UNIT 1
Introduction to Occupational Health

Introduction to Unit

Student will learn about the background of occupational health.

Objectives to Unit

After this session, students should be able to:

- Understand changes in approach to occupational safety and health throughout history
- Be aware of some of the important people, events and laws affecting occupational health and safety

1.0 Content

1.1 Occupational Health
1.2 Historical Perspective of Occupational Health
1.3 Social Changes and Other Factors
1.4 Occupational Health Organisations
1.5 Other Related Organisations
1.6 United Kingdom
1.7 United States of America
1.8 Recent Tragedies
1.9 Current Perspectives of Occupational Health
1.10 Customer-Driven Occupational Health
Important Notes

1.1 Occupational Health

- Observation of the relation between occupational hazards and poor health dates back several centuries
- Stone age was the first age of occupational risk – flint knapping – the process of making stone tools
- Hunter-gatherers
- Iron age – smelting of iron
- Ancient Egyptians recognised the hazardous effects of mining and restricted such work to slaves and criminals
- Agricultural age
- Industrial revolution – UK – poor sanitation and a lot of rural populations moved to town to work – employers were not concerned and was profit-oriented
- Information technology and K-economy

1.2 Historical Perspective of Occupational Health

- Hippocrates (c. 460-377 b.c.) described a case of lead poisoning plus its symptoms
  - The first recorded observation due to occupational disease
- Pliny (23–70 a.d.) spoke of the poisonous nature of lead, mercury, and sulphur, but nothing was done to protect the workers
  - Described how lead refiners used membranes as masks, very inadequate form of protection
  - However, medical care was provided to the upper classes and to those who entertained, such as the gladiators, but never to manual labourers
- At the end of the 15th century, literature began to be devoted to occupational diseases
- Increase in trade had stimulated a demand for gold and silver
Firearms were being developed, creating a demand for iron, copper, and lead

- In 1473, a German physician, Ulrich Ellenbog, wrote a short treatise - *On the Poisonous Wicked Fumes and Smokes*, referring to fumes from coal, nitric acid, lead, mercury encountered by goldsmiths and other metal workers.

- Agricola (Georg Bauer, 1494–1553) German mineralogist and scholar - physician and practiced in a mining town
  - 1526, published *De Re Metallica, a book on metallurgy*
  - described the diseases and accidents prevalent among miners, and recommendations for prevention
  - He says dust “... eats away the lungs, and implants consumption ...”
  - In the Carpathian mountains women have married seven husbands . . . .
  - Among those at risk were miners, chemists, potters, tinsmiths, glassmakers, painters, tobacco workers, lime-workers, tanners, weavers, coppersmiths, and printers

- Ramazzini found that sewage workers showed severe reddening of the eyes and that many of them, after years of such work, became blind
  - Linked the pathology to acidic substances (ammonia vapours) present in the sewer
  - idea for his treatise - attention was attracted by the speed with which a sewage worker emptied the sewer at Ramazzini’s house
  - When questioned the man answered that too long a stay in such a place would cause blindness

- Charles Turner Thackrah published an extensive study of industrial illnesses and poverty in 1831

- Sir Thomas Legge (1863-1932) First Medical Inspector of Factories – England – Lead poisoning

- Under Legge’s influence, lead poisoning was made a nationally notifiable disease in Britain in 1899

- Amanda Hamilton (1869-1970) First women Professor at Harvard and expert in occupational health
  - Pioneer in the field of toxicology studying occupational illnesses and the dangerous effects of industrial metals and chemical compounds
Occupational Health tragedies - US Organised labour

- Workplace disaster in the early 1990s
  - Outrage over catastrophic events often lead to legislation to protect workers

- America
  - Triangle shirtwaist company in 1911 - Workers are paid low wages and work in unsafe and unsanitary conditions – 146 died in a fire
  - Gauley Bridge Disaster in 1930 – construction of tunnel caused massive exposure to silica dust – 500 (silicosis) and 1500 disabled African American men

1.3 Social changes and other factors

- Organised labour
  - Labour unions influence improvements in workplace health and safety by influencing legislations as well as forcing concessions from management

- Studies on worker’s health
  - In 1914 in the US, studies found workers living in unsanitary conditions have tuberculosis – abolished sweat shops
  - 1923, development of industrial hygiene sampling equipment for studies of the dusty trades

- Professional organisations
  - American Industrial Hygiene Association, 1939

- Economic factors
  - The Great Depression, 1929 to 1930s
  - Government in the US established labour standards

- World War II
  - Started a period of industrial growth in the US and Great Britain
1.4 Occupational health organisations – International Labour Organization

- Play a big role in occupational health
- International Labour Organisation or ILO 1919
- League of Nations (since WW1)
- Tripartite – government, employers, workers
- Come out with conventions and recommendations
- ILO encyclopaedia
- ILO classification of pneumoconiosis

1.5 Other related organisations

- World Health Organisation under the UN
  - Occupational health unit (workers’ health)
  - Health settings (workplaces) approach
- International agency for research in cancer or IARC in Lyon, France
  - International Agency for Research on Cancer classification of carcinogens
- American Conference of Governmental Industrial Hygienists (ACGIH)
  - Come out with threshold limit values or TLV

1.6 United Kingdom

- Factories Act 1833
- Inspectorate system
- Medical Inspector of Factories
- Medical surveillance – 1895 for lead and phosphorus
- Health and Safety at Work Act 1974 – Roben’s Commission – safety and health responsibility of those who create the risks and those who work with risks

1.7 United States of America

- 1914 – USPHS – Office of Industrial Hygiene and Sanitation – NIOSH
- 1916 – American Association of Industrial Physicians and Surgeons – ACOEM
- 1939 – American Industrial Hygiene Association
- 1946 – American Academy of Occupational Medicine
- 1955 – American Board of Preventive Medicine (Occupational Medicine)
- 1970 – Occupational safety and Health Act

1.8 Recent tragedies

1. Chernobyl nuclear disaster, Kiev, Ukraine
   - April 26, 1986, a reactor at the Chernobyl nuclear power plant experienced a catastrophic failure
   - Resulted in the worst nuclear power disaster in history
   - Due to a flawed reactor design and poorly trained plant personnel
   - Amount of radiation released was at least 100 X that of the Hiroshima and Nagasaki atomic bombs combined

2. Bhopal tragedy, India
   - December 1984, a highly toxic gas was leaked from a pesticide plant in city
   - Winds spread the poison through a densely populated area
   - Many died instantly, others as they tried to flee, more than 20,000 people died in total in the aftermath of the leak

3. Bright Sparklers Fireworks Explosion at Sungai Buloh
   - Tragedy happened in 7th May, 1991
   - Fireworks factory and fire killed 22 people and injured 103 others
   - Bright Sparklers Sdn. Bhd violated many laws to carry out dangerous operation
   - Commission found that legislations pertaining to siting, construction, maintenance and operations of the factory were not adhered to
1.9 Current perspective of OH

- Chemicals
- Gasses
- Dusts
- Particles
- Light
- Heat
- Noise
- Vibration
- Slips, trips, falls
- Radiation
- Information Technology and K-economy

- Working hours
- Stress
- Ergonomics

1.10 Customer-driven OH

- Example 1: Fairtrade organisation
  - Fairtrade is an alternative approach to conventional trade
  - Fairtrade Standards applies to workers - employers pay decent wages, guarantee the right to join trade unions, ensure health and safety standards and provide adequate housing where relevant

- Other examples are Nike and Apple iPhone (exposure to n-hexane)
  - Prolonged over-exposure to n-hexane can cause extensive damage to the peripheral nervous system and ultimately the spinal cord, leading to muscular weakness and atrophy and even paralysis
Child Labour in the 21st Century?

- Chocolate and child slavery
  - Ivory coast, West Africa – cocoa exporter almost 50% of the world
  - In 2001, BBC investigation found cocoa farmers employ thousands of children to work
  - Mali, Burkina Faso, and Togo
  - Children were trafficked and sold to work
  - Usually 12-to-14-years-old or younger, forced to do hard manual labour 80 to 100 hours a week.
  - Hershey’s and M&M Mars, ADM Cocoa, Ben & Jerry’s, Cadbury Ltd., Kraft, Nestle, See’s Candies, The Chocolate Vault, Toblerone.

Conclusion to Unit

The science in the occupational health field is recent however the practice has dated back in centuries and has evolved since the time man began to manipulate the earth resources for their livelihood. Our current knowledge on occupational health is in depth but due to new technologies being created, new information and research is important to ensure the health and safety of workers.
Additional References

3. http://www.johnrobbins.info/blog/is-there-slavery-in-your-chocolate/

Discussion 1.0

1. What “forces” led to the creation of worker protection laws early in this century?
2. Are these forces still in effect?
3. What forces drive occupational safety and health in today’s world?

Answers to Discussion 1.0

1. Workplace disaster, organized labor, professional organizations, economic factors and world war
2. No
3. Customer-demands for products adhering to basic occupational health and safety standards
UNIT 2
Roles of Occupational Health Professionals

Introduction to Unit

Student will learn about the roles of occupational professionals.

Objectives to Unit

- After this session, students should be able to:
  - Understand changes in approach to occupational safety and health throughout history
  - Be aware of some of the important people, events and laws affecting occupational health and safety

2.0 Content

2.1 Basic concept of Occupational Health
2.2 Roles of Professionals
2.3 Competencies
2.4 Knowledge areas and skills
2.5 Challenges
2.1 Basic concept of Occupational Health

- Definition 1: Occupational Health is the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations by preventing departures from health, controlling risks and the adaptation of work to people, and people to their jobs

  - (ILO-WHO 1950)

- Definition 2: Occupational Health is the maintenance and promotion of workers’ health and working capacity, improvement of working environment and work to become conducive to safety and health and the Development of work organisation and working culture – safe, healthy and enhance productivity

  - (ILO-WHO Committee on Occupational Health 1955)

- The Team - But not limited to:

  o Occupational physicians
  o Nurses
  o Psychologist
  o Industrial hygienist
  o Epidemiologist
  o Engineer
  o Toxicologist
  o Microbiologist
  o Chemist
  o Information technician
  o Statistician
  o Health promotion specialist
Some important definition in Occupational Health

- **Hazard**: A **hazard** is any source of potential damage, harm or adverse health effects on something or someone under certain conditions at work.
- **Risk**: **Risk** is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss.

### 2.2 Roles of Professionals

The roles of professionals are as follows:

- Identify and assess the risks from health hazard in environment/workplace
- Protect and promote public/workers’ health
- Carry out surveillance of factors which may affect health
- Improve the conditions that might harm health through sound control measures
- Maintain health and achieve the highest possible standards of health in the interest of the workers
- Strengthen health promotion and ensure continuous improvements
- Develop safe and healthy culture and management

The Principal Approach used by these professionals is:

1. **Primary prevention**
   - Risk assessment – determine whether the risk is high or low
   - Hazard control is performed
   - Health promotion is included
2. Secondary prevention
   - Treatment for injuries and diseases

3. Tertiary prevention
   - Rehabilitation
   - Therapy

The Principle Approach is best understood when it is based on the Natural history of disease as the diagram below.

OH Professionals As Role Models should be able to take on these roles

- Adviser – individual, group, organisational
- Agent of change – worker, environment, process
- Expert – evaluation, risk assessment
- Counsellor
- Trainer
- Source of knowledge – disseminating relevant information
- Skill development resource
• Have expertise to:
  
  o Identify the problems
  o Treat or fix the problems
  o Assess the effectiveness of the programs and interventions or in other words, to evaluate the programs

2.3 Competencies

Competencies 1

- Identification and assessment of the risks from health hazards
  
  o Health risk assessment – carry out assessment on hazards that may arise from operation, e.g. machinery
  o Advise for control methods
  o Diagnosing ill-health related to environment or occupation
  o Assessment by multidisciplinary team

- Occupational health hazards
  
  o Physical Hazards – are in the form of energy or force
  o Chemical Hazards – Chemical hazards can appear as gasses, vapours, liquids, solids, dust, fumes, or mists which can be flammable, toxic, corrosive, reactive or explosive
  o Biological Hazards – can cause disease and are found in living organisms
  o Ergonomic Hazards – results from poorly designed equipment, work processes or work stations
  o Psychosocial Hazards – affect the psychological well-being
- Medical surveillance program
  - Pre-employment and pre-placement examination – medical check-up to obtain base line health data
  - Periodical medical monitoring – auditory status, blood lead level, lung function
  - Examination after illness or injury – to determine whether worker is able to work
  - Termination examination – start work disease free, should stop work disease free

- Competencies 2
  - Advising of occupational health
    - Assessing control systems designed to eliminate or reduce exposure and ensure it is working
    - Selecting appropriate personal protective equipment – but this is the last resort
- Walk through survey
  - Why walk-through survey is important?
  - To enable the visualisation of the possibility for injury to occur
  - To enable OH professionals to observe workers in order to give effective advice

**Competencies 3**

- Advising on the planning and organisation of work/project
  - Providing safe operating procedures to be used by workers for existing work system
  - Provide information, instruction guidance and training
  - Advising on introduction of new working systems/technique
  - Including human factors in the process design

**Competencies 4**

- Participating in formulating safety, health and environment policies
  - Policies based on ethical principles – identify who formulate the policy?
    - Sometimes the policy formulated by management is not in line with the occupational health aspiration
  - Public/workers fully informed of the policy and their right

**Competencies 5**

- Collaborating in providing information and training
  - Dissemination of information and skill development
  - Participating in relevant committees – MIHA, DOSH, NIOSH
  - Evaluation of work-related diseases – lung cancer
Competencies 6

- Contributing to scientific knowledge regarding hazards to health
  - Recognising and investigate ill-health determinants
  - Analysing routinely collected data – statistical analysis to identify pertinent risk factors
  - Conducting scientific investigation – collaborate with research organisations

Competencies 7

- Advising and supporting the implementation of relevant legislation
  - Application and implementation of relevant laws and regulations – e.g. certificate of fitness is obtained for specific machinery before it is used
  - Formulating a Health policy in the workplace
  - Advising workers and management of their legal obligation

Competencies 8

- Participation in health promotion programs
  - Needs analysis – based on the evidences obtained
  - Cost-benefit analysis
  - Seeking participation from various relevant groups
  - Evaluating and auditing health promotion programs

Competencies 9

- Management of health and safety - ISO
  - Policy
  - Organising
  - Planning and implementation
  - Evaluation
  - Action for improvement
Competencies 10

- Working as part of a multidisciplinary services
  - Promoting multidisciplinary scientific work on exposure data gathering
    - e.g University of Manchester developed THOR (The Health and Occupation Network) and SWORD (Surveillance of Work-Related and Occupational Respiratory Disease)
  - Planning the efficient use of multidisciplinary resources
  - Coordinating health surveillance, environmental surveillance and other risk assessment

2.4 Knowledge areas and skills

- Medical sciences – diagnosis, treatment, risk assessment/analysis
- Laboratory sciences – monitoring
- Relevant legislation and policies
- Health promotion
- Education, training and communication skills
- Scientific research – epidemiology and biostatistics
- Genetics
- Surveillance – disease, exposure and behaviour
- Toxicology – study of agents that produce adverse responses in the biological system with which they interact
- Public health ethics – human right, confidentiality, equity
- Risk communication – exchange of information of health risks
- Management – planning, effective evaluation, cost benefit analysis, capacity building
2.5 Challenges

- Need for focused national and international leadership
  - Lack of disease exposure tracking, training of relevant professionals, developing strategic partnership and financial support
  - Focus on health promotion, trained professionals, developing national performance standards and best practice and providing technical assistance

- Emerging threats
  - Rapid industrialisation, globalisation, natural disasters, terrorist attacks, epidemics, under reporting of diseases
  - Preventive approach, coordination of multidiscipline agencies

Conclusion to Unit

The roles of occupational health professionals are myriad and to ensure workers’ health and safety is placed at the utmost priority, each and every one of the professionals mentioned need to work together as a team player to serve the common goal.

Additional References

Discussion 2.0

Occupational Health accidents

Example 1: Good Hoist Drum Motor Fell on the Worker’s Head
Photo: View at lower ground floor which was covered with blood

- The incident involved a machine that has been installed in a furniture store.
- It has the characteristic of a hoisting machine which had resulted in a worker being crushed to death by a drum motor which had fallen down.
- The victim body was discovered at the lower ground of the building and covered with blood with his head smashed.
- From the initial investigation, it was found that the incident was due to hook installation on the cross beam structure at the top level which is used to hang the drum motor.

The hook cannot withstand the load, which was being lifted.
The victim was believed to have started work after the holiday.
He is likely to have not received any safety training on use of the machinery, which was newly fitted in that furniture store, and it is not yet completely installed and tested properly.

What improvements would you suggest as an Occupational Health professional?
Answers to Discussion 2.0

1. The followings are some of the suggested safety precautions

2. Providing a safe operating procedure for workers who will be operating the machinery;

3. Carry out risk assessment on hazards that may arise from the machinery or its operation;

4. Load capacity that can be accommodated by the machinery should be known and communicated to the operator who operates the machine so that it will not be operated beyond safe working load limit;

5. Information, instruction guidance and training as well as effective supervision from time to time to be given to the operator who operates this machine;

6. Employers must ensure the safety of its employees who carry out their tasks using such machinery in the work area;

7. The structural integrity of any installed machinery must be tested before it is used;

8. Design and installation drawing for this type of machinery must have the approval from the professional engineer[PE] for submission to the department; and

9. Certificate of fitness must be obtained from the regional office before the machinery is used.
**UNIT 3**

**History of Occupational Health Services**

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**Introduction to Unit**

Student will learn about the evolution of occupational health services (OHS) as globally and also locally in Malaysia.

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**Objectives to Unit**

- After this session, students should be able to:
  - Provides a general view on the history of occupational health services in globally and also in Malaysia.
  - Highlights few international and national agencies which are related with the occupational health related activities are explored in this topic.

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**3.0 Content**

3.1 Introduction
   - 3.1.1 Definition
   - 3.1.2 Objectives

3.2 International Organizations
   - 3.2.1 World Health Organization (WHO)
   - 3.2.2 International Labour Organization (ILO)
   - 3.2.3 ICOH
   - 3.2.4 IOHA
   - 3.2.5 ISSA
3.3 Occupational health services in Malaysia

3.3.1 Factory and Machinery Act and Occupational Safety and Health Act 1994
3.3.2 Ministry of Health and Ministry of Human Resource
3.3.3 National Council of Occupational Safety and Health (NCOSH)
3.3.4 Departments of Occupational Safety and Health (DOSH)
3.3.5 National Institute of Occupational Safety and Health (NIOSH)
3.3.6 Social Security Organisation (SOCSO)

Important Notes

3.1 Introduction

- This chapter provides a general view on the history of occupational health services in globally and also in Malaysia. In order to highlights this, few international and national agencies which are related with the occupational health related activities are explored here.
- The Ramazini of 18th century was known as the Father of occupational medicine. He has published one of the earlier versions of systemic account of occupational disease.
- This chapter is based on the standards, principles and approaches embodied in the ILO Occupational Health Services Convention, 1985 (No. 161) and its accompanying Recommendation (No. 171); ILO Occupational Safety and Health Convention, 1981 (No. 155) and its accompanying Recommendation (No. 164); and the Working Document of the Twelfth Session of the Joint ILO/WHO Committee on Occupational Health, 5-7 April 1995.

3.1.1 Definition

- The ILO Occupational Health Services Convention defines “occupational health services” as services entrusted with essentially preventive functions and responsible for advising the employer, the workers and their representatives in the undertaking on the requirements for establishing and maintaining a safe and healthy working environment which will facilitate
optimal physical and mental health in relation to work and the adaptation of work to the capabilities of workers in the light of their state of physical and mental health.

3.1.2 Objectives

- The objectives of occupational health practice that were originally defined in 1950 by the Joint ILO/WHO Committee on Occupational Health stated that: Occupational health should aim at the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize: the adaptation of work to man and of each man to his job.

3.2 International Organizations

- Globally, there are several highly recognized international organizations related to occupational health.

- These organizations might be intergovernmental or non-governmental (Table 1) (Frederica et al., 2012).

Table 3.1: Example of International inter and non intergovernmental organizations

<table>
<thead>
<tr>
<th>International Intergovernmental Organizations</th>
<th>International Non-Intergovernmental Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Health Organization (WHO)</td>
<td>International Commission on Occupational Health (ICOH)</td>
</tr>
<tr>
<td>International Labour Organization (ILO)</td>
<td>International Occupational Hygiene Association (IOHA)</td>
</tr>
<tr>
<td>International Agency of Research on Cancer</td>
<td>International Ergonomic Association (IEA)</td>
</tr>
<tr>
<td>International Program on Chemical Safety</td>
<td>International Commission on Radiation Protection</td>
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<td></td>
<td>International Union of Toxicology (IUTOX)</td>
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</tbody>
</table>
3.2.1 World Health Organization (WHO)

- The WHO is an international organization that directs and coordinates people’s health issues under the support of the UN. It was founded back in 1948 and as of 2010 it has 193 member states.
- The Ministry of Health of the member states is the contact point of the WHO.
- Among the responsibility of the WHO are such as providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support, monitoring and assessing health trends.
- One of the main departments in the WHO, who is in charge for occupational and environmental health are The Department of Public Health and Environment (PHE).
- The headquarters of WHO are based in Geneva, Switzerland.
- Meanwhile, among the WHO six Regional Offices are: African Region (AFRO), The Americas (PAHO), South-East Asia (SEARO), Eastern Mediterranean (EMRO), Western Pacific (WPRO) and Europe (EURO).
- Each regional office has its own coordinators for occupational and environmental health (OEH), addressing occupational health in its member states.

3.2.2 International Labour Organization (ILO)

- The ILO is the international organization is primarily responsible for drawing up and overseeing international labor standards. It was founded in 1919 and has 189 member states.
- The Ministry of Labor or Employment of the member states is the contact point of the ILO.
- One of the important functions of the ILO is its tripartite structure which brings together representatives of governments, employers, and workers for promoting ‘Decent Work for All’.
- Meanwhile, among the five ILO Regional Offices are: Africa, Americas, Arab States, Asia and the Pacific, and Europe and Central Asia. Each regional office has its own coordinator for OSH, who leads prevention of occupational injuries and diseases in its member states.
- The ILO brings together not only OSH specialists, but also employers and managers, trade unions, public administration and insurance professionals as well as manufacturers and importers.

3.2.3 ICOH

- The International Commission on Occupational Health (ICOH) is an international non-governmental professional society; it was founded in 1906 in Milan, Italy to celebrate the successful prevention of occupational diseases during construction of the Simplon tunnel (Hobson, 2006; ICOH, 2011).
- ICOH is the world’s leading international scientific society in OH with a membership of 2000 professionals from 93 countries, whose specialties include occupational medicine, toxicology, industrial hygiene, nursing, psychology, statistics, epidemiology and administration (ICOH).

3.2.4 IOHA

- The International Occupational Hygiene Association (IOHA) is an international professional association of occupational hygiene organizations from across the world (IOHA, 2011). The members of IOHA are 27 associations of industrial hygienists from 25 countries. IOHA hosts a biannual international congress since 1987 and the next meeting will be held in Kuala Lumpur, Malaysia in September 2012.
- IOHA provides information on occupational exposure limits (OEL) of airborne workplace chemicals in each country, which includes in the values drawn from data derived from neurotoxicity studies.
- IOHA also works on control banding, which is an ILO program to control chemicals at workplace including neurotoxicants.

3.2.5 ISSA

- The International Social Security Association (ISSA) is the international organization bringing together social security agencies and organizations, which was founded under ILO in 1927 (ISSA, 1927).
- Its aim is to promote exchange of knowledge and experience on social security. Its members include 350 agencies from 150 countries.
ISSA has many agencies for workers compensation insurance as well as health insurance or pension agencies. The Special Commission on Prevention, which is one of 12 Technical Commissions, has 12 international sections on the prevention of occupational risks including research and culture of prevention.

3.3 Occupational health services in Malaysia

- In the past 80 years, the occupational health services have undergone massive transformation in Malaysia.
- The first practiced of occupational health in Malaysia can be related to the controlling malaria in rubber estates.
- And one of the first recorded laws that associate with Occupational Health was as early as 1926 with the FMS mining enactment.

3.3.1 Factory and Machinery Act and Occupational Safety and Health Act 1994

- In Malaysia, among the two important act which are related Occupational Health are the Factory and Machinery Act (Akta Kilang dan Jentera) and Occupational Safety and Health Act 1994 (OSHA).
- The Factory and Machinery Act basically covers the safety, health and welfare of workers in factories and working with machinery.
- The Occupational Safety & Health Act 1994 is enacted to complement the FMA 1967.
- OSHA is superior to than the FMA.
Therefore, whenever there are any areas of conflict between the two Acts, OSHA (1994) will over-rule FMA act.

- OSHA responsibilities are to ensure that safety and health at the workplace lies with those who create the risk and with those who work with the risk.
- It stresses more on the self-regulation and required workers cooperation and participation.
- One of the important aspects of OSHA is that it covers all people at the workplace except on board ships and the armed forces.
- Some of the OSHA regulations are OSH (Safety and Health Officer) (1997), OSH (Prohibition of Use of Substance) Order (1999) and OSH (Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Disease) Regulation (2004).

3.3.2 Ministry of Health and Ministry of Human Resource

- In Malaysia, among the two important responsibility bodies related with the Occupational Health are Ministry of Health and Ministry of Human Resource.
- The Ministry of Health has limited power under the OSHA (1994).
- Among the main function of Ministry of Health are to enhance that the employer provide a safe and healthy work environment for all its workers and as the custodian of the Nation health to provide the curative and preventive service for the Malaysian population.
- The Ministry of Human Resource has more responsibility compared to the Ministry of Health in aspects of Occupational Health.
- Among the important bodies in the Ministry of Human Resource which perform this functions are National Council of Occupational Safety and Health (NCOSH), Departments of Occupational Safety and Health (DOSH), National Institute of Occupational Safety and Health (NIOSH) and Social Security Organisation (SOCSO).

3.3.3 National Council of Occupational Safety and Health (NCOSH)

- The NCOSH was formed in the 1995 which compromise a 15 members representing the government, employers, employees and non-governmental or professionals organizations.
- Each member will serve a three year terms.
Among the duties of NCOSH are to discuss, analyse and investigate through the process of tripartism and subsequently forward suggestions to the Minister on matter which is line with the aims of the OSHA (1994).

3.3.4 Departments of Occupational Safety and Health (DOSH)
- The DOSH, formerly known as the Factories and Machinery Department, enforces both FMA 1967 and OSHA 1994.
- It begins in 1878 with the appointment of the first Machinery Inspector.
- Among the responsibilities of the DOSH are to ensure the safety, health and welfare of persons at working place.
- It also provides protections to other people from hazards to safety and health which arise from the activities of persons at a working place.
- Among the important activities related with the DOSH are such as setting up standards, enforcement and promotion of occupational safety and health.

3.3.5 National Institute of Occupational Safety and Health (NIOSH)
- The NIOSH is a government-owned company established in 1992 under the Malaysian companies Act 1965.
- It is entrusted to contribute towards efforts in upgrading occupational safety and health (OSH) practices in Malaysia through developing curriculum and training programmes, conducting applied research and development, providing advisory and consultancy services, and disseminating OSH information to industries in Malaysia.
- The board of directors for NIOSH is represented by the Government, the Private Sectors and the Workers Unions.

3.3.6 Social Security Organisation (SOCSO)
- The SOCSO was set up in 1971. It provides compensation for injured workers through its insurance scheme (injury scheme and invalidity pension scheme).
- SOCSO also provides health promotion activities and enhancing the clinical services.
- It have introduced certified training for disability assessment i.e. Certified Medical Impairment Assessor (CMIA), developed Guidelines for assessment of traumatic injuries and occupational diseases and embarked on smart
partnership with a private institution to provide rehabilitation for work related injuries.

Conclusion to Unit

Transforming Malaysia into a developed country by the year 2020 has greater occupational health and safety on the workforce. Therefore, well designed of occupational health services are very important to ensure the health and safety of the workforce.

Additional References

1. World Health Organization. www.who.int

Discussion 3.0

1. Give 3 examples of highly recognized International Intergovernmental Organizations related to occupational health
2. List down two important acts which are related to Occupational Health in Malaysia.
3. What are the function of National Institute of Occupational Safety and Health (NIOSH)?
Answers to Discussion 3.0

1. WHO, ILO and International Program on Chemical Safety
2. OSHA and FMA
3. Upgrading occupational safety and health (OSH) practices in Industries
UNIT 4
Introduction to Hazard

Introduction to Unit

Student will learn about the exposure and risk identification of hazards in occupational environment.

Objectives to Unit

After this session, students should be able to:
- Provides a general view on how to identify the sources of workplace hazards and describe methods to systematically examine these hazards.
- Describes the concept of risk assessment.

4.0 Content

4.1 Introduction
4.2 Definition
4.3 Examples of Hazard Exposure
4.4 The Risk Identification Process
4.5 How to identified hazards
4.6 Step 1 Identify Hazards
4.7 Step 2 Assess Risks
4.8 Step 3 Control Risks
4.9 Step 4 Monitor / Review Controls
4.1 Introduction

- An unsuitable working condition that can lead to illness or death.
- Often, people in jobs which pose a high level of risk are paid more than similar but less risky jobs to compensate for the danger involved.

4.2 Definition

- Hazard is defined as anything that has the potential to cause harm, ill health and injury, damage to property, products or the environment, production losses or increase liabilities.
- Hazard at workplace are categorized into Physical, Chemical, Biological & Physcosocial.

4.3 Examples of Hazard Exposure

- Chemical: Hydrocarbon under pressure, Smoke, Toxic material, Volatile fluids in tanks
- Physical: Moving road tankers / vehicles, Elevated objects, Noise, People working at heights, High voltage
- Biological: Toxicological lab (catering facility at distant work station), Exposed, airborne/blood borne, microorganism.
- Physcosocial: Working outside the country without family members, Stress or violent at workplace.

4.4 The Risk Identification Process

- First it is important to understand few important terms such as ‘Hazard’, ‘Risk’ and ‘Control’
- Hazard is something that has the potential to cause harm to people, property or the environment.
- Risk is the chance or probability of that hazard causing harm or damage to people, property or the environment.
Control is a mechanism or process that minimizes the risk of the hazard becoming actual in order to protect people, property or the environment from the identified hazard.

4.5 How to identified hazards

The simple steps in identifying hazards are:

- Step 1: Identify Hazards
- Step 2: Assess Risks
- Step 3: Control Risks
- Step 4: Monitor / Review Controls

4.6 Step 1 Identify Hazards

- Incident report forms
- Self-Inspection Checklists
- Observation & consultation
- Regular maintenance checks
- Specialists assisting with specific issues in the workplace
- Knowledge sharing

4.7 Step 2 Assess Risks

- A hazard has been identified – how can the risk the hazard poses be assessed?
  - Assessing likelihood: “How likely it is that someone will be exposed to the hazard?”. The likelihood will depend on probability and frequency of exposure to a hazard.
  - Assessing consequences: “Realistically, what is the likely outcome?”. The severity or range of the potential consequences resulting from the hazard.
  - How can a risk be assessed: Plot likelihood and consequence on the risk matrix to find the risk level (Figure 1).
  - Example of Hazard = Small raise/crack in pathway
  - What is the probability of this hazard causing harm - the risk?
  - The assessor rates the likelihood as high.
  - The path is frequently used by both employees and visitors daily, therefore there is a high probability that someone will be exposed to the hazard.
The assessor rates consequences of a trip in this section of path as moderate and with a sprain or break the worst foreseeable outcome.

Therefore the risk rating for this particular hazard was assessed as high (Figure 1).

What does the risk level mean?
- **Extreme / High Risk**: Imminent / Serious danger. Immediate action required stop work. Identify and implement controls (temporary or permanent) to reduce risk to as low as reasonably practical.
- **Medium Risk**: Moderate danger. Action as soon as possible to implement controls (long & short term) to reduce the risk to as low as reasonably practical.
- **Low Risk**: Minor to negligible danger. Assess if further action can be taken. Take steps to monitor the controls so the hazard is maintained as “low” if the hazard cannot be eliminated completely.

![Risk Matrix](image)

Figure 4.1: Plot *likelihood* and *consequence* on the risk matrix

### 4.8 Step 3 Control Risks
- Often a series of controls should be implemented to reduce the risk posed by a hazard.
- The *hierarchy of risk control* is useful in determining appropriate or interim risk control measures.
- **The best method of controlling a risk is to eliminate the hazard** – (it is not always possible to do this immediately)
- The aim of implementing controls is to get as many controls in place so the risk is reduced to as low as possible.
- The Hierarchy of Risk Control (Figure 2)

1. **Elimination**
   - Completely eliminate the hazard by removal from the workplace.
   - E.g.: Engage a contractor to repair the section of path—therefore completely eliminating the hazard

2. **Substitution**
   - Replace the activity, process or substance with a less hazardous one.
   - E.g.: Use a different path/walkway to get from A to B

3. **Engineer**
   - Isolate the hazard from employees with mechanical aids.
   - E.g.: Rope the section of path off to employees/visitors

4. **Administration**
   - Implement safe work practices, procedures and policies.
   - E.g.: Ensure all path users are aware of the hazard, paint the rise yellow. Have systems in place to inspect paths regularly so that paths are repaired before injuries occur.

5. **Personal Protective Equipment**
   - Provide suitable PPE to cover and protect an employee.
   - E.g.: Provide employees with knee and elbow pads (unrealistic!)

Figure 4.2: The Hierarchy of Risk Control
4.9 Step 4 Monitor / Review Controls

- Do I have to document any identified hazards and controls?
  - All identified hazards and their controls should be documented – usually referred to as a Hazard Register.
- Hazards and controls need to be reviewed regularly but at least every 5 years or when:
  - New plant or substances are introduced to the workplace
  - Before work of a type not previously performed at the workplace is commenced
  - When there is a change in the type of work, work practices or plant that may result in an increased risk to workers or others
  - When information becomes available concerning work, work practices, plant or substances that may impact of workers or others
- How are controls monitored?
  - Ensure audits and workplace inspections are conducted; and ensure listed control measures are in use and maintained.
- Risk Register reviewed on regular basis
  - It is an ongoing process and should be integrated into all workplace activities.

Conclusion to Unit

The primary goal of hazard recognition and assessment is to reduce incidents, accidents, injuries and property damage.
1. Chemical, Physical and Biological
2. Elimination, Substitution, Engineering, Administration and PPE
UNIT 5
Legal requirements of Occupational Safety and Health

Introduction to Unit

Student will learn about the legal requirements of occupational safety and health.

Objectives to Unit

After this session, students should be able to:

- Understand the changes in approach to occupational safety and health law throughout history
- Be aware of some of the important people, events and laws affecting the occupational safety and health

5.0 Content

5.1 Human Rights
5.2 Legal Standing
5.3 Malaysia: Evolution of Occupational Health Law
5.4 Occupational Health related Laws in Malaysia
5.5 Factory and Machinery Act 1967
5.6 Occupational Safety and Health Act 1994
5.1 Human Rights

- The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being
- As defined by WHO

5.2 Legal Standing

- Act
  - General rules
  - Endorsed by Parliament

- Regulation
  - Details of act
  - Endorsed by minister

- Industry Code of Practice
  - Any code, standard, rule, Specification related to OSH
  - Approved by minister

- Guidelines
  - Technical advisory document by national commission
  - Detailed information
  - No legal standing
5.3 Malaysia: Evolution of Occupational Health Law

The evolution of the occupational health law in Malaysia is presented in the following simple diagram.

5.4 Occupational Health Related Law in Malaysia

Occupational health related law in Malaysia is under the authority of the Ministry of Human Resource

1. Department of Occupational Safety and Health or DOSH
   - Factory and Machinery Act or FMA and Regulations

2. Social Security Organisation
   - Employees’ Social Security Act 1969
5.5 Factory and Machinery Act 1967

- Prescriptive in nature and very specific
- Approach: traditional checklist and stressing on enforcement
- Coverage: manufacturing, construction, mining and quarrying work
  (23% workforce)
- Purpose: prevent occurrence of occupational accidents and disease at specified workplaces

- FMA and Regulations – health related
- FMA 1967
- Notifiable industrial diseases – in the 3rd schedule
- Lead regulations 1984
- Asbestos process regulations 1986
- Noise exposure regulations – 1989
- Mineral dust regulations 1989

- Area covered in FMA regulations
  - Standard
    - Action level and Permissible Exposure Limit or PEL
  - Control measures
    - Engineering, administrative and PPE
  - Surveillance
    - Exposure monitoring – ambient and biological sampling
    - Medical examination – content, frequency, medical removal
  - Others
    - Record keeping and penalty

Example 1: Lead regulation 1984

- Medical surveillance
  - Baseline – exposed > action level
  - Yearly – blood level > 40 ug/ml
  - Content: work/medical history, blood pressure, neurological exam, investigation (blood lead, hb, haematocrit, renal profile)
- Medical removal protection
– Blood lead > 80 ug or average 3 blood sampling > 75 ug
– Women of child bearing capacity
– Pregnancy and breast feeding

Example 2: Asbestos Process Regulation 1986

• Surveillance:
  – exposure (personal) monitoring – at interval not longer than 3 months

• Medical exam:
  – frequency: pre employment, 2 yearly
  – content: history, physical exam, chest x-ray, lung function test
  – Medical removal: early state of asbestos induced disease

Example 3: Noise Exposure Regulation 1989

• Standard:
  – Action level: 85 dB (A)
  – PEL
    • Continuous >90 dB
    • Intermittent at any one time – 115 dB
    • Impulsive – 140 dB

• Control measures
  – Engineering and administrative
  – Training, warning signs
  – Hearing protection devices

• Exposure monitoring
  – Audiometric test
    • Conducted by a competent person
    • Standard technique
    • Frequency: yearly, or 2 yearly
5.5 Occupational Safety and Health Act 1994

The Need for OSH Act 1994

Enacted on the 25th of Feb, 1994 on the basis of:

- Inadequacy of Factory & Machinery Act 1967 on factors pertaining to its:
  1. Scope
  2. Prescriptive on machinery sector
  3. Dependency on government for regulatory processors
- Statistics on occupational accidents was high:
  - saw the need to reduce rates of accidents arise


Provisions for:

- Securing the safety, health & welfare of persons at work
- Protecting others against risk to S&H due to activities at work
- To establish the National Council for OSH & other relevant matter
- Act is self-regulatory, based on principles of cooperation and consultation
- Wider scope – covers all workers in all economy related activities (1st schedule) excluding
  - those working on board ships governed by Merchant Shipping Ordinance 1952
  - Armed forces
- Was estimated in 2002, 7 million of working citizens are protected under OSH 1994 (NIOSH 2002)

- Concept of OSHA 1994

  1. Responsibility
     - on the one who create the risk & work with the risk

  2. Place of work
     - Premises where persons work or use for storing

  3. Control measures
     - “as best as employer provide” Depends on severity, Cost & suitability
2. First Schedule
   • Manufacturing
   • Transport, storage & communication
   • Mining & quarrying
   • Wholesale & retail trades
   • Construction
   • Hotels & restaurants
   • Agriculture, forestry & fishing
   • Finance, insurance,
   • real estate & business service
   • Utilities: Electricity, gas, water & sanitary service
   • Public services & statutory authorities

3. Objects of OSHA 1994
   1. Secure safety, health & welfare of workers
   2. Protect other persons at place of work (visitor, etc.)
   3. Promote occupational environment adapted to physiological & psychological need
   4. Provide system that is flexible to cater rapid change

5. Regulations
   • Policy Statements (Exception) 1995
   • CIMAH 1996
   • S&H Committee (>40 workers) 1996
   • CPL Hazardous Chemicals 1997
   • S&H Officer 1997
   • Prohibition of Use of Substance Order 1999
   • USECHH 2000
   • NADOOPOD 2004

6. Content of OSHA 1994
   • National Council for OSH
   • Department of Occupational Safety and Health
• General duties of employers and self-employed
• General duties of designers, manufacturers, importers and suppliers
• General duties of employees
• Safety and health committee at work
• Notification
• Enforcement and investigation
• Under OSHA, the National Council For Occupational Safety And Health was established
• Members consist of
  - 3 rep from employers organization
  - 3 rep from employees organization
  - 3 rep from government
  - 3 or > rep from professional bodies

7. Duties of employer & self-employed persons
• (Section 15) Ensure safety, health and welfare at work
  - Ensure safety during operation, handling, storage & transport
  - Provide information Instruction, training & supervision
  - Provide & maintain Safe outlet for entering & leaving
  - Provide & maintain safe working environment
  - Maintenance of plant & system of work

• Section 16, 17 & 18
  - Provide a safety policy (workers >5)
  - Ensuring other persons are not exposed to risk from activities at the work place
  - Disseminating information on aspects of work activities that could affect S&H of others
  - Liable to fine of RM 50k or 2 years of imprisonment or both when contravene with section 15, 16, 17 or 18
“So Far As Is Practicable….”
- Severity of hazard or risks involved
- Current state of knowledge about the hazard or risk & means to control it
- Availability of suitable means to eliminate or reduce the hazard or risk
- Cost that is involved

8. Duties of Designers, Manufacturers & Suppliers – Section 20
• Ensuring design & construction of plant is safe
• Carry out tests for the above purpose
• Disseminate information on the use of plant
  - Penalty : RM 20k or 2 years of imprisonment or both

9. General Duties of Employees – Section 24
• Take reasonable care for S&H of himself & other persons
• Co-operate with employer in regards to adhering to this act
• Wear provided PPEs
• Comply with instruction instituted by employer on OSH
  - Penalty : RM 1k or 3 months imprisonment or both

10. Other Provisions of OSHA
• S&H Organization
• Notification of Accidents …
• Prohibition against Use of plant or substance
• Industry codes of practice
• Enforcement & investigation
• Liability for offences
• Appeals
• Regulations
Conclusions to the Unit

The evolution of the OSH law in Malaysia follows the natural progression of the major economic-generating activities. The Factory and Machinery Act 1967 is still widely used in Malaysia but the main legislation being focused is the Occupational Safety and Health Act 1994.

Additional References


Check Your Understanding 5.0

1. What are the objects of the most recent Occupational Safety and Health act in Malaysia?
Answers to Check Your Understanding 5.0

1. Secure safety, health & welfare of workers
2. Protect other persons at place of work (visitor, etc.)
3. Promote occupational environment adapted to physiological and psychological need
4. Provide system that is flexible to cater rapid change
UNIT 6

Noise

Introduction to Unit

This topic will cover about occupational noise exposure and the effect to the worker’s health.

Objectives to Unit

After this session, students should be able to:

- Understand the introduction to the physical property of noise, the characteristics of noise, the method in surveying excessive noise.
- Be able to suggest control measures and understand the ill-effects of noise to human though the interpretation of audiometry.

6.0 Content:

6.1 Introduction to sound
6.2 Physical properties of sound
6.3 Sound pressure
6.4 Types of sound
6.5 General classification of noise exposure
6.6 Sound survey
6.1 INTRODUCTION TO SOUND

- Define as transmission of energy in the form of vibration. Transmission can be through air, water and other medium
- Pure tone – is a simple sound produced by a tune (pure tone). Consist of single frequency. Sound pressure generated is of a simple sinusoidal function of time
- Complex sound: is combination of frequency which is true in the real world

6.2 PHYSICAL PROPERTIES OF SOUND

1) FREQUENCY OF SOUND

- Is the number of sound pressure variation per second.
- Measured in cycles per second @ hertz. Frequency of hearing varies among individual as stated in the last lecture

![Figure 6.1 Sinusoidal pattern of noise (low and high frequency)](image-url)
2) WAVELENGTH

- Distance required for sound wave to travel in a cycle or distance measured between two analogous point on two succesive part of the wave.
- The greek letter lambda (\( \lambda \)) is to express wavelength and measured in meters or feet.
- If the sound wave have larger wavelength than the obstacle, the sound waves will bend around the obstacle – low frequency sound.
- If the sound wave is smaller the obstacle, the sound will be reflected and cast a shadow – high frequency sound.
- Therefore a wall is useless as a shield against low frequency sound (long wavelength) but effective barrier against high frequency sound (short wavelength).

![Figure 6.2 Behaviour of low and high](image-url)
3) VELOCITY

- Speed of sound within any medium. The spread of sound is a product of wavelength and frequency

\[ C = f\lambda \]

- The speed of sound spread depends on mass and elastic properties of the medium
- Velocity based on medium
  - \( c = 344 \text{ m/s} \) in air
  - \( c = 1423 \text{ m/s} \) in water
  - \( c = 3962 \text{ m/s} \) in wood
  - \( c = 5179 \text{ m/s} \) in steel

6.3 SOUND PRESSURE

- Refer to root mean square value of the pressure changes above and below the atmospheric pressure when measure steady state noise.
- Unit measured: N/m², μPa, µbar.
- Most common sound consists of negative and positive pressure and therefore will get the value as zero.
- Therefore the root mean square (rms) will convert all the negative sound to positive sound.
- The rms will square the value of each sound pressure at a time. With all the value added and averaged.
1) DECIBELS AND SOUND PRESSURE LEVEL

- Even though the weakest sound pressure perceived as sound is a small quantity, the range of sound pressure perceived in a extremely large
- The weakest sound that can be heard by a person with very good hearing in extreme quiet location is known as the threshold of hearing
- At a reference tone of 1000 Hz, the threshold of hearing is equal to sound pressure of 20 dBPa (0.0002 bar)
- The greatest sound pressure that can be perceived is 10 million times greater

![Figure 6.3 Relationship between a weighted sound pressure level and decibels (dB) and sound pressure in N/m²](image)

Figure 6.3 Relationship between a weighted sound pressure level and decibels (dB) and sound pressure in N/m²
Therefore a relative scale is preferred

- The bel, a unit to measure sound (decibel)
- It is preferred as it is also dimensionless unit related to the log of the ratio of a measured quantity to a reference quantity

\[ L = 20 \log \frac{p}{p_0} \]

Where as:
- \( L \) = sound pressure level
- \( P \) = rms sound pressure
- \( P_0 \) = a reference sound pressure (threshold value of an average person at 1000 Hz and value at 20 \( \mu \text{Pa} \))

- Log = log to the base of 10
- the instrument used to measure sound pressure level is called as sound level meter
- The sound level meter is calibrated in decibels to directly indicate sound pressure level
- Due to logarithmic scale is used, small increase in decibels represent a doubling of sound energy

- Technically, an increase in 3 dB represent a doubling of sound energy
- An increase in 10 dB represent a tenfold increase
- A 20 dB represent a 100 fold increase in sound energy
- Zero dB level, will not mean that absence of sound but show it show that it is equal to reference level
- Even calculation is not direct calculation

2) EXAMPLES

Problem
- Machine 1 = 85 dB, machine 2 = 82 dB.
- What is the total noise emitted
Solution

- M1 = 85 dB, M2 = 82 dB, therefore the difference is 3 dB.
- By looking from the correction chart = 1.7 dB
- Total noise = correction + higher value = 86.7 dB

![Figure 6.4 Noise level addition chart](image)

3) LOUDNESS

- Loudness depend on the sound pressure, it is also affected by frequency (high frequency and low frequency)
- Human ear is more sensitive to high frequency sounds than it low frequency sound
- Therefore, a sound that has a constant pressure can be made to appear quieter or louder by changing the frequency

4) SOUND PRESSURE WEIGHTING

- Therefore a simple electronic circuit that sensitivity act as human ear.
- Resulted in three different weighting networks “A”, “B”, and “C”.
- “A” weight equal loudness curve at low sound pressure level, “B” weight equal loudness curve at medium sound pressure levels while “C” was designed for high levels.
- Weighting network are the method on how the sound level meter react to some frequencies compared to others
- The very low frequencies are discriminated (attenuated) severely by A network
- “B” network were moderately filter the low frequency
- “C” network were hardly attenuate the lower frequency
- Therefore if the measured sound level is much higher on C weight rather than the A weight, the frequency most probably from the lower frequency
- A weighted sound measurement: become popular assessment of the overall noise hazard since this level is thought to indicate the injurious effects such noise has on human ear and reasonable good assessment of speech interference
- Adapted by ACGIH and DOSH

![Figure 6.5 Frequency-Response characteristics of a sound level meter with A-, B- and C-weighting](image)

5) **EQUIVALENT SOUND PRESSURE LEVEL (LEQ)**
- Sound from noise usually fluctuates widely over time
- Therefore the average value measured is known as LEQT
- It deliver the same amount of energy as A weight fluctuating sound
- The weighted sound is integrated and averaged
- Therefore a person exposed to actual sound equal LEQT for the same duration of time

6) FREQUENCY ANALYSIS
   - To determine the composition of a complex sound (determine the frequency of each sound pressure)
   - This analysis must be done if engineering must be done (industrial noise is made up of complex noise)
   - Octave band analysis to determine the frequency spectra

Figure 6.6 Octave band analyzer
6.4 TYPES OF SOUND

Types:

1) **Broadband** – the sound level with wide range of frequency

2) **Narrowband** – sound level concentrated in a narrow frequency range

3) **Impulse** – characterized as single event of short duration, each duration is $< 0.5$ seconds with magnitude change of more than $40$ dB within $0.5$ seconds

Repeated event, jack hammer etc.

4) **Transient sound**

4.1 Steady sound – quality and intensity is constant (varying less than $3$ dB), steady continuous state sound.

4.2 Steady uncontinuous state sound – constant but with $2$ discrete time segment.

4.3 Fluctuating noise – intensity rise and fall more than $3$ dB

4.4 Steady intermittent noise – discontinuous sound level (sudden drop to ambient level several times, different between $1 - 2$ second or more.

4.5 Fluctuating intermittent – the same as 4.4 but the intensity rise and fall more than $3$ dB.
6.5 GENERAL CLASSIFICATION OF NOISE EXPOSURE

For occupational noise exposure
1. Continuous noise
2. Intermittent noise
3. Impact noise
Continuous noise

- Define as broadband noise that expressed for 8 hours/day and 40 hours a week
- OSHA – Guidelines for permissible employee noise exposure in term of duration in hours/day
- PEL: 90 dBA for 8 hours
  
  \[ \text{Doses for sound level are computed relatively based on PEL with the exchange criteria of 3, 4 and 5} \]

- Example:
  Every increase of 5 dBA in noise level will cut the allowable exposure time to half (doubling rate)

<table>
<thead>
<tr>
<th>Duration (hours)</th>
<th>Sound level (slow response)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>90 dBA</td>
</tr>
<tr>
<td>4</td>
<td>95 dBA</td>
</tr>
<tr>
<td>2</td>
<td>100 dBA</td>
</tr>
<tr>
<td>1</td>
<td>105 dBA</td>
</tr>
<tr>
<td>0.5</td>
<td>110 dBA</td>
</tr>
<tr>
<td>0.25</td>
<td>115 dBA</td>
</tr>
</tbody>
</table>

- If a worker are exposed to different noise level. Mix exposure must be calculated

\[ E_m = \left[ \frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} + \ldots + \frac{C_n}{T_n} \right] \times 100\% \]

Whereas:

- \( E_m \) = the noise dose
- \( C \) = The total time of exposure at specific time
- \( T \) = The duration of time corresponding to the permitted time

**Example:**
A worker exposed to the following noise:
- 85 dBA for 3.75 hours
- 90 dBA for 2 hours
95 dBA for 2 hours  
110 dBA for 0.25 hours

**Solution:**

Therefore daily dose:

\[
\text{Solution:} = \left[ \frac{3.75}{\text{no limit}} + \frac{2}{8} + \frac{2}{4} + \frac{0.25}{0.5} \right] \times 100
\]

\[
= \left[ 0 + \frac{2}{8} + \frac{2}{4} + \frac{0.25}{0.5} \right] \times 100
\]

\[
= 125\%
\]

Therefore the percentage of daily dose exceed 100 %, and the worker is exposed excessively.

| Intermittent Noise | • Exposure to a given broadband sound level several time during normal working day  
|                   | • Example: a safety officer periodically makes trips to quiet and then to noisy production area  
|                   | • Intermittent noise are said to be less dangerous compared to continuous due to the ability of the ear to recuperate  

| Impact Noise | • Sharp burst noise, generally occur less than one half of a second  
|             | • More than 140 dB  

6.6 SOUND SURVEY

2 categories
1. Source measurement  
2. Ambient noise measurement

**1) SOURCE MEASUREMENT**

- Measure any presence of noise by sources that form ambient noise.  
- Describe characteristic of a particular sound source.  
- Standard protocol of report must be done. This include  
  - Techniques of measurement  
  - Operation condition  
  - Instrument calibration
2) PRELIMINARY SOUND SURVEY

- Should be done before conservation program start
- Using appropriate sound level measurement
- Where do we start?
  - Areas that difficult to communicate at normal tone
  - Or after observing workers after exposure: speeches are muffled and with ears ringing

3) DETAILED NOISE SURVEY

- After preliminary survey: able to determine specific locations so that further study and attention to determine the TWA exposure
- The purposes:
  - To obtain specific information on te noise levels at each employee workstation
  - To develop guidelines for engineering and admin control
  - Define areas where protection will required
  - Determine work areas where audiometric testing is required

4) STEP OF NOICE PROCEDURE

- Step 1: Area measurement
  - The sound level meter must be set at A scale, slow response, and measure the maximum and minimum noise level
  - Each work area is limited to 93 m². If the work area do not exceed 80 dB then the place is satisfactory
  - If between 80 – 92 dBA, a further measurement to be done

- Step 2: Workstation measurement
  - The sound level meter must be set at A scale, slow response, and measure the maximum and minimum noise level
• Each work area is limited to 93 m². If the work area do not exceed 80 dB then the place is satisfactory
• If between 80 – 92 dBA, a further measurement to be done

- Step 3: Exposure duration
  • The sound level meter must be set at A scale, slow response, and measure the maximum and minimum noise level
  • Each work area is limited to 93 m². If the work area do not exceed 80 dB then the place is satisfactory
  • If between 80 – 92 dBA, a further measurement to be done

![Sound level meter](image1.jpg)

![Method of monitoring](image2.jpg)
6.7 THE DEGREE OF NOISE CONTROL PROGRAMME

- Is determined by comparing measured levels with acceptable noise levels
- Next to consider various noise control measures such as alterations in engineering designs, limiting time exposure or using PPE so as to achieve desired level of reduction

6.8 NOISE PROBLEM: BROKEN INTO 3 PARTS

1) A source that radiates sound energy
2) A path along which sound energy travels
3) A receiver such as in human ear

Therefore solving the problem or control program should be based on this 3 part.
6.9 SOURCE THAT RADIATE

- The most desirable control: reduction at the source.
- These are done by modifying existing equipment and structures or introduce noise reduction measure

1.0 Acoustical design

1.1 Reduce energy for driving vibrating systems

1.2 Change coupling between this energy and acoustical radiating systems

1.3 Change structures so less sound is radiated

2.0: Substitute with less noise equipment

3.0: Change method of processing

6.10 NOISE PATH

- Noise reduction cannot always be implemented at the source
- Therefore modification at noise path must be considered:

1. Increase distance between source and receiver

2. Acoustical treatment of ceiling, walls and floor to absorb sound and reduce reverberation. This can be achieve by using acoustical material

3. Enclosure of noise source (can reduce reflecting sound)

RECEIVER

1. By using personal protection
2. Enclosure – by isolating worker
3. Rotation - rotating personnel to reduce exposure time
4. Changing job/work schedules
ENCLOSURES

- Prevent noise from getting inside and from noise to be exposed out
- Example – soundproof booth for machine and workers
- Enclosure should be done using sound absorption material (to reduce internal sound build up)
- Sealing can also be used to reduce noise (noise that enter and leaving the enclosure). Extreme cases: double sealing
- Sealing include lead panel and by covering with gasket around the enclosure door

6.11 CONTROL MEASURE

Types of control measures:

1. Engineering
2. Administrative control
3. Personal hearing protection

Engineering Control

1. Maintenance:

- Replace/adjust worn, loose and unbalanced machine
- Lubricating machine part
- Use properly shaped and sharpened cutting tools
- Substitution of machines:
  - Substitute larger and slower machine with smaller and faster machine
  - Substitute presses for hammer
  - Substitute Rotating shears for square
  - Substitute hydraulic pressure for mechanical
- Substitute process:
  - Substitute welding process for riveting
  - Substitute pressing for rolling / vibrating
- Sound surface:
  - Reduce the force on the surface
  - Minimizing rotational speed
  - Isolation

- Response of vibrating survey:
  - Reduce the force
  - Minimizing rotational speed
  - Isolation

- Response of vibrating surfaces:
  - Damping
  - Increase the stiffness of the material

- Sound radiation from vibrating surfaces:
  - Reducing the radiating area
  - Reducing overall size

- Reduce sound transmission through solid:
  - Flexible section of pipe runs
  - Resilient flooring

- Reduce sound by gas flow:
  - Use muffler for exhaust
  - Fan blade that have low turbulence
  - Large, low speed rather than smaller and faster
  - Reduce velocity of air
  - Reduce pressure or air turbulence

- Reduce noise through air:
• Use absorptive material for ceiling and walls
• Barriers and enclosures
• Enclose machine
• Confined to isolated room.

- Isolate operators into sound proof booth

1. Administrative Control

- Many of the exposure by employees can be control by administration
- E.g.: production schedules: changed and rotate such as transfer of a worker from high noise exposure to reduce low noise exposure
- Scheduling machine operation: so that the number of workers exposed is reduce.

2. Personal Hearing Control

- pending engine cx to reduce employees exposure and final solution is PPE
- Part of law requirement
- *It can be define as an acoustical barrier that reduce the amount of sound energy transmitted through the ear canal to the receptors in the inner ear*
- *Sound attenuation: define as capability of hearing protection devices (dB) is the differences in the measured hearing threshold level of an observer wearing PPE (test threshold) and the measured hearing threshold when the observer’s ears are uncovered (reference threshold)*

6.12 HEARING PROTECTIVE DEVICES

- Divide into 4 classification:
  1. Enclosures (entire head)
  2. Aural inserts
  3. Superaural protectors
  4. Circumaural protectors
Enclosures

- Entire head enveloped
- Helmet worn by astronaut
- Attenuation by acoustical properties of the helmet
- Max: 35 dB at 250 Hz or 50 dB at higher frequency
- Helmet and protector additional 10 dB reduction
- Usually being used for special application

Aural inserts

- Earplugs, inexpensive but service time is limited (single time to several months)
- Material used: rubber, plastic, foam etc.
- Soft and little danger of injury
- 3 categories:
  1. Formable type: good attenuation and fit all ears
  2. Custom molded type: made custom for individual
  3. Premolded type; prefabricated, made in large quantity and in multiple cavity mold

Figure 6.7 Comparison of the attenuation properties of a molded-type earplug and an earmuff protector. Note that the earplug offers greater attenuation of the lower frequencies, while the earmuff is better at the higher frequencies
Superaural protectors

- Seal external ear canal
- Soft, rubber like material, overhead and light
- 2 types of superaural protector devices:
  
  1. Insert type protector: attenuate by pluggin external canal
  2. Muff types protector: attenuate by encloses the auricle of the ear to provide acoustical seal

- Effectiveness of superaural

  Depend on:

  1. Seal leaks
  2. Material leaks
  3. Hearing protection devices vibration
  4. Conduction (bone/air)

- Seal leaks

  - Max. protection if:
  
    - Airtight seal
    - Fit the contour of ear canal
    - Any air leak will reduce the low frequency attenuation and permit more low frequency pass through

- Material leaks

  - Hearing protective device attenuation but some sound is still allowed to pass through

- Protection vibration
• Happen when the PPE itself set into vibration mode in response to external sound energy
• Vibrate in piston like manner
• Likely reduce low frequency attenuation

• Bone/air conduction

• If everything perfect, sound can run through bone conduction through the skull
• A perfect PPE cannot provide more than 50 dB of sound attenuation

Circumaural protectors

• Ear muff, cup or dome type and can fit the entire external ear
• Factors to be considered:
  1. Circumference
  2. Width
  3. Material use

• Selection of protector
  1. Attenuation properties – considered before specific application
2. Workplace consideration: in confined space, the use of earmuff is unpractical

3. Types of hazards: where there is electrical hazard the use of nonconductive systems in connection with muff protector is recommended

4. Frequency of exposure: if infrequent once a day / once a week use insert plug will do

   If frequent, therefore muff type is preferable

6. NRR (noise reduction rating)

6.13 INDUSTRIAL AUDIOMETRY

- Objective of audiometry

  1. To obtain baseline audiogram so that to indicate individual hearing ability

  2. Provide record of employee’s hearing history

  3. Check the effectiveness of noise control measures by measuring hearing threshold

  4. Record of any significant hearing threshold shift during their course of employment

  5. Compliance of government regulation

- Threshold audiometry

  - Used to determine employee’s auditory threshold for a given stimulus
  
  - Sensitivity to pure tones are measured at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz and 8000 Hz for air conduction and bone conduction
- Result from air conduction: quantitative information on amount of hearing loss
- Critical frequency: 500 Hz, 1000 Hz, 2000 Hz and 3000 Hz

<table>
<thead>
<tr>
<th>Pure tone average</th>
<th>Classification</th>
<th>Effect of speech and understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 20 dB</td>
<td>Normal</td>
<td>No significant different</td>
</tr>
<tr>
<td>&gt; 20 – 40 dB</td>
<td>Mild</td>
<td>Different with soft speech</td>
</tr>
<tr>
<td>&gt; 40 – 60 dB</td>
<td>Moderate</td>
<td>Different with normal speech</td>
</tr>
<tr>
<td>&gt; 60 – 80 dB</td>
<td>Severe</td>
<td>Only can hear if shouting</td>
</tr>
<tr>
<td>&gt; 80 dB</td>
<td>Profound</td>
<td>Cannot hear even amplified</td>
</tr>
</tbody>
</table>

- Audiometry test interpretation

![Diagram showing audiometry results]

Normal hearing sensitivity in right ear

Air conduction results demonstrate a hearing loss, but bone conduction result is within normal range
6.14 OCCUPATIONAL HEARING LOSS

- Noise induced hearing loss (NIHL)
- 3 categories:
  1. Acoustic trauma: sudden loss caused by single intense noise that can lead to conductive, sensory or mixed hearing loss
  2. TTS
  3. PTS

- Principle for Occupational NIHL
  - Always sensory-neural
  - Always bilateral and audiometric pattern are always similar
  - Never produces a profound hearing loss, usually low frequency about 40 dB and high frequency at 75 dB
  - If exposure to noise discontinue, no substantial further progression of hearing loss
  - The earliest damage to inner ear reflect loss at 3000, 4000 and 6000 Hz
  - Greatest loss occur at 4000 Hz
Classical progress of many cases of NIHL

- Earliest damage occurs between 2000 – 8000 Hz
- Frequency below 3000 Hz almost never damage by occupational exposure without earlier damage to the higher frequency
- The pathogenesis is unclear but frequency between 6000 Hz and 3000 Hz has little effect on the ability to understand speech but if impaired extended into the frequency region of 2000 Hz and below, understanding speech etc. will be affected

6.15 AUDIOMETRIC PROCEDURES

- Pre – audiometric
  - Particulars of employee
  - Hobbies, employment, social
  - Medical history
  - Present medical examination
  - Ear examination

- B. Testing procedures

Pre – audiometric (particulars of employees)

- Name, gender, age, IC
- Test date
- Proxy of exposure
  1. Work area
  2. Designation
iii. Employment data  
iv. Noise level (max LEQ)  
v. Noise dose  

Pre – audiometric (Hobbies, employment, social)  
- Other exposure related to noise and pressure  
- Loud noise  
- Barometric pressure  
- Occupations:  
  - Divers, pilot, armes forxes etc.  
  - PPE  
  - Smoking  

Pre – audiometric (Medical history)  
- Hearing loss  
- Ear: discharge, bleeding, ear ache, tinnitus  
- Head injury, nose, throat problems  
- Other related diseases: mumps, measles  
- Drugs  
- Genetic  

Pre – audiometric (present medical condition)  
- Exposure to noise < 14 hours  
- Common cold  
- Ear discharge  
- Exposure to barometric pressure – divers, pilot  

Pre – audiometric (Ear examination)  
- External auditory canal: wax, foreign body  
- Tympanic membrane perforation  

6.16 AUDIOGRAM INTEPRETATION  
- Normal  
- Hearing loss: Hearing threshold at or more than 25 dB in any frequency  
- Hearing impairment: Average permanent hearing threshold at 500 Hz, 1 Khz, 2 Khz and 3 Khz shifted 25 dB or more than reference  

Audiometric threshold shift  
- An average shift of more than 10 dB at frequencies of 2000, 3000, 4000 Hz relative to the baseline audiogram in either ear
- Temporary threshold shift: retest within 3 months

Audiometric testing

Normal

Hearing loss (at 500 Hz and 4 KHz)
Standard threshold shift

Hearing impairment with STS
Conclusion to Unit

Student will be able to determine the type of noise the workers exposed to, the method of assessment, determining the health effect through audiometry and control measures that is most suitable in reducing the effect of noise.

Additional References


Discussion 6.0

Select a chiller room in the faculty, you should determine:

1. The type of noise inside the chiller room
2. Identify the source of noise
3. Determine the noise level
4. Discuss the type of control measure
Answers to Exercise 6.0

1. The type of noise: continuous noise
2. Source of noise: chiller pump
3. Use sound level meter
4. Based on hierarchy of control
UNIT 7
Physical Hazard - Suspended Particulates

Introduction to Unit

Student will learn the particulate and its physical and chemical properties, biological problem, health problems and types of particulate that consist of silicosis, asbestosis, beryllium, black lungs and other dust.

OBJECTIVES TO UNIT

After this session, students should be able to:

- To describe the type of particulate
- To explain the physical and chemical properties of particulate
- To describe the type of particulate and its function
- To calculate the dust level
- To explain the type of dust control method

7.0 Content:

7.1 Introduction
7.2 Silicosis
7.3 Asbestosis
7.4 Beryllium
7.5 Black lungs
7.6 Measurement of airborne dust
7.7 Dust control method
7.0 INTRODUCTION

- Aerosol is the dispersion of solid or liquid in the gasesous medium
- Dust is particles suspended in air, generated by mechanical or physical means
- Fumes are solid particles formed as a result of the condensation of the gaseous state of a solid which have been heated to a very high temperature
- Aerosol is the dispersion of solid or liquid in the gasesous medium
- Dust is particles suspended in air, generated by mechanical or physical means

7.1 PHYSICAL AND CHEMICAL PROPERTIES OF PARTICULATE

Particle size

Aerodynamic Equivalent Diameter
- Diameter of a hypothetical sphere of unit density having the same terminal settling velocity of the particle in still air

2 methods for AED
I. Direct measurement
II. Terminal settling velocity

Method II Terminal Settling Velocity

\(\text{For occupational health: use method 2}\)
The bigger the dust size, the higher settling rate and lower chance to be inhaled

<table>
<thead>
<tr>
<th>Settling rate AED micrometer</th>
<th>Terminal Velocity mm/s</th>
<th>Settling time over a minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>$7.8 \times 10^{-3}$</td>
<td>2137</td>
</tr>
<tr>
<td>1.0</td>
<td>$3.1 \times 10^{-2}$</td>
<td>528</td>
</tr>
<tr>
<td>5.0</td>
<td>0.78</td>
<td>21</td>
</tr>
<tr>
<td>10.0</td>
<td>3.1</td>
<td>5</td>
</tr>
<tr>
<td>50.0</td>
<td>7.8</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Shape and aspect ratio
- important when dealing with fiber: eg asbestos
- Respirable fibre
  - Aspect ratio: 3:1
  - Length>5 mikrometer, width < 3 mikrometer
  - Respirability function: depend on diameter and not the length

Surface area and volume
- Reactivity increase when size reduce because the relative surface area rapidly increase

Solubility
- This influence the rate of absorption in the body
- Water or liquid soluble: the effect is generally systemically – ammonia (very soluble)
- While the insoluble the effect is at the point of contact or deposited – eg deposited at nasopharynx can cause nasopharyngeal cancer
Composition
- Chemical composition has direct bearing on resulting health effect due to differing properties or chemical interaction
- Eg: A particulate with 10 % of silica bears less health effect compared to a particulate with 90% silica

Reactivity
- Under certain conditions, chemical in particulates could give rise to dangerous reaction or decomposition
- Release of toxic, flammable or combustible gases with release of heat

7.2 ROUTE OF ENTRY
- Inhilation: very significant route
  I. 50 mikrometer AED will be filtered at the nose
  II. 7 – 20 mikrometer AED: deposited at the nasopharynx
  III. 5 – 7 mikrometer AED: deposited at tracheo-bronchial air ways
  IV. 0.5 – 5 mikrometere AED: alveolar region

- Aerodynamic behavior in air stream:
  I. Impaction – proportional to momentum (mass and velocity)
  II. Sedimentation – proportional to the diameter (bigger diameter, higher sedimentation)
  III. Brownian diffusion – particle size less than 0.1 micron which behave more like reactive gas

- Particle size fraction
  I. Inhalable fraction
    - Mass fraction of total airborne particles inhaled through the nose/mouth
  II. Thoracic fraction
    - Mass fraction of inhaled particles penetrating the respiratory systems beyond the larynx
  III. Respirable fraction
- Mass fraction of inhaled particles penetrating to the unciliated airways of the lungs

7.3 FACTORS ASSOCIATED WITH HEALTH PROBLEM

(i) Type of dust involved
   - 2 broad categories:
     - Organic
     - Man made
     - Dinitrobenzene
     - Plant
     - Animal
     - Neutral

(ii) Length of exposure time
   - After several years of dust exposure: developed pneumoconiosis
     1. Silicosis
     2. Asbestosis
3. Pneumoconiosis

- Toxic metal dust: lead/manganese (shorter period of exposure: several days to weeks)

(III) Concentration of airborne dusts in the breathing zone of exposed

- Actual concentration present in breathing zone
- Permissible exposure limit (Pel)
- Measured by preweigh filters except for asbestos fiber
- Additional measurement: using AAS
- Asbestos fibers: microscopic examination

(IV) Size of particles presents in the breathing zone

- Actual size of airborne particles – is also Important
- Respirable particles – (<10 mikrometer) and not seen by naked eyes
- Industrial dust – vary widely in size include large particles and small particles
- Smaller size, lower 5 mikrometer and can enter alveolar and inner part of lung

7.4 BIOLOGICAL REACTION

- 6 types of biological reaction
  
  [1] Lung disease
  - Fibrosis
  - Bronchitis
  - Asthma
  - Cancer
  - heart damage (congestive heart failure)
  
  [2] Systemic reaction – blood toxicity – lead, cadmium, mercury etc
  (blood absorb)
  
[4] Allergic/sensitization reaction – inhalation/direct contact of organic dust (flour, grains, woods etc)
[5] Irritation of nose and throat – acid/alkali, dust and mist
[6] Damage to internal tissues – inhalation of radioactive materials – radium etc

7.5 SILICOSOS

- Silicon dioxide – amorphous silica (non-crystalline), crystallized silica and silicates and etc (from crystalline)
- Lung disease by inhalation of silica dust (quartz)
- Workers exposure: foundries, glass manufacturing, granite cutting
- Other name: Miner’s asthma, grinder’s consumption, stonemason’s disease

FACTOR INFLUENCES

- Silicosis manifestation:
  I. Amount and kind of dust inhaled
  II. % of free silica in dust
  III. Form of silica
  IV. Size of silica inhaled
  V. Duration of exposure
  VI. Power of resistance of individual
  VII. Absence of concurrent infection
PATHOPHYSIOLOGY OF SILICOSIS

- Free silica dust
- Deposit in lung
- Accumulate in lung
- Tissue react by development of fibrous tissues and death of macrophage
- Reduce elasticity and normal cells
- Obliterate bv
- Proliferate - severe
- Reduce blood flow
- Shortness of breath
- Enlarge heart
- Cor pulmonae

SYMPTOM OF SILICOSIS
I. Presence of cough
II. Dyspnea
III. Wheezing
IV. Non specific chest illness

7.6 ASBESTOSIS

- Inhalation of asbestos fiber
- Asbestos is generic name for natural occurring, fibrous, hydrated mineral silicates
- 2 groups of mineral:
  1. Pyroxenes: chrysotile
  2. Amphibole: amosite, crocidolite, termolite, actinolite
- Chrysotile: white asbestos and most common
- Crocidolite: specialized asbestos
- Amosite – ferrous magnesium silicate (south africa) brownish to yellow and almost white
- Anthophyllite – brownish on white fiber
EFFECT OF ASBESTOS EXPOSURE

- Asbestosis – diffuse, interstitial, non-malignant scarring of the lung
- Bronchogenic carcinoma – malignancy of the lining of lung air passage
- Mesothelioma – diffuse malignancy of the lining of the chest cavity (pleural mesothelioma) or lining of the abdomen (peritoneal mesothelioma)
- Cancer of the stomach, colon, rectum

CLINICAL SYMTOMS

- Finger clubbing
- Rales
- Dyspnea

7.7 BERYLLIUM

7.7.1 BERYLLIUM INTOXIC

- Severe systemic disease that result from inhalation of dust fumes from metallic beryllium, beryllium oxide and soluble beryllium compound
- 2 form of disease:
  (I) Acute: chemical pneumonitis – cough, pain, difficulty in breathing, cyanosis and loss weight
  (II) Chronic: berylliosis – loss of appetite, weakness, coughing, extreme difficulty in breathing, cyanosis and cardiac failure
7.7.2 BERYLLIOSIS

- Several years after exposure (5-10 years)
- Characterized by granulomas in the lung, skin and other organs
- Enlargement of the heart, kidney, liver and spleen
- Respiratory symptoms as the previous slide

7.8 BLACK LUNG

- All lung disease associated with chronic overexposure to coal dust including:
  - Chronic bronchitis
  - Silicosis
  - Coal workers pneumoconiosis
  - Simple fibrosis to massive progressive fibrosis (fibrotic nodules)

7.9 OTHER PNEUMONICOSIS

- Mica pneumoconiosis: grinding operation (happen when massive exposure)
- Kaolinosis: inhalation of china clay
- Bauxite pneumoconiosis:
  - AKA shaver’s disease
  - workers exposed to fumes containing aluminium oxide and ultramicroscopic silica
- Siderosis – iron oxide – fumes from welding operation
  - black and red in the lung of iron ore minor

7.10 OTHER DUST

- Limestone
- Marble
- Lime
- Gypsum
- Cement dust
7.11 BACTERIA AND FUNGI

- Lung infection from inhalation of bacteria and fungi
- Pulmonary anthrax – inhalation of dust containing anthrax spores
- Fungi from grain

7.12 MEASUREMENT OF AIRBORNE DUST

- Evaluate dust exposure so to determine composition of dust that workers breathe
- Necessary to actually obtain sample of air borne dust and analyze the composition
- Measured in mikrometer

1.1 DUST MEASUREMENT

(i) Count Procedure
   - Microscopic counting – index of concentration
   - Darkfield illumination
   - Difficult because of different technique
   - Inefficient but able to show effectiveness of control measure

(ii) Total mass concentration method
   - Total weight of dust collected in a given volume of air
   - Total dust and respirable dust included
   - Not reliable for respirable dust concentration

(iii) Respirable mass size selection measurement
   - personal breathing zone respirable mass sampling
   - Dust sample separated by design or flow of the sampling device
   - Sampling device include impactors, centrifugal and miniature cyclone
7.13 DUST CONTROL METHOD

- Numerous, complicated and expensive
  
  (I) Local Exhaust
  - Local exhaust ventilation at the point of high dust production
  - Combine with hood be an effective control
  - Operation requirement – high suction pressure

(II) General Ventilation system with dilution
- When source of dust generation is numerous and widely distributed
- Exhausting air from plant and add with air from window and outside

(III) Recirculate the air from the dust
- Recirculate the air from the dust collector

(IV) Moisture control
- Using wet drilling and grinding can reduce up to 75% dust generated

(V) Respirator
- Can be used as primary or secondary protection
- Effective matche to the type of particulate hazard present, type of dust. Length of exposure, dust concentration and particle size

Conclusion to Unit

Particulate is made up from aerosol, dust and fumes. The particulate has different chemical and physical properties. There are a few types of particulate which are silicosis, asbestosis, beryllium, black lung and other dust. The airborne dust can be measured and there are a few methods for controlling dust.
Discussion 7.0

1. Describe the physical and chemical properties of particulate.

Answers to Exercise 7.0

1. Particle size
2. Shape and aspect ratio
3. Surface area and volume
4. Solubility

Additional References

UNIT 8
Physical Hazard – Radiation and Heat

Introduction to Unit

Student will learn about the common physical hazards in the workplace and their effects to workers’ health.

Objectives to Unit

- After this session, students should be able to:
  - Provides a general view on the common physical hazards such as the radiation and heat stress in the workplace.
  - Describes the sources, health effects and prevention methods from this type of hazards.

8.0 Content

8.1 Introduction
8.2 Physical Hazards
8.3 Type of Physical Hazards
8.4 Terminology related to Radiation
8.5 Types of Ionizing Radiation exposures
8.6 Health effects of Radiation
8.7 Types of Ionizing Radiation
8.8 Types of Non-ionizing Radiation
8.9 Type of Radiation Injury
8.10 Prevention and Protection from radiation
8.11 Occupational Heat Stress
8.12 Heat exchange  
8.13 Sources of heat stress  
8.14 Health Effects of Heat Stress  
8.15 Prevention and Protection from Heat Stress

**Important Notes**

### 8.1 Introduction

- Hazard is any source of potential damage, harm or adverse health effects on something or someone under certain conditions at work.
- Risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard.

### 8.2 Physical Hazards

- Physical exposures that occur over time can cause human illness  
- Physical exposures are widespread in industry, in nature, and in various community and medical setting:
  - noise, vibration, thermal stress,  
  - electromagnetic radiation,  
  - Increased or decreased pressure

### 8.3 Type of Physical Hazards

- Extreme temperature  
- Pressure  
- Noise  
- Illumination  
- Vibration  
- Radiation  
- electric and magnetic fields
8.4 Terminology related to Radiation

- The most important concepts to understand in the field of radiation are:
  - Ionizing and non ionizing radiation
  - Exposure and dose
  - Half-life and activity
  - Risk

- Ionizing Radiation: Is caused when an electron is ejected from its atomic structure
- Non Ionizing Radiation: Does not eject electron, but causes molecules to vibrate
- Exposure: Represent the amount of radiation that is absorbed in air
- Dose: Refers to the amount of energy absorbed in a specified materials other than air, usually tissue
- Half Life: Is the amount of time it takes for half of the radioactive material to decay
- Activity: Represents the decay rate or how quickly that radioactivity material decay
- Risk: Is defined as the increment of some adverse health affect associated with a known amount cumulative radiation dose
- Ionizing Radiation exposures

8.5 Types of Ionizing Radiation exposures

- External exposures: Occur when the body is irradiated by a radioactive sources outside the body
- Internal exposures: Occur when a radioactive material enters the body via inhalation, ingestion, injection, or absorption through the skin

8.6 Health effects of Radiation

- The health effects of radiation varies with: The type; Amount, and Duration of exposure
- When radiation exposes a cell, it may:
  - Pass through without doing any damage
  - Interact and damage the cell, with later repair by the cell
Interact and damage the cell in such a way that it continues to reproduce itself in a damaged state
- Kill the cell

The death of single cell may not be harmful, but if many cells are killed within an organ then that organ may not function properly

8.7 Types of Ionizing Radiation
- Electromagnetic
  - x-rays
  - gamma rays
- Particulate
  - electrons
  - protons
  - neutrons

8.8 Step 3 Control Risks
- Ultraviolet
- Infrared
- Microwave
- Laser radiation

8.9 Type of Radiation Injury
- Irradiation can cause many types of effect on the human body, depending on the dose and the condition of exposure:
  - Mutagenic effect
  - Carcinogenic effect
  - Teratogenic effect
  - Radiation Sickness

8.10 Prevention and Protection from radiation
- Engineering controls → eliminate or reduce the potential exposures at the source Exp. Interlocks, shielding, bonding, grounding and filtering
• Administrative control: Increasing the distance between the source and the worker, controlling the duration of exposure, restricting access, placing warning signs

8.11 Occupational Heat Stress
• There are an estimated 5 to 10 million in industries where heat stress is a potential safety and health hazards
• Heat related occupational illness, injuries and strain occur in any situation where total heat load (environmental heat plus heat generated by the body’s metabolism)
• The major modes of heat exchange between workers and their environment are: convection, conduction, radiation, evaporation

8.12 Heat exchange
• Convection: Refers to the rate of heat exchange between the individual’s skin and the air immediately around the skin
• Conduction: The transfer of heat to the skin from direct contact with hot equipment or floors of from hot liquids
• Radiation: Refers to heat that is transferred between the skin and solid surfaces or object, without direct skin contact
• Evaporation: Evaporation of water from the surface of the skin (sweating). It is also the body’s primary method of regulating internal body temperature

8.13 Sources of heat stress
• Natural Conditions
• Hot work processes related to furnaces, kilns, boilers and smelting

8.14 Health Effects of Heat Stress
• Some of the disorders due to heat stress are: Prickly Heat (Miliaria rubra), Heat cramps, Heat exhaustion and Heat stroke
8.15 Prevention and Protection from Heat Stress

- Acclimatization
- Measuring environmental temperature
- Assessing metabolic work rates

Conclusion to Unit

Physical exposures due to radiation and heat stress that occur over time can cause human illness. Therefore, suitable working environments that fit to human physiological & psychological needs to taken consideration by the employer for their employees.

Additional References


Discussion 8.0

1. Give 3 examples of physical hazards.
2. List down the health effects of heat stress.
3. What are the steps that can be taken for the prevention and protection from heat stress?
Answers to Discussion 8.0

1. Extreme temperature, Pressure and Noise
2. Heat cramps, Heat exhaustion and Heat stroke
3. Acclimatization, Measuring environmental temperature and Assessing metabolic work rates
UNIT 9
Introduction to Ergonomic Hazards – Vibration and Musculoskeletal Disease

Introduction to Unit

This topic will cover the common ergonomics hazards in the workplace and their effects to workers’ health.

Objectives to Unit

After this session, students should be able to:

- Provides a general view on the common ergonomic hazards such as the vibration and musculoskeletal disorders (MSDs) in the workplace.
- Describes the sources, health effects and prevention methods from this type of hazards.

9.0 Content

9.1 Introduction
9.2 Definition of Ergonomics
9.3 Ergonomic Study Areas
9.4 Ergonomic Goals
9.5 Resulting Injuries of ergonomics
9.6 Common Symptoms of MSDs
9.7 Common Causes of MSDs
9.8 Examples of MSDs
9.9 Prevention and Protection from radiation
9.1 Introduction

- Ergonomics involves the following: Using special design and evaluation techniques to make tasks, objects, and environments more compatible with human abilities and limitations.
- Seeking to improve productivity and quality by reducing workplace stressors, reducing the risk of injuries and illnesses, and increasing efficiency.

9.2 Definition of Ergonomics

- Ergonomics is derived from the Greek language.
- *Ergon* means work and *Nomos* means laws, so ergonomics means work laws.
- Ergonomics is the science of fitting the job to the worker.

9.3 Ergonomic Study Areas

- Workers - what they bring to the job
- Tools - what they bring to the worker
- Tasks - what the worker must do
- Environment - the conditions
- Surrounding the worker and the tool

9.4 Ergonomic Goals

- to reduce work-related musculoskeletal disorders (MSDs) developed by workers
- MSDs are injuries and illnesses that affect muscles, nerves, tendons, ligaments, joints or spinal discs.

9.5 Resulting Injuries of ergonomics

- Cumulative Trauma Disorders (CTD),
- Repetitive Strain Injuries (RSI),
- Musculoskeletal Disorders (MSD)
9.6 Common Symptoms of MSDs

- Painful joints
- Pain, tingling, numbness in hands, wrists, forearms, shoulders, knees and feet
- Shooting or stubbing pains
- Swelling or inflammation
- Fingers or toes turning white
- Back or neck pain
- Stiffness

9.7 Common Causes of MSDs

- Repetitive and/or prolonged activities
- Awkward postures/positions for an extended time
- Static postures
- Vibration
- High/low Temperatures for an extended time
- Forceful exertions

9.8 Examples of MSDs

- Tendonitis- An inflammation of the tendon. Typically occurs in the shoulder, wrist, hands, or elbow.
- Carpal Tunnel Syndrome- Irritation of the median nerve, which runs through a bony channel in the wrist called the carpal tunnel. Usually results from excessive flexing or twisting of the wrist.
- Trigger Finger Syndrome- Tendons in the fingers become inflamed, causing pain, swelling, and a loss of dexterity.
- Eye Strain - The eyes become strained as a result of poor lighting, glare or viewing from awkward positions.
9.9 Prevention and Protection from ergonomic hazards

- Administrative controls
  - Employee rotation/job task expansion
  - Physical adjustments to the work pace
  - Redesign of work methods
  - Alternative tasks
  - Breaks

- Work practice controls
  - Safe & proper work techniques & procedures
  - Posture & Angles: Whether your tasks are performed while sitting or standing, always maintain proper posture & angles--and avoid: Awkward positions, and Extreme reaches for materials
  - Training
  - Physical conditioning period

- Engineering controls
  - Workstations: Fit the workstation to the employee and reduce awkward positions
  - Tools/equipment: Use of Force or of grip-strength, repetitive motion, awkward positions, forceful exertions, static positions and vibration
  - Facilities: Lighting/glare, temperature and noise

Conclusion to Unit

Many workers suffer from injuries and diseases that result from manual work and the increased mechanization of work. Ergonomics looks at ways to make the job fit the worker, instead of forcing the worker to fit the job. Ergonomics can be used to improve poor working conditions. It can also be used to prevent bad design from being built into a job if applied when a job, tools or workstations are being set up. Without the application of ergonomic principles, workers are often forced to adapt themselves to poor working conditions.
Additional References

3. Taylor & Francis Online: Ergonomics. [www.tandfonline.com/toc/terg20/current](http://www.tandfonline.com/toc/terg20/current)

Discussion 9.0

1. Give definition of ergonomics.
2. List down the 5 common symptoms of MSDs
3. What are the steps that can be taken for the prevention and protection from ergonomic hazards?
Answers to Discussion 9.0

1. Ergonomics is the science of fitting the job to the worker
2. Painful joints, Stiffness, stubbing pains, numbness and swelling
3. Administrative controls, work practice controls and engineering controls.
UNIT 10
Organic Solvent Poisoning

Introduction to Unit

This session is intended to be an informative overview of the organic solvents and their toxicological effects.

Objectives to Unit

After this session, students should be able to:

- Provide an overview of occupational solvent exposure.
- Review potential health outcomes due to organic solvent exposure.
- Provide background information on specific solvents.
- Illustrate the diverse effects of solvents through cases involving solvent toxicity.
- Able to describe the control and management of solvent related exposure.

10.0 Content

10.1 Introduction to organic solvent
10.2 Occupation related to organic solvents
10.3 Route of entry to human
10.4 Health effects of exposure
10.5 Managing cases of organic solvent poisoning
10.6 Control and management of exposure
10.7 Legislation perspective
10.1 INTRODUCTION TO ORGANIC SOLVENT

- Organic solvents are chemicals routinely used in chemical industries to dissolve a variety of substances.
- Organic solvents are useful due to its ability to dissolve oils, fats, resins, pigments, rubber, plastics and others.
- Organic solvents are made up of large group of compounds with varied chemical structures and there are more than 500 kinds of organic solvent in the market.
- They share a common structure where it is made up of at least 1 carbon atom and 1 hydrogen atom, have low molecular weight, is lipophilic in nature, and is volatile and they exist in liquid form at room temperature.
- They may be grouped further into:
  - Aliphatic-chain compounds, such as \( n \)-hexane.
  - Aromatic compounds with a 6-carbon ring, such as benzene or xylene.
  - Halogenated hydrocarbons, such as perchloroethylene (PCE or PER), trichloroethylene (TCE), and carbon tetrachloride.
  - Other groups of solvents are alcohols, ketones, glycols, esters, ethers, aldehydes, and pyridines.

10.2 OCCUPATION RELATED TO EXPOSURE OF ORGANIC SOLVENTS

4) Car or construction painters
5) Adhesive and glue manufacturing
6) Production of coating and degreasing or cleaning agents
7) Electronic workers
8) Furniture refinishers – \( n \)-hexane
9) Paint and pigment manufacturing
10) Polymer and plastic production – styrene
11) Rayon industries – carbon disulphide
12) Shoe workers
13) Textiles
14) Wood workers
15) Production of printing inks
16) Manufacturing of agricultural products
17) Manufacturing of pharmaceutical products
18) Manufacturing of phone industries

The following table presents the distribution of organic solvents use across different type of work in Japan (Ukai et al. 1997)

<table>
<thead>
<tr>
<th>Type of solvent</th>
<th>Printing (°)</th>
<th>Adhesive spreading (°)</th>
<th>Degreasing and wiping (°)</th>
<th>Painting (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toluene</td>
<td>56%</td>
<td>51%</td>
<td>16%</td>
<td>70%</td>
</tr>
<tr>
<td>Isopropyl alcohol</td>
<td>34%</td>
<td></td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>Ethyl acetate</td>
<td>33%</td>
<td></td>
<td>19%</td>
<td>41%</td>
</tr>
<tr>
<td>Xylene</td>
<td>28%</td>
<td></td>
<td></td>
<td>69%</td>
</tr>
<tr>
<td>n-Hexane</td>
<td></td>
<td></td>
<td>23%</td>
<td></td>
</tr>
<tr>
<td>Methyl Isobutyl Ketone</td>
<td></td>
<td></td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>Dichloromethane</td>
<td></td>
<td></td>
<td>15%</td>
<td></td>
</tr>
</tbody>
</table>

Reports from Japan also published the 10 most used solvents in industries in Japan which are as follows:

1. Toluene
2. Xylenes
3. Ethyl acetate
4. Methanol
5. Isopropanyl alcohol
6. Butyl acetate
7. Methyl ethyl ketone
8. Methyl isobutyl ketone
9. Acetone
10. Isobutyl alcohol

10.3 ROUTE OF EXPOSURE TO HUMAN

As solvents tend to be volatile liquids, workers are usually exposed to vapors. Solvents also can pass through the skin, although not usually a significant route of exposure.

Vapor concentration can be expressed as ppm or mg/m³, according to the following relationships:

\[
\frac{mg}{m^3} = \frac{molecular\ weight \times ppm}{24.45}
\]

and

\[
ppm = \frac{(mg/m^3)(24.45)}{molecular\ weight}
\]

Solvent exposure is affected by airborne concentration, solubility, and exposure frequency.

- Higher vapor concentrations for enclosed spaces with poor ventilation, and with solvents having a high vapor pressure.
- When inhaled, lipid-soluble solvents will easily enter the blood.

10.3.1 Absorption is as the following:

- **Pulmonary**
  - Pulmonary is the primary route of exposure.
  - Solvent-volatile, lipid soluble are absorbed across alveolar-capillary membrane.
  - Pulmonary retention is 40-80% at rest
  - Physical exercise at work increases pulmonary uptake and retention at 2-3 times
• Percutaneous or skin
  ▪ Lipid and water soluble solvent is readily absorbed
  ▪ High volatile solvent is less well absorbed since they tend to evaporate

• Gastrointestinal tract
  ▪ Ingestion

10.3.2 Distribution is as the following:

- Lipohilic solvents are distributed to lipid rich tissue such as the adipose tissue, nervous tissue, liver, blood-tissue membrane barriers.
- Large blood flow organ such as the cardiac system and the skeletal muscle.
- Most solvents cross placenta and could also be present in breast milk.

10.3.3 Metabolism and excretion

- Some solvents are extensively metabolised and some are not at all.
- Excretion primarily through exhalation of unchanged compound.
- Other routes of elimination include kidney and bile excretion.

10.4 HEALTH EFFECTS OF EXPOSURE

The toxicity of solvents depends to a great deal upon the chemical nature of the compound.

10.4.1 Solvent neurotoxicity has been classified by the 1985 International Solvent Workshop as follows:

- Type 1: (the least severe)
  Characterised by fatigue, memory impairment, irritability, difficulty in concentrating, and mild mood disturbance. This corresponds to the WHO classification of organic affective syndrome. It is reversible on removal from exposure.

- Type 2:
  Symptoms of neurotoxicity and abnormalities of performance on
neuropsychological testing. Type 2 disorder has been subdivided into:

*Type 2A*: sustained personality or mood change, and
*Type 2B*: impairment in intellectual function.

This level corresponds to the WHO classification of mild chronic toxic encephalopathy.

- **Type 3**: (most severe)
  Global deterioration in intellectual and memory functions (dementia).
  This corresponds to the WHO classification of severe chronic toxic encephalopathy and is usually irreversible.

10.4.4 The health effects due to organic solvent toxicity could also be explained according to the diagram below:

1) Brain – memory loss, confusion, difficulty concentrating, fatigue, headache
2) Nervous system
- Central nervous system - cranial neuropathies, psychiatric
- Peripheral nervous system – numbness, weakness, foot drop, wrist drop

3) Reproductive system – miscarriages, fetal alcohol syndrome
4) Kidneys – Glomerulonephritis\Skin – Irritant dermatitis, defatting
5) Liver – Fatty liver, chemical hepatitis
6) Cardiovascular system – Increased sensitivity to epinephrine, exacerbation of coronary artery disease
7) Skin – Dermatitis

10.4.5 Cancer causing solvents are described in the following table:

<table>
<thead>
<tr>
<th>Type of solvent</th>
<th>Group IARC</th>
<th>Health effects in Human</th>
<th>Health effects in experimental animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>1</td>
<td>Leukemia</td>
<td></td>
</tr>
<tr>
<td>Trychloroethlyne</td>
<td>2A</td>
<td>Liver, lymphoma</td>
<td>Liver, kidney, lymphoma</td>
</tr>
<tr>
<td>Chloroform</td>
<td>2B</td>
<td></td>
<td>Liver, kidney, thyroid</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>2B</td>
<td></td>
<td>Liver, lung, mamary gland</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>2B</td>
<td></td>
<td>Liver, lung, mamary lung</td>
</tr>
<tr>
<td>Styrene</td>
<td>2B</td>
<td></td>
<td>Liver, lung, mamary lung</td>
</tr>
<tr>
<td>Toluene</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xylene</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10.4.6 Examples of known diseases due to organic solvent exposure

- *n*-Hexane polyneuropathy – the first patient in the world who was diagnosed to be *n*-hexane polyneuropathy was a 19 year old man whose work include polyethylene lamination between August 1962 to December 1962. Among the symptoms until January 1963 was easy fatigability, body weight loss, tingling sensation, gait disturbance and loss of grip power in the hands.
- Stevens-Johnson syndrome due to trichloroethylene where after 4-8 weeks of exposure, symptoms such as skin rash, mucous membrane damage and hepatitis occurred.

10.4.5 Relevant Symptoms related to chronic solvent neurotoxicity

Symptoms consistent with chronic solvent neurotoxicity include:

- fatigue
- sleep disturbances
- irritability
- anxiety
- loss of appetite
- alcohol intolerance
- memory and concentration difficulties

There is often impairment of frontal lobe function, resulting in problems with planning, organisation and abstract thinking.

10.5 MANAGING CASES OF ORGANIC SOLVENT POISONING

The steps used to manage cases of organic solvent poisoning at the workplace are as follows:

1) Complete history taking and thorough physical examination. Checklist of the signs and symptoms of organic solvent poisoning would be helpful as a screening questionnaire (Questionnaire 16) or a neuropsychological performance testing.
• This has shown statistically significant differences between solvent exposed and reference groups in such Central Nervous System functions as simple reaction time, manual dexterity, perceptual speed and new learning.

• Standardised batteries of tests, such as the WHO Neurobehavioral Core Test Battery has been developed for screening purposes and for assessment of individuals.

• Neuropsychological performance testing has been the main method of assessing chronic solvent effects on exposed workers.
WHO Neurobehavioral Core Test Battery

A) Santa Ana Manual Dexterity Test

B) Simple Reaction time

C) Benton Visual Retention Test

D) Digit Span Test

E) Digit Symbol Test

F) Pursuit Aiming Test
An example of the Questionnaire 16 – A questionnaire for CNS symptoms for chronic exposure to organic solvent

Questions – Yes or No answer
1. Do you have a short memory?
2. Have your relatives told you that you have a short memory?
3. Do you often make notes about what you must remember?
4. Do you often have to go back and check things you have done such as turned off the stove, locked the door, etc?
5. Do you generally find it hard to get the meaning from reading newspapers and books?
6. Do you often have problems with concentrating?
7. Do you often feel irritated without any particular reason?
8. Do you often feel depressed without any particular reason?
9. Are you abnormally tired?
10. Are you less interested in sex that what you think is normal?
11. Do you have palpitations of the heart even when you don’t exert yourself?
12. Do you sometimes feel oppression in your chest?
13. Do you perspire without any particular reason?
14. Do you have a headache at least once a week?
15. Do you often have painful tingling in some parts of your body?
16. Do you have any problems with buttoning and unbuttoning?

Further investigation is indicated if, on completion of Questionnaire 16, there is:

A. A total of more than 4 positive answers in a worker younger than 28 years of age, or

B. A total of more than 6 positive answers in a worker aged 28 years or older.
2) Walk through of workplace
   - Assess workplace and potential exposures
   - Personal or area industrial hygiene sampling
   - Ventilation of worksite
   - Potential skin exposure

3) Specific investigations to support the diagnosis such as neurological tests and electrophysiological test.

4) Detail information on exposure such as properties of organic solvent, exposure concentration, duration etc.

5) Biological monitoring results to be reviewed if available.
   - Biological monitoring is the measurement of a toxic chemical (or chemical metabolite) in the body of an exposed person, as opposed to the monitoring of levels in the environment.
   - The biological samples used for monitoring includes blood, urine, or exhaled air of workers exposed to chemical substances.
   - Ethyl benzene, styrene, toluene, trichloroethylene and xylene all have biological monitoring methods that may be useful in evaluation of workers exposed to these solvents.

6) Establish relationship between organic solvent exposure and health disorder.

7) Manage accordingly.

### 10.6 CONTROL AND MANAGEMENT OF EXPOSURE

1) Elimination or Substitution
   - Ceasing to use the chemical
   - Replace the harmful compound by less hazardous form - substitution of benzene by cyclohexane or toluene

2) Selection of substitution of solvent
   - Take into account both the desirable and undesirable property of solvent.
   - Compare toxicity, volatility, flammability, explosiveness and stability.
   - E.g. substitute water-based paint for solvent-based paint
3) Engineering control

- Consider its volatile property
- Enclosure – e.g. closed system for trichlorotrifluoroethane for dry cleaning.
- Isolation – e.g. paint spray booth
- Ventilation system – proper design, regular mechanical maintenance
  - Ensure safe and effective removal of contaminated air to a safe place
  - a-local exhaust ventilation
  - b-dilution ventilation (precipitation): high air flow

4) Administrative control

- Keeping chemicals in safe place
- Provision of means for safe storage, storage areas should be kept separate from process areas
- Not leaving dangerous materials lying about
- Regular cleaning of contaminated walls, surfaces
- Prohibition of eating, drinking, and smoking
- Emergency procedures - Adequate precautions against accidental release, fire, and chemical reactivity

5) Personal protection

- Respiratory protection
  - Respirator Program must include:
    - Training
    - Cleaning
    - Fit testing
    - Medical Clearance
    - Change of filters – schedule depends on exposure type and amount

- Protective clothing – proper material to make impermeable aprons
- Protective barrier creams to protect against dermal absorption
- Gloves – Breakthrough time depends on type of glove, solvent exposure and activity.
Chemically resistant gloves: natural rubber, butyl rubber, chloroprene, nitrile, and fluorocarbon; or various plastics: polyvinyl chloride, polyvinyl alcohol, polyethylene

- Goggles

10.7 LEGISLATION PERSPECTIVE

Under the Occupational Safety and Health Act 1994, it has been clearly stated that:

- Section 15 - General duties of Employer and Self-employed Person:
  - to ensure, so far as practicable, the safety, health and welfare of all employees
- Section 15 (2)(b) -
  - making of arrangement to ensure safety and absence of risk to health in connection with the use, operation, handling, storage and transport of plant and substances

The legal requirements includes the scope of

- Classification, packaging and labeling of chemicals
- Health risk assessment
- Hygiene monitoring of area or personal
- Biological monitoring of chemicals substances
- Medical surveillance
- Control measures to be put in place

10.7.1 Regulations and Order requirement under the Occupational Safety and Health Act 1994 includes:

1) Use and Standard of Exposure to Chemicals Hazardous to Health Regulations 2000
   - Made under Section 66 of OSHA 1994
   - Sixth Regulation under OSHA 1994
   - To protect safety and health of employee and other person from being affected by chemical hazardous to health use at the place of work
• Gazette on 4th April 2000
• Come into force on 4th April 2001
• Requires chemical management of hazardous substance inclusive of chemicals in Schedule 2
• Laid out standards for chemicals exposure
• Requires Chemical Health Risk Assessment and medical surveillance to be performed – examples Benzene, Carbon disulphide, N-Hexane

2) Classification, Packaging and Labelling of Hazardous Chemicals Regulations 1997
• Requires information from supplier
• Chemical Safety Data Sheet to be included with chemicals purchased

3) Control of Industrial Major Hazard Regulations 1996
• Transportation of hazardous substances
• Identification and notification of major hazard if using chemicals as listed in Schedule 2

4) Notifiable Occupational Poisoning and Disease Regulations 2004
• Reporting of accident, dangerous occurrence, occupational poisoning and occupational disease
• Among the type of poisoning that needs to be reported is poisoning by alcohols, benzene, carbon disulphide, glycols and hydrocarbons

5) Prohibition of Use of Substance Order 1999
• This Order shall come into operation on 2 August 1999
• The substances listed in column (1) of Schedule shall be prohibited from use to the extent as specified in column (2).
Conclusion to Unit

Students should be able to get the overview on the following:

- There are a variety of organic solvents are used in numerous workplaces.
- Many workers might be at risk of poisoning.
- Diagnosis of chronic poisoning is not easy.
- Toxicity has not yet been fully clarified.
- Difficult to treat and prevention of exposure is easier.
Discussion 10.0

1. Name the route of entry which is most significant in determining workers exposure to solvents. Please explain why.

2. Why are lipid-soluble substances such as solvents absorbed through the skin more easily than water-soluble ones?

Answers to Discussion 10.0

1. Inhalation is the most common and for the occupational health professional the most important route of entry. The lungs are designed to provide an efficient gas exchange between the air and blood. They contain a very thin surface, with area between 300 to 1000 square feet. There is a potential for a lot of airborne toxins to come into close contact with the lungs and the bloodstream of the person breathing the contaminated air.

2. Significant portion of the skin tissue is comprised of lipid molecules while water-soluble materials are not easily absorbed by the skin because the lipid layer affords insulation and provides and effective barrier against them.
UNIT 11
Chemical Hazards: Heavy Metal

Introduction to Unit

Student will learn about the heavy metal classified under chemical hazards.

Objectives to Unit

After this session, students should be able to:

- Understand about the heavy metal exposure at the work place.
- Identify the steps to control and manage exposures according to the legislation requirements.

11.0 Contents

11.1 Definition
11.2 Heavy metal
11.3 Metals in the workplace
11.4 Legislations
11.5 Understanding metal toxicity
11.1 Definition

- ‘Metals’ originally included only gold, silver, copper, iron, leads, and tin.
- Dense, malleable (able to be hammered or pressed permanently out of shape without breaking or cracking), lustrous
- Conduct heat and electricity, cations
- Many other elements since added to the list with some of these characteristics
- ‘Metalloids’ are elements with features intermediate between metals and non-metals.
- Example: Arsenic - near or in hazardous waste sited and area with high levels naturally occurring in soil, ricks, and water

11.2 Heavy metal

- Heavy metal are chemicals elements with a specific gravity that is at least 5 times the specific gravity of water
  - Arsenic 5.7; cadmium 8.65; lead 11.34; mercury 13.54
- A metal having an atomic weight greater than Na, a density greater than 5 g/cm³
- Physical properties
  - High reflectivity, electrical and thermal conductivity, strength
  - Easily traced and measured and fate determined
- Some notion of toxicity
  Usually includes lead, cadmium and mercury
11.3 Metals in workplace

- Metals are extensively used in industrial operation thus resulting in a high risk of exposure to workers and environment
  - Welding
  - Grinding
  - Soldering
  - Painting
  - Smelting
  - Storage battery
  - Recycling

- Industries with high potential of lead exposures include construction work, most smelter operations, radiator repair shops, and firing ranges.

- Cadmium is found in industrial workplaces, particularly where any ore is being processed or smelted.
  - Common sources of mercury exposure include mining, production, and transportation of mercury, oil and gas industry as well as mining and refining of gold and silver ores.

- Recycling Industry.
  - Ship breaking industry
  - Mercury is a naturally occurring trace element in fossil fuels
  - It is predominantly present in the metallic form but may be present in the form of inorganic salts and organic species.
11.4 Legislations

- METALS/Chemicals for which medical surveillance must be performed according to Schedule 2-USECHH 2000
  1. Arsenic and any of its compound
  2. Beryllium
  3. Cadmium
  4. Chromium
  5. Lead
  6. Manganese
  7. Mercury

- Notifiable Occupational Poisoning and Disease
- 3rd schedule OSH (Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease) Regulations (7) 2004
- Poisoning by Cd, Ar, Pb, Hg, Mn, Phosphorus, antimony, chromium, nickel, beryllium
- Column 2 in NADOPOD – the use of handling, or exposure to fumes, dust, vapor
  E.g. FUMES
  Solid aerosols generated by the condensation of vapours or gases from combustion or other high temperature processes + usually very small and spherical

  Compensable occupational disease (5th schedule SOCSO act 1969)

- Poisoning by
  ○ Lead or compound of lead
  ○ Arsenic
  ○ Mercury
  ○ Beryllium
  ○ Cadmium
  ○ Antimony
  ○ Nickel
  ○ Chromium
11.5 Understanding Metal Toxicity

Fundamental concepts of:
1. Classification of Metal
2. Absorption, storage and excretion of metal
3. Mode of action of metal toxicity

Classification of Metal
- Based upon physical properties
  - High reflectivity and metallic cluster
  - High electrical conductivity
  - High Thermal conductivity
  - Strength and Ductility - characterized by the material's ability to be stretched
- Based upon biological perspective
  - Solubility
  - Oxidation state
- Heavy metal ⇔ Toxic metals
Absorption

- **Respiratory Absorption**
  - Metal may be inhaled as vapor or aerosol (fume or dust particulate)
    - Fume or vapor of some metals & compound are readily absorbed in from alveolar space (cadmium, mercury, tetraethyl lead)
  - Large particles trapped in upper respiratory tract, cleared by mucociliary transport to pharynx and swallowed (equivalent to oral exposure)
    - Small particles may reach alveolar/gas exchange. Water soluble metal aerosols are rapidly absorbed from alveoli into the blood
  - Gastrointestinal Absorption
    - Metal may introduce into GI tract through food, water, mucociliary clearance
    - Metal are absorbed into the cells lining the intestinal tract by:
      - Passive or facilitated diffusion
      - Specific transport process
      - Pinocytosis
    - Depends on many factors
    - Solubility of metal in fluids of the intestinal tract
    - Chemical forms of metal (lipid soluble methyl mercury is completely absorbed compare to inorganic mercury – poorly absorbed)
    - Presence and composition of other materials in GI tract
    - Composition for absorption sites between similar metals (zinc & cadmium or calcium & lead)
- Physiological state of the person exposed (Vitamin D enhance the absorption of lead)

**Excretion**

- Kidney - Important route of excretion
  - Metals in blood plasma are bound to plasma proteins and amino acids
  - Metals bound to low molecular weight proteins and amino acids are filtered in glomerulous into fluid of the renal tubule
  - Some metals (Cd & Zn) are effectively resorbed by tubular epithelia before they reach the urinary bladder where very little resorption occurs

- Enterohepatic Circulation
  - Absorbed metal may also excreted into intestinal tract in bile, pancreatic secretion or saliva

- Minor Pathways
  - Hair (Hg, Zn, Cu and As)
  - Nails
  - Saliva
  - Perspiration
  - Exhaled air
  - Lactation
  - Exfoliation of skin
• Enterohepatic Circulation
  ▪ Absorbed metal may also excreted into intestinal tract in bile, pancreatic secretion or saliva

• Minor Pathways
  ○ Hair (Hg, Zn, Cu and As)
  ○ Nails
  ○ Saliva
  ○ Perspiration
  ○ Exhaled air
  ○ Lactation

• Exfoliation of skin

- Organs and tissue affected are those involved in the absorption and elimination
- Result of the accumulation of high, critical concentrations of metal that at these sites with little opportunity to detoxify, eliminated or adapted to metal

• The of acute metal intoxication is design to:
  ○ Enhance the elimination of the metal through neutralization
  ○ Prevent irreversible damage to organs and tissue
  ○ Treat the symptoms of acute toxicity

Chronic Toxicity
• Duration of initial exposure to the onset of signs and symptoms months to years
  ○ Diagnosis of chronic metal intoxication is more difficult than acute intoxication
• Diagnosis – presence of excessive metals in blood and urine
• Organ system not involve in absorption or elimination of metal such as hematopoetic or immune system may be affected
Mechanism of intoxication

- There is often little correlation between the sensitivity of organ or tissue to the toxic effects of metal and concentration in that tissue
  - 95% percent of the body burden of lead in adults are found in calcified tissue (bone and teeth); however toxicity is manifest primarily in the nervous systems, renal systems and hematopoetic systems

- There is often little correlation between the sensitivity of organ or tissue to the toxic effects of metal and concentration in that tissue
  - 95% percent of the body burden of lead in adults are found in calcified tissue (bone and teeth); however toxicity is manifest primarily in the nervous systems, renal systems and hematopoetic systems

- **Lead**
  - **Types of lead**
    - Inorganic – PbO2
    - Organic – Tetraethyl lead, tetramethyl lead, not water soluble lead
  - **Sources of exposure**
    - Mining/Smelting (melting, baking, cooking, burning, and producing)
    - Cutting and welding lead-painted structure
    - Manufacture/Recycling of lead storage batteries
    - Production of lead based paints
  - **Routes of exposure**
    - Respiratory tract
      - Dominant pathway – 50% absorbed
      - Particle size of lead dust <5 micron
      - Soluble
  - **Absorption**
    - Inorganic lead is poorly absorbed from GI tract
    - Pregnant woman is 50%, normal adult

- **Transport and storage**
  - Pb is transported to all organs and tissue of body by blood
95% of Pb in blood is associated with the erythrocytes and remain with plasma protein

- Lead accumulates in bone throughout life
- 90% of body burden of lead is found in bone and most remaining 10% in kidneys and liver
- Biological half-life of lead bone is 10-20 years, while half life of lead in soft tissues is several months

- **Organ systems**
  - GI
  - Hematopoetic
  - Nervous & neuromuscular
  - Renal and cardiovascular
  - Reproductive system – low sperm count, abortions, stillbirths, low sperm motility, premature baby

- **Signs and symptoms include**
  - Muscle weakness, anemia, Insomnia, loss of memory, headache, paralysis of extensor muscles of the wrist

- **Correlation between blood lead levels and clinical effects**
  - < 40 ug/dl – usually none
  - 40 – 80 ug/dl – mild symptoms
  - > 80 ug/dl – severe manifestation such as convulsions

- **Lead Regulation, 1984 under FMA**
  - Action level
  - Airborne concentration of 75 ug/m3 of air averaged over 8-hour period

- **PEL in airbone**
  - 150 ug/m3

- **Exposure monitoring**
  - Full shift personal samples, at least 1 sample per work area
  - If below action level no further assessment needed unless there has been a change in production, process, control or personnel
  - If at or above action level, should repeat every 6 months
  - If at/above PEL, repeat every 3 months

- **Medical surveillance**
- For all workers exposed above action level for more than 30 days per year

- Biological monitoring
  - At least every 6 months for exposed workers
  - Every 3-months if blood Pb 40-60 ug/100 gm blood
  - Monthly if 60-80, during removal period for female worker of child bearing capacity

- Lead – preventive measures
  - Improvement of work process – elimination, substitution, enclosure, engineering control
  - Work-place hygiene
  - Appropriate PPE
  - Appropriate signage
  - Prevent childhood lead poisoning

- Engineering control equipment
  ▪ Local exhaust ventilation system
  ▪ Water spray to control dust or
  ▪ Airborne chemical removal and containment equipment
  ▪ Maintenance requirements
    - During operational conditions
    - Monthly inspection
    - Annual examination and testing
    - Record keeping

- Control measures USCHH Regulation 15(2), (3)

- Safe work systems and practices
  - Documented
  - Implemented
  - Reviewed if

- Changes to
  - Process
- Equipment
- Materials and control measures

- PPE Part V, USCHH regulation 16
  - Impracticable application of control measures a to g
  - As an interim measure
  - Control measures are not adequate

- Test used to identify lead poisoning
  - Blood lead
  - Heme metabolism
    - Pb inhibits delta-amino-levulinic acid dehydratase (enzymes involved in synthesis of porphyrins and heme)
    - Inhibition of the enzymes result in accumulation of the substrate aminolevulinic acid (ALA) in blood or urine

- Nerve conduction velocity
  - Lead decreases the velocity at which nerve impulse is conducted along the arm

- Ca EDTA mobilization test – estimate body burden of lead

- Susceptibility of Nervous System to effects of toxins
  - Large surface area of nervous system – will increase exposure to toxins
  - High lipid content (myelin) – accumulate and retain lipophilic toxins
  - Neuron is sensitive to shortage of O2
  - Electrochemical transmission at the synapse – toxins disrupts synaptic function
  - Nerve cells killed by toxins cannot regenerate

- Investigation tools for neurological toxicity
  1. WHO Neurobehavioral Core Test Battery
  2. Detect subtle, mild neurological changes in early stage of intoxication
<table>
<thead>
<tr>
<th>TEST</th>
<th>FUNCTIONAL DOMAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple reaction time</td>
<td>Attention/domain</td>
</tr>
<tr>
<td>Digit span</td>
<td>Auditory memory</td>
</tr>
<tr>
<td>Santa Ana dexterity test</td>
<td>Manual dexterity</td>
</tr>
<tr>
<td>Digit symbol</td>
<td>Perceptual-motor speed</td>
</tr>
<tr>
<td>Digit symbol</td>
<td>Perceptual-motor speed</td>
</tr>
<tr>
<td>Benton visual reaction</td>
<td>Visual perception</td>
</tr>
<tr>
<td>Aiming</td>
<td>Motor steadiness</td>
</tr>
</tbody>
</table>

**Cadmium**

- **Sources**
  - By-product from smelting of lead & zinc ores
  - Solders containing cadmium
  - Welding
  - Food & smoking

- **Absorption, Storage, Elimination**
  - Poorly absorbed from GI
  - Inhaled cadmium is absorbed more efficiently (10 – 50 %) depends on size and solubility
  - Absorb cadmium is bound to plasma proteins and transported to liver and accumulated in kidney
  - Biological half life –20 years
  - Renal Tubular damage occurs when the Cd concentration reaches or exceeds 200 ug/g wet weight in the kidney vortex

- **Toxic effects**
  - Mechanism
    - Displacing or replacing zinc from the many (over 200) enzymes requiring zinc as a catalytic or structural component
  - Acute exposure to Cd fumes
- Cough, chest pain, irritation to upper Resp. tract, respiratory damage
- Death
- Chronic
  - Liver damage, anaemia, tetratogenic effects, renal tubular necrosis
- Facts – “Itai-Itai” is Japanese for “ouch-ouch” – refers to bone pain related to calcium loss

- Diagnosis of intoxication
  - History of exposure
  - Increase urinary cadmium (blood cadmium)
  - Reduce pulmonary function
  - Impaired renal tubular function (proteinuria)

- Diagnosis of intoxication
  - History of exposure
  - Increase urinary cadmium (blood cadmium)
  - Reduce pulmonary function
  - Impaired renal tubular function (proteinuria)

**Arsenic**

- Toxicokinetics
  - $T_{1/2}$ of inorganic arsenic in the blood is 10 hrs and of organic arsenic is around 30 hours
  - 2-4 weeks after the exposure ceases, most of the remaining arsenic in the body is found in keratin-rich tissues (nails, hair, skin)
- Inorganic arsenic is converted to organic arsenic (biomethylation to monomethyl arsonic- MMA or DMA) in the liver
- This may represent a process of detoxification
- Renally excreted (30-50% of inorganic arsenic is excreted in about 3 days)
- Both forms are excreted depend on the acuteness of the exposure and dose
- Manifestations of acute arsenic poisoning

<table>
<thead>
<tr>
<th>Bodily system affected</th>
<th>Symptoms or signs</th>
<th>Time of onset</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systemic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thirst</td>
<td></td>
<td>Minutes</td>
</tr>
<tr>
<td>Hypovolemia, Hypotension</td>
<td></td>
<td>Minutes to hours</td>
</tr>
<tr>
<td><strong>Gastrointestinal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garlic or metallic taste</td>
<td></td>
<td>Immediate</td>
</tr>
<tr>
<td>Burning mucosa</td>
<td></td>
<td>Immediate</td>
</tr>
<tr>
<td>Nausea and vomiting</td>
<td></td>
<td>Minutes</td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td>Minutes to hours</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td></td>
<td>Hours</td>
</tr>
<tr>
<td>Hematemesis</td>
<td></td>
<td>Hours</td>
</tr>
<tr>
<td>Hematochezia, melena</td>
<td></td>
<td>Hours</td>
</tr>
<tr>
<td>Rice-water stools</td>
<td></td>
<td>Hours</td>
</tr>
<tr>
<td><strong>Hematopoietic system (formation of blood or blood cells in the body)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemolysis</td>
<td></td>
<td>Minutes to hours</td>
</tr>
<tr>
<td>Hematuria</td>
<td></td>
<td>Minutes to hours</td>
</tr>
<tr>
<td>Lymphopenia</td>
<td></td>
<td>Several weeks</td>
</tr>
<tr>
<td>Pancytopenia</td>
<td></td>
<td>Several weeks</td>
</tr>
<tr>
<td><strong>Pulmonary (primarily in inhalational exposures)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cough</td>
<td></td>
<td>Immediate</td>
</tr>
<tr>
<td>Dyspnea</td>
<td></td>
<td>Minutes to hours</td>
</tr>
<tr>
<td>Chest Pain</td>
<td></td>
<td>Minutes to hours</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td></td>
<td>Minutes to hours</td>
</tr>
<tr>
<td><strong>Liver</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jaundice</td>
<td></td>
<td>Days</td>
</tr>
<tr>
<td>Fatty degeneration</td>
<td></td>
<td>Days</td>
</tr>
<tr>
<td>Central necrosis</td>
<td></td>
<td>Days</td>
</tr>
<tr>
<td><strong>Kidneys</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proteinuria</td>
<td></td>
<td>Hours to days</td>
</tr>
<tr>
<td>Hematuria</td>
<td></td>
<td>Hours to days</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td></td>
<td>Hours to days</td>
</tr>
</tbody>
</table>
• Biological Monitoring
  • Urinary arsenic measurement
    - Spot sample (mcg/L)
    - Timed urine collection (mcg/24 hours)
  • Normal values
    - Spot urine= ~10 mcg/L (10-150 mcg/L)
    - 24 hours urine collection=<25 mcg/24 hours
    - Whole blood= < 1mcg/L (usually is elevated in acute intoxication)

MERCURY
• Was used as “cure” for almost every ailment in the past
• Incident of methyl mercury
  - Minimata Bay 1953 – 1960
  - Methylmercury - The highly toxic compound bioaccumulated in fish and shellfish when eaten by the people living around the bay, gave rise to Minamata disease
  - On grain in Iraq 1971 – 1972
• Metabolism – Three form
  - Elemental – Hg^o
  - Inorganic : Hg^+ and Hg^{2+}
  - Organic
• Absorption
  - Hg^o via respiratory tract (80% retained)
  - Hg^+ and Hg^{2+} about 7% retained
  - Organic Hg about 70% retained
• Distribution and Metabolism
  - Oxidation finally to Hg^{2+}
  - Affinity for kidney
• Excretion (half life 70 days for organic, 35-90 days for elemental)
  - Mainly via urine
- Organic Hg mainly faecal

- Cross placenta

- Absorption
  - \( \text{Hg}^0 \) via respiratory tract (80% retained)
  - \( \text{Hg}^+ \) and \( \text{Hg}^{2+} \) about 7% retained
  - Organic Hg about 70% retained

- Distribution and Metabolism
  - Oxidation finally to \( \text{Hg}^{2+} \)
  - Affinity for kidney

- Excretion (half life 70 days for organic, 35-90 days for elemental)
  - Mainly via urine
  - Organic Hg mainly faecal

- Cross placenta

- Symptoms of chronic and acute toxicity of inorganic mercury

- Inorganic mercury intoxication

<table>
<thead>
<tr>
<th>Acute</th>
<th>Chronic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
<td>Ataxia – lack of muscle coordination</td>
</tr>
<tr>
<td>Headache</td>
<td>Dysarthria – motor speech disorder</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>Dysphagia – difficulty in swallowing</td>
</tr>
<tr>
<td>Abnormal pain</td>
<td>Impaired vision</td>
</tr>
<tr>
<td>Metallic taste</td>
<td>Loss if coordination</td>
</tr>
<tr>
<td></td>
<td>Hearing</td>
</tr>
<tr>
<td></td>
<td>Taste &amp; smell</td>
</tr>
</tbody>
</table>
• Biological Effects
  • Central Nervous System
    - Neuropsychiatric by Hg°
      ▪ Tremor, insomnia, emotional instability (ereethism), depression
    - Sensorimotor for organic Hg
      ▪ Tremor, loss of senses, incoordination, paralysis
    - Mechanism
      ▪ Disrupts metabolism and causes degeneration of neurons
  • Kidney
    - Mainly inorganic – tubular damage
  • Others
    - Stomatitis
    - Gingivitis
    - Excessive salivation
• Uses
  - Alloy with iron (stainless steel), cobalt, nickle
  - Chrome pigment
  - Tanning leather
  - Wood preservative
  - Anticorrosive in cooling system, boiler, oil drilling mud
  - Cement

• Health Effects CHROMIUM
  • Acute
    - Acute renal tubular necrosis
  • Chronic
    - Skin allergic
    - Chrome ulceration & perforation of nasal septum
    - Skin ulceration
    - Cancer of respiratory tract (genotoxic mechanism)
• Summary: Target-organ toxicity

<table>
<thead>
<tr>
<th>Metal</th>
<th>Kidney</th>
<th>Nerve</th>
<th>Liver</th>
<th>Gut</th>
<th>Lung</th>
<th>Blood</th>
<th>Bone</th>
<th>Repro</th>
<th>Skin</th>
<th>Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Cadmium</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Chromium</td>
<td></td>
<td>+</td>
<td>+</td>
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<td>+</td>
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<td>+</td>
</tr>
<tr>
<td>Lead</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
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<tr>
<td>Mercury</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Nickel</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Conclusion to Unit

Examples of heavy metals that are harmful to workers are large in number and include mercury, lead, nickel, chromium, cadmium, arsenic and a few others. Chronic exposure to these metals can have serious health consequences. Legislations related to the use of these metals needs to be identified and the suggested control measures in order to protect workers from harmful levels of exposure needs to be given a priority.
Discussion 11.0

1. List the occupations or tasks related to lead exposure.
2. Explain the route of exposure to lead.
3. Explain the symptoms of poisoning and the regulation related to lead exposure in Malaysia.
Answers to Discussion 11.0

1. Occupations or tasks related to lead exposure are:
   a. Mining/Smelting (melting, baking, cooking, burning, and producing)
   b. Cutting and welding lead-painted structure
   c. Manufacture/Recycling of lead storage batteries
   d. Production of lead based paints

2. Routes of exposure
   a. Respiratory tract - Dominant pathway with more than 50% absorbed
   b. Absorption - Inorganic lead is poorly absorbed from gastrointestinal tract

3. Lead Regulation, 1984 under the Factory and Machinery Act
UNIT 12
Chemical Hazards - Pesticides

Introduction to Unit

Student will learn about one of the chemical hazards most common in the agricultural or plantation sector.

Objectives to Unit

After this session, students should be able to:

- Obtain a general understanding of the hazard caused by pesticides.
- Determine the important effects on health arising from exposure to specific groups of pesticide
- List out steps used to control exposure to pesticides at the workplace.

12.0 Contents:

12.1 What are pesticides?
12.2 Classification of pesticides
12.3 Occupational and environmental exposure
12.4 Factors contributing to pesticide poisoning
12.5 Effects of pesticide poisoning
12.6 Prevention
12.7 Controlling exposure
12.1 What Is Pesticide?

- US EPA definition: Pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.

- Used to protect both the supply of food and its wholesomeness
- To safeguard the public’s health and protect buildings and other structures from harmful pests
- Often misunderstood to refer only to insecticides
- The term pesticide also applies to herbicides, fungicides, and various other substances used to control pests

12.2 Classification of Pesticide

- Pesticides can be classified by
  
  - Uses of pesticide (I)
  - Level of toxicity (II)
    - Lethal dose
    - Colour coding
  - Chemical properties (III)

- Classified according to uses (I)
  
  - Fungicides
    - Kill fungi (including blights, mildews, molds, and rusts) – dithiocaptan
  
  - Insecticides
    - Kill insects and other arthropods - organophosphate, carbamate, DDT, chlorpyrifos
- Herbicides
  - Kill weeds and other plants that grow where they are not wanted – paraquat, acetic acid, glyphosate

- Rodenticides
  - Control mice and other rodents – anticoagulant, thalium

- Nematocides
  - Kill nematodes (microscopic, worm-like organisms that feed on plant roots)

- Fumigants
  - Produce gas or vapor intended to destroy pests in buildings or soil – ethylene dibromate, DBCP

- Miticides (also called acaricides)
  - Kill mites that feed on plants and animals.
  - Microbial pesticides
  - Microorganisms that kill, inhibit, or out compete pests, including insects or other microorganisms

- Molluscicides
  - Kill snails and slugs

- Ovicides
  - Kill eggs of insects and mites

- Pheromones
  - Biochemicals used to disrupt the mating behavior of insects

- Repellents
  - Repel pests, including insects (such as mosquitoes) and birds
The term pesticide also includes these substances:

- **Defoliants**
  - Cause leaves or other foliage to drop from a plant, usually to facilitate harvest

- **Desiccants**
  - Promote drying of living tissues, such as unwanted plant tops

- **Insect growth regulators**
  - Disrupt the maturity from pupal stage to adult, or other life processes of insects

- **Plant growth regulators**
  - Substances (excluding fertilizers or other plant nutrients) that alter the expected growth, flowering, or reproduction rate of plants

- **Classified according to toxicity (II)**
  - **Acute toxicity**
  - Refers to the immediate effects (0-7 days) of exposure to a pesticide
  - Highly toxic pesticides can be lethal at very low doses
  - Toxicity categories are based on the LD$_{50}$
    - the dose (in mg of substance per kg body weight) that kills 50% of the test animals in a standard assay
    - through either oral or dermal exposure routes
    - For inhalation exposures, the LC$_{50}$ is used - the concentration in air in mg per litre that kills 50% of the test animals

- **Colour coding of pesticides**
  - Ia – Red
  - Ib – Black
  - II – Yellow
  - III – Blue
  - IV – White
WHO acute toxicity classification

- WHO Toxicity classification

<table>
<thead>
<tr>
<th>WHO Toxicity classification</th>
<th>Rat LD50 (mg of chemical per kg of body weight) solid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solids (oral)</td>
</tr>
<tr>
<td>Ia</td>
<td>Extremely hazardous</td>
</tr>
<tr>
<td>Ib</td>
<td>Highly hazardous</td>
</tr>
<tr>
<td>II</td>
<td>Moderately hazardous</td>
</tr>
<tr>
<td>III</td>
<td>Slightly hazardous</td>
</tr>
</tbody>
</table>

- Classified according to chemical properties (III)
  - Organophosphate Pesticides
    - Affect the nervous system by disrupting the enzyme that regulates acetylcholine, a neurotransmitter
    - Most organophosphates are insecticides
    - Some are very poisonous as they were used in World War II as nerve agents but they usually are not persistent in the environment
    - Example chlorpyrifos, 2,4-Dichlorophenoxyacetic acid
  - Carbamates Pesticides
    - Affect the nervous system by disrupting an enzyme that regulates acetylcholine, a neurotransmitter
    - The enzyme effects are usually reversible
    - There are several subgroups within the carbamates
    - Example carbaryl (Sevin)
  - Organochlorine Insecticides
    - Commonly used in the past, but many have been removed from the market due to their health and environmental effects and their persistence (e.g. DDT and chlordane)
- Many organochlorines are endocrine disruptors or carcinogens in experimental assays

- Pyrethroid Pesticides
  - Developed as a synthetic version of the naturally occurring pesticide pyrethrin, which is found in chrysanthemums
  - They have been modified to increase their stability in the environment
  - Some synthetic pyrethroids are toxic to the nervous system
  - Example bifenthrin

12.3 Occupational and Environmental Exposure

- Non-occupational exposures
  - Recreational gardeners
  - Household use of fly-killers
  - Rodenticides
  - Pesticide residues on food
  - ‘Bystander’ exposure from neighbouring fields
  - Accidental and spills
  - Suicide and homicide
  - Children's exposure to contaminated surfaces
Example of non-occupational effects

- Occupational exposures
  - Agricultural workers
  - Farmers
  - Gardeners
  - Vets
  - Bulk-handlers of food stuffs
  - Dock loaders - transportation
  - Vermin exterminators
  - Biocides- ship painters, metalworkers
  - Manufacturing of pesticides
  - Sprayer/Foggers/Mixer of pesticides
  - Research and developments
Handling pesticide with bare hands

Wear short pants and short sleeves without proper PPE

Apply most of the protection but without proper mask

No boots and poor work practices
6.4 Effects of Pesticide Poisoning

- Toxic effects from pesticide exposure
  - Acute exposure – high dose within short period of time
  - Chronic exposure – low dose within long duration of time
  - Carcinogenicity
  - Reproductive and developmental toxicity
  - Endocrine disruption
  - Neurotoxicity

- Carcinogenicity
  - Some pesticides have been evaluated for their ability to cause cancer by the U.S. EPA, International Agency for Research on Cancer (IARC), National Institutes of Health (NIH)
  - All of these groups use a weight-of-the-evidence approach, where a panel of scientists evaluate the available data for a particular chemical
  - The absence of a chemical on any of these lists does not necessarily mean it is *not* a carcinogen
  - It may mean that it has not yet been evaluated
  - Example DDT are possible human carcinogen
  - The International Agency for Research on Cancer (IARC) has 5 ratings:
    - Group 1: Known carcinogens
    - Group 2a: Probable carcinogens
    - Group 2b: Possible carcinogens
    - Group 3: Unclassifiable because the data are incomplete or ambiguous
    - Group 4: Probably not carcinogens

- Reproductive and developmental toxicity and endocrine disruptors
  - Some pesticides are known to cause birth defects or interfere with normal development - The endocrine (or hormonal) system controls many crucial aspects of the working of the body, for example development of sexual characteristics, and development of the brain
  - Many pesticides are capable of interfering with the proper functioning of estrogen, androgen and thyroid hormones in humans and animals
Exposures can cause sterility or decreased fertility, impaired development, birth defects of the reproductive tract, and metabolic disorders

- Neurotoxic effects
  - Many insecticides are neurotoxic to humans and other animals because their mechanism of action targets the insect nervous system
  - The most common mechanism of action is inhibition of the enzyme cholinesterase, which is essential for transmission of nerve impulses
  - Most pesticides in this category are organophosphorus or carbamate compounds
  - Environmental risk factors for Parkinson’s disease and parkinsonism: the Geoparkinson study, Occ and Env Med F Dick et al. 2007

- Cholinesterase inhibition
  - Exposure to:
    - carbamates
    - organophosphates
    - chlorinated derivatives of nicotine
  - May result in:
    - build-up of acetylcholine
    - cholinesterase inhibition
    - constant firing of electrical messages
    - potential symptoms of: twitching, trembling, paralyzed breathing, convulsions, and in extreme cases, death
    - has been linked to impaired neurological development in the fetus and in infants, chronic fatigue syndrome, and Parkinson's disease
Typical synapse in the body’s nervous system, in which a muscle is being directed by a nerve to move

An electrical signal, or nerve impulse, is conducted by acetylcholine across the junction between the nerve and the muscle (the synapse) stimulating the muscle to move

Normally, after the appropriate response is accomplished, cholinesterase is released which breaks down the acetylcholine terminating the stimulation of the muscle

The enzyme acetylcholine accomplishes this by chemically breaking the compound into other compounds and removing them from the nerve junction

If acetylcholinesterase is unable to breakdown or remove acetylcholine, the muscle can continue to move uncontrollably

Electrical impulses can fire away continuously unless the number of messages being sent through the synapse is limited by the action of cholinesterase.

Repeated and unchecked firing of electrical signals can cause uncontrolled, rapid twitching of some muscles, paralyzed breathing, convulsions, and in extreme cases, death
12.5 Factors Contributing To Pesticide Poisoning

- Lack of enforcement
- Misuse of pesticides
- Poor knowledge, attitude and practices safe use of pesticides
- Lack suitable personnel protective equipment

12.6 Prevention

- Government roles
- Workers/users
- Manufacturers
- Sellers
- Doctors

Government

- Pesticides Act 1974
- Pesticides (Registration) Rules 1976
- Pesticides (Importation for Educational and Research Purposes) Rules 1981
- Pesticides (Licensing for sales and storage) Rules 1988
- Highly Toxic Pesticide Regulations 1996

Is classified as chemical hazardous to health under Use and Standards of Exposure of Chemicals Hazardous to Health Regulations 2000 or USECHH under Occupational Safety and Health Act 1994

- Assessment of risk to health
- Use of approved PPE
- Labelling and relabeling
- Chemical Safety Data Sheet
- Medical Surveillance
Workers
- Before using pesticides
- Knowledge about hazard/safe use of pesticide
- First aid
- Read label

During mixing and spraying/fogging
- Good knowledge and practices
- Use personnel protective equipment

After spraying
- Wash equipment
- Shower with soap and water
- Wash clothes
- Puncture and bury the empty containers

Integrated Pest Management or IPM
- Integrated Pest Management (IPM) relies on a combination of common-sense practices
- IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment
- IPM is a series of pest management evaluations, decisions and controls
- IPM consist of 4 steps
  - Set Action Thresholds
  - Monitor and Identify Pests
  - Prevention
  - Control

Set Action Thresholds
- IPM first sets an action threshold, a point at which pest populations indicate that pest control action must be taken. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

Monitor and Identify Pests
- IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with
action thresholds. This removes possibility that pesticides used when they are not really needed.

- **Prevention**
  - IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock.

- **Control**
  - Once preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective, less **risky** pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.
Pesticides in Agriculture: Reducing the risk from chemicals

- Hierarchy of control
  - Elimination
  - Substitution
  - Isolation
  - Engineering controls
  - Administrative controls and work practices
  - Personal protective equipment

- Eliminate and reduction
  - Removing substance from workplace
  - Or reducing its use
  - Removing the pest of manipulating the environment
    - Better hygiene
    - Removing pest breeding areas
    - Biological control and beneficial insects
    - Rotating crops or alternative crop varieties
    - Physical barriers
    - Integrated pest management – biotechnology
    - Eradication

- Substitution
  - Using less toxic chemical
  - Using less volatile chemical
  - Altering the physical form such as replacing emulsifiable concentrate with a granular formulation
  - Purchasing only returnable or reusable containers

- Isolation
  - Separate areas used for storing, mixing and preparing pesticides with limited access to all
  - Using air-cond truck or tractor with well functioning carbon filters to reduce vapours
  - Wearing respiratory if a carbon filter is not available
  - Carriage of chemicals in a section of vehicle isolated from driver
- Storage in separate building or fenced area
- Fencing off a contaminated dip site
- Closed chemical transfer system

• Engineering control
  - Extraction ventilation equipment to remove vapours after treatment
  - Using pumps to transfer chemicals instead of pouring
  - Changing nozzles to control droplet size
  - Using a workplace with good natural ventilation

• Admin controls and work practices
  - Reduce the number of person exposed
  - Limitating the time period of exposure
  - Prohibiting food and water when handling chemicals
  - Washing facilities
  - Appropriate time of day to minimise heat stress
  - Correctly calculate crop volume and amount of pesticide use
  - Calibrate equipment
  - Signs indicating hazards
  - Notification of neighbours

• Personal Protective Equipment (PPE)
  - PPE should be used
  - According to instruction on the label and the MSDS
  - In an open field situation when engineering controls are not available
  - When mixing, decanting or spraying
  - In some circumstances as a backup for control measures
Contribution to Unit

Accidental exposure or overexposure to pesticides can have serious implications. All pesticides in a given chemical group generally affect the human body in the same way; however, severity of the effects vary depending on the formulation, concentration, toxicity and route of exposure of the pesticide. It is important, therefore, to know both the type of pesticide any workers are using and the signs and symptoms associated with poisoning from it.

Additional References

1. Pesticide classification of acute poisoning. World Health Organization
   http://www.who.int/bulletin/volumes/86/3/07-041814-table-T1.html

Exercise 12.0 / Activity 12.0

4. Explain the mechanism by which organophosphate poisoning symptoms such as involuntary muscle twitching occur. Explain your answers by comparing the poisoning mechanisms with normal mechanism by which acetylcholinesterase is broken down.
**Answers to Exercise 12.0**

Normal reaction of enzyme cholinesterase

1. Nerve signals cause the release of the neurotransmitter acetylcholine into a cholinergic nerve terminal.
2. Acetylcholine travels across the terminal and binds to a cholinergic receptor on the end organ: either smooth or voluntary muscle, or an exocrine gland.
3. This causes the end organ to perform its normal function: muscle contraction or gland secretion.
4. The end organ activity ceases when acetylcholine leaves the receptor and is broken down by the enzyme acetylcholinesterase, located on the surface of the organ.
5. The broken-down acetyl and choline are taken up by the cholinergic nerve and are recycled for the next activity.

Reaction of enzyme cholinesterase with nerve agent

1. Nerve signals cause acetylcholine release and
2. The neurotransmitter binds to receptors on end organs
3. The end organ activates, but because
4. The cholinesterase-inhibiting compound (in this case an organophosphate, OP) binds to acetylcholinesterase; the acetylcholine does not break down, and causes excessive activity of the end organ.
UNIT 13
Bio Hazard Management

Introduction to Unit

This topic will cover about the fundamental of microbes, the classification of microbes that is hazardous to human, the classification of biosafety and the overall management of Bio Hazard in the working environment.

Objectives to Unit

After this session, students should be able to:

- Understand the classification of microbes
- Understand the classification of biosafety of each type of microbes
- Undertand the classification of biosafety cabinet for biosafety management

13.0 BIO HAZARD MANAGEMENT
13.1 Definition
13.2 Biological Agent
13.3 Transmission
13.4 Bio Hazard Classification
13.5 Bio Safety
13.1 Definition

- The combination biological agent and hazard.
- Association between human, animal or products that are potentially causing risks to human health or animal
- Spreading of disease directly or indirectly caused by interruption of the environment
- A biohazard can be defined as any organism, and/or its toxin, known or suspected to cause human or animal disease. It includes microorganisms such as viruses, bacteria, fungi, and parasites and their toxic metabolites.
- Blood and body fluids, and certain types of nucleic acids such as DNA derived from pathogenic organisms, human oncogenes, and DNA from transformed cell lines are considered biohazards as well.

13.2 Biological Agents

- Bacteria
- Virus
- Rickettsia / Chlamydia
- Protozoa
- Parasite
- Fungus
- Arthropod
- Prion

13.3 Transmission

- Inhalation
- Ingestion
- Injection
- Direct contact to skin
13.4 Bio Hazard Classification

- **Class 1**
  - Agent that is not hazardous and the health effect of manipulation is minimal.
  - Can be hold/manipulate without any special tools.
  - Techniques used for non-pathogenic materials
  - (Bio-safety level 1 standards of practice).

- **Class 2**
  - Agent that have the potential to cause “normal” disease
  - Agent - moderate hazard to personnel and environment - includes agent - with various degrees.
  - From accidental inoculation, injection + cutaneous penetration - ordinary laboratory techniques
  - (Bio-safety level 2 standards of practice and facility)

- **Class 3**
  - Exotic Agent that need special attention and special permit (e.g. USDA) unless stated for higher classification.
  - Pathogens that need to be quarantine and isolation
  - Agents - serious or potentially lethal disease - exposure by inhalation route
  - Also exotic agents that need federal permit unless Serious and can cause death
  - (Bio-safety level 3 standards of practice and facility)

- **Class 4**
  - Agent that need strict regulation for keeping
  - Extremely hazardous
  - Agent that can cause epidemic outbreak

- **Class 5**
  - All foreign agents that is being isolated by government regulation or policy
  - Applicable to culture of strain - vaccines and passages.
BACTERIA

- One cell organism
- 3 morphological structure
  1. Cocci
  2. Bacilli
  3. Spirillia
- Some are pathogenic, some harmless
- Occupational Health: Most are caused by small wound that are not attended
- Staphylococcus and streptococcus infection
- Food poisoning: rare in occupational health
- Agent classification:
  - Class 1:
    All agent that is not included in higher class
  - Class 2
    Campylobacter fetus, Campylobacter jejuni, Clostridium botulinum,
    Clostridium chauvoei, Clostridium histolyticum, Clostridium septicum,
    Clostridium tetani, Clostridium novyi,
    Corynebacterium diptheriae, Corynebacterium pyogenes, Corynebacterium
    renale, Corynebacterium equi,
    Dermatophilus congoensis, E.coli (enteropathogenic, enterotoxigenic,
    enteroinvasive and K1 strain),
    Klebsella, Legionella pneumophilia, Listeria, Mycoplasma avium, Salmonella,
    Staphylococcus aureus, Vibrio cholera, Shigella
  - Class 3
    Bartonella sp,Mycobacterium bovis, Mycobacterium Tuberculosis,Pasturella
    multocida type B,Pseudomonas mallei,Pseudomonas pseudomallei and
    Yersinia pestis.
  - Class 4
    None from bacteria group
RICKETTSIA/CHLAMYDIA

- Coccoid and rod shape
- Similar to bacteria but smaller, intracellular and obligate parasite
- Transmit through blood sucking arthropod
- Typhus, Rocky Mountain spotted fever
- Chlamydia: obligate parasite, but smaller than rickettsia
- Transmission: Inhalation
- Agent classification:
  - Class 1: All Rickettsia and chlamydia that is not in the list of higher class
  - Class 2: Lymphogranuloma venereum agent: through sexual contact
  - Class 3: psittacosis – Ornithosis
  - Class 4 and 5 : None

VIRAL

- Non cellular, pathogenic parasite, smaller than rickettsia and chlamidia
- Virus from animal respiration:
  - Poxvirus
  - Enterovirus
  - Arbovirus
- Agent classification:
  - Class 1: All virus not in higher classification
  - Class 2: Adenovirus, Coronavirus, Coxsackie A and B, Encephalomyocarditis virus (EMC), Herpesvirus (exc. Herpesvirus simiae), Hepatitis virus, Influenza virus, Polioviruses, Poxvirus (exc. Smallpox and whitepox), Rabies (exc. street), Rubella virus, Vesicular stomatitis
  - Class 3: Monkey pox (invitro), Arboviruses (exc class 2 and class 4), Dengue virus, Lymphocytic choriomeningitis virus (LCM) and Rabies - street strain
  - Class 4: Ebola virus, Hemorrhagic fever virus (crimean hemorrhagic fever, congo, junin and machupo virus), Herpes simiae, Marburg virus and Venezuelan Equine Encephalitis
  - Class 5:
    A. Animal disease and vector are forbidden entry in US by law: FMD
B. Organism which may not be studied in US: small pox, white pox and oncogenic viruses
C. Animal disease and vector are forbidden entry in US by USDA policy: African swine fever, Bovine infectious petechial fever, Hog cholera, Mycoplasma agalactiae, Newcastle disease, Rhinderpest and Vesicular exanthema.

FUNGUS

- Classify in protista kingdom together with algae
- Parasitic and sapropitic fungus
- Occupational health: farmers, outdoor workers and animal herder
- Agent Classification:
  - Class 1: All fungus that is not in higher classification
  - Class 2: Actinomycetes, blastomycetes, dermatididis
  - Class 3: Histoplasma capsulatum, Coccidiodes immitis, Histoplasma capsulatum var. duboisii

PARASITE

- Including protozoa, helmin, trypanosoma
- Protozoa: malaria, leishmaniasis, trypanosomiasis
- Helmith: schitosomiasis, hookworm
- Atropod: Dermatosis and vector for parasite
- Agent Classification:
  - Class 1: All parasitic agent that is not in higher classification
  - Class 2: Leishmania spp, Toxocara canis, Schistosoma mansoni, Toxoplasma gondii, Trichinella spiralis and Trypanosoma cruzi
  - Class 3: None

GROUP THAT ARE EXPOSED

a) Research Lab
   - The most exposed.
   - This is due to the fact that workers need to manipulate biohazard agents
   - Transmission is by: Accident, Clinical specimen, Autopsy and post mortem, Direct contact with used/contaminate glass apparatus, Direct contact with infected lab animal and ecto-parasite, Air, Inhalation of agent
from bacteria culture, viral procedure (grinding, centrifuge, sonification of tissue, organ, blood or body fluid) and Diseased animal

- Infection is caused by: Inadequate training to personnel, inadequate knowledge of personnel and Malpractices of workers.

b) Hospital
- The next in line after research lab
- Even though macroscopically clean
- Hospital have the potential to cause disease to workers, patient and visitors
- Common: bacterial: Streptococcus, staphylococcus
- Common viral: hepatitis B, rubella
- Transmission:
  - Anybody including workers, visitors and patient. This entire group can be carrier or exposed,
  - Generally from direct contact
  - High risk: hospital workers (laundry, housekeeping, lab workers and doctors)

c) Agriculture
- Human health affected due to direct contact with animal
- Classification of Zoonosis
  - A classification system based on the type of life cycle of the infective organism seems the most useful in planning a preventive medicine program.
  - The following categories are recommended by the World Health Organization Expert Committee on Zoonoses:
    1. Direct Zoonoses. Transmitted from infected vertebrate host to a susceptible vertebrate host by direct contact, fomite, or by a mechanical vector. No developmental change or propagation of the organism occurs during the transmission. Examples: Rabies, trichinosis, and brucellosis.
    2. Cyclozoonoses. Requires more than one vertebrate host, but no invertebrate host. Examples: Human taeniasis, echinococcosis, and Pentastoma infections.
3. Metazoonoses. Agent multiplies, develops, or both in an invertebrate host before transmission to a vertebrate host is possible. (This means that a definite prepatent or incubation period must be completed before transmission.) Examples: arboviruses, plague, and schistosomiasis.

4. Saprozoonoses. To transmit these infections a non-animal development site or reservoir is required, such as food plants, soil, or other organic material. Examples: larva migrans and some of the mycotic diseases.

- Direction of transmission
  - Anthropozoonoses - Infections transmitted to man from lower vertebrates.
  - Zooanthropozoonoses - Infections transmitted from man to animals.
  - Amphixenoses - Infections maintained in both man and lower vertebrates, and may be naturally transmitted in either direction.

- Prevention (general):
  1. Written plan to be implemented
  2. Workers must be brief on their working situation and had been trained to manipulate biological agent
  3. Emergency plan and written notice to manipulate hazardous agent and material
  4. If the agent worked have vaccine available. Workers must undergo immunization

- Principle of Prevention:
  - Any accident that associate with biohazard can cause infection
  - When a worker is working with biological agent, if the etiology and the epidemiology is not known. It must be considered as biohazard

- Prevention for Lab Personnel:
  - Immunization if the known agent has vaccine available
  - Extreme cautions to zoonotic exposures, biting, scratching, and abnormal disease animal.
13.5 BIO SAFETY

- Principles of Biosafety
  - "Containment" - safe method for management of infectious agent in lab.
  - Purpose of containment - to reduce and eliminate exposure of workers, persons, external environment that caused by the potential of hazardous agents
  - Primary containment - protection of personnel and immediate lab env.

From exposure to hazard.
  1) Good microbiological techniques
  2) Appropriate safety equipment
  3) Vaccination

- Secondary containment - combination of facility design and operational practices (protection of environment external to lab from exposure to infectious material): 3 element of 2dary containment
  1) Lab practices and technique
  2) Safety equipment
  3) Facility design

LAB PRACTICES TECHNIQUE

• Strict adherence to standard microbiological practices and technique - persons working - aware to hazard and trained with techniques

• Biosafety/operational manual standard - which hazard he will encounter and must follow all instructions

• Additional measures if standard not enough

SAFETY EQUIPMENT (primary barrier)

• Inclusive of
  1. Biological safety cabinet - BSC I, II, III
  2. Enclosed container
  3. Engineering control design – minimize exposure, Centrifuge cup - prevent aerosol exposure, Gloves, coats, gowns, shoe covers, boots, respirator, face shields, safety glasses, goggle - PPE
FACILITY DESIGN (secondary barrier)

- To protect persons working inside/outside lab and within facility, protect persons and community from accidental released from lab.
- Recommendation is based on type of risk transmitted by specific agents.
  - **Biosafety Cabinet**
    - Bio-safety level 1
    - Bio-safety level 2
    - Bio-safety level 3
    - Bio-safety level 4

BIO-SAFETY LEVEL (BSLS)

- Combination of lab practices, techniques, safety equipment and lab facilities
- Each combination specifically appropriate based on operation to performed, suspected routes of transmission, lab. Function and activity

BIO-SAFETY LEVEL 1

- Practices, safety equipment, facilities - undergraduate, secondary education, teaching lab, work with microbial not known to cause disease in healthy adult humans.
- Bacillus subtilis, Naegleria gruberi, infectious canine hepatitis.
- Basic level containment - standard microbiological practices with no specific/primary barrier – hand-sink for washing

BIO-SAFETY LEVEL 2

- Practices, safety equipment and facilities - applicable - clinical diagnosis, teaching, research and other facilities
- Broad spectrum of indigenous moderate risk agents - to the community and disease (varying severity) – human
- If good techniques is applied - open bench – careful – must reduce aerosol/splash
- Hepatitis B, Salmonella, toxoplasma spp and: Human derived blood, Body fluid and Infected tissues or not known
**BIO- SAFETY LEVEL 3**

- Practices, safety equipment, facilities -applicable for clinical diagnosis, teaching, research, production facilities - indigenous and exotic agents - possible potential of respiratory transmission - serious, potentially lethal infections.
- Mycobacterium tuberculosis, St louis encephalitis, Coxiella burnetti
- 1\textsuperscript{st} hazard - autoinoculation, ingestion and exposure to infectious aerosol.
- Emphases - both primary and secondary - protect personnel. Community and environment - exposure to infectious aerosol.
- Primary barrier - manipulation must be done in BSC or enclosed equipment.
- Secondary barrier - controlled access to lab and specialized ventilation system.

**BIO- SAFETY LEVEL 4**

- Practices, safety equipment and facilities - applicable with dangerous and exotic agents - high individual risk (life threatening) - transmitted via aerosol - no vaccines or therapy
- Marburg or Congo - Crimean hemorrhagic fever
- 1\textsuperscript{st} hazard - respiratory exposure to infectious aerosol, m.m expose to aerosol droplet, autoinoculation. All material inc. diagnostic material, natural or experiment infected animal - serious threat.
- Primary barrier - complete isolation - BSC class III, air supplied positive pressure personnel suit.
- Secondary barrier - separate building or complete isolation, specialized ventilation system and waste management.
- Animal facilities - described by Vertebrates animal Bio-safety I, II, III and IV - combination of practices, safety equipment and facilities
- Vertebrate animal Bio-safety: Experimental animal - Management - provide facilities, staff and establish practices - to assure environmental quality, safety, and care
- Should not be a lab but extension of it. - must also separate from quarantine, production house, clinical lab and patient care rooms.
- Design should facilitate - cleaning and housekeeping. Traffic flow - minimize contamination - dirty/clean hall, floor drain, drain trap and suitable disinfectant.
• Hazard condition are caused by 1. personnel, 2. equipment being used and 3. Animal activities (aerosol and biting)

• Vertebrate - must meet guide 1. Guide for care and use of Laboratory Animal 2. Laboratory Animal welfare Regulations

• Four combination of practices, safety equipment and facilities - ABSL 1-4

• Invertebrate - guide - Laboratory safety for arboviruses and other Viruses of vertebrate - arthropods

- Clinical Lab
  
  - Receive clinical specimens - variety of diagnostic and clinical support infectious nature of clinical material is unknown - often submitted for routine, acid fast etc. Management - establish standard procedure
  
  - Except for extraordinary - isolation etc – Bio-safety level 2 - consistent with OSHA. BSL 2 and OSHA - prevention of per-cutaneous and MM - to clinical material.
  
  - Primary barrier - BSC class I and II - prevent splashing, spraying or splattering of droplets.

- Importation and interstate shipment of certain Biomedical materials

  - Must have requirement - specify packaging, labeling, shipping requirement: etiologic agents, exotic specimens - shipped

- Recommended Bio-safety Levels for infectious Agents and infected Animals

  - Appropriate bio-safety - agents and animals study - depend factors: Virulence, Pathogen, Biological stability, Route of infection, Communicability of agents, Nature or function of lab, Procedures and manipulation involving agents, Endemicity of agent and Availability of vaccines/therapeutic measures.

  - Based on Agents summary statement (classification of agents) criteria –

    1) Agents - proven to be hazardous to lab personnel’s

    2) Potential for lab. associated infection is high

    3) Consequences of infection are grave

  - Vaccines - specifically targeted to at risk lab personnel and people who work or enter the

  - Individual factors –
1) Immunocompetent of individual (risk when exposed) - hereditary, congenital, induced by neoplastic, therapy and radiation
2) Age, sex, race, pregnancy, surgery (splenectomy, gastrectomy)
3) Predisposing disease - diabetes, lupus erythematosus.

- Bio-safety level - based on type of activities:
  1. Clinical material - less threat to personnel than activities such as culture: Lower biosafety level recommended. Larger volume/concentrated preparation - additional personnel precautions and higher primary/secondary containment
  2. Lab director - occasionally - select biosafety level higher than recommended - 1. Unique nature of proposed activities or recommend a bio-safety to compensate certain absence - of safety.
  3. If type of operation kept changing - director should select appropriate safeguard.
    - e.g. - sera (human derived) - contain hepatitis B - blood, blood derived fluid - preclude cutaneous, mm or parenteral exposure of personnel.
    - Sputa - tubercle bacilli - preclude generation - aerosol during manipulation of clinical material
    - facility features – bio-safety level 2, provided standard practices, special practices and safety equipment for bio-safety level

Example:
- HIV - routine Diagnostic work – Bio-safety level 2 for practices and procedures
- Research, co-cultivation, virus replication, manipulation - BSL 2 facility but BSL 3 practices and procedures
- Virus production - BSL 3 facilities and BSL 3 practices and procedures
- Finally - rule of thumb
  1. Locate agent under listing
  2. Utilize practices, safety: Equipment, type facility recommended as described in Bio-safety guidelines.
Risk assessment

- Subjective process
- Consideration - risk associated and type of activity conducted
- Example:
  - Hepatitis B - ubiquitous human pathogen and most prevalent - lab associated infections
  - Variety of bodily fluid (excretions and secretions) inc - saliva, semen and blood
  - Natural transmission - parenteral inoculation, contamination of broken skin, MM.
  - No evidence of airborne and interpersonal spread (casual contact)
- Prophylactic measures - licensed vaccine/ hyper immunoglobulin
- 1st hazard of HBv - accidental parenteral inoculation, exposure of broken skin or MM of eyes, nose and mouth. - typical for Bio-safety level 2 - recommendation using standard and special microbiological practices - minimize or eliminate exposure
- HCv and HIV - similar bio-safety level

Bio-Safety Cabinet
- Most effective and most common with infectious agents.
- Act as primary containment
- 3. Three general types - (Class I, II and III)
- Very effective when used with good microbial techniques

Class I BSC
- Provide personnel and environment protection, no product protection. Similar to fume hood.
- Class I - air is drawn across work surface and negative pressure - personnel protection - inward airflow (75 lfpm)
- BSC I for enclose equipment - centrifuges, harvesting equipment, small fermenters, cage dumping, culture or homogenizing tissue
- Attached to exhaust fan (provide negative pressure)
- Hepa filter - exhaust plenum or end terminal of exhaust.
- Some integrated with exhaust fan - cabinet turn off automatically.
• Additional arm length gloves can be attach
• Designed for general microbial research with low and moderate risks
• Not suitable for material that vulnerable to airborne contamination (inward air can carry contamination into cabinet)
• Decline in use

– Class II BSC
  • Used of sterile animal and cell culture systems- propagations of viruses - the need to include product protection
  • Include HEPA vertical and downward laminar flow technology for product protection
  • Particulate free environment
  • Class II - (types A, B1, B2 and B3)
  • HEPA filtered exhaust air - air flow into front grille - provide personnel protection
  • Filtered air will be circulated back to cabinet surface or ducted out
  • Not effective against volatile chemicals or gases - only that ducted outside should be used
  • Class II - microorganism – bio-safety level I,2 and 3

– Class II type A
  • Suitable for work with microbial in absence of volatile /toxic chemical
  • Air can be exhaust out/back in lab
Class II type B

- Subtype into B1, B2 and B3
- Type B are hard ducted to exhaust systems and contain negative pressure
- Velocity 100 lfm
- Able to work with toxic chemical
- BSC I and II must be certified in situ at the time of installation

Class II type B1

- Hard ducted and have its own exhaust systems
- Cabinet supply blowers draw room air and portion of cabinet recirculated air – through front grille and through HEPA filter at the bottom
- Particulate free air flow upward and then downward through the work area
Class II type B2

- Total exhaust cabinet - air is not circulated within.
- Provides simultaneous primary biological and chemical containment
- Air collected from the top pass through the cabinet and through HEPA filter and down into work area
- Air are also collected at rear/front grille – HEPA Minimum 100 lpm
- If system fail - interlock system - prevent pressurize air drawn from workstation to lab.
Class II type B3

- Minimum inward flow of 100 lfm
- Contaminated positive pressure - surround by negative air pressure
  - leakage only in the workstation and not in the environment
- Special application: Eye microscope, rigid plate with arm holes, microbiological aerosol tracer
Class III BSC

- Designed for working with bio-safety level 4 - provide maximum protection to environment and workers
- Gas tight enclosure + non opening view window
- Access - through dunk tank (through cabinet floor, double door pass through autoclave that can be decontaminated
- Exhaust air - 2 HEPA filters (supply and exhaust) or a HEPA filter and an incinerator - b4 discharge
- Long heavy duty gloves attached to gas tight ports in the cabinets - allow manipulation - prevent direct contact of personnel
- Several Class III BSC joint - "line". Such as: 1. Refrigerators, small elevators, shelves to hold cages, microscopes, centrifuges, incubators, etc

HORIZONTAL LAMINAR FLOW AND VERTICAL LAMINAR FLOW

- Not BSC, discharge HEPA filtered air - across work surface - toward user - product protection.
- HLF - dust free assembly of sterile equipment, electronic device.
- VLF - preparation of intravenous drugs
- Never used as a substitute for BSC
CHEMICALS IN BSC

- Evaluation of chemicals - b4 using BSC
- Un-ducted class II - no volatile and toxic chemical - use of chemical fume hood - work with volatile chemicals, and chemical carcinogens - ducted to building exhaust system
- Class II types A - nonvolatile, anti – neo-plastic, chemotherapeutic drugs and low level radionuclides.
- Class II - not for labeling with radioactive iodine

FACILITY AND ENGINEERING REQUIREMENT

- Act as secondary barrier.
- BSL I and II - not important - BSL III and IV - maintain inward air flow

BUILDING EXHAUST

- BSL III and IV - must be exhausted - potential contamination
- Exhaust room air can be HEPA

ROOM EXHAUST

- Room exhaust - handle both room and containment devices - vented through system.- building exhaust air should be discharged away from supply air intakes
- Prevent entrainment of exhausted laboratory air back to building air supply.

ULTRAVIOLET LAMPS

- Cleaned weekly - dust and dirt - periodically - check UV intensity - make sure to turn off - protect eyes and skin

BSC PLACEMENT

- Certain consideration - 1. A 12 inch clearance - provided behind and at each side - allow easy maintenance and to ensure air is not hindered 2. A 12 - 14 inch above the cabinet - accurate air velocity across exhaust filter.
– Location - remote from the entry (rear of lab - away from traffic)
– An activity that creates air movement - cannot be near to BSC.

HEPA FILTER

– High efficiency particulate air
– Able to remove microscopic contaminants – dust free work environment
– Remove particles greater than 0.30 micrometers (all bacteria, spores and viruses)
– Efficiency up to 99.97%
– Made of borosilicate fiber
– Plated with corrugated aluminum separator
– Replacement - loaded - air flow cannot longer be maintained.
– Filter decontaminated - before removal by using formaldehyde
– If not possible - BIBO (bag in/bag out)

**Conclusion to Unit**

There are different classification levels of microbes for bacteria, virus, fungi, parasite and others. Each of the microbes is managed through different level of biosafety level due to the nature of transmission. Each biosafety level introduce implies different level of control measures such as the use of biosafety cabinet.

**Additional References**

Discussion 13.0

1. List the classification of bacteria, virus and parasite

Answers to Discussion 13.0

1. Bacteria : Level 1 – 3
   Virus      : Level 1 – 5
   Parasite  : Level 1 - 2
UNIT 14

Occupational Psychosocial Hazards

Introduction to Unit

There are a number of occupational psychosocial hazards which have been identified by previous studies. Psychosocial hazards cause a wide range of psychological and physical illnesses to the workers. There is evidence that these hazards also affect the organization. Several theories have been developed to understand the association between psychosocial hazards and various undesirable consequences. Some tools have been designed to assess these psychosocial hazards. In this topic, students will understand the description about psychosocial hazards and their association with multiple negative effects in occupational setting.

Objectives to Unit

After this session, students should be able to:

- Identify psychosocial hazards at the workplace
- Understand the association between psychosocial hazards and individual and organisational consequences
- Be able to assess the risk of psychosocial hazards at the workplace.
14.0 Content

14.1 Definition of Psychosocial Hazards
14.2 Scope of occupational psychosocial hazards
14.3 Commonly identified psychosocial hazards
14.4 Occupational Stress
14.5 Why occupational stress is significant?
14.6 How stress can lead to ill health?
14.7 Alarm Stage (GAS)
14.8 Resistance Stage
14.9 Exhaustion Stage
14.10 How stress can affect your work?
14.11 The mechanism of exposure to psychosocial hazards
14.12 Job Demands Resources Model (Demerouti, et al., 2001)
14.13 Job-Demand-Control-Support Model (Karasek and Theorell, 1990)
14.14 Effort-Reward-Balance Model (Siegrist, 1998)
14.15 Risk measures for psychosocial hazards
14.16 Subjective studies for stress symptoms
14.17 Subjective studies for psychosocial hazards
14.18 Changing in working population - Segregation of work by gender
14.19 Changing in working population – Increased migration of workers
14.20 Changing in working population – Aging population
14.21 Impact of psychosocial hazards
14.22 Psychosocial hazards and psychological health

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14.1 Definition of Psychosocial Hazards

- Psychosocial = interrelationships between individual’s thoughts, behaviours and their social environment
- Hazards = any source of potential damage
- Work-related psychosocial hazards = concern aspects of the design and management of work and its social and organisational context that have the potential for causing psychological or physical harm (Leka and Cox, 2008).

14.2 Scope of occupational psychosocial hazards

- In occupational health and safety, psychosocial hazards usually focused on
  - Stress
  - Bullying
  - Harassment
  - Violence
  - Fatigue

14.3 Commonly identified psychosocial hazards.

- Job content
  - Lack of variety or short work cycles, fragmented or meaningless work, under use of skills, high uncertainty, continuous exposure to people through work

- Workload & work pace
  - Work overload or under load, machine pacing, high levels of time pressure, continually subject to deadlines

- Work schedule
  - Shift working, night shifts, inflexible work schedules, unpredictable hours, long or unsociable hours

- Control
  - Low participation in decision making, lack of control over workload, pacing, etc.

- Environment & equipment
Inadequate equipment availability, suitability or maintenance; poor environmental conditions such as lack of space, poor lighting, excessive noise

- Organisational culture & function
  - Poor communication, low levels of support for problem solving and personal development, lack of definition of, or agreement on, organisational objectives

- Interpersonal relationships at work
  - Social or physical isolation, poor relationships with superiors, interpersonal conflict, lack of social support, bullying, harassment

- Role in organisation
  - Role ambiguity, role conflict, and responsibility for people

- Career development
  - Career stagnation and uncertainty, under promotion or over promotion, poor pay, job insecurity, low social value to work

- Home-work interface
  - Conflicting demands of work and home, low support at home, dual career

**14.4 Occupational Stress**

- Definition: The physiological and psychological responses of workers who perceives that their work demand exceeds their resources and/or abilities to cope with the work (Leka and Griffith, 2003)

- Stress response is multifactorial

- Physiological
  - Cognitive and
  - Emotional

- Stress is not a disease but can lead to illnesses
14.5 Why occupational stress is significant?

- Depression is a leading cause of disability (WHO, 2011)
- One in three of Europe’s workers, more than 40 million people, report that they are affected by stress at work (EU-OSHA, 2002)
- In the 15 Member States of the pre-2004 EU, the cost of stress at work and the related mental health problems was estimated to be on average between 3% and 4% of gross national product, amounting to €265 billion annually (Levi, 2002).

14.6 How stress can lead to ill health?

- The pathway of stress to ill health is explained explicitly by Selye (1956)
- The theory of ‘General Adaptation Syndrome’ (GAS)
- The body physiological response to stress are divided into three stages
  - Alarm
  - Resistance and
  - Exhaustion
- The principal idea of the theory: chronic stress lead to different stages of hormonal changes in the body.

The Stress Response (2010)

14.7 Alarm Stage (GAS)

- Known as the ‘fight or flight’ the response
Your body recognises that there’s a danger
Your body prepares to deal with the treat
Activation of the HPA axis, the nervous system (SNS) and the adrenal glands
The main stress hormones cortisol, adrenaline, and noradrenaline, is released to provide instant energy
This energy if not used by physical activity will become harmful
Excess adrenaline increase blood pressure that can damage cardiovascular system
Excess cortisol will damage cells and muscle tissues
Stress related disorders: cardiovascular conditions, stroke, gastric ulcers, and high blood sugar levels.
Now your body is equipped with enough energy and you are ready to handle the stressful event.

14.8 Resistance Stage
- Homeostasis begins restoring balance
- A process involves cell repair and renewal
- Stress hormones levels may return to normal but your energy and defence system is reduced
- However, if the stressful condition persists, your body remains in the arousal stage
- If these stages of alarm and resistance stage repeated with little or no recovery, your body will move to the next stage

14.9 Exhaustion Stage
- Stressful condition persist (chronic)
- Exhaustion stage is also known as overload
- You lost your body resistance mechanism
- Adaptation energy supply is vanished
- damage nerve cells in tissues and organs
- thinking and memory impaired
- leads to adverse function of the autonomic nervous system - high blood pressure, heart disease, rheumatoid arthritis, and other stress related illness.
- Ultimately, you will die.

14.10 How stress can affect your work?

The Human Function Curve describes the relationship between good stress eustress and bad stress (distress) and performance (physically and mentally)
- Optimum zone/comfort zone: A stage of a healthy tension when a worker receive the right amount of eustress that increases their performance
- When eustress increases and persists, functionality begins to falter
- The body and mind reach a ‘hum’ where a worker is already fatigue
- When stress increase, eustress becomes distress
- Body starts to lose coordination and the mind loses concentration
- When distress increase, a worker is exhausted and stress-related illnesses begin to manifest.
- when stress becomes unrelenting, the body and mind break down completely
The mind become dysfunctional with paranoia, overwhelming fear, psychological regression, and to the extreme, schizophrenic catatonia.

14.11 The mechanism of exposure to psychosocial hazards

- Psychosocial risks in the workplace have been demonstrated to have a possible detrimental impact on workers’ physical, mental and social health.
- Several models and theories have been developed to easily understand the association between psychosocial hazards and the health of employees in occupational settings.
- Examples:
  - Job Demands Resources Model (Demerouti, et al., 2001)
  - Job-Demand-Control-Support Model (Karasek and Theorell, 1990)
  - Effort-Reward-Balance Model (Siegrist, 1998)

14.12 Job Demands Resources Model (Demerouti, et al., 2001)

- Interaction between job demands and job resources

![JD-R Model of Work Engagement (Bakker & Leiter, 2010, p. 187)]
- Definition of job demands - those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological (cognitive and emotional) effort or skills.
- Definition of job resources - those physical, psychological, social, or organizational aspects of the job that are either/or
  - functional in achieving work goals
  - reduce job demands and the associated physiological and psychological costs.
  - stimulate personal growth, learning, and development.
- High job demands exhaust employees' mental and physical resources
- job resources buffers the impact of job demands on stress-reactions

14.13 Job-Demand-Control-Support Model (Karasek and Theorell, 1990)

- Interaction between job demand, job control/decision latitude and social support
- Decision latitude refers to the worker's ability to control his or her own activities and skill usage
- Employees working in a high-strain job (high job demands and low job control) experience the lowest mental health and well-being or psychological strain.
- Employees working in a passive job (low demand and low job control) cause a very “demotivating” job setting which leads to “negative learning” or gradual loss of previously acquired skills
- Employees working in an active job (high job control and high psychological demands but not overwhelming) adapts to the situation by learning, behavioural changes and effective problem solving
- Social support can moderate the negative impact of high strain on well-being.

14.14 Effort-Reward-Balance Model (Siegrist, 1998)

The imbalance between high efforts and low rewards at work is the concept which is the crucial course of stress-related diseases.

Rewards include money, promotion prospects, job security, and esteem,

Stress effects are enhanced by a personal coping pattern termed overcommitment

14.15 Risk measures for psychosocial hazards

Psychosocial work hazards have been measured in a number of ways
Usually using questionnaires since they are inexpensive and easy to analyse.

Three category of measurements
- Subjective – occupational stress perception
- Objective – archival data including sick leaves, performance measures and accidents
- Biological – heart rate, blood pressure, cortisol, serum cholesterol.

The most accurate objective assessments of work-related stress appear to be a combination of physical hormone tests, objective workload measurements, and observations of working conditions that are matched against information from workers.

14.16 Subjective studies for stress symptoms
- General Health Questionnaire (GHQ) (Goldberg, 1972) – a robust instrument repeatedly used in many studies
- Generic work-related stress questionnaire (NIOSH, 1997)
- Occupational Stress Questionnaire (OSQ) (Elo et al. 1992)
- Job Stress Survey (JSS) (Speilberger & Vagg, 1991)
- Occupational Stress Indicator (OSI) (Cooper et al., 1988)
- General Well-being Questionnaire (GWBQ) (Cox & Gotts, 1987)

14.17 Subjective studies for psychosocial hazards
- Job Content Questionnaire (JCQ) (Karasek et al., 1985),
- Effort Reward Imbalance (ERI) Questionnaire (Siegrist, 1996)
- Copenhagen Psychosocial Questionnaire (Kristensen et al., 2005)
- QPS Nordic: and the General Nordic Questionnaire for Psychological and Social Factors at Work (Lindstrom et al., 2000).

14.18 Changing in working population - Segregation of work by gender
- Men tend to be more exposed to physical and chemical hazards
- Women are more frequently exposed to emotionally demanding work, and to work in low-status occupations with often restricted autonomy
- Men are three times more likely than women to have serious accidents at work
- Women are more likely to report work-related upper limb disorders, work-related stress, infectious diseases and skin problems.

14.19 Changing in working population – Increased migration of workers
- Particularly from developing countries to developed countries
- Legal workers have better working condition than illegal workers

14.20 Changing in working population – Aging population
- Older workers have decreased opportunities to gain further knowledge
- Less opportunity for task rotation
- Lower carrier development
- Less support from supervisors
- Increased in the prevalence of musculoskeletal disorders

14.21 Impact of psychosocial hazards
- Illnesses – migraines, headache, distress, depression, anxiety
- Diseases – cardiovascular diseases, respiratory health, mental disorders, gastrointestinal problems.
- Injuries
- Behaviour – violence, bullying, poor sleep
- Unhealthy lifestyle – smoking, drinking, over-eating, physical inactivity
- Organisation – work absenteeism, low productivity

14.22 Psychosocial hazards and psychological health
- Burnout - characterized by exhaustion and depersonalization (negativism/cynicism) and is found predominantly in caring and social professions (e.g. social workers, teachers, nurses, doctors, dentists).
- Depression – A range of mental conditions characterized by persistent low mood, absence of positive affect (loss of interest and enjoyment in ordinary things and experiences), and a range of associated emotional, cognitive, physical, and behavioural symptoms.
- Anxiety - A feeling of worry, nervousness, or unease, typically about an imminent event or something with an uncertain outcome.

- Mental and behaviour disorders – Classified in Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) produced by the American Psychiatric Association (APA. e.g. Acute stress disorders, Bipolar disorders, Alcohol abuse, and cognitive disorders.

**Conclusion to Unit**

At the end of this class, students will be able to identify the psychosocial hazards at their workplace by conducting appropriate assessment. Students should be able to appreciate the identified psychosocial hazards and use the information for intervention strategies.

**Exercise 14.0 / Activity 14.0**

1. Choose one of the standardized questionnaires on psychological/physical health of employees related to psychosocial hazards. Fill in the form and give scores to yourself based on the method of calculation given for the questionnaire. Based on the result, determine whether you are at risk of psychological illnesses or not. If yes, state the most significant psychosocial hazards at your workplace.
Answers to Exercise 14.0

1. Determination of the risk of psychological illnesses depends on the chosen standardized questionnaire. Scoring of the students’ psychological health is according to the manual of the questionnaire.
UNIT 15
Prevention and Control Principles

Introduction to Unit

Student will learn about the concept of prevention and control principles in industrial hygiene.

Objectives to Unit

- After this session, students should be able to:
  - Understand the concept of industrial hygiene in managing hazard in the workplace.
  - Understand common steps taken in the practice of industrial hygiene.
  - Understand the hierarchy of industrial hygiene control measures.

15.0 Content

15.1 Introduction
15.2 Prevention and Control Principles
15.3 Recognition
15.4 Evaluation
15.5 Prevention and Control
15.1 Introduction
What is the definition of industrial hygiene? It is defined as the science of anticipation, recognition, evaluation and control hazards in workplace which would impair workers health

15.2 Prevention and Control of Hazards
Control of hazards will break the vicious cycle of existing unhealthy working environment in order to create a healthy work environment. The roles of occupational or industrial hygienist are:

- Anticipate and recognize health hazards from work process, operation and equipment
- Assess and worker’s exposure to potential hazards
- Evaluate work process- possible generation & release of hazards (how to eliminate/reduce)
- Recommend design and evaluate control measures
- Participate in risk analysis and management with other multidisciplinary team members
- Involve in hazard communication

The principle of risk is as follows:

- **HAZARD** is a substance, agent or physical situation with a potential to cause harm (injury, ill health, property damage)
- **RISK** is the probability of harm (injury, disease or death) occurring under specific circumstances
- **Risk = likelihood occurrence X severity of outcome**
- “Zero risk” Practically impossible
- Taking care of risks to extent community can live and work without worrying
- The **RISK** of health increases with the severity of the **HAZARD**, the amount of used and the duration and frequency of **EXPOSURE**
The practice of Industrial Hygiene will involve these three simple steps:

- Recognition of possible health hazard
- Evaluation of hazards
  - Exposure assessment
  - Risk level
- Prevention and control of hazard

15.3 Recognition

The first step in the prevention and control of risk is the recognition of possible health hazards. This step is performed in order to:

- To determine:
  - Which agent is present?
  - Which circumstances?
  - Nature and magnitude of the adverse effect on health

In order to determine the agent, circumstances and the nature and magnitude of the adverse effect, the industrial hygienist will need to perform a number of assessments which includes:

- The toxicity of a substance
- Evaluation of toxicology data

The toxicology data should consist of this following information

- Acute toxicity (oral/inhalation/dermal)
- Acute toxicity (skin or eye irritation)
- Skin sensitization
- Sub acute (28 days)
- Sub chronic (90 days)
- Mutagenicity
- Carcinogenicity
- Reproduction toxicity

Further in the step of recognition, workplace characterization is compulsory. It is important for the industrial hygienist to consider the following:

- Type of industry?
- Activities involved? Does it involve different sections?
- Number of people working?
- Working condition-close/open system, ventilation system
- Detail information on process/operations and materials use/produce

The recognition of occupational hazards is ideally categorised according to these classification of hazards:

- Physical
  - Noise, vibration, radiation, extreme temperature, pressure, electricity, illumination and visibility
- Chemical
  - Dust, fibres, fumes, mist, vapours, liquid
- Biological
  - Virus, bacteria, fungi
- Ergonomic & mechanical
  - Overexertion, repetitive actions, posture, impact
- Psychosocial and organizational
  - Work demand and condition, work environment, organization, individual character

These hazards could be identified according to the methods listed below:

- Accident and ill health statistics
- Investigation of accidents, ill health effects and complaints
- Audits
- Checklists
- Workplace inspection
Detail information on process/operations and materials used or produced may be assessed from the following sources:

- MSDS – Material Safety Data Sheet
  - Information about properties of the substance such as:
    - Identity of substance
    - Physicochemical properties
    - Health effects
    - First aid & fire fighting measures
    - Recommendations for handling, storage, and disposal
    - Transport information

15.4 Evaluation

Evaluation is performed to assess:

- Worker’s exposure
- Provide information for designing & testing the efficiency of control measures

Exposure assessment performed will enable the industrial hygienist to identify the following information.

- Determine how much/how often/how long of an agent that workers have been exposed to
- Initial study to assess workers’ exposure
- Follow up monitoring
- Essential to decide whether intervention are required

When hazards are obvious, it is important to control it first and carry out more precise evaluation later.

- Follow up evaluation:
  - Evaluating adequacy, efficiency or disclosing possible failures in control system
  - Detecting whether alterations in the process have altered the exposure situation
- Qualitative survey
  - Walk through survey
- Quantitative survey
- Direct reading
  - Sound level meter – noise
  - Gas detector tubes – CO, H2S
- Indirect reading
  - Sampling pump- dust, air particulate

Once the control measures have been implemented, further evaluation could be performed.

- Assess the efficiency of control measure:
  - Area sampling/source sampling
  - Personal sampling – workers exposure
- Exposure limit
  - TLV (threshold limit value): levels at which nearly all workers may be repeatedly exposure day after day to the hazard without causing adverse effect
  - Permissible Exposure Limit (PEL): an exposure limit that is published and enforced by act/regulation
- Malaysian PEL examples are as follows:
  - Lead: <150 micrograms per cubic meter of air averaged over 8 hour period
  - Asbestos dust: < one fibre per millimetre of air averaged over 8 hr period
  - Noise: <90 Db(A) – continuous sound
  - Respirable cristobalite < 0.005mg/m3
  - Respirable quartz < 0.1 mg/m3
  - Respirable tridymite < 0.05 mg/m3
15.5 Prevention and Control
Preventive action to interrupt the chain by which the hazard is transmitted from the source to the workers could be performed according to the stated hierarchy of control:

- Hierarchy of control
  1. Elimination
  2. Substitution
  3. Isolation
  4. Engineering controls
  5. Safe works practices (administrative)
  6. Personal protective equipment (PPE)

1. Elimination
   - Removal from further use
   - Best way of hazard control
   - Applies to materials, process and technologies
     - Using clips/clamps instead of an adhesive purchasing supplies of a materials in a ready cut sized rather than out dust producing cutting process on site

2. Substitution
   - Hazardous substances/process substituted to non hazardous substance
     - Consideration base on the toxicity of reactants, intermediates, products, wastes and contaminants
     - Benzene: toluene (paint manufacture)
     - Asbestos: synthetic mineral fibre (insulation)

3. Isolation
   - physical separation of hazardous material/process to prevent emissions of that material to prevent emissions of that material into environment
     - installation a physical barrier
     - enclosing operators in a clean environment
     - storage of flammable liquids inside an enclosed boundary
4. Engineering control
   - hazards control usually of a mechanical nature, specifically designed for plant equipment/process
   - control hazard at the source by preventing exposures from reaching workers
   - ventilation – local exhaust ventilation
   - using pumps for hazardous substances rather than manual transfer
   - wet cutting process (stone, brick) that reduce dust

5. Safe work practices
   - planned practices and process which lead to workers being adequately informed, trained and supervised
   - rely on human behaviour
   - reducing number of employee exposed
   - reducing period of exposure for employees
   - providing information on hazards
   - safety culture
   - job rotation

6. Personal Protective Equipment (PPE)
   - Barrier between the hazard and the wearer
   - Offers protection only to the wearer
   - Should be the last resort of control
   - Short term measure and specific use during part of the process
     o General (overall, clothing)
     o Skin protection (aprons, gloves)
     o Eye protection (chemical glasses, face shield)
     o Respiratory protective equipment
     o Hearing protection (ear plug, ear muff)
   - When to use PPE?
     o Other control measures are not reasonable practicable
     o Close contact with the source of hazards required
     o For hazardous task of short duration
     o Maintenance activities
**Conclusions to the Unit**

Preventive and control strategies aim at eliminating or reducing to acceptable levels the occurrence of hazardous agents and factors in the work environment, preferably at their source of generation/dissemination, secondly during their path of transmission, and lastly by protecting the worker. Specific measures include the selection of the least toxic materials, substitution of materials, substitution/modification of equipment and processes, correct operation and maintenance of processes and equipment, enclosures and closed systems, local exhausts and general ventilation, isolation of workers, good work practices and personal protective equipment as a last resort. Information, training and education of workers and employers on hazards and their prevention including on emergency response should also be part of such strategies.

**Additional References**


**Discussion 15.0**

1. Industrial hygiene practice for controlling worker exposure to health hazards generally require that employers utilize engineering controls to the extent feasible before other control methods are employed. Why is engineering out the hazard the preferred option?
Answers to Discussion 15.0

1. Engineering controls are methods of designing or modifying plants, processes and equipment so as to minimize workers' exposure to the hazard. They are preferred because they work independently of workers.
Introduction to Unit

Compensation is benefits and services received by employees as part of their employment. Compensation can be categorized into financial and non-financial and is compulsory under laws and regulation. Laws and regulations for compensation are different between foreign workers, private sector workers and civil servants. In this topic, students will understand why work compensation is important, define the types of workers compensation available in Malaysia and aware about the related laws and regulations.

Objectives to Unit

- After this session, students should be able to:
  - Learn types of compensation
  - Understand the important of work compensation
  - Understand law and regulations related to work compensation
16.0 Content

16.1 General definition of workers compensation
16.2 Specific definition of workers compensation
16.3 Why do we need workers compensation protection at the workplace?
16.4 Perspective of compensation
16.5 What are the benefits provided?
16.6 Direct financial compensation
16.7 Indirect financial compensation
16.8 Non-financial compensation
16.9 Legislation in Malaysia for workers compensation
16.10 Work compensation scheme in Malaysia - General
16.11 Workmen’s Compensation Act 1952
16.12 List of Foreign Workers Compensation Scheme Insurance
16.13 Workmen’s Compensation Act 1952 - Foreign Workers Compensation Scheme Insurance covers
16.14 Workmen’s Compensation Act 1952 - Incentive payment
16.15 Employees' Social Security Act 1969
16.16 Schemes under the SOCSO
16.17 Employment Injury Insurance Scheme
16.18 Benefits
16.19 Invalidity Pension Scheme
16.21 Work compensation for public service workers
16.22 Covers for workers compensation for public services
16.23 Benefits provided
Imported Notes

16.1. General definition of workers compensation
- All forms of tangible/ clear financial returns, benefits and services received by employees as part of their employment

16.2. Specific definition of workers compensation
- A form of insurance providing wage replacement and medical benefits to employees injured in the course of employment in exchange for mandatory relinquishment of the employee's right to sue his or her employer for the tort of negligence.

16.3. Why do we need workers compensation protection at the workplace?
- Protect employees from the financial hardships associated with work-related injuries and occupational diseases.
- Company/institution can get penalized for noncompliance
- Risk the high cost of claims, penalties and liabilities
- Company can endure financial ruin if they lost a court case to the employee

16.4. Perspective of compensation
- Society’s view
- Stockholders' view
- Employees’ view
- Managers ‘ view
16.5. What are the benefits provided?

- Financial
  - Direct
  - Indirect
- Non-financial

16.6. **Direct financial compensation**

- Salary (s)
- Bonuses
- Commission
- Gain-sharing
- Incentive
- Cost of living adjustment

16.7. **Indirect financial compensation**

- Assurance plan (pension, insurance, inability scheme)
- Services (education, recreation etc.)
- Leave (vacation, breaks, holidays)
- Insurance plans (medical, dental and life)

16.8. **Non-financial compensation**

- Compliment
- Self-esteem
- Recognition
- Self-worth
- Pride

16.9. **Legislation in Malaysia for workers compensation**

- Workmen’s Compensation Act 1952
  - applicable for foreign workers and local workers whose salaries \( \leq \text{RM 500} \)
- Employees' Social Security Act 1969
  - applicable for Malaysian workers
16.10. Work compensation scheme in Malaysia - General

- Privately employed - SOCSO
- Civil servants – Ex gratia Scheme
- Foreign workers – insurance
- NONE for the self-employed

16.11. Workmen’s Compensation Act 1952

- Compensation for foreign workers - Foreign Workers Compensation Scheme Insurance order 2005
- Employees must ensure that the workers are insured with the panel insurance company appointed under the Foreign Workers’ Compensation Scheme by the Human Resources Minister.
- The Subsection 26 (1) of Workmen’s Compensation Act 1952 also states that failure to do so is an offence. If convicted, the employer will be fined not more than RM20,000, or jailed for not more than two years or both.
- To ease the process and the management of foreign worker’s compensation cases, the Labor Department of Semenanjung Malaysia (JTKSM) has taken the initiative to develop the e-Compensation system

16.12. List of Foreign Workers Compensation Scheme Insurance

- Allianz General Insurance Malaysia Berhad.
- Berjaya General Insurance Berhad.
- Kurnia Insurans (Malaysia) Berhad
- LonPac Insurance Berhad.
- Malaysian Assurance Alliance Berhad.
- Mayban General Assurance Berhad.
- Malaysia National Insurance Berhad.
- Syarikat Takaful Malaysia Berhad.
- Takaful Nasional Sdn. Berhad.
- Tahan Insurance Malaysia Berhad
- AmAssurance Berhad
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16.13. Workmen’s Compensation Act 1952 - Foreign Workers

Compensation Scheme Insurance covers

- injuries during working hours
  - death
  - temporary disability
  - permanent disability
- injuries outside working hours
  - death
  - permanent disability


- for injuries - direct payment to the workers
- for death cases
  - payment to the dependents through Department of Labour.
  - the department will identify the dependents
  - bank draft issued to the dependents by high commissioners or embassy

16.15. Employees’ Social Security Act 1969

- Enforced by the Social Security Organisation of Malaysia (SOCSO)
  (Pertubuhan Keselamatan Sosial Malaysia)(PERKESO)
- Among functions of SOCSO
  - registering employer/employees
  - collection of employers/employee contributions
  - processing and disbursing claims made by salaried employees and their dependents
  - provides physical and vocational rehabilitation benefits to claimants
  - promotes occupational safety and health awareness.
16.16. Schemes under the SOCSO
- Employment Injury Insurance Scheme
- Invalidity Pension Scheme

16.17. Employment Injury Insurance Scheme
- Provides protection to employees who suffer from accidents arising from work.
- Employment injury = personal injury to an employee caused by an accident or an occupational disease arising out of and in the course of employment in an industry to which the Employees’ Social Security Act 1969 applied.
- Coverage:
  - commuting accidents - while travel to and from workplace and home without diversion
  - while working
  - work environment
  - dealing with equipment
  - crimes
- Accident during emergency (while helping others)
- Occupational diseases
  - asthma, back pain, hearing loss etc.

16.18. Benefits
- Medical Benefit
  - free access to government hospitals and clinics and panel clinics.
- Temporary Disablement Benefit
  - off days
  - payments of 80% from daily salary
- Permanent Disablement Benefit
  - lump sum payments
  - payments of 90% from daily salary with maximum limits RM 88.50
- Rehabilitation Benefit
  - payments of 80% from daily salary
  - artificial limbs
  - return to work program
- Dependant's Benefit
  - payments of 90% from daily salary
- Funeral Benefit
  - RM1500 burial cost
- Education Benefit
  - scholarship or education loan

16.19. Invalidity Pension Scheme
- Provides twenty four (24) hours coverage for workers from invalidity or
dies irrespective of the cause of death.
- Invalidity = a serious disablement or morbid condition of a permanent
  nature that is either incurable or not likely to be cured, as a result of
  which an employee is unable to earn at least 1/3 of what a normal able
  person could earn.
- Benefits
  - Constant Attendance Allowance
  - Survivor's Pension
    - pension for life
  - Funeral Benefit
    - RM1500 burial cost
  - Rehabilitation Benefit
    - payments of 80% from daily salary
    - artificial limbs, vocational
    - Return to work programme
  - Education Benefit
    - scholarship or education loan

16.21. Work compensation for public service workers

- Called Ex-gratia Compensation Scheme
- “Ex-gratia” in Latin means “compensation payment by government or organization when compensating victims of an event such as an accident or similar, but not to admit liability to pay compensation, or for causing the event”
- Introduced by the Government in Malaysia in 1994, revised and improved in 2001 to increase the coverage with better benefits
- Administered by the Treasury, and the two circulars, Treasury Circular No. 13, 1994 and Treasury Circular No.7, 2001 are the reference documents for its implementation

16.22. Covers for workers compensation for public services

- All government servants except those in the military, police and the fire services;
- Those engaged under the services with the government Trustee fund or Tabung Amanah;
- Attached officers and daily paid workers who have been covered under different schemes accordingly
- states, local government and statutory bodies workers
16.23. Benefits provided are:

- Lump sum ex-gratia payment
- Monthly ex-gratia
- Constant Attendance Allowance
- Monthly ex-gratia payment for dependents
- Workers are not required to pay premium

Conclusion to Unit

Compensation is an important component for the workers need of security. Employers are obliged by laws and regulation to ensure that their employees are covered with compensation scheme. Understanding different type of compensation and its requirement by law and regulations will help students in the management of work compensation at the workplace.

Discussion 16.0

1. Make a group of six and prepare a speech on the important of work compensation. The target groups are employees at tea plantation Malaysia.
Answers to Discussion 16.0

1. Answer is the same as in the slides provided (16.3). The information given must include the Foreign Workers Compensation Scheme Insurance covers because most of the workers in Malaysian tea plantation are foreign workers.
INTRODUCTION TO UNIT

Biological monitoring is one of the methods used in occupational health and industrial hygiene in determining the effect due to exposure to various hazards, especially due to chemical hazards. There are various methods in biological monitoring, with different types of biomarkers such as urine, blood, saliva, etc. The result will be compared with various standards.

OBJECTIVES TO UNIT

After this session, students should be able to:

- Classify the type of exposure assessment and effect assessment of workers due to various chemical hazards
- Define biological monitoring and the type of guidelines used by different countries.

17.0 Content

17.1 Type of exposure assessment
17.2 Strength and weakness of exposure assessment
17.3 Definition of biological monitoring
17.4 Biomarkers
17.5 Type of biological monitoring
17.6 Standards in biological monitoring
17.7 Advantage and weakness of biological monitoring
17.8 Biological Exposure Indices
17.1 SCOPE OF INDUSTRIAL HYGIENE AND THE CONTEXT FOR BIOLOGICAL MONITORING

GOAL: PROTECT THE HEALTH OF THE WORKER

- Anticipation
- Recognition
- Evaluation
- Control

17.2 Means of Evaluating Exposure

- Air sampling
- Skin sampling
- Surface sampling
- Biological monitoring – measures inside body

17.3 Strength of Air Sampling

- Long-standing tradition
- Good worker acceptance
- Established standards & guidelines
- Good equipment
- Standard methods available

17.4 Weakness of Air Sampling

- Does not account for:
  - All routes of exposure, esp. skin
  - Workload
  - Individual differences in absorption of inhaled dose
  - Misuse or malfunction of PPE
  - Concomitant exposures
  - Sensitive individuals
17.5 Strengths of Surface Sampling
Can identify potential for surface derived exposures
- Easy to obtain
- Minimally disruptive of operations
- Favored by most regulators

17.6 Weakness of Surface Sampling
- Highly variable results
- Surface transfer to skin is variable and poorly understood
- May overestimate absorbed dose

17.7 Strengths of Skin Sampling
- Indicates individual skin

17.8 Weakness of Skin Sampling
- Differences between techniques, some overestimate or underestimate exposure
- Relevance to biologically available or absorbed dose uncertain

17.9 What is biological monitoring?
- Biological monitoring is the measurement and assessment of chemicals or their metabolites (substances the body converts the chemical into) in exposed workers.
- These measurements are made on samples of breath, urine or blood, or any combination of these.
- Biological monitoring measurements reflect the total uptake of a chemical by an individual by all routes (inhalation, ingestion, through the skin or by a combination of these routes).
- Thus it differs from environmental monitoring
17.10 Biomarkers

- Measure of exposure, effect, or susceptibility by analyzing biological sampling media
- A biological marker of exposure is defined as a xenobiotic substance or its metabolite(s) or the product of an interaction between a xenobiotic agent and some target molecule(s) or cell(s) that is measured within a compartment of an organism

17.11 Exposure to Effect Continuum
17.12 The Role of Biological Monitoring

• Detects dermal, inhalation and ingestion exposures
• Detects non-workplace exposures
• Evaluates effectiveness of PPE
• Captures worker hygiene, contact rate (e.g., respiration) and metabolism variability

Table 17.1 Examples of chemicals that can be assessed by biological monitoring

<table>
<thead>
<tr>
<th>Biological monitoring (measuring the chemical itself)</th>
<th>In blood</th>
<th>In urine</th>
<th>In breath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead, cadmium, polychlorinated biphenyls</td>
<td>Cobalt, nickel, 4,4’-methylenebis-(2-chloroaniline)</td>
<td>Tetrachloroethylene, carbon monoxide</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biological monitoring (measuring a metabolite)</th>
<th>In blood</th>
<th>In urine</th>
<th>From methyl bromide exposure</th>
<th>From styrene</th>
<th>From trichloroethylene</th>
</tr>
</thead>
</table>
17.13 Types of biological monitoring

17.14 Biomarkers of Susceptibility

Genetic, inherited:
— Alpha-1-antitrypsin phenotype
— Acetylator phenotype
— P-450 2D6 polymorphism

Acquired:
— Antigens (hypersensitivity) in response to exposure to toluene diisocyanate or cotton dust

Co-existing conditions:
— Cirrhosis of the liver, renal deficiency

17.15 Biomarkers Of Exposure

• biomarker of exposure is an exogenous substance, its metabolite, or the product of an interaction between a xenobiotic agent and some target molecule or cell that is measured in a compartment within an organism

• This includes:
  • Markers of internal dose
  • Markers of biologically effective dose
17.16 Markers of Internal Dose

- Lead, cadmium, mercury, etc.; blood
- Trichloroethylene; trichloroacetic acid; urine
- Phenol; urine
- Toluene; o-cresol, urine
- Xylene; methylhippuric acid, urine
- Methylenedianiline, urine
- Toluene; expired air

17.17 Biomarkers of Effect

- A biomarker of effect or response is a measurable alteration - biochemical, physiological, or other - within an organism that can be recognized, depending on its magnitude, as an established or potential health impairment or disease.
  
  - Zinc protoporphyrin: lead
  - Delta-aminolevulinic acid: lead
  - Carboxyhemoglobin: carbon monoxide; methylene chloride
  - Beta-2-microglobulin: cadmium
  - Cholinesterase: organophosphorus pesticides
  - Chromosome aberrations: antineoplastic drugs
  - Sister chromatid exchanges: ethylene oxide
  - Urine mutagenicity: antineoplastic drugs

17.18 Medical Monitoring Biomarkers — Liver

- Albumin, bilirubin, globulin, total protein
- Alkaline phosphatase (AP)
- Gamma glutamyl transpeptidase (GGTP)
- Alanine aminotransferase (ALT)
- Aspartate aminotransferase (AST)
- Lactate dehydrogenase (LDH)
17.19 Medical Markers — Kidney
- BUN (Blood Urea Nitrogen)
- Creatinine
- Uric acid

17.20 Medical Monitoring – Blood forming
- CBC
- Differential
- WBC, RBC
- Hemoglobin & hematocrit
- Reticulocyte count

17.21 Medical Monitoring – general
- Urinalysis
  - Appearance, color, ketones
  - Bile, occult blood, pH
  - Glucose, protein
  - Microscopic evaluation of sediment

17.22 Common Biological Monitoring Media
- Urine
- Blood
- Exhaled Breath
17.23 Urine Collection

- 24 hour urine
- Spot urine
- Timing preferences:
  - End-of-shift
  - end-of-shift, end-of-week
  - prior to last shift of workweek
  - not critical

17.24 Principal Advantages Of Biological Monitoring

- Individual variation in the absorption of contaminants can be assessed
- Measures total exposure including all routes of exposure
- Effectiveness of PPE/work practices assessed
- Exposure outside of the workplace identified
- Individual absorption differences among workers identified
- Can confirm compound absorption when skin
• and/or oral exposure occur
  • Provide powerful individual and group feedback and is an incentive for personal involvement in their own protection

17.25 Biological Monitoring Weaknesses

• Not as simple as air sampling
  □ Reflects total exposure, not just occupational
  □ May be invasive
  □ Workers may perceive themselves as guinea pigs
  □ Marker may not be agent specific, or only for workplace exposures
  □ Few standards or guidelines are available
  □ Analytical methods may not be available or costly
• □ Management/workers may fear this type of information

17.26 Biological monitoring is often best for estimating absorbed dose and risk

• Individual Variation in Absorption of Airborne Contaminants Can Be Assessed

<table>
<thead>
<tr>
<th>Physical Workload (W)</th>
<th>Alveolar Ventilation (L Air/Min)</th>
<th>Heart Rate (L/Min)</th>
<th>Increase Ventilation (vs. Light)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (Rest)</td>
<td>5.0</td>
<td>6.0</td>
<td>1.0</td>
</tr>
<tr>
<td>50 (Light Work)</td>
<td>16.0</td>
<td>9.0</td>
<td>1.0</td>
</tr>
<tr>
<td>100 (Moderate)</td>
<td>27.0</td>
<td>13.0</td>
<td>1.7</td>
</tr>
<tr>
<td>150 (Heavy)</td>
<td>38.0</td>
<td>19.0</td>
<td>2.4</td>
</tr>
</tbody>
</table>
Effect of Exercise on Excretion of Hippuric Acid Following Toluene Exposure

Lead on Hands Remaining After Washing and After Eating in Workplace Cafeteria
17.27 Skin Absorption Versus Inhalation

- The Importance of Skin Exposure is Often Overlooked or Under-appreciated

- PCBs
  - 1 mg/m³ airborne exposure for 8 hours
    - 8 mg
  - One drop of 70% PCB on one hand
    - 54 mg
17.28 The Skin & Percutaneous Permeation

- Chemicals that are somewhat soluble in organic oils and lipids as well as water are absorbed most readily through skin
- Those that are highly insoluble in either oils or water are poorly absorbed.

17.29 Factors Affecting Skin Absorption

- Location of skin on the body
- Hydration or wetness
- Temperature
- Skin condition
17.30 Effectiveness of PPE and work practices can be assessed

17.31 Exposure outside of the workplace can be identified
17.32 Biological Monitoring Standards & Guidelines

- OSHA Mandated Biological Monitoring
  - Lead
  - Cadmium
- ACGIH BEIs
- Advisory only
- German BATs
- Malaysia?
Deutsche Forschungsgemeinschaft

List of MAK and BAT Values 2001

Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area
Report No. 37

HEALTH & SAFETY LABORATORY

Guidance on Laboratory Techniques in Occupational Medicine

Seventh Edition 1996
© Crown Copyright

An agency of the Health and Safety Executive
17.33 BEIs - Biological Exposure Indices

- Definition
- Reference Values of Biological determinants; the levels most likely observed when healthy persons are exposed to air concentrations at the TLV

- Biological monitoring ... entails measurement of the concentration of a chemical determinant in the biological media of the exposed and is an indicator of the uptake of the substance.

- The BEI® determinant can be the chemical itself; one or more metabolites; or a characteristic reversible biochemical change induced by the chemical

- Major Intended Uses
  - Compare exposure from all routes of exposure
  - Give absorbed dose relationship to individual’s integrated air sampling
  - Determine the effectiveness of PPE

- Based on Human Data
  - Experimental and Field Studies
  - Relationship between external and internal doses at TLV® levels
  - Relationship between internal dose and reversible health effects

BEI Table
Includes the following:

- Chemical
- Determinant
- Specimen to collect
- Time of collection
- BEI
- Notation
17.34 BEI – Time of Collection

- Biological Half - Life of Determinant
  - Short half-life indicates recent exposure
  - Long half-life indicates integrated exposure over time
  - Very long half-life, collection is not critical, cadmium half-life is 20 years!

17.35 BEI Notations

“B” – Background: found in non-exposed population.
“Ns” – Non-specific: the determinant detected in other chemical exposures
“Sq” – relationship is semiquantitative.
“Nq” – monitoring is recommended, but no BEI available.
“Sc” – increased susceptibility in some populations

17.36 Issues in Biological monitoring

- Why are you doing this sampling?
- □ Who are you going to sample?
- □ What are you going to measure?
- □ When and Where are you going to sample?
- □ How are you going to transport and store the sample?
- □ How will the samples be analyzed?
- □ How will the results be reported?
- □ What criteria will be used to determine what actions will be taken?
CONCLUSION TO UNIT

This unit describes the type of exposure assessment, the strength and weakness of each sampling method and the use of Biological Indices in the workplace.

Additional References


Discussion 17.0

1. Describe the strength and weakness of air sampling?
Answers to Discussion 17.0

1. The strength and weakness are as follows:

   a. Strength:
      • Long-standing tradition
      • Good worker acceptance
      • Established standards & guidelines
      • Good equipment
      • Standard methods available

   b. Weakness
      • Does not account for:
      • All routes of exposure, esp. skin
      • Workload
      • Individual differences in absorption of inhaled dose
      • Misuse or malfunction of PPE
      • Concomitant exposures
      • Sensitive individuals
Unit 18

Stress and Violence At Work

Workplace violence is any act or risk of physical force, harassment, provocation, bullying, or other threatening disruptive behavior performed by employees or employers including customers or visitors at the workplace. Workplace violence varies from verbal abuse, physical offensive and to homicide. In this topic, students will learn about the definition of violence and how it associates with workers’ health.

Objectives to Unit

- After this session, students should be able to:
  - Identify
  - Statistics of workplace violence and workers who are at risk
  - Understand the factors of violence at the workplace by briefly reviewing the mainstream general theories of stress and violence

18.0 Content

18.1. Definition of violence
18.2. Workplace Violence Increasing Worldwide (ILO)
18.3. Legislation related to violence in Malaysia
18.4. Violence and stress
18.5. Industries and occupation commonly affected
18.6. Major types of workplace violence
18.7. Sub-types of workplace violence
18.8. Physical Assaults
18.9. Treat
18.10. Abuse
18.11. Harassment
18.12. Sexual harassment
18.13. Bullying/ Mobbing
18.14. Certain situation can put people at increased risk from workplace violence
18.15. Risk of violence may be greater when…
18.16. Factors of geographic location of the workplace
18.17. Why workplace violence is underreported?
18.18. Model of psychological harassment process
18.19. Antecedents of violence
18.20. Environmental and organizational antecedence (Management style)
18.21. Environmental and organizational antecedence (Work organisation)
18.22. Environmental and organizational antecedence (Work organisation)
18.23. Individual antecedence of violence
18.24. Individual antecedence of violence of victims (characteristics)
18.25. Individual antecedence of violence of victims (personality)
18.26. Individual antecedence (perpetrator)
18.27. Societal antecedence
18.28. Consequences of workplace violence
18.29. Consequences to the victims
18.30. Consequences to the organization
18.31. Consequences to the society
18.32. An example of violence at the workplace
Important Notes

18.1. Definition of violence
Incidents where employees are abused, threatened, assaulted or subject to other offensive behaviour in circumstances related to their work

18.2. Workplace Violence Increasing Worldwide (ILO)
- A 2000 survey - 15 member states of the European Union showed that bullying, harassment and intimidation were widespread in the region.
- In Germany, a 2002 study estimated that more than 800,000 workers were victims of mobbing.
- In Japan, the number of cases brought before court counselors totaled 625,572 between April 2002 and March 2003. Of these, 5.1 percent, or almost 32,000, were related to harassment and bullying.
- In developing countries, the most vulnerable workers include women, migrants and children
- In Malaysia, a 2002 study estimated that more than 800,000 workers were victims of mobbing.

18.3. Legislation related to violence in Malaysia
- Under the Occupational Safety and Health 1994
- Responsibility of employer to maintain safe work environment

18.4. Violence and stress
- Stress and violence are closely interrelated
- It is therefore important to tackle stress and violence together
- The means to reduce or eliminate them are largely the same

18.5. Industries and occupation commonly affected
18.6. Major types of workplace violence

- **Type I:** Violence by strangers – no legitimate relationship between offenders and employees. Most common workplace violence (convenience store employees, taxicab drivers, restaurants employees)
- **Type II:** Violence by customers or clients – offender receive service from the employees (e.g. police officers, social workers, attorneys)
- **Type III:** Violence by coworkers, former employees, current or former friends, relatives and families – offenders have relationship with the employees

18.7. Sub-types of workplace violence

18.8. Physical Assaults

- Attempt at physical injury or attack on a person leading to actual physical harm.
- It includes beating, kicking, slapping, stabbing, shooting, biting, sexual assault and rape, among others.

18.9. Treat
- Promised use of unlawful force resulting in fear of physical, sexual, psychological harm or other negative consequences to the victim(s).
- Types of threat:
  - veiled – involved reference to a violence act and its association with the present situation
  - conditional – contain words such as ‘if’ or ‘or’ and reference to a violent act with the condition
  - direct – warning of a pending violent act

18.10. Abuse
- Behaviour that departs from reasonable conduct and involves the misuse of physical and psychological strength.
- It includes harassment, bullying and mobbing

18.11. Harassment
- Unwanted conduct - verbal, non-verbal, visual, psychological or physical – based on age, disability, HIV status, domestic circumstances, sex, sexual orientation, race, colour, language, religion, political, trade union or other opinion or belief, national or social origin, association with a minority, birth or other status that negatively affects the dignity of men and women at work.
- It includes sexual harassment.

18.12. Sexual harassment
- Unwanted conduct of a sexual that is perceived by the victim as placing a condition of sexual nature on her/his employment, or that might, on reasonable grounds, be perceived by the victim(s) as an offence or humiliation or a threat to his/her well-being.
- Forms of sexual harassment
verbal – offensive and suggestive remarks, comments and jokes
- non-verbal/gesture – hand signal or sign language denoting sexual activity
- visual – showing pornographic materials, drawing sex-based sketches
- psychological – repeated unwanted social invitation, relentless proposal for dates, physical intimacy
- physical – inappropriate touching, patting, pinching, stroking, brushing up against the body, hugging, kissing, fondling, sexual assault

18.13. Bullying/ Mobbing

- A form of psychological harassment consisting in persecutory behaviour through vindictive, cruel, or malicious attempts to humiliate or undermine an individual or groups of employees,
- including unjustified, constant negative remarks or criticisms,
- isolating a person from social contacts and gossiping or spreading false information.
- create feelings of defenselessness and undermine individual’s right to dignity
- often involve an abuse and misuse of power

18.14. Certain situation can put people at increased risk from workplace violence.

Workplace violence can strike anywhere, anytime, and no one is immune.
- working with the public.
- handling money, valuables or prescription drugs (e.g. cashiers, pharmacists).
- carrying out inspection or enforcement duties (e.g. government employees).
- providing service, care, advice or education (e.g. health care staff, teachers).
- working with unstable or volatile persons (e.g. social services, or criminal justice system employees).
- working in premises where alcohol is served (e.g. food and beverage staff).
- working alone, in small numbers (e.g. store clerks, real estate agents), or in isolated or low traffic areas (e.g. washrooms, storage areas, utility rooms).
- working in community-based settings (e.g. nurses, social workers and other home visitors).
- having a mobile workplace (e.g. taxicab).
- working during periods of intense organizational change (e.g. strikes, downsizing).

18.15. Risk of violence may be greater when...
- late hours of the night or early hours of the morning,
- tax return season,
- overdue utility bill cut-off dates,
- during the holidays,
- pay days,
- report cards or parent interviews, and
- performance appraisals.

18.16. Factors of geographic location of the workplace
- near buildings or businesses that are at risk of violent crime (e.g. bars, banks).
- in areas isolated from other buildings or structures.

18.17. Why workplace violence is underreported?
- its’ accepted, expected and rationalized
- lack of confidence in respondents
- unaware of the value of reporting
- fear of retaliation or being blamed
- embarrassment, guilt or shame
- management uncertainties
18.18. Model of psychological harassment process

![Diagram of the psychological harassment process]

Sources: Poilpot-Rocaboy (2006)

18.19. Antecedents of violence

- Environmental and organisational antecedents:
- Individual antecedents; and
- Societal antecedents.

18.20. Environmental and organizational antecedence (Management style)
• A culture favouring a disciplinary intolerant and discriminatory style of management creates a climate of fear, distrust, excessive competition and awe. Without norms concerning social behaviour, certain persons may consider themselves 'authorised' to use abusive behavior

• Competition without rules: employees may be asked to perform not only better than colleagues, but also with less ethical concerns in order to obtain result. Horizontal forms of direction without clearly defining the rules of collaboration leaves wide scope for the abuse of power

18.21. Environmental and organizational antecedence (work organisation)

• Chronic under-staffing and heavy work constraints
• Badly defined tasks or disorganised work without established limits of behaviour allow colleagues and superiors to take advantage of the situation.
• Excessive hierarchy: E.g. In hospital, nurses are subordinated to doctors, nursing ranks, and administration
• Overcrowding and sharing of premises in shifts may also lead to a negative atmosphere where violence is accepted.

18.22. Environmental and organizational antecedence (work organisation)

• Job insecurity: downsizing and restructuring, this can result in precariousness and fear of unemployment.
• Neglect of human and local characteristics of the employees

18.23. Individual antecedence of violence

• Characteristics
• personality

18.24. Individual antecedence of violence of victims (characteristics)

• more often among women
• more often among younger, some studies shows that violence is more often among older
• Employees belonged to ethnic minorities
18.25. Individual antecedence of violence of victims (personality)

- highly conscientious
- more traditional
- rigid
- moralistic
- more anxious,
- more suspicious,
- submissive
- non-controversial
- lowered self-esteem,
- social anxiety
- and neuroticism

18.26. Individual antecedence (perpetrator)

- A male aged 25-40 years old
- has a history of violence
- tends to be a loner
- owns several weapons
- exhibit frequent anger
- has history of conflicts with others
- paranoid

18.27. Societal antecedence

- adverse economic condition
- the norm of reciprocity,
- injustice perceptions,
- norm violations, and
- distributive justice

18.28. Consequences of workplace violence

- Physical
- Psychological
18.29. Consequences to the victims

- short-term emotional (feelings of anger, helplessness)
- social (in relation to co-workers: feeling sorry for the patient who hit them)
- bio-physiological (sleep-pattern disturbance, body tension)
- cognitive reactions (preoccupation with thinking about the assault, anger towards authority)
- and long-term emotional (fear of the patient who hit them)

18.30. Consequences to the organization

- increase of sickness absenteeism,
- higher turnover rates and loss of qualified staff
- reduced motivation, satisfaction and creativity
- decreased of product quality
- increased insurance premiums.

18.31. Consequences to the society

- Economic burden for society
- High costs of unemployment
- Loss of human resources
- Medical costs and possible hospitalisation

18.32. Guidelines by the Department of Occupational Safety and Health (DOSH) Malaysia

Priority target

- Offer an integrated workplace response to the problems of violence and stress that often manifest themselves together at the workplace.
- The tools for immediate, self-sustained action at the workplace to reduce and eliminate violence at workplace
18.33. A Stepwise approach for violence prevention (DOSH)

- Stress recognition;
- Stress assessment;
- Anti-stress intervention;
- Monitoring and evaluation.

18.34. Stress recognition

Early recognition is very important before violence occur. Recognition need to be done at

- individual level
- workplace level

18.35. Warning signs of violence

Violent incidents in the workplace usually follow some sort of "trigger" that pushes an already vulnerable person to take drastic action. Be concern of employees who start to behave in the ways listed below:

- They say they've been treated unfairly
- They say they’re being forced to wait for something (a promotion, raise, etc.)
- They show signs of mental instability
- They begin to isolate themselves
- They have recently been disciplined for something

18.36. Stress recognition at individual level

- dry throat, muscle tension, headaches, indigestion, tics, insomnia,
- high blood pressure;
- irritability, impulsive behaviour,
- difficulty in making decisions,
- sudden increase in smoking or alcohol use;
- excessive worrying, feeling of worthlessness,
- brooding, forgetfulness, easily startled, daydreaming
18.37. Violence recognition at individual levels
- Always difficult to predict and since both the perpetrators and the victim vary widely in age, sex, race and background
- It is important to avoid stereotyping, which can lead to discrimination.

18.38. Violence recognition at individual levels

Perpetrator:
- A history of violence
- Being male
- Being young
- Having a troubled childhood
- Substance abuse
- Certain forms of severe mental illness
- Being in a situation conducive to violence, including having access to firearms

Victim:
- Being young and inexperienced
- Being woman
- Showing a personality
- Temperament
- Attitudes and
- Appearance that "trigger" violence by the perpetrator.

18.39. Stress and violence recognition at individual level
- High levels of absenteeism,
- Staff turnover,
- Work accidents (including minor accidents) and disabilities
- Low productivity levels
- Poor quality production,
- Frequent breakdowns and
- Difficult interpersonal relationships

18.40. Steps for making violence assessment (Planning)
- Meet with stakeholders – manager, employees, OHS committee
- chairs
- Gather a team of dedicated individuals (consider worker rep from safety committee)
- Decide what information you want to gather and how it will be gathered
- Set realistic timelines as a guide for your team
- Set dates in advance for benchmarking/group meetings

**18.41. Steps for making violence assessment (Information gathering)**

- Previous experience in your workplace – close calls and injuries
- Similar workplaces – who does the same (similar) work as you do?
- Collect information through interviews, documentation, phone calls
- Location and Circumstance of your work
- Types of interactions (ex. providing medical assistance, resident manager, facility maintenance (buildings and grounds), security, etc.)
- What causes employees to be angry?

**18.42. Steps for making violence assessment (Information gathering)**

Checklist of Situations At Risk of Violence (DOSH)

- working alone
- working in contact with the public
- working with valuables and cash handlings
- working with people in distress
- working in environment increasingly open to violence
- working in condition of special vulnerability

**18.43. Steps for making violence assessment (Information gathering) other example of an assessment tool**
18.44. Steps for making violence assessment (Summarizing findings)

- Enter the information on the Hazard/Risk/Control Table
- For single worksite, complete the Overview report
For multiple worksites, complete a separate Hazard/Risk/Control Table for any common issues.

Example:

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Risks</th>
<th>Control</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Alone</td>
<td>a) Manager</td>
<td>a) High</td>
<td>New procedures about to be implemented within the entire department.</td>
</tr>
<tr>
<td></td>
<td>b) General staff</td>
<td>b) Moderate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Custodial worker</td>
<td>c) Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>In the case of a disabling injury, or other misfortune resulting from a violent incident, the worker might not be able to secure assistance</td>
<td></td>
</tr>
</tbody>
</table>

18.45. Steps for making violence assessment (Addressing issues)

- Write an action plan to address risks (implementing recommendations).
- Start to implement recommendations
- Review on a regular basis the status of the risk assessment and action plans.

18.46. Violence intervention (DOSH) – Environmental intervention

- Improving The General Environment
- Improving The Workstation Design
- Improving The Interface Man / New Technology
- Enhancing information and communication

18.47. Violence intervention (DOSH) – Organisational intervention

- Changing work practices
- Improving job content
- Re-arranging working time
- Circulation of Best Practices

18.48. Violence intervention (DOSH)

- Selection tools such as written tests, interviews, performance tests, psychological tests and other prediction devices
- Training and education
- Maintaining Fitness
- Counseling
- Debriefing

18.49. Monitoring and evaluation
- Reporting and recording
- Evaluation

18.50. Plan-Do-Check-Act (PDCA)


18.51. Top Management Commitment

Invest time, money and energy for violence prevention management

Audit Questions
- A written violence prevention policy that sets a high priority for safety and health
- A written violence prevention goal and supporting objective
- Personally follow the violence prevention program
- Set visible example of violence prevention leadership
- Managers participate in the training

18.52. Violence prevention and control
- Engineering control
- Workplace adaptation
- Administrative
- Work practice

18.53. How to prevent type I violence (NIOSH)
- Use physical barriers to protect yourself
- Install silent alarm systems, panic buttons
- Use mirrors, raised platforms and make sure that the area where money is exchanged can be seen
- Use bright and effective lighting
- Make sure that you have enough staff members
- Use drop safes so that there is only a limited amount of cash on hand. Make sure that you post signs telling people that you only have a limited cash supply
- Use height markers on exit doors
- Use video surveillance equipment so that activity is always being monitored
- Control or limit access to the facility
- Install locks on doors that lead to staff-only areas

18.54. How to prevent type II violent (NIOSH)
- Make sure that workers never work alone
- Allow workers to carry pagers, mobile phones, etc.
- Train workers so that they know what to do in a violent situation
- Rethink your policy on wearing of uniforms. WHY?
- Meet often with your employees so they can voice concerns about safety issues

18.55. How to prevent type III violent (NIOSH)
- Have close contact with employees. Make sure that everyone is feeling a part of the organization.
- Review any act of violence that has occurred in the workplace, even if it is considered minor.
- Have a WRITTEN policy explaining how violence in the workplace will not be tolerated.
- State clearly what workplace violence is and what is and is not acceptable behavior.
- Train all staff about what to do if violence occurs.
- Set up a "Buddy" system so each employee has someone to go to in case they are having problems at work.
- Remain calm when confronting an employee.
- Look for warning signs.

18.56. Steps taken for incidence of violence

Difference between plan and unplanned violence management

![Diagram of Incident of Workplace Violence]

Source: Hire Centrix. Workplace Violence Prevention - Readiness and Response
Source: Human Resources and Skill Management Canada. 2012
Conclusion to Unit

Stress and violence are very much related. Therefore, to understand about violence, students must first comprehend the concept of work stress. The Department of Occupational Safety and Health has provided a guideline on how to manage violence at the workplace and this guideline is also applicable to manage stress at the workplace. Reported cases of violence at the workplace are increasing around the world. However, this figure is much lower than the actual numbers because most violence is under-reported. Violence is preventable and therefore it is important for every workplace to organize continuous assessment on the risk of violence.

Additional References

   http://www.hirecentrix.com/.
   and of stress and violence at the workplace. Ministry of Human Resource 
   Department.

Discussion 18.0

An example of violence at the workplace

I have been burdened with loads of difficult tasks by my superior officer. 
Even though my colleagues share the same responsibilities, I was the 
one who became the victim. It is a rare occasion for me to leave office 
the moment the clock showed six in the evening, unlike my co-workers. 
Usually I am only being able to leave at about 8 p.m. After completing a 
task, immediately I would be given another bundle of files even though 
the other workers are quite free. It was difficult for him to obtain leave. 
Even when I showed a medical certificate, many questions were hurled 
back some degree of sceptism.

1. Does the above phenomenon is categorized under violence. 
2. If yes, what type of violence does the above phenomena 
   explains about? Explain your answer.
Answer to Discussion 18.0

1. Yes.
2. Bullying. The answer is given in the notes (point 18.13).
When workers are sick, they usually consult physician and take sick leave. However, when there is too much sick leave taken in a year, it may indicate that a problem exists in their workplace. In this topic, students will learn about the types of sick leave, related legislation in Malaysia, pros and cons of sick leave and how to manage abuse of sick leave.

**Objectives to Unit**

- After this session, students should be able to:
  - Identify the type of sick leave
  - Identify the causes of sick leave
  - Understand the benefits and disadvantage of sick leave
  - Understand on how to manage sick leave

**19.0 Content**

19.1. What is sick leave?
19.2. Types of sick leave
19.3. What is the benefit of allowing sick leave?
19.4. Evidence on the benefits of sick leave
19.5. Paid sick leave allows workers to
19.6. Sick leave and legislation in Malaysia
19.7. The number of sick leave allowed in Malaysian legislation
19.8. Incidence of paid sick leave
19.9. Causes of sick leave
19.10. Causes of Too Much Sick Leave
19.11. Patterns of paid sick leave
19.12. Sick leave expenditure
19.13. Abuse of sick leave

Important Notes

19.1. What is sick leave?
- Leave that employees can take when they can't attend work because they are sick or injured
- At least 145 countries ensure access to paid sick days for short- or long-term illnesses, with 127 providing a week or more annually

19.2. Types of sick leave
- Short-term sickness absence has been defined as absences from work of up to (but less than) 4 weeks.
- Long-term sickness absence as lasting 4 or more weeks.

19.3. What is the benefit of allowing sick leave?
- a kind of social health protection and is embedded in human rights (ILO Conventions and the Decent Work Agenda)
- intended to protect the worker’s status and income during the period of illness or injury through health and financial protection
- absence of paid sick days forces ill workers to decide between caring for their health or losing jobs and income
- without paid sick leave many people working cannot afford to choose.
19.4. Evidence on the benefits of sick leave

- In 2009, many employees without the possibility of taking paid sick leave days attended work while being sick allowing H1N1 to spread into the workplace causing infections of some 7 million co-workers in the USA.
- Working while sick lowers productivity and grows health and social inequalities.
- Workers with access to paid sick leave were 28% (95% confidence interval = 0.52, 0.99) less likely than workers without access to paid sick leave to be injured (N = 38000 US workers (Asfaw, Pana-Cryan, Rosa, 2012).
- Some studies show that the cost of losing an employee is often greater than the cost of providing sick days to retain existing employees
- Presenteeism costs the U.S. economy $180 billion annually in lost productivity

19.5 Paid sick leave allows workers to:

- Access promptly medical care and the opportunity to follow treatment recommendations
- Recuperate more quickly
- Reduce the health impact on day-to-day functioning
- Prevent more serious illnesses from developing
- Reduce the spreading of diseases to the workplace and community

19.6 Sick leave and legislation in Malaysia

- The Employment Act 1955
- An employee is entitled to paid sick leave only under the following circumstances:
  - he has obtained a certificate from a registered medical practitioner duly appointed by his employer; or
  - he has obtained a certificate from a dental surgeon; or
  - if no such medical practitioner is appointed, or the services of such a practitioner are not obtainable within a reasonable time
or distance, then other registered medical practitioners or government medical officers will be accepted; and
- he has informed or has attempted to inform the employer of his sick leave within 48 hours of the commencement of the sickness.

19.7 The number of sick leave allowed in Malaysian legislation
- The number of days of paid sick leave which an employee is entitled to in each calendar year is as follows:
  - Less than 2 years – 14 days
  - 2 years but less than 5 years – 18 days
  - 5 years or more – 22 days
- If hospitalization is necessary, the amount of paid sick leave can be extended by up to 60 days per calendar year.

19.8 Incidence of paid sick leave
- In the 15 member states of the EU, 14.5 % of employees reported sickness or accident absence of at least one day in 2000.

MCs in Malaysia among highest in the region (Malaysian Employers Federation, 2010)
19.9 Causes of sick leave

- According to the World Health Organisation (2010), the origin cause of sick leave is unhealthy and unsafe workplace.
- The mechanism of sick leave can be demonstrated in Figure 1.1.
- In the framework, unhealthy and unsafe workplace can cause psychological and physical illnesses.
- Psychological and physical illnesses leads to accidents and injuries, other work-related illness, job dissatisfaction, burnout and workplace violence.
- These consequences affect organisation such as increase absenteeism, increase presenteeism, and job turnover.

19.10 Causes of Too Much Sick Leave

- Stress has become the most common cause of long-term sick leave in Britain (Chartered Institute of Personnel and Development (CIPD)) .
- Actual physical or mental illness.
- An unhealthy lifestyle.
- The need to care for family members.
- Personal emotional issues.
- Problems in the workplace, causing avoidance or stress-related illness.
- Lack of understanding of sick leave policies.
- Low job satisfaction and disengagement, often resulting from a low level of control over work or decision-making.
- Low quality of life in economic, social, and physical terms.
- A lack of appreciation that work brings obligations as well as rewards.

19.11 Patterns of paid sick leave

- paid sick leave days is strongly related to economic cycles and particularly reduced during periods of high unemployment.
- Gender specific differences occur in all sectors observed – women usually takes more sick leave
- The extent of paid sick leave varies by occupation and economic sector (e.g. civil servants takes more leave than private sectors)
- Singles, especially women and single parents have more days of paid sick leave than workers that are married with or without children
- The number of paid sick leave days is generally higher among older employees:
- Paid sick leave is also strongly linked to the socio-economic status and income level
19.12 Sick leave expenditure

- The average expenditure per capita in the 27 European countries amounts to 197 EUR / PPS per capita. Consequences of sick leave 
- In Malaysia, businesses are losing up to a whopping RM9 billion yearly as a result of workers taking sick leave (News Straits Times, 2012) 
- In comparison to expenditure on other important cash transfers provided through social protection, such as old age pensions, survivors pensions, unemployment benefits and family/child allowances paid sick leave represents the lowest expenditure per capita of all.

Source: EUROSTAT – ESSPROS, Expenditure on chosen benefits in PPS per inhabitant in 2005, 46/2008 – Statistics in focus
19.13 Abuse of sick leave

- In Malaysia, the number of deceptive cases was high, with some malingerers exhausting the maximum 22 days sick leave allowed in a year (The Star, 2010).
- Malingerers, put financial strain on employers who had to pay 250% more for each man-day lost when a worker went on sick leave.
- Employers are incurring over RM1 billion losses annually because of workers who feign illness to get sick leave.

19.14 How to prevent sick leave abuse

- Develop a clear sick leave policy
  - state that there are a certain amount of approved sick days allowed per employee per year
  - clear instructions for how to be approved for sick leave
  - steps will be taken if an employee is suspected of abusing this policy.

- Get to the bottom of employee sick incidence abuse
  - check with the supervisor of these employees to get to the root of the problem

- Have a fair system for tracking all time off
  - tracking time off for all employees. Over time, some patterns may

- Deal with offenders quickly with consequences
  - disciplinary action
Conclusion to Unit

Efficient evidence supports that sick leave do more good than harm to the workers and organization. Problems only occur when sick leave has been abused by the workers. At the end of this topic, students will understand factors of sick leave, difference between sick leave and sick leave abuse and how to manage sick leave abuse at their workplace.

Additional References


Discussion 19.0

1. Make a group of four and discuss on the best way to identify sick leave abuse among employees.
Answers to Discussion 19.0

1. Continuously monitors the sick leave pattern. Suspicious requests for sick leave,

a) such as those that fall on a day for which the employee was denied annual leave

b) or a day when the employee was supposed to do an unpopular work assignment

c) or a day that extends a holiday or weekend
UNIT 20
Water and Air Decompression

Introduction to Unit
Human breathe air which consists of 78% nitrogen. As this is an inert gas, it has no negative effects while humans are at the surface. While underwater, this normally harmless gas poses potential problems for workers who work in pressured environment. The most serious condition is decompression sickness, which is often referred to as “the bends”.

Objectives to Unit

After this session, students should be able to:

- Describe laws of gasses and relate them to pressure hazard caused by water and air
- Define decompression illness and its cause
- Identify various forms of decompression illness
- List the major factors that increase the risk of decompression sickness
- List the measures to minimize the risk of decompression sickness

20.0 Content

20.1 Definition and Introduction
20.2 Gas Laws
20.3 How does Decompression Sickness Happens?
20.4 Hyperbaric Work Environment
20.5 When does decompression sickness happens?
20.6 Symptoms of decompression sickness
20.7 Hypobaric work environment
20.8 Role of occupational health doctor
20.1 Definition and Introduction

Pressure is force acting on a unit area.

- Pressure = Force/Area
- Unit of pressure
- 1 atmosphere = 29.2 inches (760 mm) of Hg
- 22 feet (10.08 meters) of seawater
- 101.3 kilopascals (kPa)
- 14.7 pounds per sq inch (psi)

- Pressure nomenclature
  - Absolute pressure
  - Ambient pressure
  - Atmospheric pressure
  - Hydrostatic pressure
  - Partial pressure
  - Design pressure

- Composition Of Gases In Atmosphere consist of the following:

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
<th>Volume percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>78.094</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O</td>
<td>20.948</td>
</tr>
<tr>
<td>Atgon</td>
<td>A</td>
<td>0.934</td>
</tr>
<tr>
<td>Neon</td>
<td>Ne</td>
<td>0.001818</td>
</tr>
<tr>
<td>Helium</td>
<td>He</td>
<td>0.000524</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>H</td>
<td>0.00005</td>
</tr>
<tr>
<td>Others</td>
<td>(Co, Kr, Xe, etc)</td>
<td>0.01</td>
</tr>
</tbody>
</table>
20.2 Gas Laws

- **Gas laws - Dalton’s Law**
  - Total pressure of mixture of gases equals sum of partial pressure of each gas on mixture
  
  - Dalton’s Law states that the total pressure of a gas is equal to the sum of pressures of its individual components
  
  - At sea level the total air pressure is 1 atm. or 760 mm Hg. Of this total air pressure, 21% (or .21) is from oxygen, 78% (.78) from nitrogen, and 1% (.01) from other gases. The percentage of an individual gas times the total air pressure gives the pressure of that component gas.

  - Thus, at sea level:

    | in mm Hg | in atm. |
    |----------|--------|
    | 760(.21) = PO₂ | 159.6 mm Hg | .21 atm. |
    | 760(.78) = PN₂ | 592.8 mm Hg | .78 atm. |
    | 760(.01) = P_{other} | 7.6 mm Hg | .01 atm. |

    Total: 760.00 mm Hg 1.0 atm.

- **Gas laws - Boyle’s Law**: volume of gas is inversely proportional to its pressure in body. P₁V₁ = P₂V₂ (Trapped gas in cavities)
  
  - The mechanical responses to changes in pressure are in accordance with Boyle’s Law, which states that a volume of gas is inversely proportional to the pressure to which it is subjected, temperature remaining constant.
Gas laws - Henry’s Law

- The amount of gas in solution is proportional to the partial pressure of that gas over the solution.
- As the pressure of the gas above a solution increases, the amount of that gas dissolved in the solution increases.
- Reverse is also true, as the pressure of the gas above a solution decreases, the amount of gas dissolved in the solution decreases and forms a “bubble” of gas within the solution.

Henry’s Law illustration

Gas diffusion: Gas will diffuse from area of high concentration to low concentration (Transfer of gases in body such as O2 and CO2)
20.3 How does Decompression Sickness Happens?

- What happens to inhaled air at depth?
  - At depth all pressure increase
  - Doubling of ambient air pressure occurs at just 33 feet
  - Tripling of ambient air pressure at 66 feet
  - Boyle’s Law and Diving as laid out in the following table.

<table>
<thead>
<tr>
<th>Air</th>
<th>Pressure (mm Hg)</th>
<th>Pressure (psi)</th>
<th>Pressure (atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea 33 ft</td>
<td>1520</td>
<td>29.4</td>
<td>2</td>
</tr>
<tr>
<td>Sea 66 ft</td>
<td>2280</td>
<td>44.1</td>
<td>3</td>
</tr>
<tr>
<td>Sea 99 ft</td>
<td>3040</td>
<td>58.8</td>
<td>4</td>
</tr>
<tr>
<td>Sea 132 ft</td>
<td>3800</td>
<td>73.5</td>
<td>5</td>
</tr>
</tbody>
</table>

- How does the increased pressure at depth affect gas in the body?
  - The increased pressure of each gas component at depth means that *more* of each gas will dissolve into the blood and body tissues, a physical effect predicted by Henry’s Law
  - Inhaled gases are in close contact with blood entering the lungs
  - Hence, the greater the partial pressure of any inhaled gas, the more that gas will diffuse into the blood.

20.4 Hyperbaric work environment

- Hyperbaric work environment (work below sea level pressure or aquatic)
- Together, Boyle’s and Henry’s laws explain what happens when compressed air is breathed
  - inhaled PO$_2$ and PN$_2$ increase and
  - the amount of nitrogen and oxygen entering the blood and tissues also increase
- Potential hazards:
  - Mechanical effects
  - Inert gas narcosis – physical and mental disturbances when breathing gas contains inert gas under pressure
  - Effects of CO2 accumulation – refer next slide
  - Oxygen toxicity – hyperoxia
  - Decompression sickness

Note:
- Inspiration: When atmospheric pressure is greater than within the lungs, air flows from outside into the lungs.
- Expiration: When pressure in the lungs is greater than the atmospheric pressure, air moves from the lungs to the outside.
- If surrounding pressure is high, CO2 could not be exhaled thus CO2 accumulated

20.5 When does decompression sickness happens?
- A diver ascends from a dive
- A worker who is doing underwater logging
- A worker comes out of a pressurized caisson, or out of a mine, which has been pressurized to keep water out
- An unpressurized aircraft flies upwards
- The cabin pressurization system of an aircraft fails.
- Divers flying in any aircraft after diving
- Pressurized aircraft are not risk-free, since the cabin pressure is not maintained at sea-level pressure

- Decompression sickness (DCS) or diver's disease
  - Describes a condition arising from dissolved gases coming out of solution into bubbles inside the body on depressurization
  - The bends, or caisson disease
  - DCS most commonly refers to a specific type of underwater diving hazard but may be experienced in other depressurization events such as caisson working, flying in unpressurised aircraft.
When the gases in cavities can't equalize with the ambient environment, the gas is considered to be "trapped"

- Lungs
- Middle ear - Middle ear squeezes occur because of obstruction of the eustachian tube.
- Sinuses - If openings of sinuses are obstructed equalization of pressure becomes difficult
- Tooth cavities - mechanically imperfect fillings
- Stomach and intestines - gases in the stomach and intestines expand during ascent

20.6 Symptoms of decompression sickness

- Bends – bubble location at mostly large joints of the body (elbows, shoulders, hip, wrists, knees, ankles)
- Chokes – lungs, burning deep chest pain
- Skin bends – Itching usually around the ears, face, neck arms, and upper torso, Sensation of tiny insects crawling over the skin
- Neurologic - Confusion or memory loss, Headache, Abnormal sensations such as burning, stinging, and tingling around the lower chest and back

Factor predisposing to decompression sickness

- Ill health
- Old age
- Obesity
- Exercise / exertion
- Drugs
- Alcohol
- Cold
- Hypoxia
- Previous exposure to decompression
  - e.g. several unpressurized flight scube or professional diving before flight
20.7 Hypobaric work environment

- Work in conditions with reduced pressure – above sea level
- For example
  - Aviation
  - Space industry

As altitude increases, excess nitrogen will begin to try to escape the body to the lower pressure outside. This results in decompression sickness, which can be very painful and even deadly.

- Potential hazards
  - Reduction in partial pressure of oxygen
  - Decompression sickness

- Manifestation of decompression sickness at 28000 feet altitude
  - Bends – joint pains 74%
  - Creeps – skin rash 7%
  - Chokes – chest discomfort 5%
  - Staggers – neurological complaints 1%
  - Visual disturbances 2%
  - Reduced awareness/confusion 9%

- Dalton’s Law and Hypoxia

<table>
<thead>
<tr>
<th>Partial pressure</th>
<th>Ambient air</th>
<th></th>
<th>Alveolar air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>600 mmHg</td>
<td></td>
<td>Nitroge</td>
</tr>
<tr>
<td>Oxygen</td>
<td>160 mmHg</td>
<td></td>
<td>Oxygen</td>
</tr>
<tr>
<td>Total</td>
<td>760 mmHg</td>
<td></td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Water vapour</td>
</tr>
</tbody>
</table>

- % saturation of hemoglobin varies with changes in partial pressure of alveolar oxygen at various altitudes
• With reduced pressure, % saturation of hemoglobin will reduce

• The effects will be on the central nervous system where increasing hypoxia (reduced O2)

• The symptoms of hypoxia includes:
  o Feeling tiredness, sleepiness
  o Euphoria with outburst of joy
  o Impairment of judgement
  o Dulling of thought
  o Light headedness, diziness, nausea
  o Tingling of hands and feet
  o Pallor of skin, cyanosis
  o In-coordination of imbs and disorientation
  o Falling od vision
  o Semi-consciousness
  o Unconsciousness

20.8 Role of occupational health doctor

• Advice on health effects of pressure changes
• Treatment of pressure related complications
• Medical selection of workers to be engaged in work in hypobaric or hyperbaric environments
• Periodic medical examination of diving or aviation personnel
• Certification
• Of invalidity for air travel
Conclusion to Unit

Decompression sickness is best known as a diving disorder but the hazard is not limited to underwater work but could also affect workers working in pressurized environment or vessel on land. Decompression sickness could be avoided with proper medical surveillance and pre-placement surveillance put in place. Pre-disposing factors should also be observed to prevent decompression sickness to occur.

Discussion 20.0

1. Which of the following statements are TRUE about pressure hazards?
   i. As the altitude above sea level increases, atmospheric pressure decreases in a non-linear fashion
   ii. Decompression sickness can result from the decompression that accompanies a rapid rise from sea level to at least 18,000 feet
   iii. Bends is a common name for decompression sickness. Early symptoms occur in body bends or joints such as elbows, knees and shoulders
   iv. Chokes occurs with symptoms of coughing and choking due to bubbles in the respiratory system
   v. Hyperoxia is a reduction from partial pressure can result from reduced available oxygen and cause a problem in breathing known as hypoxia
Answers to Discussion 20.0

1. i, ii, iii, iv
UNIT 21
Emergency Response Plan and First Aid

Introduction to Unit
The actions taken in the initial minutes of an emergency are critical. A prompt warning to employees to evacuate, shelter or lockdown can save lives. A call for help to public emergency services that provides full and accurate information will help the dispatcher send the right responders and equipment. An employee trained to administer first aid or perform CPR can be lifesaving. Action by employees with knowledge of building and process systems can help control an incident such as a chemical gas leak at a factory and minimize damage to the facility and the environment.

Objectives to Unit
After this session, students should be able to:
- Understand the importance of emergency response plan in the workplace
- Obtain an overview of First Aid at the workplace

21.0 Content
21.1 Introduction-rationale, major incidents
21.2 Medical emergency and its definition
21.3 Emergency response plan (ERP)
21.4 First aid in the workplace
21.5 First aid training program for the workplace
21.1 Introduction

The rationale of having an emergency response plan in the work environment is as follows:

- Emergency can happen in any organization at any time
- The extent of anticipation and recognition of risks, planning and practice before and emergency occurs can determine how serious the impact will be
- Preparedness is the most important aspects of assuring that an unplanned event or emergency has minimal impact on the organization, its workers, environment, and surrounding community.
- Emergency response plan in most countries is driven by the local regulations, e.g. Occupational Safety & Health Act (OSHA), 1994
- An example: the stipulation for having an emergency response plan is explained in the Control of Industrial Major Accident Hazard regulations 1996; part IV Act 18, 19, 20 & 21.

Some of the major incidents/ disasters reported globally that caused a change in the field of occupational safety and health is:

1. International
   - Bhopal, India
   - Chernobyl, USSR
   - Piper Alpha, North Sea, UK

2. Local incidents
   - Bright Sparklers, Sg. Buloh
   - Gas Processing Plant Fire, Kerteh
   - Middle Distillate Plant Explosion, Bintulu
The following tables present the Major Industrial Accidents across Worldwide and Asia.

Table 21.1 Major Industrial Accidents Worldwide

<table>
<thead>
<tr>
<th>Type</th>
<th>Date</th>
<th>Location</th>
<th>Total deaths</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine</td>
<td>1912</td>
<td>Atlantic struck iceberg, Atlantis Ocean.</td>
<td>1517</td>
<td>Regulations regarding numbers of lifeboats; all passengers ships equipped for round-the-clock radio watch; International Ice Patrol</td>
</tr>
<tr>
<td>Explosion</td>
<td>1937</td>
<td>New London School, Texas</td>
<td>294</td>
<td>Odorant applied into natural gas</td>
</tr>
<tr>
<td>Nuclear</td>
<td>1984</td>
<td>Chernobyl, Russia (nuclear plant explosion, released explosion over Russia and Europe)</td>
<td>31</td>
<td>Re-evaluation of nuclear power safety</td>
</tr>
<tr>
<td>Oil &amp; Gas</td>
<td>1988</td>
<td>Piper Alpha, UK</td>
<td>167</td>
<td>Changes in the regulation of offshore operation, design and emergency response procedures</td>
</tr>
<tr>
<td>Oil spill</td>
<td>1989</td>
<td>Exxon Valdez, USA</td>
<td>NiL</td>
<td>Global implement of Corporate Policy on Alcohol &amp; Drug in the workplace</td>
</tr>
</tbody>
</table>
Table 21.2 Major Industrial Accidents in Asia

<table>
<thead>
<tr>
<th>Type</th>
<th>Date</th>
<th>Location</th>
<th>Total deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal isocyanate</td>
<td>1984</td>
<td>Union Carbide Plant, Bhopal, India.</td>
<td>2600</td>
</tr>
<tr>
<td>Gun powder</td>
<td>1987</td>
<td>Seoul, Republic of Korea</td>
<td>9 (59 injured)</td>
</tr>
<tr>
<td>Liquid petroleum gas</td>
<td>1990</td>
<td>Nagothane India</td>
<td>36 (15 injured)</td>
</tr>
<tr>
<td>Fireworks</td>
<td>1991</td>
<td>Bright sparkles factory, Sg Buloh, Malaysia.</td>
<td>40 (60 injured)</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1991</td>
<td>Dhaka, Bangladesh</td>
<td>7 (30 injured)</td>
</tr>
<tr>
<td>Flammable Chemicals</td>
<td>1991</td>
<td>Bangkok, Thailand</td>
<td>5 (&gt;200 injured)</td>
</tr>
<tr>
<td>Gun powder</td>
<td>1993</td>
<td>Hubei, China</td>
<td>63 (52 injured)</td>
</tr>
<tr>
<td>Reaction between hydrosulphate &amp; sodium sulphide</td>
<td>1993</td>
<td>Shenzen, China</td>
<td>15 (26 injured)</td>
</tr>
<tr>
<td>Ethene</td>
<td>1997</td>
<td>Beijing, China</td>
<td>9 (6 injured)</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>1999</td>
<td>Chiang Mia, Thailand</td>
<td>35 (104 injured)</td>
</tr>
<tr>
<td>Petrol</td>
<td>1999</td>
<td>Chonduri, Thailand</td>
<td>7 (12 injured)</td>
</tr>
<tr>
<td>Carbonyl chloride (phosgene)</td>
<td>2000</td>
<td>Rayong, Thailand</td>
<td>1 (101 injured)</td>
</tr>
</tbody>
</table>
21.2 Medical Emergency and its definition

What is a medical emergency? A medical emergency occur when any of the followings exist:

- A defect in the structure or function of an organ or organ system either at birth or acquired during life
- A serious disease caused by an infection organism such as bacterium or virus
- Effect of a harmful substance, such as poison or a drug

The medical emergency could also occurs at individual level as well as at group/mass level.

- Different actions are required for the different level of emergencies
- In mass emergency, multiple internal and external agencies are usually involved

Definition of Medical Emergency could be phrased as one of the followings:

- A situation or state characterized by a clear & marked reduction in abilities of people to sustain their normal living condition, with resulting damage & risk to health, life & livelihood
- Presence of an expected condition requiring specific action plan to normalize, e.g. fire, explosion, product or gas leak, loss of containment, or threats.
- Life threatening condition which requires the administration of life-saving measures (German Red Cross)

Disaster: Impact on PEAR

- People
- Environment
- Asset
- Reputation
What is the cost of disaster?
The cost of disaster could present itself in terms of insured and uninsured costs as in
the following table.

Table 21.3 The costs of disaster

<table>
<thead>
<tr>
<th>Insured costs</th>
<th>Uninsured costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Combined liability (employers, product&amp; public)</td>
<td>• Property, materials &amp; equipment</td>
</tr>
<tr>
<td>• All risks (property, materials damage&amp; business interruption)</td>
<td>damage</td>
</tr>
<tr>
<td></td>
<td>• Legal costs</td>
</tr>
<tr>
<td></td>
<td>• Expenses on emergency supplies</td>
</tr>
<tr>
<td></td>
<td>• Overtime &amp; Temporary labour</td>
</tr>
<tr>
<td></td>
<td>• Investigation time</td>
</tr>
<tr>
<td></td>
<td>• Loss of expertise/ experience</td>
</tr>
<tr>
<td></td>
<td>• fines</td>
</tr>
</tbody>
</table>

Categories of emergencies are also different according to the following table.

Table 21.4 Categories of emergencies

<table>
<thead>
<tr>
<th>Natural Disasters</th>
<th>Human Error</th>
<th>Process Error</th>
<th>Equipment Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adverse weather</td>
<td>Vehicle impact</td>
<td>Process overheat</td>
<td>Essential utility failure due to natural disaster</td>
</tr>
<tr>
<td>Floods</td>
<td>Confined space entry</td>
<td>Process overflow</td>
<td>Valve leaks</td>
</tr>
<tr>
<td>Earthquakes</td>
<td>Aircraft crashes</td>
<td>Vapour release</td>
<td>Chemical spills</td>
</tr>
<tr>
<td>Avalanches</td>
<td>Packaging failures</td>
<td>Explosions</td>
<td>Fires</td>
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<tr>
<td>Volcanic eruptions</td>
<td>Public civil disturbances</td>
<td>Community noise</td>
<td>Radiation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>accidents</td>
</tr>
</tbody>
</table>
The management of a medical emergency are according to these steps:

- **Triage**
  - Act of sorting the disabilities according to the type or severity with the aim of doing the greatest good for the greatest number

- **Emergency lifesaving procedures**
  - Airways management & rescue breathing
  - Cardiopulmonary resuscitation (CPR)
  - Control of breathing

- **First aid**
  - Splinting of fractures
  - Dressing of wounds
  - Covering burnt area
  - Analgesia (pain relief)
  - Reassurance

- **Evacuation**
  - At the earliest possible
  - By the most appropriate means
21.3 Emergency Response Plan

1. Emergency preparedness

- Identification and assessment of risk associated with potential emergencies (scenario-based hazard and risk assessment)
- Medical Emergency Response Plan should include:
  - Procedures
  - Resources
  - Emergency medical equipment
  - Internal and external contact and support
  - Management of injury & triage
  - Evacuation plan
  - Training for those who would be involved or affected, including simulated & desktop drills
2. Hazard & Risk Assessment (HRA) for ERP

- Business or facility type
  - Nature & location of business will determine extent of emergency which might affect the customer & community
  - e.g. hazardous chemicals, radiation source, infectious agents, high energy or high temperature equipment

- Assessment should focus on identification of potential site-pacific emergencies because of unique nature of the business and its location

- Planning also takes into consideration of:
  - Hazards identified by industrial hygienist/ Chemical Health Risk Assessment assessor
  - Possibility of transportation incidents and customer emergencies

3. Developing the ERP

- Involvement of all operating areas of the business & local facilities
- ERP is well understood & known by all at worksite
- HRA provides the basis for developing ERP
- Site security is an additional concern
- Set up an emergency control centre
- Communication such as telephone line & cell phone
- Human resources
- Building / site plan
- Training and refresher
- Regular simulated drills & preparedness
- Assessment /audit
4. Emergency Response planning

- Policy and procedures to be developed
- Considers hazards at site and worse case and likely scenarios
- National Safety Directive 20 to be followed when managing major incidents

A. NSD 20-Level One

- Incident can be controlled locally and there is no potential for spread
- Incident is not too complex and cause minimal loss of life and assess and generally does not impede daily activities of the population
- Local authorities have the ability to control and overcome the incident through district agencies with or without little external assistance

B. NSD 20-Level Two

- Incident is more serious & encompasses a larger area or involves more than two districts & has potential to spread
- Likelihood of extensive life & assess loss. Such incident destroys infrastructures & disrupts population activities. It is more complex than disaster at Level 1, whereby search & rescue operations are more difficult
- Need to be managed by state authorities with limited or no help from external agencies

C. NSD 20-Level Three

- Originate from Level 2 situations but progress to become more complex and cover a larger area or more than two states
- Need to be managed by central authorities with or without help from other countries
5. Planning

- ERP should have:
  - Scope which include contingency plan specific for the work site
  - Objectives which include details such as:
    - Level of management involved in responding to an emergency
    - Ensuring safety of all personnel is always considered
    - Minimization of damage in the event of an emergency
    - Provision for safety when resuming operations
    - Specific procedures for certain emergency situations that are most probable and/or most damaging
    - Ensuring line of communication / notifications are clearly defined and workable
    - Details related to alternates whether for people, equipment or procedures

- Set up the Communication & Emergency Coordination Centre (COMCEN) at strategic location
- COMCEN commander should be a representative from senior management

6. Initiation

- Initiation of Emergency Response Plan
  - Alarm triggered either automatically or manually
  - Situation assessed by area custodian and reported to Onscene Commander (OSC)
  - OSC evaluate the situation. Level 1 – resolve on site, followed by a report to COMCEN
  - If level 2 or 3, OSC reports immediately to COMCEN either by radio/fax using Emergency Report From which consist of the following:
• Type of emergency situation
• Name/location & date/time of incident
• Description of incident & description of injury/damage
• Name/designation of person authorizing the message
• Telephone contact number
• Alarm can be in the in the form of bell, siren, etc
• In noisy areas, there should also be coloured light, e.g. blue light for process upset; amber light for emergency alarm and red light for evacuation
• Specific assembly point for headcount should be identified and all personnel or visitors to the work site are made aware of this

7. Elements of ERP

- Evacuation plan
- Area custodian/damage control team  
  - Contain or control exposures to employee, general public & environment

- Fire brigade  
  - Industry in remote areas or with special fire hazard

- Emergency medical facility  
  - First Aid Box  
  - First Aid personnel  
  - First Aid facility  
  - Industrial nurse  
  - Medical doctor

8. Evacuation Plan

- Who authorizes evacuation?  
- Media/Channel of instruction?  
- Who else to notify?  
- Responsibility of ensuring evacuation?
• Where do evacuees go?
• How to determine all employees out?
• Have all personnel and visitors been evacuated?
• What medical facilities are needed?
• Will electricity and gas be shut down?
• Manufacturing process that needs to be shut down?
• Who will do shut down?

9. Headcount and Checklist

• Work site should ensure that all personnel and visitors are accounted for & the list available during emergency for headcount
• Checklist is available for systematic shutdown of the site/plant during emergency
• Checklist must also have the contact number of key personnel involved in the emergency

10. Checklist should also provide guide on what medical facilities are needed.

11. Emergency Systems

• Alarm systems & air horns
• Fire detection & alarm
• Automatic gas detector
• Heat and smoke detection
• Fire fighting system
• Assembly points
• Messaging network system
• Resources
12. Training

- Training Method
- Training session
- Drills
- In-house
- Joint emergency
- Exercise
  - Desktop
  - Small scale
  - Full scale

13. Some lessons from the drill.

- Rescue teams to slow to arrive in with full gear
- OSC (On–Scene commander) too near to the scene
- No air/gas monitoring of surrounding area
- Wrong alarm was active
- Decontamination procedure was not performed
- Medical team not informed of victim exposure
- No medical post, triage/treatment area
- No request for medical help/back up
- No “SAFE” zone established

14. Responsibilities

- Chairman/CEO/MD
  - Provide overall guidance for emergency response
  - Evaluate incident, impact on the company & response action
  - Allocate appropriate resources
  - Review & approve all external/employee communications
  - Maintain communication with HQ (depending on the organization)
- Maintained contact with relevant State & Federal officials at the Ministerial level
- Issue public statements
- Make site visit if appropriate

- **COMCEN Commander**

  - Obtain factual data of incident
  - Review response actions
  - Provide technical support/evaluation
  - Keep CEO informed/make recommendations
  - Maintain communication with OSC
  - Liaise with Public Affairs manager
  - Assist on legal matters, claims, insurance, etc
  - Announce end of emergency

- **Public Affairs Manager**

  - Review/support Operating Site PA activities
  - Coordinates external communications
  - Develop employee communications
  - Keep CEO informed/ provide guidance of PA implications
  - Review/ issue public statements
  - Review/ approve PA expenditure
  - Liaise with local media as appropriate
  - Make a visit if appropriate

- **On-scene commander**

  - Notify through pre-arranged channels to COMCEN commander
  - Of emergency of emergency condition
  - OSC or his designate (DCT Leader) assesses the situation and determine if his personnel are able to control the emergency
without outside assistance. If Level 1, continue to guide DCT until it is under control and announce end of emergency
- If Level 2 or Level 3, inform COMCEN immediately
- Keep COMCEN Commander informed and provide guidance to DCT Leader
- Evacuate if the situation is out of control or announce end of emergency

- Damage Control Team Members
  - Each work site shall designate individuals to serve as members of DCT
  - Should be healthy and fit
  - Involve an search and rescue, should pass the respirator fit-test
  - Should ensure that all emergency equipment are maintained and ready to use all the time

### 21.4 First Aid

- What is First Aid?
  - It is the immediate care given to an injured or ill person to control the situation until proper/specialized medical care arrives

- The Chain of Survival

```
Early access
  ▼
Early CPR/Treatment
    ▼
Early advance care
```
First Aid Guidelines should consist of the following three items:

- References
- Legal provision
- Components
  - First aiders
  - First aid box
  - First aid room

### References
- Guidelines of First Aid Facilities in the workplace, DOSH
- First aid training centres recognised by the Ministry of Health
- Recommended contents of a first aid box
- Typical layout of a first aid room at the worksite
- Recommended facilities for a first aid room
- Checklist for a first aid box

### Legal provision
- Factories And Machinery Act (FMA) 1967
  - SECTION 25 (Parent Act) Regulation 38 (Health, Safety And Welfare)
  - Provide and maintain a readily accessible first aid box or cupboard
  - Assign responsibility who must be proficient in first aid training if >20 employees
- Occupational safety and health Act (OSHA) 1994
  - SECTION 15 (Parent Act)
  - Every employer and self employed must ensure, so far as practicable, the safety, health and welfare at work of all employees

### Components
1. First aider
2. First aid box / first aid room
3. First aid equipment/manual
1. First Aider
   - Number
     - >20 workers
       - 1 First aider
     - 20-400
       - Low risk: 2 first aider for tp 150 employees
       - High risk: 1 first aider for every 20 employees
     - >400 workers
       - 2 First Aiders for every 150 workers
       - State registered nurse (SRN) or Medical Assistant (MA) on site
   - Selection criteria
     - Mature, responsible
     - Calm in emergency, free to leave work in emergency
     - Physically fit
   - Training
     - Recognized training
     - Refersher courses
   - Responsibilities
     - Management Of Casuality
     - Maintain First Aid Facilities/ Equipmet
     - Maintain Treatment Records

2. First Aid Box
   - Design
     - Sturdy, portable, white cresent on green background
   - Location
     - Clearly identified, well illuminated, accessible location
     - Employees informed of location
- **Content**
  - Listed in appendix of FA Guidelines
  - Sufficient quantity of suitable materials
  - Frequent checks
  - Kept locked with responsible available during all working hours

<table>
<thead>
<tr>
<th>First Aid Box Content</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Factories &amp; Machinery Act 1967, Fourth Schedule, Regulation 38 (2) (I)</em></td>
<td></td>
</tr>
<tr>
<td>- Small individual medicated or unmedicated sterilised dressing for finger</td>
<td>- Suitable splints &amp; wool or other material for padding</td>
</tr>
<tr>
<td>- Medium individual medicated or unmedicated sterilised dressing for hand &amp; feet</td>
<td>- Approved eye ointment or eye drop</td>
</tr>
<tr>
<td>- Large individual medicated or unmedicated sterilised dressing, for other injured parts</td>
<td>- Individual sterilised eye pads in separate sealed packets</td>
</tr>
<tr>
<td>- Assorted adhesive wound dressings</td>
<td>- Rubber or pressure bandage</td>
</tr>
<tr>
<td>- Tringular bandages</td>
<td>- 2% alcoholic solutions of iodine or 1% aqueous solution of gentian violet in a stoppered 2 oz bottle</td>
</tr>
<tr>
<td>- Roller bandages 1&quot; &amp; 2&quot;</td>
<td>- A bottle of sal volatile with the dose and mode of administration indicated on the label</td>
</tr>
<tr>
<td>- Adhesive plaster</td>
<td>- Blunt-nose surgical scissors</td>
</tr>
<tr>
<td>- Absorbent sterilised cotton wool in ½ oz packets or cotton wool strip contained in cotton-wool dispenser</td>
<td>- Safety pins</td>
</tr>
</tbody>
</table>
3. First Aid Room

- **Design**
  - Size - couch and space to moveabout, emergency light, easily cleansed walls and floor, non-slip floor, privacy, comfortable environment

- **Location**
  - Proximity to toilets, lift, main passage ways
  - Accessibility to works areas and car park

- **Content**
  - Listed in Appendix of FA Guidelines

21.5 First Aid Training Programs For The Workplace

- **Introduction to the First Aid and Medical Emergencies**
  - What is First aid and qualities of a first aider
  - Medical Emergencies, e.g
    - Chest pain – angina and heart attack
    - Stroke
    - Diabetic emergencies
    - Convulsion such as epilepsy

- **Risk assessment and analysis of workplace**

- **Emergency preparedness**

- **First aid program**
  - Assessment of the casualty & Triage
  - Shock management
  - Recovery position (practical)
  - Management of burn
  - Heat stress
  - Poisoning
  - Medical emergencies
  - Trauma management
    - Wound management
    - Fracture management
- Bandaging and splinting (theory and practical)
- Introduction to CPR (theory & practical – single person CPR)
- Choking (theory & practical- conscious & unconscious casualty)
- Drowning
- Transportation of casualty
  - Handling of victim with spine injury
  - Application of stiff neck collar and spine board
- Mock drill
- Assessment- Multiple Choice Questions and Practical

**Conclusion to Unit**

Emergencies and disasters can occur any time without warning. The more an organization is prepared for them, the better the organization will be able to act, minimizing panic and confusion and ultimately avoiding injuries and lost of lives when an emergency occurs. Emergency response plan should also be combined with effect first aid facilities in order to ensure the extent of injuries sustained is controlled before medical help arrives.
Discussion 21.1

1. With proper training, emergency can be prevented? True/False

2. Which of the following is the primary use of an emergency response plan?
   a. A reference to be consulted during an incident
   b. A training tool for emergency responders
   c. Both of the above

3. Which of the following are addressed in the emergency response plan?
   a. Who to call during emergency
   b. When to sound the alarms
   c. Ensuring that the responders know evacuation route
   d. All of the above

4. Most emergency response training does not include practice sessions and drills? True/False

5. First Aid Guidelines should consist of which three items?
Answers to Discussion 21.0

1. False
2. Both of the above
3. All of the above
4. False
5. First aid
   a. References
   b. Legal provision
   c. Components
      i. First aiders
      ii. First aid box
      iii. First aid room
Risk communication is an interactive method of exchange of knowledge and judgment on risk among risk assessors, top managers, employees and other interested parties. The exchange of information aims to increase the understanding of employees and employers on their health risk at their workplace. This understanding guides them to take an appropriate action to ensure their safety and health at their workplace. In this topic, students will learn about what important of risk communication and how to develop an efficient risk communication.

Objectives to Unit

After this session, students should be able to:

- Define risk communication
- Understand the important of risk communication
- Knows various methods of efficient risk communication
- Be able to apply the knowledge to set up or improve risk communication system at their workplace.

22.0 Content

22.1 Introduction
22.2 Risk Communication Approach
22.3 Risk Communication Strategies
22.4 Risk Communication Pitfalls
22.5 Message Delivery Channels
22.6 Chemical Safety Data Sheet
22.1 Introduction

- **Definition of risk**
  - A characteristic of a situation or action wherein two or more outcomes are possible, the particular outcome that will occur is unknown and at least one of the possibilities is undesired.

- **Definition of risk communication**
  - Exchange of information and opinions, and establishment of an effective dialogue, among those responsible for assessing, minimizing, and regulating risks and those who may be affected by the outcomes of those risks.
  - Risk communication = Hazard x Probability x Severity + Outrage

- **Three Primary Goals of risk communication**
  - Increased Knowledge and Understanding
  - Enhanced Trust and Credibility
    - Oil spill in Prince William Sound (Alaska), rig explosion in the North Sea (U.K.), fire at the Footscray Terminal (Australia)) and the chemical industry (e.g. Bhopal incident (India)) have made the public perceive that companies cannot be trusted to carry out their occupational health responsibilities.
    - Risk communication is often riddled with suspicion, therefore, initial strategies are needed that build trust.
    - Trust is an important pre-requisite for effective orientation and action.
    - There are four key issues on which trust must be based, including: perceptions of commitment, competence, caring, and predictability (Kasperson et al. 1992).
  - Enhanced Dialogue to Resolve Disagreements
- **Domain of risk communication**
  - Infectious diseases outbreak
  - Industrial, Chemical or technological risks

- **Phases of risk communication**
  - Preparedness – Pre-event risk communication related to preparedness that can be taken for various hazard
  - Response – Crisis communication immediately prior to, in the midst of, or during the hours following the events
  - Recovery – risk communication needs in the weeks, months, and years following the events.

- **Best practice for risk communication**
  - Incorporate risk communication into the process of policy development
  - Treat risk communication as a process
  - Account for uncertainty inherent in risk
    - Accept uncertainty and ambiguity
    - Assure that accurate and reliable information will be shared as soon as it is available
  - Design risk message to be culturally sensitive
  - Acknowledge diverse levels of risk tolerance
  - Involved the public in dialogue about risk
  - Deliver message with honesty
  - Meet risk perception needs by remaining open and accessible to the public
    - Without openness, the public will seek information from less accurate sources
  - Collaborate and coordinate about risk with credible information resources.
    - Establish strategic relationships and networks before a crisis
    - Identify subject area experts
  - Conduct pre-event planning and strategies when accidents/incidents occur.
- Address existing, emerging and anticipated issues
- Determine how to reduce risk, plan an initial response, update regularly
- Conduct practice exercises and drills

22.2 Risk communication approach

- Commonly called SOCHO = single, overriding communication health objective
- The risk should be boiled down into a single most important message
- That message should be repeated until the audience shows responses (e.g. evacuate the place, take precaution action, apply PPE)
- However, this approach has some drawbacks:
  - Difficult to practice for a complex situation
- In a complex situation, craft a set of message that covers all aspects

22.3 Risk Communication strategies

- Determine the goals of the communication effort;
- Identify communication restraints;
- Identify the audience(s);
- Identify audience concerns; April 2004 Page 29-3
- Identify what the audience(s) knows about the issues, both correct information and misinformation;
- Design the message(s) to be sent out to the community;
- Design the “channels”/choose the best methods to reach people;
- Prepare to deliver/present the message;
- Anticipate communication problems;
- Evaluate the program; and
- Modify program as needed.
22.4 Principles of Risk Communication

- The message duration is limited
- The message content is limited
- Aim to enhance knowledge/trust

Audiences may include

- Environmental groups;
- Civic organizations;
- Professional and trade organizations;
- Educational and academic groups;
- Religious groups;
- Other government agencies;
- Neighborhood/school organizations;
- Industries; and
- Other organizations

Seven Cardinal Rules of Risk Communication (Covello and Allen 1988)

- Accept and involve the public as a partner.
  - Your goal is to produce an informed public, not to defuse public concerns or replace actions.

- Plan carefully and evaluate your efforts.
  - Different goals, audiences, and media require different actions.

- Listen to the public's specific concerns.
  - People often care more about trust, credibility, competence, fairness, and empathy than about statistics and details.

- Be honest, frank, and open.
  - Trust and credibility are difficult to obtain; once lost, they are almost impossible to regain.

- Work with other credible sources.
  - Conflicts and disagreements among organizations make communication with the public much more difficult.

- Meet the needs of the media.
The media are usually more interested in politics than risk, simplicity than complexity, danger than safety.

- Speak clearly and with compassion.
- Never let your efforts prevent your acknowledging the tragedy of an illness, injury, or death. People can understand risk information, but they may still not agree with you; some people will not be satisfied.

When developing messages, it is important to consider the following questions:

- What does the community already know?
- Is this information factual?
- What does the community want to know?
- What does the community need to know?
- Can the information be misunderstood?

Topic or concern may include:

- Health concerns;
- Safety concerns;
- Environmental concerns;
- Economic concerns;
- Aesthetic concerns;
- Lifestyle/cultural concerns;
- Data and information concerns;
- Fairness/Equity concerns;
- Trust and credibility concerns;
- Process/value concerns (e.g., who makes decisions and how);
- Risk management concerns
- Family or community members
- Quality of life
Common Myths and Actions (Chess et al. 1988)

- Not enough time and resources for a risk communication program
- Telling people about a risk is more likely to unduly alarm them
- Communication is less important than education
- Don’t go to the public until solutions exist
- These issues are too difficult for people to understand
- Technical decisions should be made by technical people
- Risk communication is not my job
- If we give them an inch, they’ll take a mile
- If we listen to the public, we’ll devote scare resources to issues that not important to public health
- Activists are responsible for stirring up issues

Outrage factors

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
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<tbody>
<tr>
<td>Trustworthy sources</td>
<td>Untrustworthy sources</td>
</tr>
<tr>
<td>Substantial benefits</td>
<td>Few benefits</td>
</tr>
<tr>
<td>Voluntary</td>
<td>Involuntary</td>
</tr>
<tr>
<td>Controllable</td>
<td>Uncontrollable</td>
</tr>
<tr>
<td>Fair/equitable</td>
<td>Unfair/Inequitable</td>
</tr>
<tr>
<td>Natural origin</td>
<td>Man made</td>
</tr>
<tr>
<td>Familiar</td>
<td>Unfamiliar/Exotic</td>
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<td>Not dreaded</td>
<td>Dreaded</td>
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<tr>
<td>Certain</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Children not victims</td>
<td>Children are victims</td>
</tr>
<tr>
<td>Not memorable</td>
<td>Memorable</td>
</tr>
<tr>
<td>Moral/Ethical</td>
<td>Immoral/Unethical</td>
</tr>
<tr>
<td>Clear, non-verbal message</td>
<td>Mixed, non-verbal message</td>
</tr>
<tr>
<td>Responsive</td>
<td>Unresponsive</td>
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<tr>
<td>Random/Scattered</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Little media attention</td>
<td>Lots of media attention</td>
</tr>
<tr>
<td>Victims statistical</td>
<td>Victims identifiable</td>
</tr>
<tr>
<td>Immediate efforts</td>
<td>Delayed effects</td>
</tr>
<tr>
<td>Effect reversible</td>
<td>Irreversible effects</td>
</tr>
<tr>
<td>Scientifically well understood</td>
<td>Not scientifically understood</td>
</tr>
</tbody>
</table>
Earning Trust : Building Credibility

Based on four factors:

- Perceived empathy and caring
- Demonstrated competence and expertise
- Honesty and openness
- Perceived dedication and commitment

“Trust and credibility are difficult to achieve: if lost, they are even more difficult to regain” (Covello, 1993)

22.4 Risk Communication Pitfalls

- Use of jargon
- Use of humor
- Use of negative allegations
- Use of negative words and phrases
- Great reliance on words
- Display of temper
- Clarity
- Use of abstract concepts
- Inconsistency between verbal and nonverbal messages
- Attacks
- Hollow promises
- Speculation
- Focusing on the cost
- Use of organizational identity
- Blaming others
- Use of “Off the Record” statements
- Use of risk/benefit/Cost comparisons
- Risk Comparison
- Health risk numbers
- Numbers
- Technical details and debates
- Long presentations
22.5 Message delivery channels

- Presentations: Speeches to public groups.
  - Benefit: offers the audience a chance to ask questions; reaches many people at one time.
  - Limitations: if poorly presented, can distort community perception; cannot sufficiently address individual concerns; can become argumentative or confrontational.

- Open Houses/Availability Sessions: Informal meeting where public can talk to staff on a one-to-one basis.
  - Benefit: allows for one-to-one conversation; helps build trust and rapport.

- Small Group Meetings: Sharing information with interested community members and government officials.
  - Benefit: allows two-way interaction with the community.
  - Limitations: may require more time to reach only a few people; may be perceived by community groups as an effort to limit attendance; be sure your information is identical or you may be accused of telling different stories to different groups.

- Briefings: Can be held with key officials, media representatives, and community leaders; generally not open to the public.
  - Benefit: allows key individuals to question risk assessment staff before release of public information.
  - Limitations: should not be the only form of community communication; bad feelings may arise if someone feels that they were left off the invite list.

- Community mailings: Sends information by mail to key contacts and concerned/involved members of the community.
  - Benefit: delivery of information quickly; may require less planning than a meeting.
  - Limitation: no opportunity for feedback

- Exhibits: Visual displays to illustrate health issues and proposed actions
  - Benefits: creates visual impact.
Limitations: one-way communication tool, no opportunity for community feedback.

- Fact Sheets/MSDS/CSDS: To introduce new information.
  - Benefit: brief summary of facts and issues; provides background for information discussed during a meeting.
  - Limitations: one-way communication tool; needs to be well-written and understandable.

- Newsletters: To inform community of ongoing activities and findings.
  - Benefit: explains findings; provides background information.
  - Limitations: can backfire if community members do not understand or misinterpret contents.

- News Release: Statement for the news media to disseminate information to large numbers of community members.
  - Benefit: reaches large audience quickly and inexpensively.
  - Limitations: may exclude details of possible interest to the public; can focus unneeded attention on a subject.

- Public Meetings: Large meeting open to the public where experts present information and answer questions and community members ask questions and offer comments.
  - Benefit: allows community to express concerns and agency to present information.
  - Limitations: can intensify conflicts, rather than resolve controversies.

22.6 Chemical Safety Data Sheet (CSDS)

- Definition: is an up-to-date hand-out or information sheet containing relevant information pertaining to the hazardous chemical or preparation which is vital for establishing arrangements in the safe use of the chemical or preparation at work

- Law: Requirements of Regulation 9 of the Occupational Safety and Health (Classification, Packaging and Labelling) Regulations 1997 - the duty of a supplier to furnish an up-to-date Chemical Safety Data Sheet (CSDS) for each hazardous chemical supplied.
Objectives of CSDS

- to make users of hazardous chemicals understand safety recommendations and the rationale for these recommendations;
- to create awareness among users of hazardous chemicals of the consequences of failure to comply with the recommendations;
- to ensure that users of hazardous chemicals recognise the symptoms of overexposure; and
- to encourage the users of hazardous chemicals to provide inputs in establishing strategies and recommendations for the safe use of the hazardous chemicals.

Contents of CSDS

- The chemical product itself including the trade or common name of the chemical and the company identification with details of the supplier;
  - e.g. Synonyms, CAS No., Molecular Weight, Chemical Formula, Product Codes (if applicable)
- The composition of the ingredients that clearly identifies the hazardous chemical for the purpose of conducting a hazard evaluation;
  - Provide the percentage or concentration of the chemical.
  - PEL (Permissible Exposure Limit), TLV (Threshold Limit Value) etc.
  - Therefore, the seriousness of the chemicals can be referred.
- Hazard identification;
  - Provide the degree of hazard with reference to:
    - Health rating
    - Flammability rating
    - Reactivity rating
    - Contact rating
Additional information may include the potential health effects and symptom through inhalation, ingestion, dermal contact, eye contact, chronic exposure & aggravation of pre-existing conditions (if applicable).

- First-aid measures;
  To provide first aid attention prior to the arrival of physician when accident take place. The piece of information provided may refer to the chemical accident due to:
    - Inhalation
    - Ingestion
    - Dermal Contact
    - Eye Contact

- Fire-fighting measures;
  Provide details on the
    - Flash point,
    - Auto Ignition Temperature,
    - Flammability
    - Explosion capability

  Extinguishing media is according to fire classification
    - Class A – paper & wood
    - Class B – liquid & greases
    - Class C – electrical fires
    - Class D – metal/metal alloys

  Additional information may inclusive of the proper methods of using fire extinguishing media (dry chemical, foam, water or carbon dioxide) and type of suitable firefighting protective clothing used during fire emergency

- Accidental release measures
  Provide some essential guideline to deal with for instance how to deal with chemical spillage, ventilation provision, contain and recover liquid when spilled etc.
• Emergency contact number

• Handling and storage;
  Provide detail to conduct, handling and storing at a safer way. These may include:
  o How to protect the chemical?
  o How to store the chemicals (environment factors consideration)?
  o Is it compatible with other chemicals when stored together?
  o How to use it at a safer way?

Storing
  o Type of container
  o Re-labeling
  o Safety Precaution phrases
    o Eg: keep in cool & dry place

• Exposure controls and personal protection (including possible methods of monitoring workplace exposure);
  Provide details how to control the exposure of employees at the workplace when using such chemical.

Control measures
  o Hazard elimination/minimization
  o Engineering controls
  o Safe works practices

For example:
  o Ventilation system
  o PPE (Respirator, safety goggle, glove, SCBA, apron etc) for skin, eye and other bodily related protection
Physical and chemical properties;
Provide detail of some of properties of chemical, for instance:
- Appearance (clear, colorless, milky etc)
- Odor (type of “smell” of product)
- Solubility (Water soluble, slight solubility etc)
- pH
- Boiling point, melting point (OC or F)
- Vapor density
- Vapor pressure
- Evaporation rate

Stability and reactivity;
Provide some details on:
- Stability and reactivity of the chemical (e.g. during storage)
- Type of hazardous decomposition products (e.g. release of certain gases such as CO2 when heated)
- Compatibilities with other chemicals (for example acrylic acid is incompatible with strong oxidizing agents)

Toxicological information (including the potential routes of entry into the body and the possibility of synergism with other chemicals or hazards encountered at work);
- This section may refer to the toxicity of the chemical with reference to the LD 50 and LC 50. The lower the value of the LC the more hazardous will be the chemical
- Toxic health effect
  - Signs & Symptoms
  - Acute vs chronic
  - carcinogenicity
- Ecological information;
  - Provide some detail on ecological impact of the chemical when it is used or discharged to the air, water or soil.
  - Therefore, the user could take some precautious or probably engineering control when deal with this chemical
  - May include:
    - Ecotoxicity: fish, plant
    - Elimination info: persistence, degradability

- Disposal information;
  - Applied for the chemical that couldn’t be recycled, saved or recovered and is considered as hazardous waste. (Must comply with local requirements)

- Transport information; and
  - Provide some detail on the identification during transportation of chemical for both domestic and international purposes

- Date of preparation of the Chemical Safety Data Sheet.
  - Date
  - Authorized person/manufacturer
Example of CSDS
Additional References


http://64.2.134.196/committees/aqph/rcpolicy.pdf

Conclusion to Unit

Knowing and understand the concept of efficient risk communication is very important for the management and employees to ensure compliances with all protective safety and health measures developed in the workplace.

Group Activity 22.0

Form a group of four students. Each group must either;

a) Choose a local industrial chemical product and formulate a complete chemical safety data sheet for the product.

b) Choose an industrial chemical product and deliver the health risk of the product to the audience. Audiences are students and lecturers act as workers.

c) Prepare a newsletter for the workers focusing on mental health.

d) Prepare a video presentation emphasizing on the safety and health of health care workers