

OCCUPATIONAL HEALTH: RESPIRATORY PROTECTION IN THE INDUSTRY

By: Sdr. Kim Kuk Seong, BE Hons. (UTM)

ABSTRACT

As our country progresses towards fully industrialised nation status by the year 2020, many workers are still unaware of the occupational hazards that they are exposed to day after day. The most common but yet critical occupational hazard is respiratory hazard. Hazardous contaminants in the air, if not properly filtered, can cause lung diseases and if absorbed into the bloodstream can result in damage to other organs in the body. The effects are always long-term and incurable. The key to an occupational health protection program can be summarised into 4 steps: (1) identification of the hazards, (2) understanding of the effects of the hazard on workers, (3) selection of the proper personal protective equipments, and (4) training of the workers in the proper use and care of the respirators. This paper is intended to focus and elaborate specifically on a respiratory protection program and how to manage it in compliance with regulatory requirements.

INTRODUCTION

The objective of a respiratory protection program is to prevent workers from breathing contaminated air. This should be accomplished as much as possible by using accepted engineering control measures. However, when effective engineering control is not feasible, or while it is being installed, appropriate respirators may be employed.

To ensure the success of a respiratory protection program, the following 4-Step Method is recommended:

Step 1: Identify the hazard

Step 2: Understand the effects on workers

Step 3: Select the proper respirator

Step 4: Train the workers in proper respirator use and care

2 4-STEP METHOD

Identify the Hazard

It is the responsibility of the employer to conduct a regular survey or audit at the workplace to identify hazards that may be present. Many of these hazards are invisible and therefore, the understanding of each type of the hazard is very critical.

Particulates

Particulates are tiny particles that float in the air. They can be so small that a naked eye cannot see them. They can cause short or long term health problems by damaging the lungs or when they are absorbed into the bloodstream. Particles can be:

- Dusts: the suspension of solid particles in the air. These particles are generated from mechanical processes such as crushing, chipping, sanding or grinding operations;
- Mists: the dispersion of liquid particles in the air. Mist is normally generated from processes such as electroplating, spraying and dipping where liquids are atomised or foamed into fine particles;

- Fumes: the suspension of solid particles from condensation of substances from the vapour state. It is normally associated with molten metals where the metal is vaporised, followed by the oxidation of the vapour and condensation of the oxide into fine solid particles. Although fume particles are mostly less than 2 micrometres in diameter and not visible to the naked eye, the agglomeration of these particles into larger sizes usually results in some part of the fume to become visible.

Gases and Vapours

Gases and vapours are contaminants that act like air and mix easily in the atmosphere. They can cause health problems that range from simple irritation to severe long or short-term health problems. In high enough concentrations, they can cause death, especially if they replace oxygen and cause suffocation.

- Gases refer to the state of matter in which the material has very low density and viscosity; can expand and contract greatly in response to changes in temperature and pressure; easily diffuses into other gases; and readily and uniformly distributes itself throughout any container. A gas can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature (below the critical temperature).
- Vapours refer to the gaseous form of substances that are normally in the solid or liquid state (at room temperature and pressure). The vapour can be changed back to the solid or liquid state either by increasing the pressure or decreasing the temperature alone. Vapours also diffuse. Evaporation is the process by which a liquid is changed into the vapour state and mixed with the surrounding air. For example, solvents with low boiling points will volatilize readily.

Oxygen Deficiency

Oxygen deficiency occurs whenever the percentage of oxygen in the air falls below the normal level of 21%. It can occur in confined spaces where there is insufficient ventilation to maintain the necessary level of oxygen or it can be caused by fire, chemical reaction or when other gases displace oxygen from the air.

Extremes of Temperature

If the air is extremely hot or cold, it can damage lungs if inhaled. This typically could be associated with metal refining furnaces, cold storage areas or industrial ovens.

UNDERSTAND THE EFFECTS ON WORKERS

Airborne hazards can contribute to a whole series of respiratory disorders, from a mild cold-like catarrh to frank pneumonia, pneumoconiosis, chronic obstructive pulmonary disease, or cancer. It is obviously difficult to delineate when a cold begins or bronchitis begins or for that matter when cancer begins. Thus, with occupational respiratory diseases, the symptoms and signs of cough, phlegm production, chest pain, shortness of breath and the spitting up of blood merely can be considered to be one or more parts of a continuous process – namely irritation of the respiratory tract.

Particulates (dusts, mists and metal fumes) can all cause irritation to the nose, throat and upper respiratory tract. If the particulate is very small (less than 5 microns) it can travel deep into the lungs and cause damage to lung tissues resulting in serious health problems. Inhaling silica dust or asbestos fibres for instance, will cause cancer in the long term, and the inhalation of fumes such as lead can cause anemia, paralysis of limbs, brain damage or death.

Gases and vapours, if inhaled, can travel straight into the lungs. From there, they may be absorbed into the bloodstream and circulate around the body, and can cause damage to the major organs such as the brain, liver

and kidneys. For instance, carbon monoxide (CO) which is generated during the incomplete combustion of organic matter, has an affinity for haemoglobin some 200 times that of oxygen. So when CO is inhaled, it restricts oxygen supply in the blood to body tissue. Symptoms of CO poisoning are nausea, headaches, fatigue and even death when the concentration of CO is very high.

The effects of oxygen deficiency are dizziness, cramps, headache and increased heart rate. Safe oxygen level ranges from 19.5% to 21% of the air in the space. At 16%, symptoms such as fast breathing and heartbeat, drowsiness and nausea develops. Unconsciousness will happen at 12% and death at 6%.

The delicate tissue lining the nose, mouth, throat and lungs can be damaged by breathing very hot or cold air. Extremes of air temperature may prevent normal breathing.

Health effects of specific chemical hazards can be found in the Material Safety Data Sheets (MSDS) supplied by the manufacturer of the chemical. Generally, the health effects of chemical hazards are listed in Table 1.

SELECT THE PROPER RESPIRATOR

Upon understanding the health effects of the hazard, it is very important to select the right type of respirator. Each hazard is unique and special attention is required when selecting the respirator. The following factors should be considered:

- chemical and physical properties of the contaminant,
- the nature and extent of the hazard,
- work requirement and conditions, and
- the capabilities, limitations and characteristics of the available respirators.

Half-mask Respirators – Maintenance-Free

Maintenance-free half-mask respirators

are designed to offer protection from many particulates, gases and vapours, but do not need extensive maintenance or repair. Like any respirator, they form a seal on the face so that the nose and mouth are covered.

Maintenance-free respirators can filter out particles or gases and vapours or a combination of these hazards, depending on their design. The exact respirator selected must be matched to the work conditions. These respirators do not supply oxygen and therefore should not be used in an oxygen deficient atmosphere.

Half-mask maintenance-free respirators that are designed for particulate protection are made from fibrous material that traps and holds dusts, mists or fumes that pass into the filter as one breathes in. Other maintenance-free respirators are constructed with activated carbon that removes gases and vapors from the inhaled air. When a respirator is worn properly, it will protect the wearer against airborne contaminants.

Half-Mask Respirators – Replaceable Parts

Like maintenance-free respirators, these half-mask respirators cover the nose and the mouth. Cleaning of the inhaled air is accomplished with a range of particulate or gas and vapor filters which can be replaced when exhausted. The facepiece can be reused since parts are available for servicing and replacement if damaged.

A properly selected and used half-mask respirator can reduce the concentration of hazard in the air to a safe level. Cartridges and filters have labels that provide important information on the specific hazard and concentration they are designed to protect against. Reading and understanding all instructions before use is very critical. Air purifying respirators should not be used in oxygen deficient atmospheres.

Cartridges contains a specific sorbent to absorb gases and vapors whereas a filter is made of fibrous

TABLE 1: SOME GENERAL EFFECTS OF CHEMICAL HAZARDS

Hazards	Some Health Effects
Dusts	Occupational asthma, lung cancer and bronchitis
Mists	Irritation and corrosion of respiratory tract
Fumes	Metal fume fever and central nervous system dysfunction
Gases	Irritation, pulmonary edema and damage to major organs
Vapours	Central nervous system depression, lack of coordination, liver cancer, kidney damage and infertility

material (some are electrostatically charged) to capture particulates (dust, mist and fumes). The ambient air is purified as it passes through the cartridges and filter. It is important to use a cartridge and a filter specific to the hazard and they must be changed regularly.

Full-face Respirators

These respirators can be fitted with cartridges or filters to trap particulates, gases or vapors from the air. A full-face respirator is similar to a half-mask respirator, but with the added benefit of offering a lens to protect the eyes and face.

A full-face respirator can reduce the concentration of a specific gas, vapor or particulate hazard to an acceptable level in the air that one actually breathes. It is very important to be sure of using the correct cartridge or filter. Full-face cartridge/filter respirators only purify the air. They should not be used in oxygen deficient atmospheres.

A full-face respirator with cartridges or filters works just like the air purifying half-mask respirator. The specific sorbent in the cartridge absorbs the gas or vapor as the air is inhaled. Particulate filters remove dusts, mists and metal fumes from the air. The full-face mask helps protect the eyes and skin against hazardous splashes and flying debris in the work area.

Supplied-Air Respirators

Supplied-air respirators uses either an airline connected to a source of breathable quality air, or a self-

contained respirator where the clean air is carried in cylinders. Besides providing protection against respiratory hazards, supplied air systems can also provide head, eye and face protection, depending on the specific system used; for instance, full-face dual airline and loose-fitting hood and helmet.

Supplied-air systems can be used to offer protection against very high concentrations of contamination – dust, mist, metal fumes, gases and vapors. Some devices are designed so that they can be used in oxygen deficient atmospheres and extreme temperatures.

Airline respirator works by supplying clean air from an uncontaminated source, usually a compressor, tank or pump. The air supply can be either pressure demand, i.e. air only flows when a person inhales, or continuous flow. It may be necessary to control the temperature of the air by the use of special heat exchange units.

Self-contained respirators supply clean air from a cylinder carried by the user. The air flows through a regulator to the facepiece. Most cylinders can supply sufficient air for approximately 40 minutes but the length of time of supply will depend on the user size and the work rate. An alarm will sound to warn the user when the air supply is low.

Assigned Protection Factors (APF)

Assigned protection factors (APFs) are estimates of a respirator's ability to reduce the wearer's inhalation exposure to an air contaminant. A respirator with a

higher APF is expected to provide greater reduction in exposure (more protection) than a respirator with a lower APF. OSHA expresses APFs as multiples of the Permissible Exposure Limit or PEL in the substance specific standards. In other words, for a respirator allowed to be used up to 10 times, the PEL has an APF of 10.

A half-mask respirator. Designed to help provide comfortable, reliable worker protection against certain non-oil based particles. Its lightweight construction promotes greater worker acceptance and comfort and increased wear time.

A full-face respirator. These low maintenance half facepieces are designed for comfort, convenience and economy. Used against a variety of gases, vapours and particulate hazards according to DOSH approval.

TRAIN WORKERS IN PROPER RESPIRATOR USE AND CARE

Workers must be trained in the use of the respiratory protective equipment. They must also understand the capabilities and the limitations of the respirators.

A respirator can give the expected protection only when it is properly fitted on the face. The manufacturer's instructions should be followed carefully to get a correct fit. If multiple sizes are offered, choose the one that fits best. Fit can be reduced significantly by facial hair, missing dentures, scars and other facial irregularities. Always have the fit of a respirator tested before wearing it for the first time and check it before each use.

Qualitative Fit Testing (QLFT)

For QLFT, a determination of adequate fit is based upon whether or not the individual can smell, taste or detect the challenge agent. OSHA will accept tests using the following challenge agents currently available: irritant fume, isoamyl acetate (banana oil), saccharin or Biltrex aerosol.



Half-mask respirator



Full-face respirator

- Special ventilation eg. extraction units (engineering control)
- Written safety procedures
- Regular identification and measurement of hazards
- Regular medical assessment of employees
- Correct respirator selection
- Training of employees
- Correct fitting of respirators
- The right respirator for the work
- Maintenance and care of the respirator
- Regular program evaluation ■

Fit Check

In contrast to fit testing, a fit check is a quick determination of respirator fit by the wearer each time a respirator is donned to assure that a proper face-to-respirator seal has been achieved. There are positive and negative fit checks and a wearer should follow the instruction given by the manufacturer.

Use and Maintenance

Before entering a contaminated area, the user should inspect the respirator to ensure that it will function properly. Inspection for torn rubber, dents, cracks or broken parts shall be made. The respirator must be replaced immediately if it is damaged. Filter elements should be replaced immediately if they become difficult to breathe through or an odor or taste is detected.

Respirators that are routinely used should be cleaned after each use. An established program to clean and inspect respirators will simplify this task. Cleaning and disinfecting solutions are available that effectively clean the respirator and provide protection against bacterial growth. The respirator may be immersed in the solution, rinsed in clean, warm water and then air dried or a specially treated tissue can be used with a disinfectant to wipe the respirator.

As for maintenance-free respirators, when it is used to its capacity, it may be simply discarded properly in its entirety since it is "maintenance-free". The respirator should be replaced with a new one if breathing becomes difficult, it is damaged or a taste or odor is detected.

CONCLUSION

The 4-step method mentioned above is a guide to implementing a respiratory protection program at a workplace. Regular workplace survey and evaluation of the program are required due to the changing of work procedures or processes. These include the change of chemicals used at the workplace, introduction of new chemicals, new workers or new hires at the workplace, etc.

In summary, the following elements shall be considered in the implementation and improvement of a respiratory protection program:

We are a well-established company and the leader in PVC leathercloth, PVC films & sheetings, prefabricated drainage systems and customized rotational moulding products.

Our continued growth has created exciting opportunities for dynamic individuals in the following positions:

SALES ENGINEER

Main Responsibilities:

The incumbent will be responsible to handle the sales and marketing of geotechnical engineering products

Requirements:

- Degree in Civil Engineering or its equivalent
- Minimum 2 years sales experience in the industry
- Possess passion and drive to achieve sales targets
- Possess excellent interpersonal communication and negotiation skills

A competitive remuneration package with attractive benefits and advancement opportunities will be offered to successful candidates

Interested candidates are invited to submit their applications with a comprehensive curriculum vitae, contact telephone number, present and expected salary and a recent passport-sized photograph (N.R) before 30th September 2004 to:



The Human Resources Department
NYLEX (MALAYSIA) BERHAD (9076-1)
 Peralatan Selangor, P.O. Box 7033,
 40910 Shah Alam, Selangor Darul Ehsan
 Email: hr@nylex.com Fax: 03-5510 3843



TABLE 2. ANSI ASSIGNED PROTECTION FACTORS

Type of respirator	Respiratory inlet covering	
	Half mask ¹	Full facepiece
Air purifying	10	100
Atmosphere supplying		
SCBA (demand) ²	10	100
Airline (demand)	10	100

Type of respirator	Respiratory inlet covering			
	Half mask	Full face	Helmet/ Hood	Loose-fitting facepiece
Powered air purifying	50	10003	10003	25
Atmosphere Supplying				
Airline				
Pressure demand	50	1000	---	---
Continuous flow	50	1000	1000	25
Self-contained breathing apparatus				
Pressure demand open/closed circuit	---	--- ⁴	---	---

- 1) Includes 1/4 mask, disposable half masks, and half masks with elastomeric facepieces.
- 2) Demand SCBA shall not be used for emergency situations such as fire fighting.
- 3) Protection Factors listed are for high-efficiency filters and sorbents (cartridges and canisters). With dust filters, an assigned protection factor of 100 is to be used due to the limitations of the filter.
- 4) Although positive-pressure respirators are currently regarded as providing the highest level of respiratory protection, a limited number of recent simulated workplace studies concluded that all users may not achieve protection factors of 10 000. Based on this limited data, a definitive assigned protection factor could not be listed for positive-pressure SCBAs. For emergency planning purposes where hazardous concentrations can be estimated, an assigned protection factor of no higher than 10 000 should be used.

NOTE - Assigned protection factors are not applicable for escape respirators. For combination respirators, e.g., airline respirators equipped with an air-purifying filter, the mode of operation in use will dictate the assigned protection factor to be applied.