis, and social or political factors.[7] The culmination of effective Risk Identification and Risk Assessment will allow decisions concerning the following actions:[13]

- Risk Removal
- Risk Reduction
- Risk Transfer

Risk Removal means that the operation is so dangerous that it must be discontinued. Risk Reduction mitigates predicted or potential accident or injury. For example, the use of high efficiency respirators when working with asbestiform materials is an item of Risk Reduction. Risk Transfer has a third party, such as an insurance company, accept responsibility for potential losses. Transference of risk is usually highly complex.[13]

An example of the Risk Management process is typified in the case of a high carbon ferromanganese manufacturer utilizing a high arsenic ore as a feedstock. The company's routine sampling program (detailed in Risk Identification) detects airborne arsenic overexposure of the furnace tappers. A Risk Assessment analysis leads to the conclusion that arsenic exposure above the PEL places the employee at risk (See Tables II and VI) and places the company at potential liability. Risk Removal is not an acceptable solution in this case. Risk Transfer is not required and may be very expensive. The problem is resolved through Risk Reduction. Once the problem is understood, tappers are rotated on four hour schedules instead of the usual eight hour shift. This reduces their exposure by one-half. Simultaneously,

TABLE VII - CONSEQUENCE and PROBABILITY Definitions

CONSEQUENCE	
1. Catastrophic	Imminent danger capable of causing death, widespread illness, great property loss.
2. Critical	Severe injury, serious illness, property loss.
3. Marginal	Injury, illness, and non-serious damage.
4. Negligible	Injury requiring minimal first aid.
PROBABILITY	
1. Probable	Likely to occur immediately.
2. Less Probable	Probably will occur in time.
3. Remote	May occur in time.
4. Extremely Remote	Unlikely to occur.

engineering efforts are directed toward improved taphole fume collection to reduce airborne arsenic at its source. Once the improvements are complete, further personal monitoring confirms acceptable airborne arsenic levels; work schedules are returned to normal.

If a Ferroalloy Company is to be successful in occupational health, it must involve anticipatory planning at all levels. Each engineer or manager with responsibility in this area should be evaluating risk at all phases of Risk Management. An engineer may perform the industrial hygiene sampling which identifies a contaminant. An Occupational Health Manager may assess the risk by means of CONSEQUENCE in conjuncton with PROBABILITY. A Plant Manager has all of the above at his access including site contingency plans. A company executive must always be prepared to educate himself or herself concerning actual incidents as well as potential accidents. He or she must bear in mind the principles of Risk Identification, Risk Assessment and Risk Transfer or Removal.[13] Above all, the accountable company executive must be prepared to recognize that Risk Management involves asset protection, improved quality and increased productivity as well as personnel protection.

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