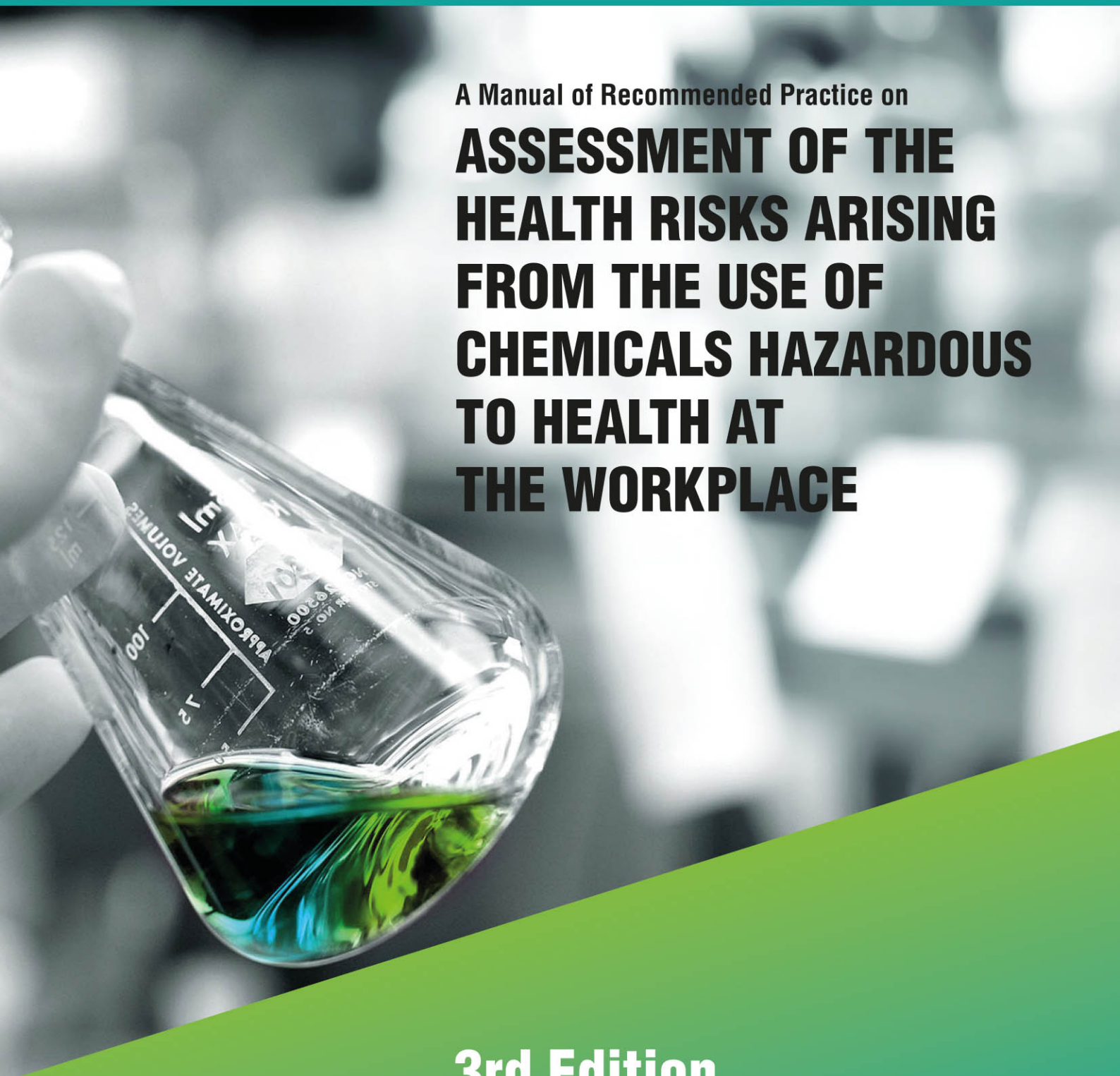
Department of Occupational Safety and Health
Ministry of Human Resources
Malaysia



A Manual of Recommended Practice on

ASSESSMENT OF THE HEALTH RISKS ARISING FROM THE USE OF CHEMICALS HAZARDOUS TO HEALTH AT THE WORKPLACE

3rd Edition

First reprint 2018

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PREFACE

This guideline may be cited as a Manual of Recommended Practice on the Assessment of the Health Risks Arising from the Use of Chemicals Hazardous to Health at the Workplace 3rd Edition.

The manual provides practical guidance and advice for conducting an assessment of risk to health related to the use of chemicals hazardous to health (CHTH) at the workplace for compliance to the requirements of the Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations 2000 or as amended hereinafter referred to as USECHH Regulations.

This manual specifically provides a standardised protocol for assessor to conduct a full assessment using a method known as Chemical Health Risk Assessment (CHRA). This manual has also been designed to assist employers and occupational safety and health practitioners to understand the scope of the assessment sufficiently in their objective review of the report.

This manual will be reviewed from time to time. Written comments from any interested persons or parties are welcomed. These should be sent to the Department of Occupational Safety and Health (DOSH) for further consideration in improving the manual.

Director General
Department of Occupational Safety and Health Malaysia
2017

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Drafting Committee

1.	Ir. Hj. Anuar bin Mohd Mokhtar	DOSH (*Chairman from 2009 until August 2014*)
2.	Ir. Dr. Majahar bin Abd. Rahman	DOSH (*Chairman from September 2014 to 2017*)
3.	Shabanon binti Mohd Sharif	DOSH
4.	Ir. Roslenda binti Hasan	DOSH
5.	Hamidi bin Saidin	DOSH
6.	Rusnah binti Nanyan	DOSH
7.	Noor Fazira binti Ab Aziz	DOSH
8.	Hj. Mohd Salleh bin Abd Rahman	DOSH (*2009-2017*)
9.	Dr. Rajinderjit Singh Hullon	DOSH
10.	Sulaiman bin R. Rahman	DOSH (*2009 – 2016*)
11.	Hjh. Wan Sabrina binti Wan Mohamad	Shell Malaysia Trading Sdn. Bhd.
12.	Azizin bin Zainudin	Petroliam Nasional Berhad (*2009 – 2014*)
13.	Marina binti Zainal Farid	Petroliam Nasional Berhad (*2015 – 2017*)
14.	Hjh. Noormahani binti Harun	Malaysian Industrial Hygiene Association
15.	Marina Yong Poh Nyuk	Malaysian Industrial Hygiene Association
16.	Norhamimi binti Mohd Yusof	ExxonMobil Exploration and Production Malaysia Inc.
17.	Suhaily binti Amran	National Institute of Occupational Safety and Health (*2009-2017*)
18.	Mohd Hafizullah bin Harun	DOSH
19.	Syarikin binti Mat Nayah	DOSH (*Secretariat*)

We also wish to thank individuals who have directly or indirectly contributed in the preparation of this manual.

CONTENTS

ABBREVIATION

ACGIH	American Conference of Governmental Industrial Hygienists
AM	Arithmetic mean
AP	Action priority
BEL	Biological exposure limit
CEI	Combined exposure limit
CL	Ceiling limit
CHRA	Chemical health risk assessment
CHTH	Chemicals hazardous to health
CLASS Regulations	Occupational Safety and Health (Classification, Labelling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013 or as amended
DOSH	Department of Occupational Safety and Health
DR	Duration rating
ECHA	European Chemicals Agency
EPA	Environmental Protection Agency, United States
ER	Exposure rating
FDR	Frequency-duration rating
FR	Frequency rating
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GM	Geometric mean
HR	Hazard rating
ICOP CHC	Industry Code of Practice on Chemical Hazard Classification and Hazard Communication
MEL	Maximum exposure limit
MR	Magnitude rating
NITE	National Institute of Technology and Evaluation
NTP	National Toxicology Program, Department of Health and Human Services, United States
OEL	Occupational exposure limit
OHD	Occupational health doctor
PEL	Permissible exposure limit
PPE	Personal protective equipment
RR	Risk rating
SDS	Safety Data Sheet
STEL	Short term exposure limit
TWA	Time-weighted average
USECHH Regulations	Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations 2000 or as amended

TERMINOLOGY

Abnormal exposure means exposure other than during normal work or operation;

Acute effects mean effects that are caused by short periods of exposure (e.g. seconds or minutes) to high concentrations of a chemical;

Adverse health effect means effect that causes changes in the morphology, growth, development or life span of an organism and which results in impairment of functional capacity or impairment of the ability of the organism to maintain homeostasis or do not enhance susceptibility to the deleterious effects of other environment factors;

Aspiration means the entry of a liquid or solid chemical or mixture directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system;

Biological effect monitoring means the sub-clinical biological effect caused by the hazards;

Biological monitoring means the measurement and assessment of agents and their metabolites either in tissues, secreta, excreta, expired air or any combination of these to evaluate exposure and health risk compared to an appropriate reference;

Breathing zone means the region where the concentration of the airborne contaminant is the same as that entering the nostrils and it is defined as zone in front of the face within 20 to 30 cm radius from the nostrils;

Carcinogenicity means a chemical or a mixture which induces cancer or increases its incidence;

Assessor means person appointed by employer and registered with the Director General to carry out an assessment of risk to health;

Chronic effects mean effects that result from repeated or prolonged exposure (continuing day after day or week after week), typically involving relatively low levels of a chemical;

Hazard class means the nature of physical, health and environmental hazard, e.g. flammable liquid, carcinogenicity, oral acute toxicity;

Irreversible effect means effect that remains following the cessation of exposure, and may even progress;

LC_{50} means the concentration of chemical in air which causes the death of 50% of group of test animals;

LD_{50} means the amount of chemical, given all at once, through dermal or oral which causes the death of 50% of a group of test animals;

Local effect means one that occurs at the site of first contact with the chemical;

Medical surveillance means assessment of the state of health of a worker, as related to exposure to chemicals hazardous to health, and includes biological monitoring;

Mixed exposure means exposure from multiple chemicals which affect the same target organ;

Mutagenicity means a permanent change in the amount or structure of the genetic material in a cell;

Maximum exposure limit (MEL) means a fifteen-minute time-weighted average airborne concentration which is three times the eight-hour time-weighted average airborne concentration of the chemicals specified in Schedule 1 (USECHH Regulations);

Permissible exposure limit (PEL) means occupational exposure limit of chemicals hazardous to health as specified by the USECHH Regulations;

Personal protective equipment (PPE) means any equipment which is intended to be worn or held by a person at work and which protects him against one or more risks to his health or safety and any additional accessory designed to meet that objective;

Respiratory sensitizer means chemicals that will lead to hypersensitivity of the airways following inhalation of the chemical;

Reversible effect means effects that subside once exposure ceases;

Safety data sheet (SDS) means a document which contains relevant information on chemical and is furnished in pursuance of the CLASS Regulations;

Serious eye damage means the production of tissue damage in the eye, or serious physical decay of vision, following application of a test chemical to the anterior surface of the eye, which is not fully reversible within 21 days of application;

Skin corrosion means the production of irreversible damage to the skin following the application of a test chemical up to 4 hours;

Skin irritation means the production of reversible damage to the skin following the application of a test chemical up to 4 hours;

Skin sensitizer means chemicals that induce allergic response following skin contact;

Short term exposure limit (STEL) means a fifteen-minutes time-weighted average airborne concentration that shall not be exceeded at any time during a workday, even if the time-weighted average airborne concentration is within the time-weighted average limit;

Systemic effect means the effect occurs at a site distant from the initial point of contact, and takes place after a chemical has been absorbed into a body;

Target organ means organ or tissue where adverse effect occurs;

Reproductive toxicity means adverse effects on sexual function and fertility in adult males and females, as well as developmental toxicity in the offspring;

Use in relation to a chemical hazardous to health means production, processing, handling, storage, transport, removal, disposal or treatment.

CHAPTER 1

INTRODUCTION

Protecting workers from the adverse effects of chemicals is one of the primary duties of an employer under the Occupational Safety and Health Act 1994. To perform this duty, an assessment of all chemicals used in the workplace must be carried out in order to identify, evaluate and control any health risk associated with work activities involving the use of the chemicals.

Under the USECHH Regulations, employers are not permitted to carry out any work which uses any CHTH unless the assessment has been conducted. Therefore, the employer has a duty to perform an assessment of the potential health risks arising from the use of CHTH at the place of work. The requirement is applicable to the production, processing, handling, storage, transport, removal, disposal or treatment of any CHTH at the place of work. An assessment of risk to health is the evaluation of how CHTH are used at work and the health risks involved. The decision about appropriate action to control workers' exposure will depend on the degree of risk to health that arises from the use of CHTH in particular work activities.

This manual has been designed to provide guidance on procedure to conduct full assessment of risk to health using a Chemical Health Risk Assessment or in short, CHRA method by going through a step-by-step procedure and using prescribed techniques and format.

1.1 SCOPE

This manual applies to full assessment of risk to health where CHTH are used at the place of work. A chemical hazardous to health is defined under the USECHH Regulations as a chemical which is:

a) listed in Schedule I or II of the USECHH Regulations;
b) classified in any hazard class specified under Health Hazards of First Schedule of the CLASS Regulations;
c) a pesticide as defined under the Pesticides Act 1974; and
d) a scheduled waste listed in the First Schedule to the Environmental Quality (Scheduled Wastes) Regulations 2005.

Use in relation to CHTH includes work activities involving production, processing, handling, storage, transport, removal, disposal or treatment of CHTH at the workplace.

1.2 PURPOSE AND OBJECTIVES OF A CHEMICAL HEALTH RISK ASSESSMENT

Purpose of conducting CHRA is to enable decisions to be made on:

- appropriate control measures;
- induction and training of workers;
- the necessity of exposure monitoring programme; and
- the necessity of medical surveillance programme;

as may be required to protect the health of workers who may be exposed to CHTH at work. Objectives of CHRA are:

a) To identify the hazards posed by each CHTH use within the workplace;
b) To evaluate the degree of exposure of workers to the CHTH, either through inhalation, dermal or ingestion;
c) To evaluate the adequacy of existing control measures; and
d) To recommend further appropriate control measures and prioritise actions to be taken to prevent or reduce risks.

1.3 CONTENT OF ASSESSMENTOF RISK TO HEALTH

The USECHH Regulations stipulates that the assessment conducted must contain the following:

a) The potential risks to a worker as a result of exposure to CHTH;
b) The method and procedures adopted in the use of the CHTH;
c) The nature of the hazard to health;
d) The degree of exposure to such CHTH;
e) The risk to health created by the use and the release of chemicals from work processes;
f) Measures and procedures required to control the exposure of a worker to CHTH;
g) The measures, procedures, and equipment necessary to control any accidental emission of a CHTH as a result of leakage, spillage, or process or equipment failure;
h) The necessity for worker exposure monitoring programme;
i) The necessity for medical surveillance programme; and
j) The requirement for the training and retraining of workers.

1.4 ASSESSMENT STRATEGIES

There are basically two approaches to conduct the assessment of risk to health, any one of which may be applied depending on the hazard classification of the chemical, chemical use situation and the complexity of the work process. These approaches are:

a) Full assessment; and
b) Simple assessment

1.4.1 Full assessment

In principle, full assessment is conducted using a CHRA method as outlined in this Manual. Full assessment should be the first approach considered. There are two types of assessment that can be conducted:

a) Site specific CHRA
b) Generic CHRA

Site specific CHRA should be conducted for each and every workplace where CHTH are used.

Generic CHRA is done at representative locations which may be applied to all other locations in which the work activities are *similar, with comparable levels of risk, and similar control measures*. Detailed criteria and procedure on the conduct of a generic assessment can be referred to in the application guidance published by DOSH.

1.4.2 Simple assessment

Simple assessment is an alternative approach of chemical health risk assessment and may be conducted if the CHTH is:

a) listed in the chemical register; and
b) not classified as carcinogenicity category 1; mutagenicity category 1; or respiratory sensitisation category 1.

Simple assessment can be conducted using a Simple Risk Assessment and Control for Chemicals (SiRAC) method. For purpose of conducting simple assessment the required information is the hazard classification (according to CLASS Regulations), physical form, boiling point or vapour pressure and operating temperature of the chemicals (where applicable), the quantity used and total duration of exposure to the chemicals.

The flow chart for assessment of risk to health is shown in the **Figure 1** and the procedure to conduct a simple assessment is described in the Manual of Simple Risk Assessment and Control for Chemicals (SiRAC) published by DOSH.

Assessment of Risk to Health

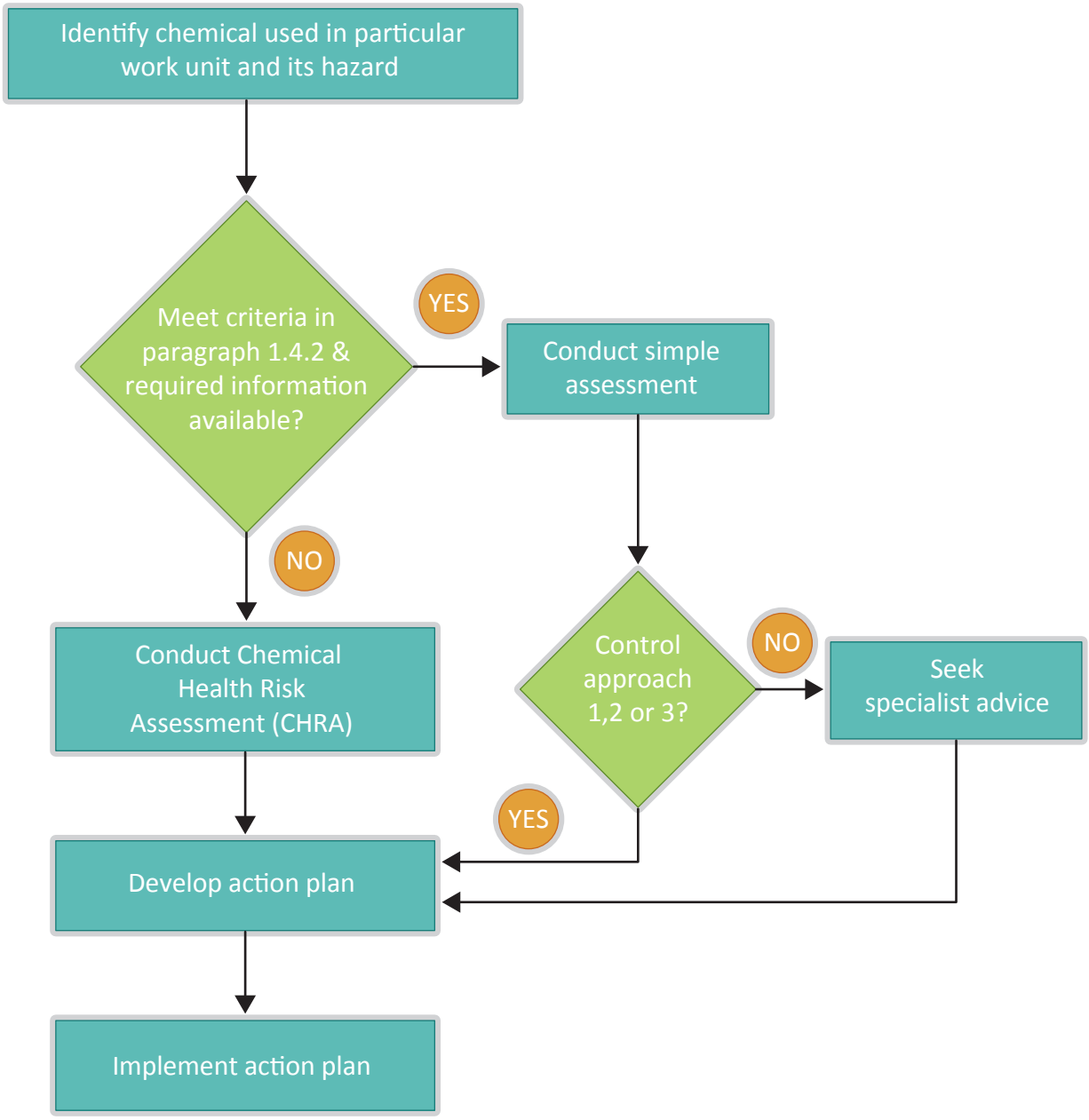


Figure 1: Flow Chart on Approach of Assessment of Risk to Health

1.5 ASSESSMENT CONCEPT

1.5.1 Hazard

A chemical health hazard is the potential of a chemical to cause harm or adversely affect health of workers in the workplace. Adverse health effect ranges from fatality, permanent and serious health impairment to mild skin irritation at the other end.

1.5.2 Exposure

A worker is exposed to a chemical if there is a possibility of the chemical being inhaled; in contact with the eyes or skin; absorbed through the skin; or being ingested.

1.5.3 Risk

Risk is the likelihood that a chemical will cause adverse health effects or illness in the conditions of its use. The risk to health usually increases with the severity of the hazard, the amount used, the duration and frequency of exposure. Risk has been defined as the probability of over exposure and the consequences of that exposure. This is so because a potentially toxic chemical may cause death or serious health effects if the exposure is substantial. Therefore, the risk equation can be defined as:

Risk = Hazard x Exposure

1.6 SELECT ASSESSOR

In carrying out an assessment involving a large number of chemical substances, chemical mixtures or preparations or complex chemical processes, a team comprising of assessor(s) and specialist(s) and or competent personnel is recommended.

1.6.1 The assessment team

The assessment team is to be headed by an assessor and assisted by one or more of the following team members where appropriate but not limited to:

a) An experienced and knowledgeable member of the safety and health committee;
b) An occupational health doctor;
c) An engineer in related field;
d) An industrial/occupational health nurse; or
e) Supervisor of the work area.

1.6.2 Competency of assessor

The appointed assessor should be competent to conduct the assessment and in particular should have the ability to:

a) Interpret the information in the SDS and labels as prescribed by the CLASS Regulations and detailed out in the ICOP CHC;
b) Understand the hazard classification as prescribed by the CLASS Regulations, Pesticide Act 1974 and the Environmental Quality (Scheduled Wastes) Regulations 2005;
c) Observe the conditions of work and anticipate potential risk to health;
d) Communicate effectively with workers, contract workers, managers, specialists and others;
e) Draw all the information together in a systematic way to form valid conclusions about exposures and risks; and
f) Report the findings accurately to all parties concerned.

For the purpose of complying with the USECHH Regulations, the appointed assessor must be registered with the Director General of DOSH, Malaysia. The registration of the appointed assessor must be valid until completion of the assessment. For details on procedure of registration, please refer to the Guidelines for the Registration of Assessors, Hygiene Technician and Occupational Health Doctor published by DOSH.

1.6.3 Duties of an assessor

The appointed assessor is expected to:

a) Carry out assessment of health risks arising from the use of CHTH at the workplace;

b) Without any delay inform the respective employer of the immediate danger discovered during the assessment process;

c) Make recommendations on the necessity to:

   i) make changes or institute a programme to control exposure of workers to CHTH;
   ii) control any accidental emission of a CHTH as a result of leakage, spillage, or process or equipment failure;
   iii) conduct exposure monitoring programme;
   iv) carry out a medical surveillance programme; and
   v) institute a training programme for workers.

d) Furnish and present his findings and recommendations to the employer within one (1) month upon completion of the assessment report.

1.6.4 Specialist advice

In certain case where advanced or specialist advice is required, the assessor may seek the assistance of appropriate subject matter experts on occupational hygiene, occupational medicine, toxicology, chemical exposure monitoring and specialised engineering control equipment. The specialist who may be consulted may include, but is not limited to the following:

a) An occupational/industrial hygienist – an expert on the identification of hazards, exposure evaluation and control of health risks;
b) An occupational health physician/doctor – a person who has expertise in occupational medicine and medical surveillance programme;
c) A hygiene technician – competent person on the inspection and testing of engineering control equipment and the exposure monitoring of airborne chemicals; and
d) A toxicologist – an expert on chemical toxicity.

1.7 STEPS IN CHRA

The procedure in carrying out a CHRA consists of 10 steps and is summarized in **Figure 2**:

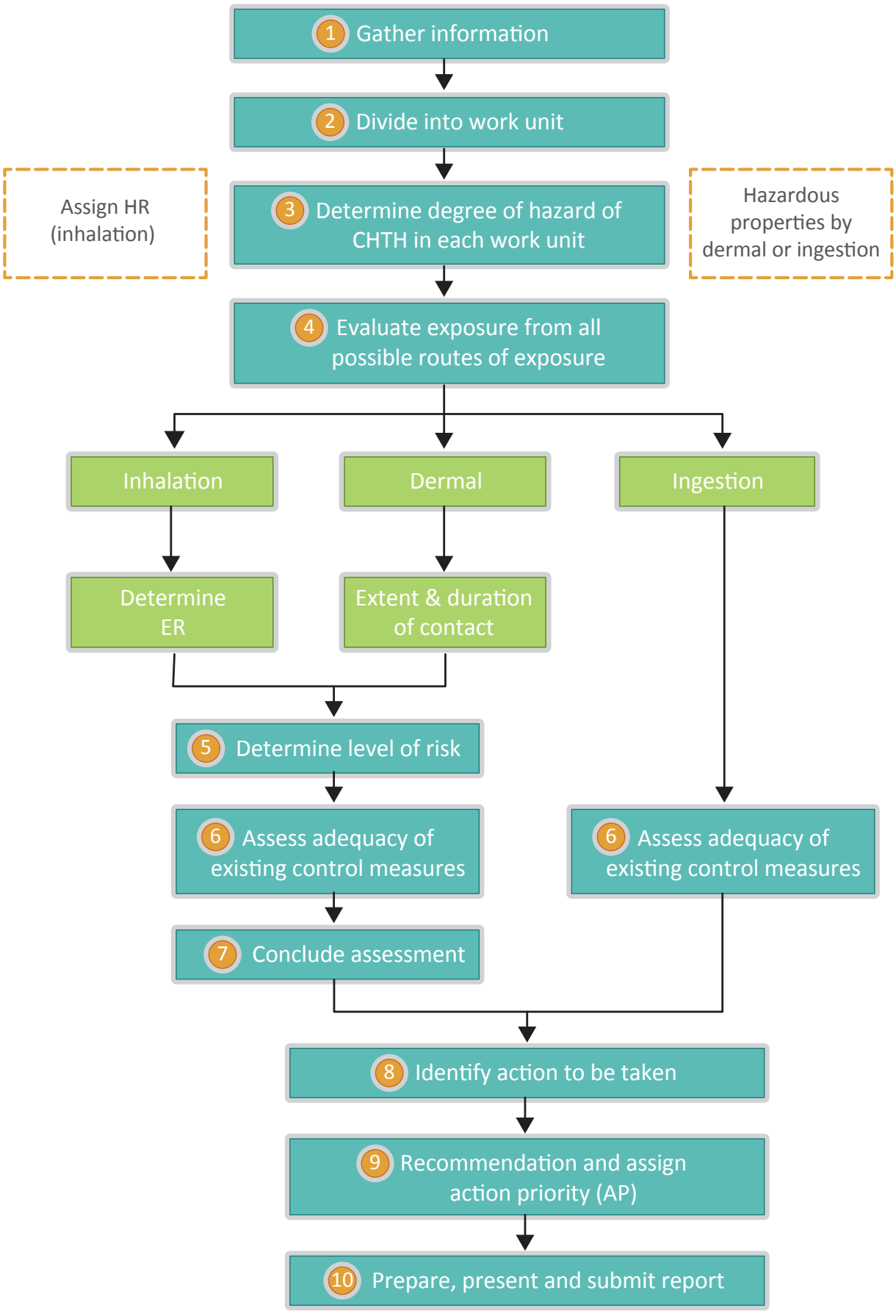


Figure 2: Steps in conducting CHRA

CHAPTER 2

GATHER INFORMATION

An assessment will require all relevant information to be provided to the assessor. The assessor needs to gather all of this information which may include:

a) Information on CHTH used or released in the workplace;
b) Layout plan of work area;
c) Process flowchart;
d) Particulars on workers at risk;
e) Control equipment design parameter and maintenance record;
f) Occupational accident, dangerous occurrence, incidence, poisoning and diseases record as well as corrective and preventive action records (Refer to the forms used for reporting under the Occupational Safety And Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease) Regulations 2004 ;
g) Personal exposure monitoring programme;
h) Health or medical surveillance programme;
i) Training programme related with use of CHTH (at the minimum, chemical hazard communication and emergency response);
j) PPE programme;
k) Standard operating procedures; and
l) Safe work procedures.

2.1 INFORMATION TO BE GATHERED

2.1.1 Information on CHTH

The information required on the CHTH are:

a) List of chemicals used or released in the workplace;
b) Hazard information of the CHTH;
c) The nature and degree of exposure to the chemicals;
d) Exposure standards and performance criteria against which to evaluate the risk to health; and
e) Recommended control measures for the chemical substance.

Create an inventory of all CHTH used or released in each work area and obtain health hazard information on each. Use **Form B** to capture the necessary information.

2.1.2 Layout plan of work area

Obtain the layout plan for each work area where CHTH are used or released. In the absence of such layout plan, a sketch should be made showing the locations of the machinery, tanks or vessels, engineering control equipment, barriers or enclosures, the locations of CHTH and the locations of workers.

2.1.3 Process flowchart

Obtain the process flowchart for all work processes carried out in the premise. The flowchart should show the various steps in the process starting from the raw material to the finished product or starting from the preparatory stage to the completion of the tasks.

2.1.4 Workers at risk

Obtain information on those workers that are exposed to CHTH and should include the following:

a) Number of male and female workers in each work area;
b) Working hours; and
c) List of job categories handling or exposed to CHTH and the number of male and female workers for each job categories for each work shift.

2.1.5 Engineering control equipment

Obtain information on the design parameters of the engineering control equipment and the records of their maintenance. This should include:

a) Design parameters such as the hood face velocity and duct transport velocity for a local exhaust ventilation system;
b) Record of monthly inspections by the employer;
c) Record of examination and testing of the control equipment by a registered hygiene technician.

2.1.6 Accident and incidences

Obtain the occupational accident, incidence, poisoning and diseases records. This record gives information on the nature of accidents or incidences occurring and should also include the corrective and preventive actions taken (refer to JKKP 6, 7 and 8 forms).

2.1.7 Personal exposure monitoring programme

Obtain personal exposure monitoring reports by competent person, if such monitoring was carried out.

2.1.8 Health or medical surveillance programme

Obtain summary of health or medical surveillance result which relates to the exposure to CHTH. This record should include summary of complaints and cases of occupational diseases diagnosed (refer to JKKP 7 form) and any related medical removal protection.

2.1.9 Training programme

Obtain records of training conducted, including training on legal requirements; PPE selection, use, care and maintenance; chemical hazard communication; and emergency response. The record should include the training syllabus, training schedules and attendance.

2.1.10 PPE programme

Obtain information on the PPE programme provided to workers which relates to the use of CHTH. Elements of PPE programme could be referred to the Guidelines on the Use of Personal Protective Equipment against Chemicals Hazards, 2005.

2.1.11 Standard operating procedures and safe work procedures

Obtain documented procedures that describe the process and safe work measures where the CHTH are being used or released.

2.2 SOURCES OF INFORMATION

2.2.1 Information on chemicals

An important source of information is the chemical register kept by the employer. Under the USECHH Regulations, it is mandatory to keep a register of the chemicals used at the workplace. The register should include the following information:

a) List of all CHTH processed, produced or stored;
b) Average quantity processed, produced or stored per month or per year whichever is applicable for each of the CHTH;
c) The process and work area where the CHTH are processed, produced or stored;
d) The name and address of the supplier of each of the CHTH;
e) Physical form of the CHTH;
f) The hazard classification of the CHTH; and
g) The current SDS for each of the CHTH.

The information ((a) to (g)) should be made available to the assessor in order for them to carry out an assessment.

Hazard information can be obtained from various sources. A complete SDS provides useful information on hazard classification; composition of hazardous ingredients; physical and chemical properties; toxicological data; health effects; exposure controls and personal protection; and accidental release measures. ICOP CHC may be referred to for information on hazard classification of hazardous chemicals. For scheduled waste, the information could be obtained from the waste card.

However, for chemicals released into the work environment as a result of chemical reaction, decomposition or thermal degradation, hazard information may need to be obtained from other sources as the supplier's SDS only provides information on the supplied products.

Where a SDS is not available, the supplier should be contacted to get a copy of the SDS. Under the CLASS Regulations it is the supplier's duty to furnish an up-to-date SDS.

Where the required information is not available or suspected to be inaccurate, other information sources should be consulted. These sources of information include but not limited to:

a) Chemical hazard or toxicity reference book;
b) The International Chemical Safety Data Card (ICS Card) published by the International Programme on Chemical Safety (IPCS);
c) Internationally recognised classification database e.g. ECHA, NTP, EPA, Japan's NITE;
d) SDS from Internet sites and commercial software for chemical being used; and
e) National Poison Centre, University Science of Malaysia (for cases of chemical poisoning).

2.2.2 Other information

Other sources of information may be sought from various department/division within the organisation/company. For example:

- Personnel or Human Resources Department for workers' particulars and training records.
- Maintenance Department for records on the maintenance of the engineering control equipment.
- Medical Department or clinic for medical surveillance records and other records pertaining to health.
- Production Department for plant layout plan, process flow chart and process descriptions.

CHAPTER 3

DIVIDE INTO WORK UNIT

In this chapter, the discussion is on the assigning of workers into similar risk groups or work unit so that assessment could be conducted for each work unit where there are exposures to CHTH.

3.1 CATEGORISATION OF A WORK UNIT

In the evaluation of exposure to a particular chemical, the worker or person exposed to the risk should be identified. Ideally the risk of each worker exposed to the CHTH should be assessed. However, this practice of assessing each individual worker would be too time consuming and a burden not only to the assessor but also to the employer. In order to avoid these problems, workers are to be assessed in groups whom the employer believes to be exposed to similar health risk arising from the use of a particular CHTH. This manual describes such grouping of workers as a work unit.

3.1.1 Work unit

A work unit must fulfil two basic requirements:

a) Work similarity

Workers in the work unit must perform similar tasks. 'Similar tasks' means that the workers are having similar potential for exposure.

b) Similarity with respect to the hazardous agent

Workers using or are exposed to the same CHTH. Being 'exposed to the same CHTH' means that the workers are potentially exposed to the same hazard. Even though the workers are exposed to the same CHTH, the risk may not be the same as other factors may affect the severity of the health effects, such as susceptibility. Therefore, the risk to health could only be said to be similar.

Note:
The work unit could be a job (i.e. lab personnel, lorry driver), task (i.e. filling operator) or process (i.e. moulding operator).

3.1.2 Application

The work unit definition will only apply to the routine entry of persons into the workplace. These are applicable to workers and in-house contract workers. **Routine entry** includes the following:

a) Routine work (scheduled jobs, tasks, processes such as production, maintenance, laboratory, housekeeping, etc.)

b) Non-routine work which is normally periodic but intensive (periodic/preventive maintenance works, repairs, delivery, administrative work, management tasks, safety inspections, internal audits, etc.)

Non-routine entry includes the following:

a) Single entry, sporadic entry, deliveries to administrative offices, etc.
b) These may be applicable to visitors such as vendors, contractors, customers, external auditors, and external inspectors.

Note:
An assessment is not required for non-routine entry and general control measures may be applied at the discretion of the employer. As a general guide, where respiratory protection and eye protection is required for the workers in the work area, the visitor shall also wear respiratory and eye protection that affords a similar level of protection. If direct skin contact is not expected, then the provision of skin protection is at the discretion of the employer.

3.1.3 Job rotation

Job rotation is practiced in some facilities and is normally for the purpose of:

a) Grooming workers to become multi-skilled;
b) Prepares workers for promotion to supervisory or higher levels; or
c) To reduce the exposure duration to CHTH.

Regardless of the purpose of job rotation, the classification of the work unit must consider the rotation frequency which in turn will affect the duration and frequency ratings of the job. The hazard of the CHTH, regardless of it being acute or chronic, toxic or otherwise does not affect the classification of the work units which are involved in the job rotation.

a) If the job rotation covering two or more separate tasks / processes occurs on a daily, weekly or monthly basis, then the work unit classified and assessed shall be a single work unit covering all the rotated jobs.

   For example, if the workers rotate the job of welding and pipeline inspection every two weeks then the work unit will be a single work unit that could be named welding and pipeline inspection work unit.

b) If the job rotation covering two or more separate tasks / processes occurs on a less frequent period i.e. quarterly or half-yearly, then the work unit will be separately classified according to the task / process and separately assessed.

For example, if the workers rotate the job of welding and pipeline inspection every three months then the work unit will be two separate work units that could be named welding work unit and pipeline inspection work unit.

3.2 PRACTICAL STEPS TO IDENTIFY WORK UNIT

Practical steps to identify the work unit are as follows:

a) Conduct a walk-through inspection to identify all persons who might be exposed, this might include persons who:

- Work directly with the CHTH;
- Work near or pass through areas in which the chemical is used, produced (including discharge of emissions), stored, transported or disposed of;
- Enter a confined space in which the chemical might be present; or
- Clean, perform maintenance or other work in areas where the chemical might be present.

b) For each department or work area get the list of jobs, tasks and processes;

c) Identify the CHTH used or released for the task(s) carried out at the location within the work area;

d) Interview the supervisors and workers at each work location regarding practical information about work practices and procedures;

e) Assign the work unit as per paragraph 3.1.1;

f) Where the CHTH is used, or released into the work environment, and the tasks are similar for a number of jobs, tasks and processes, they may be grouped together and considered as a single work unit (e.g. a line leader and the production operators under his supervision may be considered a work unit).

g) Fill in the information obtained for each work unit using **Form A**.

CHAPTER 4

DETERMINE DEGREE OF HAZARD

Chemicals that can adversely affect the health of an exposed person are termed as CHTH. The degree of hazard reflects the severity of chemicals health hazard which is determine based on the hazard classification or health effects of the chemical or properties of scheduled waste.

The hazard classification of CHTH is in-line with the classification of hazardous chemicals under the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) and the CLASS Regulations. If the hazard classification of the chemicals is given in previous classification system under the Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997 (CPL Regulations) or the European Union Directive 67/548/EEC, the assessor has to convert or reclassify into the hazard classification under the CLASS Regulations using the conversion table in **Appendix 1**. Hazard classification consists of hazard class and hazard category (including subcategory) as specified in the First Schedule of CLASS Regulations. For example, carcinogenicity category 1A, hazard class is 'carcinogenicity', category is '1' and subcategory is 'A'.

The effects of CHTH can be either acute or chronic effects. Some chemicals may cause both acute and chronic effects. The health effect due to an exposure to the chemicals may be local effects and or systemic effects. Localised effects involve the area of the body in contact with the chemical and are, typically, caused by reactive or corrosive chemicals, such as strong acids, alkalis or oxidizing agents. Systemic effects involve tissues or organs unrelated to or removed from the contact site when chemicals have been transported through the bloodstream. For example, methanol that is ingested may cause blindness, while a significant skin exposure to nitrobenzene may affect the central nervous system.

4.1 IDENTIFICATION OF HAZARD

Identify each CHTH used or released in each work unit assessed. Get hazard information for those CHTH in the work unit. Use **Form B** to make the list of CHTH used or released in each work unit.

In general, the hazard information could be obtained from SDS or labels of the CHTH or waste cards of the scheduled waste. Information on the hazard classification and toxicological data of the CHTH could be obtained in a SDS (refer to Section 2: *Hazard Identification and Section 11: Toxicological Information*). If the SDS is not available, use information of hazard statements available at label of the CHTH. In the case the information is not sufficient or not available, contact the supplier of the CHTH or refer to other source of information e.g. hazardous chemicals database (refer to **Chapter 3**). For scheduled waste, properties of scheduled waste which is in Section A of the waste card could be used as the hazard information (*Section A. Properties*).

For chemicals released into the work environment as a result of chemical reaction, decomposition or thermal degradation, hazard information may need to be obtained from other sources or seek for specialist advice.

4.2 DEGREE OF HAZARD

The degree of hazard is determined based on the hazard classification, acute toxicity or health effects of the CHTH including scheduled waste by considering also the route of exposure (refer to **Appendix 2**). For route of exposure through inhalation, hazard rating is used to indicate the degree of hazard. For dermal, the hazardous properties are used.

If a process involves mixing of two or more CHTH and the mixture is then used in another process or task, the assessor needs to classify the mixture based on hazard classification or LC_{50} data of each chemical. Refer to Part 2.5 of ICOP CHC on procedure to do classification for health hazards. The hazard determination is based on hazard classification of the mixture and not on the individual hazard classification. Classification of mixture is not applicable to scheduled waste.

Fill in the information obtained for each CHTH using **Form B: List of Chemicals Hazardous to Health Assessed.**

4.2.1 Degree of hazard for exposure through inhalation

4.2.1.1 Hazard rating- inhalation

For route of exposure through inhalation, degree of hazard is rated on a scale of 1 to 5. Rating of 1 implying least adverse health effects and a rating of 5 implying most severe adverse health effects. The hazard rating (HR) is used to prioritise hazard based on the potential health effect of the CHTH. Use **Table 1** for determination of HR, either by using information on health effects, hazard classification, hazard statements or acute toxicity data through route of inhalation. If the information on the hazard classification did not indicate the route of exposure, assume the hazard classification apply to all route of exposure (inhalation, dermal or oral/ingestion).

Table 1: Hazard Rating for Inhalation Exposure Based on Health Effect, Hazard Classification, H-Code and Acute Toxicity Data

HR	Health Effects	Hazard Classification	H-code	Acute toxicity
5	• Injury of sufficient severity to threaten life; • Causing fatality at low doses or concentration; • Severe irreversible effects (damage to target organ e.g. central nervous system effects, kidney necrosis, liver lesions, anaemia or paralysis) after a single exposure; • Known to have carcinogenic potential for humans; • Known to induce heritable mutations in the germ cells of humans; • Known human reproductive toxicant	Acute toxicity category 1 (inhalation)	H330	$LC_{50} \leq 0.5$ mg/l (vapours) $LC_{50} \leq 100$ ppmV (gases) $LC_{50} \leq 0.05$ mg/l (dusts/mists)
		Carcinogenicity category 1A	H350, H350i	
		Mutagenicity category 1A	H340	
		Reproductive toxicity category 1A	H360, H360D, H360F, H360FD, H360Fd, H360Df	
		Specific target organ toxicity – single exposure category 1	H370	
4	• Injury of sufficient severity to cause permanent impairment, disfigurement or irreversible change from single or repeated exposure. • Very serious physical or health impairment by repeated or prolonged exposure; • Serious damage to target organ from single exposure; • Presumed to have carcinogenic potential for humans; • Chemicals which should be regarded as if they induce heritable mutations in the germ cells of humans; • Presumed human reproductive toxicant	Acute toxicity category 2 (inhalation)	H330	$0.5 < LC_{50} \leq 2.0$ mg/l (vapours) $100 < LC_{50} \leq 500$ ppmV (gases) $0.05 < LC_{50} \leq 0.5$ mg/l (dusts/mists)
		Carcinogenicity category 1B	H350, H350i	
		Mutagenicity category 1B	H340	
		Reproductive toxicity category 1B	H360, H360D, H360F, H360FD, H360Fd, H360Df	
		Effects on or via lactation	H362	
		Specific target organ toxicity – single exposure category 2	H371	
		Specific target organ toxicity – repeated exposure category 1	H372	
		Respiratory sensitisation category 1	H334	

HR	Health Effects	Hazard Classification	H-code	Acute toxicity
3	• Serious damage to target organ from repeated exposure; • Toxic effects after exposure; • Suspected human carcinogens; • Chemicals which cause concern for humans owing to the possibility that they may induce heritable mutations in the germ cells of humans; • Suspected human reproductive toxicant. • Effect to respiratory tract after single exposure.	Acute toxicity category 3 (inhalation)	H331	$2 < LC_{50} \leq 10$ mg/l (vapours) $500 < LC_{50} \leq 2500$ ppmV (gases) $0.5 < LC_{50} \leq 1$ mg/l (dusts/mists)
		Carcinogenicity category 2	H351	
		Mutagenicity category 2	H341	
		Reproductive toxicity category 2	H361, H361f, H361d, H361fd	
		Specific target organ toxicity – repeated exposure category 2	H373	
		Specific target organ toxicity – single exposure category 3 *(respiratory tract irritation)*	H335	
2	• Reversible effects, not severe enough to cause serious health impairment; • Changes readily reversible once exposure ceases • Harmful effects after exposure	Acute toxicity category 4 (inhalation)	H332	$10 < LC_{50} \leq 20$ mg/l (vapours) $2500 < LC_{50} \leq 20000$ ppmV (gases) $1 < LC_{50} \leq 5$ mg/l (dusts/mists)
		Specific target organ toxicity – single exposure category 3 *(narcotic effect)*	H336	
1	• Minimal adverse health effects	Chemical not otherwise classified	H333	$LC_{50} > 20$ mg/l (vapours) $LC_{50} > 20000$ ppmV (gases) $LC_{50} > 5$ mg/l (dusts/mists)

4.2.1.2 Hazard rating determination

Steps to determine hazard rating for CHTH are as follows:

a) Obtain hazard information for each CHTH used in each work unit. Hazard information can be obtained from SDS, labels or scheduled waste information (waste card) or other source of information.

b) Based on hazard information obtained, use **Table 1** to determine the HR.

i) Pesticides

Refer to Section 11 of the SDS to get the acute toxicity data for inhalation (LC50) and other toxicological data which relates with exposure through inhalation. Determine HR based on hazard information obtained using **Table 1**.

Note:
Classification of a pesticide indicated on its label which only considers acute toxicity through oral and dermal exposure, is for the purpose of labelling only and must not be used to determine the HR (refer to **Appendix 3**).

ii) Scheduled wastes

Refer to scheduled waste information or waste cards (Seventh Schedule of the Environmental Quality (Scheduled Wastes) Regulations 2005) of each scheduled waste. Get the information on the hazardous properties and category of the waste. Use information pertaining to risk by inhalation in Section A of the waste card (refer to item *4. Risk by inhalation, by oral intake, by dermal contact*) to determine HR using the health effect column in **Table 1**.

Note:
If the information in Section A is not sufficient, the assessor has to identify the primary content of the waste and determine HR based on its hazard and health effect information.

iii) Other CHTH

Refer to Section 2 of SDS to get information on the hazard classification and or health effect (local and or systemic effects); and Section 11 for toxicological information. In cases where the hazard information provided in SDS is inconsistent between Section 2 and Section 11, assign HR based on hazard classification.

For chemical substances, hazard classification in Part 1 of the ICOP CHC takes precedence in determining the HR.

If the SDS is not available or outdated, the minimum hazard information in the form of hazard statement can be obtained from the label. Where the hazard statements cannot differentiate the category or subcategory of the hazard classification, assume the highest category or subcategory. If the CHTH label provides only information on risk phrases or R-phrases, use **Appendix 1** to convert to hazard classification under CLASS Regulations.

Note:

1) If hazard classification or hazard statements do not specify specific routes of exposure, then the hazard classification should be applied to all routes of exposure (inhalation, dermal and oral/ingestion).
2) If inhalation identified as one of possible routes of exposure but SDS or hazard information does not indicate hazard classification or health effects through inhalation, assign HR as 1.
3) Only the health hazard classification is considered to determine HR.

c) List the HR assigned and select the highest as the HR for that CHTH.

4.2.2 Degree of hazard for exposure through dermal

Degree of hazard for exposure through dermal is categorised by the effect of chemicals to dermal (skin and eyes). Health effect of chemicals by dermal exposure could be categorised based on the hazardous properties as irritation, corrosion, sensitisation or skin- absorption and other properties (refer to **Table 2**). Hazard classification and or health effects related to dermal is used to determine hazardous properties by dermal.

Table 2: Hazardous Properties Relevant to Dermal Exposure

Hazardous properties	Description	Corresponding hazard classification and H-code
Irritation	Chemicals which is irritating to skin or eyes after contact	• Skin corrosion or irritation category 2 (H315) • Serious eye damage or eye irritation category 2 (H319)
Corrosion	Chemicals which have damaging effect on skin or eyes after contact	• Skin corrosion or irritation category 1 (H314) • Serious eye damage or eye irritation category 1 (H318)
Sensitisation	Chemicals which lead to allergic response following skin contact	• Skin sensitisation category 1 (H317)
Acute toxicity	Chemicals which cause adverse effect following dermal administration of a single dose of a chemical or multiple dose given within 24 hours	• Acute toxicity (dermal) category 1 (H310) • Acute toxicity (dermal) category 2 (H310) • Acute toxicity (dermal) category 3 (H311) • Acute toxicity (dermal) category 4 (H312)
Skin-absorption and other properties	Enter human body through dermal due to their physical chemical properties; Dermal application studies shown that absorption could cause systemic effect.	• Specific target organ toxicity-single exposure category 1* (H370) • Specific target organ toxicity-single exposure category 2* (H371) • Specific target organ toxicity-repeated exposure category 1* (H372) • Specific target organ toxicity-repeated exposure category 2* (H373) • Carcinogenicity category 1*(H350) • Carcinogenicity category 2*(H351) • Germ cell mutagenicity category 1*(H340) • Germ cell mutagenicity category 2*(H341) • Reproductive toxicity category 1*(H360, H360D, H360F, H360FD, H360Fd, H360Df) • Reproductive toxicity category 2*(H361, H361f, H361d, H361fd)

Note:
*to determine if hazard is due to dermal exposure

4.3 EXAMPLE ON DETERMINATION OF DEGREE OF HAZARD FOR INHALATION AND DERMAL EXPOSURES

1) Acetic anhydride (CAS no: 108-24-7)

Hazard classification of acetic anhydride (information referred to ICOP CHC):

- Flammable liquid category 3;
- Acute toxicity category 4 (inhalation);
- Acute toxicity category 4 (oral);
- Skin corrosion or irritation category 1B; and
- Serious eye damage or eye irritation category 1

Use **Table 1** to determine HR based on the hazard classification which relates to inhalation:

Hazard classification	HR
Acute toxicity category 4 (inhalation)	2

► HR for acetic anhydride is 2.

Use **Table 2** to determine hazardous properties by dermal:

Hazard classification	Hazardous properties
Skin corrosion or irritation category 1B	Corrosion
Serious eye damage or eye irritation category 1	Corrosion

2) Potassium cyanide (CAS no: 151-50-8)
Physical form: liquid

Hazard classification of potassium cyanide (information obtained from SDS of potassium cyanide, Section 2: Hazard Identification):

- Corrosive to metals category 1;
- Acute toxicity category 2 (oral);
- Acute toxicity category 2 (inhalation);
- Acute toxicity category 1 (dermal);
- Specific target organ toxicity - single exposure category 1;
- Specific target organ toxicity - repeated exposure category 1;
- Acute aquatic toxicity category 1; and
- Chronic aquatic toxicity category 1

Use **Table 1** to determine HR based on the hazard classification which relates to inhalation:

Hazard classification	HR
Acute toxicity category 2 (inhalation)	4
Specific target organ toxicity - single exposure category 1	5
Specific target organ toxicity - repeated exposure category 1	4

► HR for potassium cyanide is 5.

Use **Table 2** to determine hazardous properties by dermal:

Hazard classification	Hazardous properties
Acute toxicity category 1 (dermal)	Acute toxicity
Specific target organ toxicity - single exposure category 1	Skin-absorption and other properties
Specific target organ toxicity - repeated exposure category 1	Skin-absorption and other properties

3) Solvent AB

Hazard information obtained from label is risk phrases apply to solvent AB:

R48/20 Harmful-danger of serious damage to health by prolonged exposure
R36/37/38 Irritating to eyes, respiratory system and skin
R43 May cause sensitisation by skin contact

Using the conversion table in **Appendix 1**, convert R-phrases to hazard classification under CLASS Regulations. Then use **Table 1** to determine the HR.

Risk phrase	Hazard classification, H-code
R48/20	Specific target organ toxicity – repeated exposure category 2, H373
R36	Serious eye damage or eye irritation category 2, H319
R37	Specific target organ toxicity – single exposure category 3 (respiratory tract irritation), H335
R38	Skin corrosion or irritation category 2, H315
R43	Skin sensitisation category 1, H317

Then use **Table 1** to determine the HR:

Hazard classification	HR
Specific target organ toxicity – repeated exposure category 2, H373	3
Specific target organ toxicity – single exposure category 3, H335	3

► HR for solvent AB is 3.

Use **Table 2** to determine hazardous properties by dermal:

Hazard classification	Hazardous properties
Serious eye damage or eye irritation category 2, H319	Irritation
Skin corrosion or irritation category 2, H315	Irritation
Skin sensitisation category 1, H317	Sensitisation
Specific target organ toxicity – repeated exposure category 2, H373	Other properties*

Note:
*No information on skin-absorption

4) Herbicide diquat

All hazard information for herbicide diquat was obtained from SDS provided by the chemical supplier.

Health hazard classification (obtained from section 2 of SDS):

- Acute toxicity category 4 (oral);
- Acute toxicity category 3 (inhalation);
- Skin corrosion/irritation category 2;
- Serious eye damage/irritation category 2;
- Respiratory sensitisation category 1;
- Specific target organ toxicity-single exposure category 3, H335; and
- Specific target organ toxicity-repeated exposure category 1.

Acute toxicity data for inhalation obtained from section 11 of SDS:

Inhalation (dusts and mists): rat 4 hours LC_{50}: 0.64 mg/L

(a) HR determined based on the acute toxicity data using **Table 1**:

Acute toxicity data		HR
LC_{50} (inhalation)	0.64 mg/L	3

(b) HR determined based hazard classification using **Table 1**:

Hazard classification	HR
Acute toxicity category 3 (inhalation)	3
Respiratory sensitisation category 1	4
Specific target organ toxicity-single exposure category 3 (respiratory tract irritation)	3
Specific target organ toxicity - repeated exposure category 1	4

► HR for herbicide diquat is 4.

(c) Determine hazardous properties by dermal using **Table 2**:

Hazard classification	Hazardous properties
Skin corrosion or irritation category 2	Irritation
Serious eye damage or eye irritation category 2	Irritation
Specific target organ toxicity - repeated exposure category 1	Other properties*

Note:
*No information on skin-absorption

5) Waste from washing, cleaning and degreasing processes containing toluene, xylene, turpentine and kerosene, categorised as SW 322.

Hazard information obtained from the waste card:

- *Risks by inhalation: inhalation of the vapours may cause dizziness, headache, nausea, vomiting, apathy and unconsciousness;*
- *Risks by oral intake: the waste will cause the same symptoms as by inhalation; and*
- *Risks by dermal contact: the waste will cause blushing and stings.*

a) HR determined based on health effect using **Table 1**:

► HR is 2.

b) Hazardous properties by dermal determined based on description of hazardous properties using **Table 2**:

► Hazardous properties is irritation.

More examples of determining the HR for CHTH are given in **Appendix 4**.

CHAPTER 5

ASSESS EXPOSURE

The purpose of assessing exposure is to evaluate the potential of CHTH entering the body through various routes of exposure and the degree of exposure causing adverse health effects to workers in each work unit identified.

Evaluation of exposure could be carried out using the qualitative or quantitative method. The estimation of exposure via quantitative method in this manual is meant for inhalation while qualitative method is for inhalation and dermal route. However, other contribution factors should also be considered. If the contribution to the overall exposure by other route of exposure is significant, record the finding in **Forms A** and **D**, and suggest appropriate actions to be taken if applicable.

Evaluation of exposure to CHTH during normal operation is done by going through work procedures, observation of the various tasks performed and interviewing members of the work unit. Important considerations in assessing exposure in the work place are:

a) Degree of exposure

- Who is exposed;
- How and in what circumstances is the exposure;
- Possible route of exposure;
- Frequency of exposure;
- Duration of exposure; and
- Intensity or magnitude of exposure.

b) Other factors such as existing control measures in place; training and information of workers; monitoring of exposure; and medical surveillance.

Apart from assessing exposures during normal operation, the possibility of abnormal exposure such as spillage, leaks or accidental entry into the body such as through injection, increased workload, and malfunctioning of control equipment is to be considered.

Special consideration may be required for susceptible group of workers or persons who may be at increased risk, such as pregnant women; person with medical condition such as suffering from bronchitis or asthma; untrained or inexperienced workers; smokers, who may be at increased risk of additive or synergistic effects.

Report in **Form A** any possibility of abnormal exposures, mixed exposures, ingestion exposures and worker health feedback.

5.1 POSSIBLE ROUTES OF EXPOSURE

Possible routes of exposure are the likelihood of exposure of workers in the work unit to CHTH through inhalation, dermal (contact or absorption) or oral/ingestion. This manual focus on assessing exposure through inhalation and dermal. Ingestion will not be assessed in detail because it does not constitute a significant route of exposure for industrial chemicals due to the fact that:

- Few chemicals enter via this route.
- The duration of exposure via ingestion is usually shorter.
- Most workplaces prohibit eating or drinking in the work area.

Factors that could be considered to assess the likelihood of exposure are:

- physical form of the chemicals;
- physicochemical properties of the chemicals;
- nature of work;
- working method;
- working condition; and
- work practices.

Refer to **Appendix 2** for more details on routes of exposure. After all possible route of exposure have been identified, proceed to evaluate exposure through all route of exposure.

5.2 EVALUATE EXPOSURE FOR INHALATION

Exposure rating (ER) is used to represent the degree of exposure to CHTH by taking into account the intensity or magnitude of exposure, frequency of exposure and duration of exposure. Same as HR, rating of 1 implying low degree of exposure and a rating of 5 implying highest degree of exposure. Assessment of inhalation exposure could be carried out either using a qualitative or quantitative evaluation. However, quantitative evaluation is preferred. Refer to **Figure 3** on the overall flow of quantitative and qualitative evaluation.

5.2.1 Quantitative Evaluation

Quantitative evaluation of exposure is carried out for inhalation exposures if personal air sampling data for the exposed workers or the work unit assessed are available. The exposure measurement data may be valuable if the process has not changed significantly. Where exposure data is limited or unavailable, the assessor should assess the exposure qualitatively (refer to paragraph 5.2.2). The evaluation of inhalation exposure is to be done without regards to the use of respiratory protection.

Inhalation exposure evaluation is based on:

- Current measurement of personal exposure monitoring;
- Estimation from previous measurement of personal exposure monitoring; or
- Estimation of personal exposure from ambient or general air levels for total work duration.

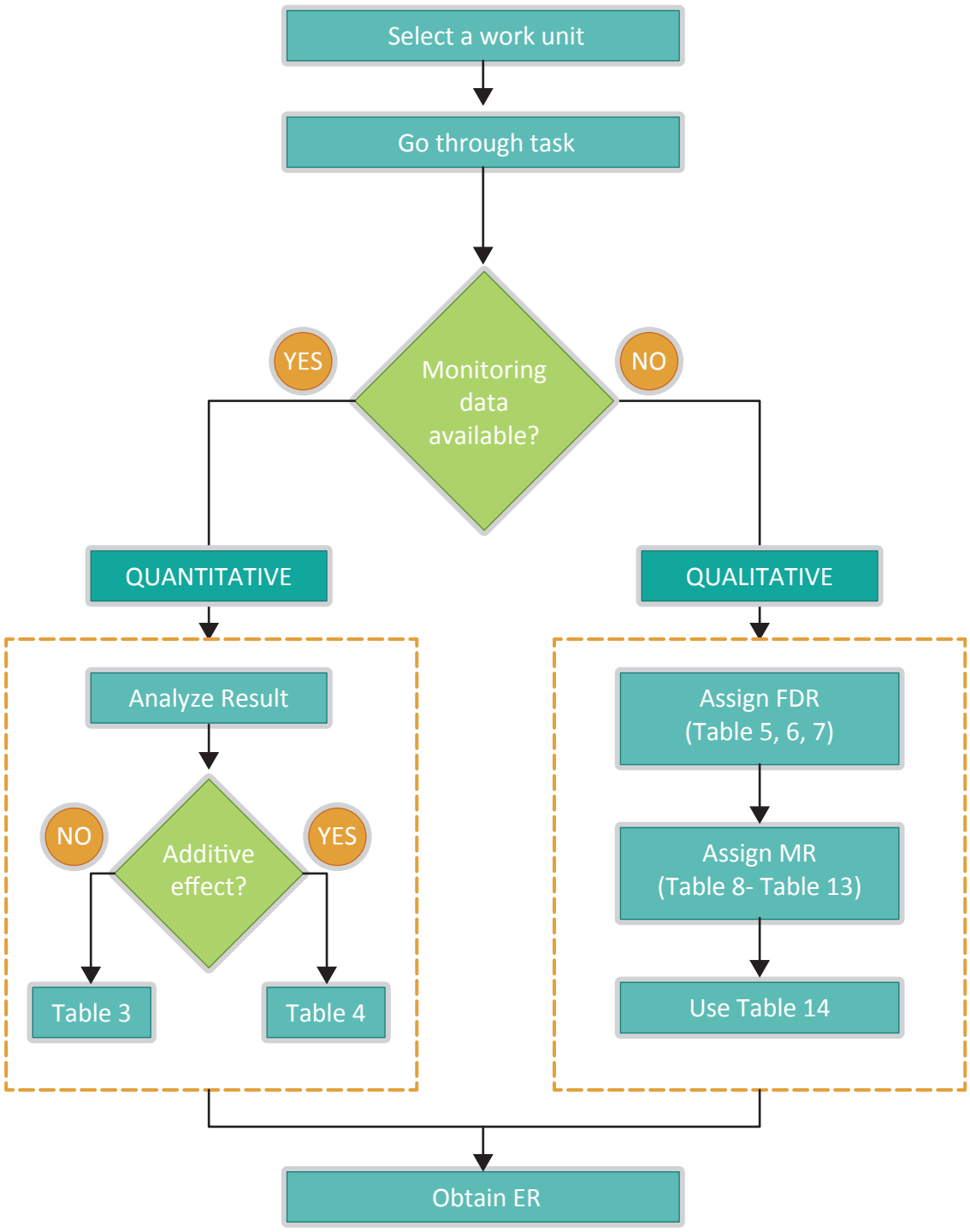


Figure 3: The Procedure for Determining Exposure Rating for Inhalation Exposure.

5.2.1.1 Rating acute exposure

Acute health effect is commonly referred to an effect which occurs rapidly as a result of short term exposure or short duration exposure. The effects may manifest within minutes or hours (up to 24 hours) or days (up to 2 weeks, but rarely longer) after exposure. Most often the acute health effects appear in terms of irritation, corrosion, sensitisation, narcosis or even death.

For chemicals with acute health effects, use exposure measurement data based on 15 minutes time-weighted average (TWA) for chemical with short term exposure limit (STEL) and 10 minutes TWA for chemicals with ceiling limit. The ER is assigned based on the fraction of the measurement result to the ceiling limit or the STEL, whichever results in a higher ER. Refer **Table 3**.

Personal exposure measurement data to be used should be of most recent data, provided exposure and control conditions remain unchanged at the time of assessment. If there are several samples taken on the same exposure group, professional judgement needs to be made, either to use the highest acceptable value to determine the ER or to take the arithmetic mean (AM) or geometric mean (GM) of the data measurement. Either way, the assessor should be able to justify the reason which type of data is used in determining the ER.

5.2.1.2 Rating chronic exposure

Chronic health effects normally occur as a result of prolonged, repetitive exposures and of long duration. The chemicals of concerns are generally, but not limited to, carcinogens, reproductive toxicants, mutagens and systemic toxicants.

For chemicals with chronic health effects, use exposure measurement data of TWA based on total work or task duration in a typical working day. The TWA is calculated as follows:

$$\text{TWA} = \frac{C_1T_1 + C_2T_2 + \ldots + C_nT_n}{T_1+T_2+\ldots T_n}$$

Where C is the concentration of each sample and T is the sampling time for that sample.

Similar to rating acute exposure, personal exposure measurement to be used should also be of most recent data, provided exposure and control conditions remain unchanged at the time of assessment. However, if several TWA data are available for the same work unit, AM or GM of the data should be used to determine the ER using **Table 3**. Either way, the assessor should be able to justify the reason which type of data is used in determining the ER. For further information of GM refer to **Appendix 5**.

Examples on how to use the exposure measurement results to determine the magnitude of exposure are given in **Appendix 6**.

Table 3: Inhalation Exposure Based on Airborne Exposure Measurement

Time-weighted average (TWA) or Short term exposure limit (STEL) or Ceiling Limit	Exposure Rating
≥ PEL	5
≥ 0.75 PEL but < PEL	4
≥ 0.5 PEL but < 0.75 PEL	3
≥ 0.1 PEL but < 0.5 PEL	2
< 0.1 PEL	1

Note:
In the absence of a Malaysian PEL, other exposure limits may be adopted.
A discussion on the Occupational Exposure Limit (OEL) is given in **Appendix 7**.

5.2.1.3 Rating additive effects

Where workers are exposed to two or more chemicals that are not known to act independently of each other, they should be treated as acting additively and a combined exposure index (CEI) can be calculated. CEI exceeding unity means the workers are overexposed to the chemicals. The CEI is calculated as follows:

$$CEI = \frac{TWA_1}{PEL_1} + \frac{TWA_2}{PEL_2} + \ldots + \frac{TWA_n}{PEL_n}$$

For example, toluene and methyl ethyl ketone (MEK) are common solvents that act on the same target organ i.e. the central nervous system. PEL of toluene is 100 ppm and MEK is 200 ppm. If 50 ppm of toluene and 120 ppm of MEK are present in the workplace air, then

$$CEI = \frac{50}{100} + \frac{120}{200} = 0.5 + 0.6 = 1.1 > 1$$

which means that the combined exposure is above the PEL. Using **Table 4**, the ER assigned for exposure to MEK and toluene exposure is 5.

Table 4: Exposure Rating for Additive Effects

Exposure Rating	Combine Exposure Index (CEI)
5	$x \geq 1$
4	$0.75 \leq x < 1$
3	$0.5 \leq x < 0.75$
2	$0.1 \leq x < 0.5$
1	$x < 0.1$

Note:
Mixed exposure ER* must be used in Form C instead of the individual ER.

5.2.2 Qualitative Evaluation

Qualitative evaluation of exposure through inhalation is estimated by the degree of chemical release or presence at the exposure boundary. As a rule of thumb, twice the volumes of material released will double the concentration. Estimation of the degree of exposure is primarily based on these parameters:

a) Frequency of exposure, F;
b) Duration of exposure, D; and
c) Intensity or magnitude of exposure, M.

The more frequent or the longer the duration of a CHTH is used, the higher is the degree of exposure. The greater the amount of chemical being inhaled, the higher is the degree of exposure. Magnitude of exposure, is determined by the degree of chemical released and the degree of chemical inhaled.

5.2.2.1 Estimation of frequency-duration rating

Frequency-duration rating (FDR) is estimated by separately assigning a rating for frequency of exposure and duration of exposure. The frequency and duration ratings are then combined to obtain the FDR.

a) Frequency of exposure

The frequency of exposure has a significant effect on the degree of exposure. For example, twice the frequency would yield a two-fold increase in exposure. The frequency of potential exposure can be estimated from observation of the work activities and feedback from the workers and management. Frequency rating (FR) is used and is determined from **Table 5**.

Table 5: Frequency Rating

Rating	Description	Definition
5	Frequent	Exposure one or more time per shift or per day
4	Probable	Exposure greater than one time per week
3	Occasional	Exposure greater than one time per month
2	Remote	Exposure greater than one time per year
1	Improbable	Exposure once per year or less

For periodic but intensive tasks, professional judgement should be made based on **Table 5**. As an example, if a task is carried out once a year but performed daily over a week, then the frequency should be assigned as 5.

b) Duration of exposure

Duration of exposure also has a significant effect on the exposure. Twice the duration results in twice the exposure. The average duration is used in determining the duration of exposure. Use **Table 6** to assign the duration rating (DR).

Table 6: Duration Rating

Rating	Duration of exposure per shift (x)
5	$x \geq 7$ hours
4	$4 \leq x < 7$ hours
3	$2 \leq x < 4$ hours
2	$1 \leq x < 2$ hours
1	$x < 1$ hour

c) Assigning frequency-duration rating

From the FR and DR obtained, use **Table 7** below to assign the FDR.

Table 7: Frequency-Duration Rating (FDR)

		FREQUENCY RATING (FR)				
		1	**2**	**3**	**4**	**5**
DURATION RATING (DR)	**1**	1	2	2	2	3
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

5.2.2.2 Estimation of magnitude rating

Magnitude rating (MR) is determined by the chemical's physicochemical properties and human interface during chemical handling. It is assessed by estimating the degree of chemical released or presence and the degree of chemical inhaled.

a) Degree of chemical release or presence

The assessor may estimate the degree of chemical release or presence through either observation or using direct reading measurement as described below.

i) Through observation

The degree of chemical release or presence in the environment is estimated from the physicochemical properties, the process characteristics, the quantity used, the method of handling, and the atmospheric conditions. This information is obtained from the SDS, process descriptions, and from observation of environmental conditions. Refer to **Appendix 8**.

Use **Table 8** to determine the degree of release or presence for inhalation exposure. The degree of release assigned is based on the observation resulting in the greatest degree of release.

Table 8: Degree of Chemical Release or Presence

Degree	Observation
Low	• Low or little release into the air. • No contamination of air, clothing and work surfaces with chemicals. • Low volatility with the boiling point more than 150°C at room temperature (20°C). ** • Low dustiness such as pellet like solids that don't break up. Little dust is seen during use e.g. PVC pellets, waxed flakes.
Moderate	• Moderate release such as: a) Solvents with medium drying time* in uncovered containers or exposed to work environment; b) Detectable odour of chemicals. Check the odour threshold. • Medium volatility with the boiling point at 50°C to 150°C at room temperature (20°C). ** • Medium dustiness such as crystalline, granular solids. When used, dust is seen, but settles out quickly. Dust is left on surfaces after use e.g. soap powder. • Evidence of contamination of air, clothing and work surfaces with chemicals.
High	• Substantial release such as: a) Solvents with fast drying time* in uncovered containers; b) Sprays or dust clouds in poorly ventilated areas; c) Chemicals with high rates of evaporation exposed to work environment; d) Detectable odour of chemicals with odour threshold at/above PEL/OEL. • High volatility with the boiling point less than 50°C at room temperature (20°C). ** • High dustiness such as fine, light powders. When used, dust clouds can be seen to form and remain in the air for several minutes e.g. cement, carbon black, chalk dust. • Gross contamination of air, clothing and work surfaces with chemicals.

Note:
*Refer to **Appendix 9**.
** For volatile chemicals at other operating temperatures, refer to **Appendix 10**.

ii) Using direct reading measurement

Suitable methods of use of direct reading measurements may provide a more objective screening in determining degree of release, in the absence of personal exposure measurement data. It may also be used as screening tools to check against "worst case" or decision in the needs for the costly personal exposure monitoring data. An assessor must study the CHTH exposure pattern and take the direct reading measurement during which the CHTH exposure level may be the highest.

Use **Table 9** to assess the degree of chemical release using direct reading measurement.

Table 9: Inhalation Exposure Based on Airborne Exposure Measurement

Direct reading measurement result	Degree of release
≥ PEL	High
≥ 0.5 PEL but < PEL	Moderate
< 0.5 PEL	Low

Note:
In the absence of a Malaysian PEL, other exposure limits may be adopted. Further information on direct reading instruments can be found in **Appendix 11**.

b) Degree of chemical inhaled

CHTH in the form of vapours, gases, mists or particulates will have inhalation as their main route of exposure into our body. Once released as airborne contaminants in the form of vapours, gases, mists or particulates, there are chances that the contaminants may be inhaled into the respiratory tract.

Use **Table 10** to evaluate the degree of chemicals being inhaled.

Table 10: Degree of Chemical Inhaled

Degree	Observation / Condition
Low	• Low breathing rate (light work) * • Source far from breathing zone
Moderate	• Moderate breathing rate (moderate work) * • Source close to breathing zone
High	• High breathing rate (heavy work) * • Source within breathing zone

Note:
*Refer to **Table 11**.

Table 11: Degree of Physical Activities and Breathing Rate

Physical Activity	Breathing Rate
Light Work Sitting, moderate arm and trunk movements (e.g. desk work, typing) Sitting, moderate arm and leg movements (e.g. hand soldering and QC inspection) Standing, light work at machine or bench, mostly arms	Low
Moderate Work Sitting, heavy arms and legs movement Standing, light work at machine or bench, some walking about Standing, moderate work at machine or bench, some walking about Walking about, with moderate lifting or pushing (e.g. machine operator)	Medium
Heavy Work Intermittent heavy lifting, pushing or pulling (e.g. pick and shovel work) Hardest sustained work	High

c) Assign magnitude rating

Once the degree of chemical released or presence and degree of chemical inhaled have been obtained, the magnitude rating (MR) can be determined using **Table 12**.

The MR in **Table 12** may however be modified by other factors such as bad work habits, poor personal hygiene, complaints of ill effects, results of biological monitoring or biological effect monitoring, signs and symptoms of related disease or illness. MR may be modified if the working conditions or the amount the CHTH handled has additional negative or positive impact to the magnitude of exposure assessed.

Depending on the conditions of the working area or the way the CHTH is handled, MR may be modified. It could increase or decrease in terms of risk. Either way, the final MR assigned should not exceed rating of 5 or less than rating of 1.

Table 12: Magnitude Rating

		DEGREE OF INHALED		
		LOW	MODERATE	HIGH
DEGREE OF RELEASE/PRESENCE	LOW	1	2	3
	MODERATE	2	3	4
	HIGH	3	4	5

Use **Table 13** to modify the MR before assigning the ER.

IMPORTANT:
If modifying factor is included, detailed justification should be included in the report in **Form C**.

Table 13: Modifying Factors

MR modifying factor	Criteria for modifying factors
+ 1 (maximum MR not to exceed 5)	• Bad work practice and or poor personal hygiene that may have potentials for the chemical agents to remain on skin or clothing once contact occurs. • Reported cases of chemical exposure incidences. Results of biological monitoring exceed the Biological Exposure Index (BEI) (such as those described by the ACGIH). • Widespread complaints of ill effects related to exposure to the CHTH, in the work unit. • Reported cases of workers with pre-clinical symptoms related to the CHTH exposure. • Susceptible persons in work unit. • Cross airborne contamination.
-1 (minimum MR not less than 1)	• Quantity used is small for solid (weight in grams or typically received in packets or bottles) and for liquid (volume in millilitres or typically received in bottles).

5.2.2.3 Assign exposure rating

Based on the FDR and the MR, an ER is assigned using **Table 14**.

Table 14: Exposure Rating (ER)

		MAGNITUDE RATING (MR)				
		1	**2**	**3**	**4**	**5**
FREQUENCY - DURATION RATING (FDR)	**1**	1	2	2	2	3
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

Note:
If confirmed case(s) of occupational disease due to exposure to the CHTH have been reported for the particular work unit and there are no corrective actions taken since then, assign ER=5.

5.3 EVALUATE EXPOSURE FOR DERMAL

Dermal exposure is described as exposure of CHTH by direct dermal contact or absorption. Some CHTH may cause localised effects while some may cause systemic effects through absorption. These effects may occur through intact or broken skin. Broken skin, for example, abraded, raw or excessively dry or wet skin, has higher risk of being permeable compared to healthy intact skin.

Dermal exposure is likely if there are work activities involving direct contact of skin and eyes with CHTH in liquids, pastes or solids form, which includes splashes on the skin or contact with contaminated working clothes or contaminated surfaces. Dermal contact may also present if there is contact with aerosols, gases and vapours.

Similar to inhalation factors, the potential for dermal exposure to occur also depends on theconcentration and the duration of exposure of the CHTH. CHTH with the ability to absorb through skin are commonly organic solvents and pesticides.

The degree of chemical absorbed or contacted is based on the observation resulting in the greatest degree.

Dermal exposure pathways include:

a) Direct contact
Contact with skin when hands are used intentionally as a tool for handling CHTH or chemical-containing materials, tools and equipment. Skin surface other than the area of the hand, may come into direct contact with CHTH due to the way the work is carried out.

b) Hand immersion
Contact with skin when hands and or forearms are immersed in a CHTH.

c) Deposition
When airborne CHTH impact or settle on the skin in the form of gas, vapour, dust, fibre, fume or liquid mist.

d) Contact with surfaces
When skin comes into contact with contaminated work surfaces.

e) Contact with contaminated clothing and or PPE

f) Chemical splash on body and or clothing

Factors considered in evaluating the degree of dermal exposure are:

- Extent of dermal contact; and
- Duration of contact.

Those factors and the hazardous properties through dermal (**Chapter 4**, paragraph 4.2.2) are then used to determine the level of risk. Process in dermal exposure assessment is summarised as in **Figure 4**.

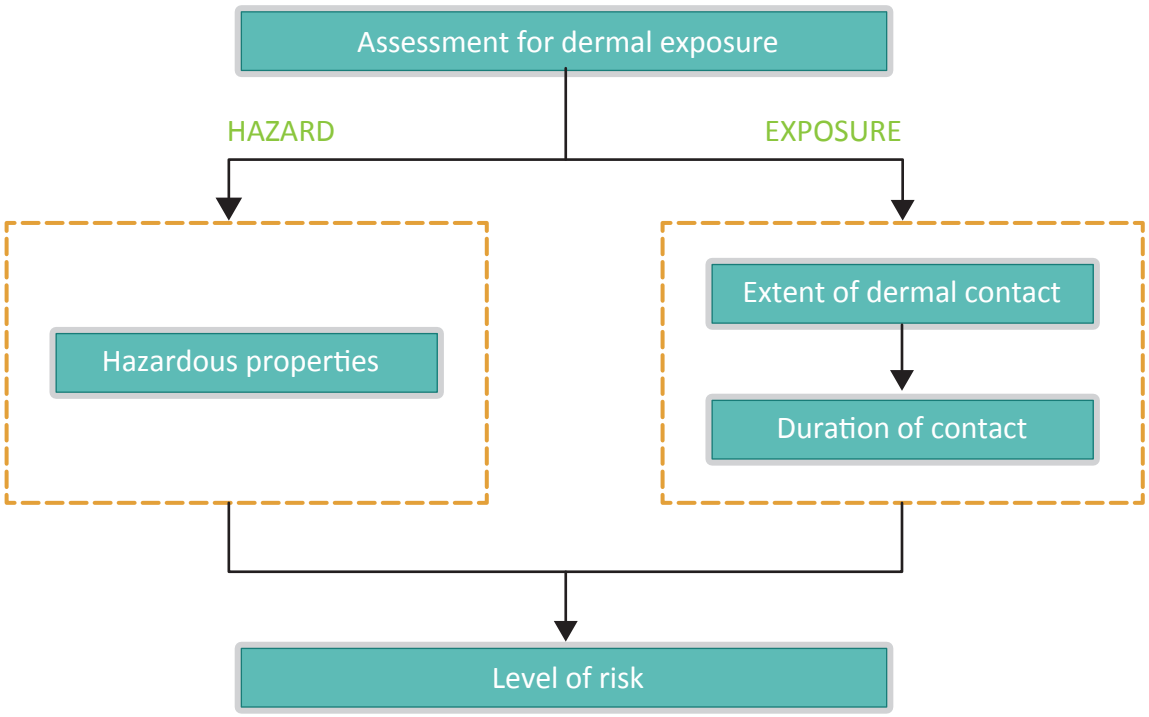


Figure 4: Estimation of Dermal Exposure

5.3.1 Extent of Dermal Contact

The extent of contact is defined by the size of the exposed area of the body surface affected as well as the frequency and intensity of contact. Extent of contact can be determined by an analysis of the work activities or working method. The quantity and concentration of the CHTH acting on skin or eyes should also be considered. A distinction is made between:

- Large area skin contact (direct skin contacts or uptake during the vapour or gaseous phase or aerosols); and
- Small area skin contact.

Use **Table 15** to estimate the extent of dermal contact.

Table 15: Extent of Dermal Contact

Extent of contact	Observation/Condition
Small	• Small area of contact with chemicals capable of skin absorption, skin sensitising or hazardous to the dermal e.g. limited to palm (intact skin) (< 2% or 0.04 m^2); • No indication of any skin condition; intact/normal skin; • No contamination of skin or eyes.
Large	• Contact with chemicals capable of skin absorption, skin sensitising or hazardous to the dermal; • Gross contamination with chemicals capable of skin absorption, skin sensitising or hazardous to the dermal – skin soaked or immersed in chemicals; • Area of contact not only confined to hands but also other parts of body. Skin area >2%; • Follicle rich area; • Skin dryness or detectable skin condition (e.g. peeling, cracking, skin redness)

5.3.2 Duration of dermal contact

Duration of dermal contact is estimated with due regard to the following distinction:

- Short term (< 15 min/shift)
- Long term (≥ 15 min/shift)

If repeated dermal contact is to be expected, the duration of exposure to the relevant chemicals during an entire shift should be ascertained. For chemicals that are skin corrosion, skin irritation or skin sensitising, the duration of skin contact begin with contamination of the skin and ended when the contamination had been efficiently eliminated.

5.4 INGESTION ASSESSMENT

Ingestion is the consumption of a chemical orally. It normally occurs by taking in the chemical through the mouth into the gastrointestinal tract, such as through eating or drinking. Chemical classified as aspiration hazard once ingested may be aspirated into the respiratory system causing severe effects or even fatality.

For some chemicals, ingestion could be a possible route of exposure due to poor personal hygiene and bad work practice. Awareness of this hazard is essential to minimise an accidental contact by contaminated skin or protective gloves. Accidental, careless or irresponsible contamination of the food chain can also lead to ingestion hazard.

Where there is possibility of ingestion exposure, the assessor should assess the adequacy of control and recommend appropriate measures to prevent or minimise ingestion of CHTH such as prohibition of eating or drinking in the workplace and good personal hygiene.

CHAPTER 6

RISK DETERMINATION

6.1 LEVEL OF RISK FOR INHALATION EXPOSURE

The level of risk is determined based on the risk rating, which is derived from the HR and ER. **Chapter 4** and **5** have described the step on how to determine the HR and procedures to estimate the ER, respectively. The risk rating is determined using the following equation:

RR = HR x ER

Where RR is the **risk rating** (1 to 25) indicating the likelihood of injury or illness;
HR is the **hazard rating** (1 to 5) indicating the severity of adverse effects; and
ER is the **exposure rating** (1 to 5) indicating the chance of overexposure to the CHTH.

Use the equation above or **Table 16** to determine the RR.

Table 16: Level of Risk Determination

		EXPOSURE RATING (ER)				
		1	2	3	4	5
HAZARD RATING (HR)	1	RR=1	RR=2	RR=3	RR=4	RR=5
	2	RR=2	RR=4	RR=6	RR=8	RR=10
	3	RR=3	RR=6	RR=9	RR=12	RR=15
	4	RR=4	RR=8	RR=12	RR=16	RR=20
	5	RR=5	RR=10	RR=15	RR=20	RR=25

LOW RISK LEVEL
MODERATE RISK LEVEL
HIGH RISK LEVEL

The level of risk is determined based on the result of RR which are:

Low risk	• RR = 1 to RR = 4
Moderate risk	• RR = 5 to RR = 12
High risk	• RR = 15 to RR = 25

6.2 LEVEL OF RISK FOR DERMAL EXPOSURE

The level of risk for dermal exposure is determine based on the information of the hazardous properties (**Table 2**), observation on extent of dermal contact (**Table 15**) and duration of exposure. Use risk matrix in **Table 17** to determine the level of risk.

In cases where there are more than one hazardous properties by dermal, select the highest level of risk for that chemical.

Level of risk for dermal exposure is categorized into three categories of risk which are:

1	• Low risk (L)
2	• Moderate risk (M1 & M2)
3	• High risk (H1 & H2)

Control measures to be taken is in accordance to the level of risk and adequacy of existing control measures in place.

Table 17: Risk Matrix for Dermal Exposure

Hazardous properties	Relevant H-code	Duration/ Extent of skin contact			
		Short-term (< 15 min)		Long-term (≥ 15 min)	
		Small area	Large area	Small area	Large area
Irritation	H315	L	M1	M1	M2
	H319	M1		M2	
Corrosive	H314	M1	H1	H1	H2
	H318	H1		H2	
Sensitisation	H317	L	M1	M2	H1
Acute toxicity	H312	M1	M1	M1	H1
	H311	M1	M1	M2	H1
	H310	H1	H1	H1	H2
Combination effect*	H310 with H314	H1	H1	H1	H2
Skin absorption and other properties**	H351	M1	M1	M2	H1
	H350	H1	H1	H1	H2
	H341	M1	M1	M2	H1
	H340	H1	H1	H1	H2
	H361, H361f, H361d, H361fd	M1	M1	M2	H1
	H360, H360F, H360D, H360FD, H360Fd, H360fD	H1	H1	H1	H2
	H370	H1	H1	H1	H2
	H371	M1	M2	M2	H1
	H372	M1	M1	M2	H1
	H373	L	M1	M2	M2

L: Low risk **M: Moderate risk** **H: High risk**

Note:

1. *For chemicals classified both as acute toxicity (dermal) category 1 or 2 and skin corrosion or irritation category 1 (1A/1B/1C);
2. **If indicate as skin absorption or effect is due to dermal exposure;
3. M2 and H2 indicating higher risk compare with M1 and H1 thus to be consider when deciding priority of action to control exposure i.e. M2 is higher moderate risk compare to M1 and H2 is higher high risk compare to H1.

CHAPTER 7

CONTROL MEASURES

Control measures are taken to prevent or minimise risks and in this context, risk from the use of CHTH.

There is a range of applicable chemical risk control measures, of could normally be exercised in the workplace at the same time. Assessing the adequacy of these multiple control measures can therefore be potentially tedious and confusing. To facilitate the assessment of the control measures, the numerous controls are categorised as follows:

- Technical controls
- Organisational controls
- Emergency response preparedness

The assessor should determine the adequacy of the existing control measures in particular those of the Technical Controls as the outcome will determine further actions required to control exposure.

It should be noted that the applicable control measures to be implemented by the employer would conform to the regulatory requirements of USECHH Regulations.

7.1 TYPES OF CONTROL MEASURES

7.1.1 Technical controls

Selection of the appropriate technical control measure(s) follows a hierarchy that begins with a consideration for eliminating the hazard entirely either by eliminating the CHTH itself or the process that uses it. Where this is not practicable, consideration should be given to each of the other control measures such as isolation, engineering control and use of PPE.

This hierarchy of technical controls is specified in the USECHH Regulations. Employers are encouraged to control significant risk arising from the use of CHTH, in the following order:

a) Elimination

This includes the total removal of a CHTH by the use of other processes not involving CHTH, redesign the task or substitute the CHTH so that the hazard is removed or eliminated. Elimination should be considered where a work activity or process involves the use of CHTH wherever practicable.

Examples of elimination include but not limited to:

- using a physical process rather than a chemical process to clean an object, for example, ultrasonic cleaning;
- using clips, clamps or bolts instead of adhesives; and
- purchasing material in already cut and sized form rather than carrying out dust generating cutting process on site.

b) Substitution

Substitution includes substituting a CHTH with a less hazardous one, using a chemical in a less hazardous form, or using the same chemical in a lower risk process. Substitution should be strongly considered for CHTH that are carcinogenic, reproductive toxicants, sensitising or neurotoxic. This is the most effective approach, particularly where less hazardous chemicals are viable substitutes. Removing the source of the risk must always be preferable to protect the worker from it.

Substitution can take two forms:

- Substitution of chemicals; e.g. substitution of organic solvents to water-based degreasing agent.
- Substitution of process or equipment; e.g. substitution of manual spraying to automation process.

Any one or combination of these forms of substitution may provide a method of control for a given hazard. To obtain optimum result, both forms of substitution should be utilised.

c) Total enclosure of process and handling systems

Totally enclosing the process and handling systems emitting CHTH can prevent or minimise their release into the work environment. Example of enclosure includes automated operations and closed loop sampling system.

d) Isolation of the work to control the emission of CHTH

Application of the principle of isolation is frequently envisioned as consisting of installation of a physical barrier between a hazardous operation and the workers. Frequently the application of the principles of isolation maximises the benefits of additional engineering control such as local exhaust ventilation. Isolation can be achieved by segregation, either by distance or a physical barrier, of the hazardous work, process or CHTH from workers. Example of isolation is relocating spray painting process away from highly populated area.

e) Modification of the process parameters

Process parameters such as temperature, pressure and flow rate can be modified to reduce the release of CHTH at the workplace. An example of modification is using lower operating temperature or pressure to minimise the release of CHTH into the work environment.

f) Application of engineering control equipment

Engineering controls are plant, process or equipment that minimise the generation of CHTH, suppress or contain CHTH, or which limit the area of contamination in the event of spills or leaks. Types of engineering control include local exhaust ventilation, general ventilation, water spray, etc. Some examples of engineering controls are as follows:

- ventilated booths for spray painting;
- robotic welding;
- extraction systems attached to grinding machines; and
- suppression of dust using water spray.

g) Provision of PPE

Minimisation of risks through the provision and use of PPE is the lowest rank in the hierarchy of control. Provision of PPE includes the proper selection, issuance, correct fit, proper use, care and maintenance, and availability of replacement when required. These are elements of PPE programme which requires management intervention and workers' cooperation for a successful implementation.

The use of PPE as a control measure shall be limited to situations where other control measures are not practicable or where PPE is used in conjunction with other measures to increase protection. PPE may also be used as an interim measure while other technical control measures are being implemented.

Situations where use of suitable PPE may be necessary include:

- Where it is not technically feasible to achieve adequate control by other means. In these cases, exposure should be reduced as far as practicable by other measures and then, in addition, suitable PPE should be used to secure adequate control;
- Where PPE is necessary to safeguard health until such time as adequate control is achieved by other means, for example, where urgent action is required because of plant failure; or
- During maintenance where the operation is not frequent and or involves small number of people.

7.1.2 Organisational controls

Organisational control measures, although they do not directly remove or minimise the risk, are equally important as they support or strengthen the technical control measures and are part of a complete chemical health risk management system. Where these organisational measures are deemed inadequate according to the following requirements, it should be addressed as actions to be taken.

a) Adoption of safe work systems and practices

Safe work system is a formal work procedure that results from systematic examination of a task in order to identify all hazards. It defines safe methods to ensure that hazards are eliminated or risks are minimised. Safe work systems are integration of men, machinery and materials in the correct environment to produce the safest possible conditions in a specific work area. In a workplace, a safe work system shall comprise fully documented hazard precautions and safe working conditions that are used in job training. Safe system of work is part of the employer's general duties under the Occupational Safety and Health Act 1994.

Safe work practices are administrative practices which require people to work in safer ways. Examples of safe work practices include:

- Reducing the numbers of workers exposed;
- Restrict access to related workers only;
- Reducing the period of exposure for workers;
- Regular cleaning of contamination from walls and surfaces;
- Providing means for safe storage and disposal of CHTH;
- Prohibiting eating, drinking and smoking in contaminated areas;
- Vacuuming dust from areas where cutting processes take place;
- Keeping lids on containers when not in use; and
- Providing and using facilities for effective decontamination.

b) Providing information, instruction and training

Information, instruction and training including risk communication and PPE programme are necessary for workers exposed to CHTH. In addition, the following group of workers should be included:

- Supervisors of workers at risk from exposure to a CHTH;
- Members of a safety and health committee;
- Workers responsible for the purchasing of a CHTH; or
- Those who have direct involvement in emergency action.

The training provided is to enable them to know, as a minimum about the risk to health created by such exposure and the precautions that should be taken. The scope of training should include:

- Legislative requirements

  ◊ General duties of employer, chemical suppliers, and workers.
  ◊ Purpose and basic requirements for medical surveillance.

- Information on CHTH

  ◊ Recognise and understand SDS and labels.
  ◊ Use of chemical register and access the SDS.
  ◊ Understanding of any work practice or procedure to be followed in the use of CHTH.
  ◊ Understanding of control measure to be used in the workplace.

- Personal safety

  ◊ Understanding of routes of exposure.
  ◊ Risks presented by CHTH.
  ◊ Methods used to control risks.
  ◊ Precautions taken for a particular risk.
  ◊ Correct use, fit and maintenance of PPE.

- Emergency procedures

  ◊ Procedures to be followed during emergency.
  ◊ First aid or incident reporting procedures to be followed in case of injury or illness.

Retraining of workers should be carried out:

- At least once in two years.

- Each time there is a change in:

  ◊ Information provided on a SDS;
  ◊ Any hazard information available; or
  ◊ Control measures.

- Each time a worker is assigned to a new task or a new work area.

c) Personal hygiene

- Washing hands before partaking of food by hand.
- Do not eat, drink or keep food and drinks in the work area where CHTH are in used.
- Keeping fingernails short and clean.
- Bathing or change of clothes, where contamination is widespread.

7.1.3 Emergency response preparedness

Emergency response preparedness would be required to mitigate the potential effects of chemical accidents and would include, but not limited to:

a) Emergency procedures

- Availability of emergency response plan or procedures
- Emergency eye wash and shower
- Spill kit
- Fire-fighting equipment
- Trained emergency response team

b) Medical emergency response

- First aid facilities – clinic, holding area, first aid box, trained first aiders
- Hospital/clinics arrangement

7.2 ADEQUACY OF CONTROL MEASURES

7.2.1 Adequacy of technical control

The existing technical control measures need to be assessed for adequacy in controlling the worker's exposure to CHTH and will determine further action required to be implemented by the employer. Adequacy of the technical control measures are assessed according to the following criteria:

a) Suitability;
b) Use and effectiveness; and
c) Maintenance.

Technical control measures are deemed adequate if all the above criteria are met. Examples of what is considered adequate within each of these criteria are elaborated in the following section. Refer to **Appendix 12** for guidance for assessing adequacy of control measures.

7.2.1.1 Suitability

It is suitable for protecting the workers, taking into consideration the physical form and toxicity of the CHTH, the nature of work, the routes of exposure of the CHTH and not prejudice to the health of the workers.

Suitability of the technical control measures depends on:

a) The toxicity of the CHTH

- For high toxicity CHTH, the use of local exhaust ventilation is suitable while the use of general ventilation is not.
- The use of job rotation is not suitable for CHTH classified as carcinogen, mutagen, reproductive toxicant and sensitizer. For these chemicals, the use of technical control is more appropriate.
- For PPE, the degree of protection must match the level of risk posed by the hazard of the chemical and its use in the workplace. Refer to the PPE specification sheet to determine the suitable degree of protection.

b) The physical and chemical properties of the CHTH

The control equipment is designed for the physical form of the CHTH that are released into the workplace e.g. the use of a particulate respirator is not suitable to protect against organic solvent vapour.

c) Nature of work

Suitable if the nature of work does not hinder the efficiency of the control measure or the control measure does not give rise to the potential for an accident or to another hazard.

d) Adaptability

Suitable if control measures are adapted to the work capacity and capability of the workers involved.

e) Route of exposure

Control measures selected prevent exposure of the CHTH through the possible route of exposure.

7.2.1.2 Use and effectiveness

The control measures are used according to the manufacturers' instructions and recommendations, and effective in preventing or minimising exposure. By observing the following conditions at the workplace, the use and effectiveness of the technical control measures can be assessed:

a) General condition

- Minimal contamination of the air, work clothing, or work surfaces, odour or irritating sensation;
- Minimal or no release or emission of CHTH into the working environment; and
- Minimal or no exposure or contact of workers to CHTH.

b) Local exhaust ventilation system (LEV)

- No accumulation of CHTH around the hood;
- Smoke tube test indicates good suction-smoke directed towards the hood;
- The velocity is within the recommended value for the specific contaminant; and
- The positioning of hood is such that it is enclosing or very close (within 1 hood diameter) to the source.

c) PPE

- Worn continuously at the designated work area: audit programmes, constant supervision and enforcement;
- Properly worn: workers have undergone instruction or training on the correct way to wear the equipment and are wearing the equipment properly;
- Correctly fitted: the sizing of the equipment has been carefully chosen and fit tested for the worker; and
- Equipment functions properly: not defective or damaged, or shelf life has not expired.

7.2.1.3 Maintenance

Maintenance of control equipment is an important aspect in ensuring that the health risks are continuously under control. It is regularly maintained in good working condition. This would entail the following:

a) Engineering controls

- Periodic inspection, examination and testing to ensure effectiveness;
- Immediate repair when there is a breakdown in the equipment; and
- Re-testing of equipment effectiveness after any repair work.

b) PPE

- Available replacements for defective part(s) or ineffective equipment;
- Regular inspection and care of equipment; and
- Provision and use of proper equipment accommodation.

7.2.2 Adequacy of organisational control and emergency response preparedness

In assessing the adequacy of organisational control and emergency response preparedness, the assessor should consider requirements of the USECHH Regulations and best occupational safety and health practices. Refer to **Appendix 12** for guidance for assessing adequacy of organisational control and emergency response preparedness.

7.3 SPECIFIC CONTROL MEASURES

7.3.1 Carcinogenicity category 1

Exposures to CHTH classified as carcinogenicity category 1 (known or presumed human carcinogens) should be eliminated. Where it is not practicable to eliminate exposure to these chemicals, the employer shall apply the following measures:

a) the design and use of appropriate work processes, systems and engineering controls and provision and use of suitable work equipment and materials;

b) the control of exposure at source including adequate ventilation systems and appropriate organisational controls;

c) totally enclosing the process and handling systems, unless this is not reasonably practicable;

d) where adequate control of exposure cannot be achieved by other means, the provision of suitable approved personal protective equipment in addition to the measures required by paragraph (a), (b) and (c);

e) cleaning floors, walls and other surfaces at regular interval;

f) designating those areas and installation which may be contaminated by carcinogens and using suitable and sufficient warning signs; and

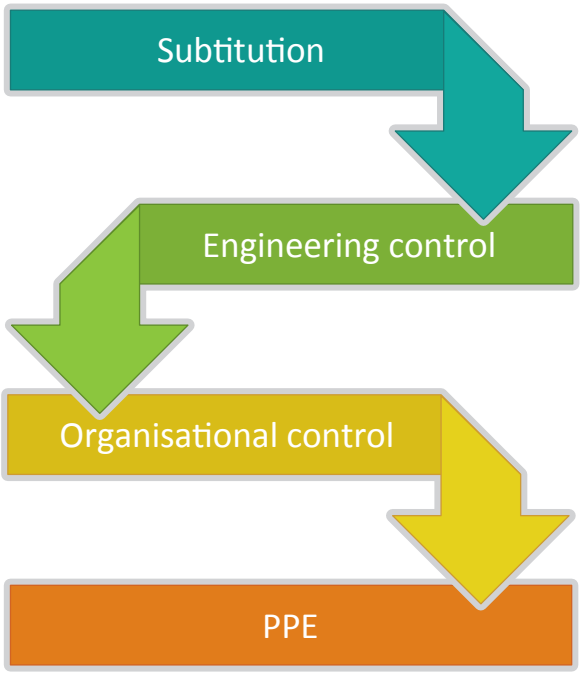
g) storing, handling and disposing of carcinogens safely, including using closed and clearly label containers.

7.3.2 Respiratory sensitisers

Exposures to CHTH classified as respiratory sensitiser should be prevented by elimination or substitution. Engineering control should be considered if elimination and substitution is not possible. Where it is not practicable to implement all of these controls, respiratory protective equipment need to be worn irrespective of absorbed dose or airborne concentration.

7.3.3 Control of dermal exposure

The order of priority of measures to control dermal exposure is substitution, engineering control, organisation and personal protective measures.



Adequate control of dermal risks usually need combination of control measures. The following measures can be applied, where practicable:

1) Avoid contact with CHTH which may cause any skin disease or skin absorption by:

- substitute a more hazardous chemical with a safer alternative;
- automate the process;
- enclose the process as much as possible;
- use equipment for handling rather than allowing the hands to be used as tools;
- use a safe working distance.

2) If the above measures are not enough to totally avoid dermal contact, protecting the skin is particularly important by:

- telling workers how to look after their skin;
- reminding them to wash any contamination from their skin promptly and dry their skin thoroughly;
- supplying moisturising pre-work and after-work creams;
- providing appropriate protective clothing/gloves and ensuring they are used correctly (donned, doffed, cleaned, stored, maintained, disposed of etc.).

3) If there is still a risk to skin health after the implementation of all reasonably practicable measure, medical surveillance programme may be necessary to be in place to check for possible harm.

- Regular skin checks can spot the early stages of dermatitis.
- Early detection can prevent more serious dermatitis from developing.
- Steps can be taken to start treating the condition.
- Checks can help indicate a possible lapse in preventative measures

7.3.3.1 Control measures for low risk

If the result of assessment indicated low risk, general hygiene measures can be taken which include:

a) Provide workers washing facilities as well as suitable with mild skin cleaning products and means to dry hands;
b) Skin contaminated with chemicals hazardous to dermal must be cleaned immediately and ensure the chemicals do not dry on the skin;
c) Arm and hand jewellery (rings) may not be worn at work because pathological changes to skin will be encouraged to a particular degree under the jewellery through the intensive action of chemicals;
d) Skin care products are used to promote regeneration of the skin. Their use is essential after the end of the work and after the skin has been cleaned.

7.3.3.2 Control measures for moderate to high risk

If the result of assessment indicated moderate to high risk, these measures can be taken:

a) Substitution

Substitute the chemicals with less hazardous alternative chemicals. If there are no substitution chemicals available, check whether the chemicals could be obtained in lower concentration. Dermal contact could also be prevented or reduced with the use of suitable substitution procedure.

b) Closed system with high risk

If substitution is not possible, a close system should where technically feasible be provided.

c) Engineering control and organisational control where there is moderate and high risk If the application of closed systems is not technically feasible, engineering control and organisational control should be taken in addition to the general hygiene measures to reduce dermal exposure. If these controls are not sufficient, suitable PPE should be made mandatory as additional measures. Engineering controls include:

- The use of devices which avoid skin contact; and
- Enclosures, extraction system or ventilation systems.

Organisational measures include:

- Information on the hazardous properties of the chemicals;
- Incorporate control measures laid down in the working instruction and communicate to workers; and
- Instruction on appropriate control measures for avoiding skin contact.

The suitable PPE can be referred to in the SDS or obtained by enquiring the manufacturer or supplier of the chemicals. Employer must make available in adequate quantities the suitable PPE needed and ensure that workers use the PPE in accordance with working instructions. All the contaminated PPE must be cleaned and or disposed.

7.3.4 Control of ingestion exposure

The exposure through ingestion could be controlled by organisational control such as the following:

- safe work procedure
- good work practice
- personal hygiene
- housekeeping
- training

Where chemicals potentially hazardous by ingestion are used, workers should:

- remove contaminated clothing in the area away from work activity;
- wash their hand, face and under fingernails before eating, drinking or smoking;
- not eating food in the work area;
- practice good personal hygiene.

CHAPTER 8

EXPOSURE MONITORING PROGRAMME

The exposure monitoring programme is conducted to evaluate the extent of workers' exposure to CHTH and adequacy of existing control measures at the workplace. Exposure monitoring may include air monitoring or biological monitoring or combination of both.

For exposure through inhalation, air monitoring is conducted using valid method of monitoring and analysis to measure the airborne concentration of CHTH in particular work area. Exposure monitoring is considered to be necessary:

a) If failure or deterioration of the control measures (e.g. a lack of containment, or LEV not performing as intended) could result in a serious health effect, either because of the toxicity of the chemicals or because of the extent of potential exposure, or both;

b) To verify that workers' exposure is not exceeding PEL or any other OEL;

c) When there are changes to work practices, processes, procedures, plants or engineering control equipment which affect the adequacy of existing control measures e.g. an increase in the quantity of a chemical used or from changing systems of work, or introducing new plant; or

d) To provide assurance on the effectiveness of the existing control measure implemented.

Air monitoring is unnecessary if:

- valid method for sampling and analysis do not exist, or cannot be devised;
- PEL or OEL is not established;
- the employer is able to demonstrate that an alternative method of evaluation has been used to ensure that exposure is adequately controlled. An alternative method of evaluation may include establishing whether the process is fully enclosed or is a continuous process under adequate control and any breaches of containment are monitored by fixed-site monitors with suitable warning devices;
- route of exposure of the CHTH is not via inhalation; or
- the chemicals are not likely to be airborne.

Therefore, in recommending a worker air monitoring programme, sampling strategy and the affected work units with perceived exposures to the chemicals need to be stated clearly in the CHRA report.

The necessity of conducting the exposure monitoring is shown in **Figure 5**.

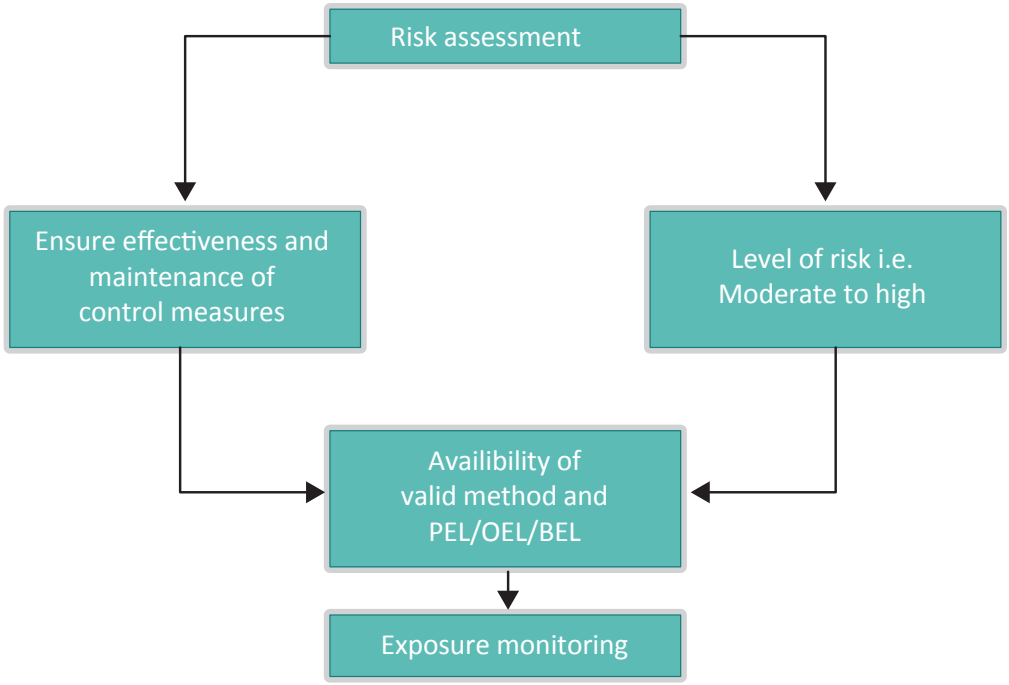


Figure 5: Necessity of Exposure Monitoring

Monitoring of exposure shall be conducted by a hygiene technician with valid registration with DOSH. Analysis of monitoring sample should be performed by accredited laboratory where available.

The frequency of air monitoring should be based on the level of exposure which are:

a) not more than six months for exposure at or above the permissible exposure limit; or
b) not more than twelve months for exposure at or above half of the eight-hour TWA but below the eight-hour TWA.

The air monitoring may discontinue if the result for at least two consecutive measurements taken at least seven days apart show that the exposures are below:

a) half of the eight-hour TWA;
b) maximum exposure limit/STEL; or
c) ceiling limit.

Previous air monitoring data must be considered in determining:

a) the exposure rating for inhalation assessment; and
b) the necessity of exposure monitoring programme.

Biological monitoring may be recommended to determine worker's exposure and adequacy of control for all route of entry where assessment indicate that the chemicals can be significantly absorbed through skin and controls solely rely upon the use of PPE (refer to **Appendix 13**).

CHAPTER 9

MEDICAL SURVEILLANCE PROGRAMME

Medical surveillance is conducted to periodically monitor worker's health effect and determine adequacy of existing control measures. Medical surveillance programme includes physical examination and medical investigation which may include biological monitoring and or biological effect monitoring. Medical surveillance is considered to be necessary if there are valid techniques for detecting indications of the identifiable disease and:

a) the results of air monitoring at or above half of 8 hours TWA;
b) the results of air monitoring exceed ceiling limits (CL), MEL or STEL;
c) the results of biological monitoring exceed biological exposure limits (BEL e.g. BEI by ACGIH, BMGV by HSE UK);
   Caution needs to be exercised if biological monitoring results exceed biological exposure limits. Further investigation is required to determine sources of exposure before recommending medical surveillance.
d) the chemical pose potential systemic effects through dermal absorption which is indicated as (skin) in Schedule I of USECHH Regulations and the task is performed with a likelihood of dermal contact or absorption;
e) the worker is exposed to chemicals listed in Schedule II of USECHH Regulations AND there is a likelihood that an identifiable disease will result from that exposure; or
f) cases of ill health or worker feedback related to exposure to CHTH at the workplace.

The necessity to conduct the medical surveillance is shown in **Figure 6**. Examples where medical surveillance is necessary are:

- where there have been previous cases of work-related ill health in the workforce/ place due to exposure to chemicals;
- where there is reliance on PPE, e.g. gloves or respirators, as an exposure control measure and there is evidence that PPE are not effective;
- where there is known health effect within specific industry; e.g. breathing in mists from chrome plating baths causing chrome ulcers and metal fume fever among welders.

This is not a definitive or exhaustive list and there will be many other instances where medical surveillance is required. Assessors will need to seek information or advice on the specific health risks identified in the health risk assessment.

Medical surveillance shall be conducted by the occupational health doctor (OHD) with valid registration from DOSH. The frequency of the medical surveillance programme should be decided by an OHD at intervals of not more than twelve months or at such shorter intervals as determined by the OHD. The OHD can decide the cessation of the medical surveillance.

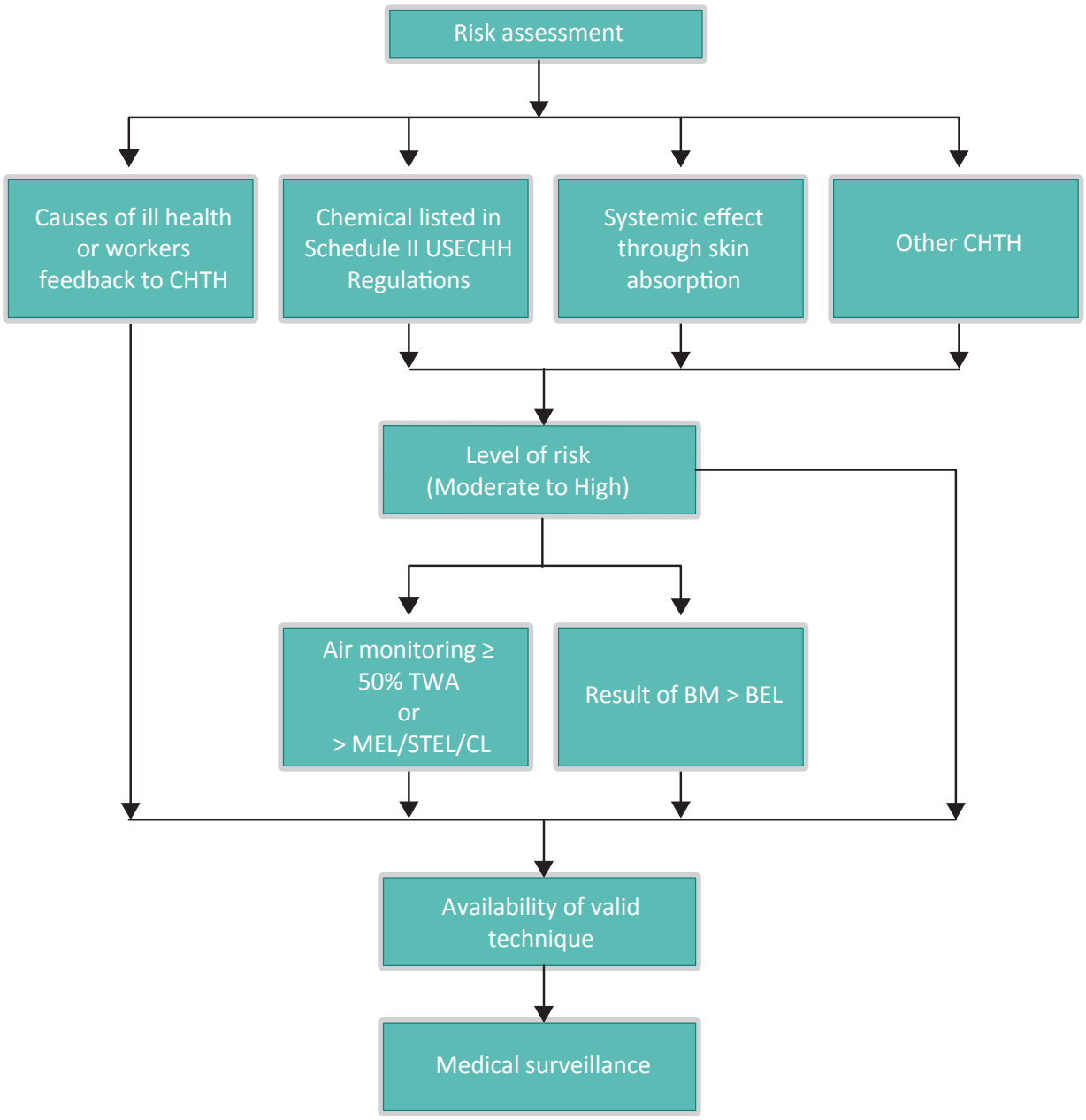


Figure 6: Necessity of the Medical Surveillance Programme

Note:
TWA : Time-weighted average
MEL : Maximum exposure limit
STEL : Short term exposure limit
CL : Ceiling limit
BM : Biological monitoring
BEL : Biological exposure limit

CHAPTER 10

CONCLUDE, RECOMMEND AND PRIORITISE

The assessment is concluded by indicating the level of risk and the adequacy of existing control measures. Based on the finding of the assessment, the assessor must identify the required action to control or minimized the exposure to CHTH. The action priority (AP) is assigned to prioritise the action to be taken by the employer based on the assessment conclusion.

The employer shall establish an action plan to implement the required action as recommended by an assessor in the assessment report. Implementation of control measures should be prioritised based on the assigned action priority.

10.1 ASSESSMENT CONCLUSION

The assessment can be concluded based on the result of the level of risk and the adequacy of existing control measures which are:

- High risk and adequately controlled
- High risk and inadequately controlled
- Moderate risk and adequately controlled
- Moderate risk and inadequately controlled
- Low risk and adequately controlled
- Low risk and inadequately controlled

The assessment conclusion is used as a basis to prioritise the action to be taken by employer for controlling the exposure to CHTH.

10.1.1 Risk is high and inadequate control measures

This is considered intolerable, where the exposure to the CHTH should be eliminated. If this is not possible, then substitution of the CHTH with a less hazardous chemical, total enclosure of the process and handling system, or isolation of the work to control emission of CHTH is to be adopted so that worker's exposure is kept well below the permissible exposure limits.

10.1.2 Risk is moderate or low, and inadequate control measures

This situation is also regarded as unacceptable. Reduce the risk by improving or implementing the technical controls. Risk is to be controlled to as low as reasonably practicable (ALARP).

10.1.3 Control measures are adequate regardless of level of risk

This situation arises when either the chemical is less hazardous or the exposure is low or adequate existing control measures to control risk.

10.2 ACTIONS TO BE TAKEN

Based on the finding of the assessment, the assessor has to identify and recommend the required action to be taken by the employer on:

a) Measures and procedures required to control exposure to CHTH;
b) Measures, procedures and equipment necessary to control any accidental emission of CHTH as a result of leakage, spillage, process or equipment failure;
c) Necessity for worker exposure monitoring programme and medical surveillance programme; and
d) Requirement for the training and retraining of workers.

When recommending control measures, be as specific as possible by referring to industry guidelines, SDS or other references where available. For example:

- when recommending glove to be used, specify the type of glove, e.g. "use neoprene glove" instead of “use glove”;
- for training, specify the topic to be covered (refer to paragraph 7.1.2 (b)).

The assessor in his capacity, is to advise the employer that if exposure monitoring and medical surveillance programme is recommended, the employer should provide the completed CHRA report to the hygiene technician and OHD prior in commencing the programme.

10.2.1 Measures and procedures required to control exposure

The assessor has to identify and recommend practicable measures and procedures required to prevent or adequately control workers’ exposure to CHTH for all route of exposure at each work unit. The assessor should emphasise on the technical control as a primary consideration that should be recommended to control exposure of CHTH and organisation control to complement the technical control. A combination of control measures will often be necessary to adequately control exposures to CHTH. Consideration of the control measures should follow the control hierarchy as specified in the USECHH Regulations. Hierarchy of control option often reflect the reliability and effectiveness of control measures.

When recommending action to be taken, it is important to bear in mind that in order for control measures to be reliable and effective in the long term, it has to be practical, workable and sustainable. The following principles can be used as guidance in recommending control to be taken:

a) Control the exposure at source
It is more effective to control exposure at source rather than to develop a way of removing the emission of CHTH once it has been released or dispersed.

b) Take into account all relevant routes of exposure when considering control measures

c) Control exposure by measures that are proportionate to the health risk
Adequate control measures should take into account the nature and severity of hazard and the magnitude, frequency and duration of exposure.

d) Choose the most effective and reliable control option that minimised the escape and spread of CHTH.

e) Where adequate control measures cannot be achieved by other measures, provide, in combination with other measures suitable PPE.

f) Check and review regularly all elements of control measures for continuing effectiveness.

g) Inform and train workers on the hazards and risks of the CHTH and the use of control measures implemented.

h) Ensure the introduction of control measures does not increase the overall risk to health and safety.

10.2.2 Measures, procedures and equipment to control accidental emission

If existing measures are deemed inadequate, then it should be addressed as actions to be taken. The assessor has to identify and recommend required measures, procedures and equipment to control any accidental emission of CHTH as a result of leakage, spillage, or process or equipment failure relevant to each work unit or work area. Refer to paragraph 7.1.3 as guidance.

10.2.3 Necessity for exposure monitoring programme

Assessor needs to identify the necessity of exposure monitoring programme for each work unit assessed. When recommending air monitoring, assessor must consider:

- The route of exposure is through inhalation.
- Likelihood of chemicals to be airborne.
- The chemical identity or the specific chemical name.
- Availability of PEL or OEL.
- Availability of validated method of sampling and analysis.

For all chemicals recommended for air monitoring, the assessor must state the parameter(s) and its associated exposure limit (PEL or OEL) in the report.

In recommending biological monitoring, assessor needs to identify:

- Specific chemical name to be monitored
- Availability of biological exposure limit (BEL)

The assessor needs to consult with OHD or industrial hygienist to decide the necessity and feasibility to conduct the biological monitoring. For all chemicals recommended for biological monitoring the assessor must state the parameter(s) and its associated exposure limit (BEL) in the report.

Assessor should recommend follow up action that needs to be taken by the employer based on the potential air monitoring outcome. Such include:

- Frequency of air monitoring (refer **Chapter 8**).
- Needs to review the control measures if exposure exceed PEL and the necessity of reassessment.
- Determine the needs for medical surveillance if result exceed PEL or OEL (**Figure 6**).

10.2.4 Necessity for medical surveillance programme

Assessor needs to identify the necessity of medical surveillance programme for each work unit assessed. When recommending for medical surveillance programme, assessor needs to consider:

- The necessity of medical surveillance; and
- The availability of valid technique to detect indication of disease or health condition related to exposure to CHTH.

Caution need to be exercise if the biological monitoring results exceed BEL. Further investigation is required to determine source of exposure before recommending the medical surveillance.

Assessor should recommend follow up action that needs to be taken by the employer if the medical surveillance shows the abnormal results. Such include the need to review the existing control measures.

10.2.5 Requirement for the training and retraining

Assessor needs to recommend further training and retraining for work units handling or exposed to CHTH. The assessor should identify the gaps in existing training programme and recommend training programme to close the gaps.

Examples of training gaps:

- Elements of worker risk communication was not included in training syllabus (refer to **Chapter 7**)
- Workers are not trained on procedure during emergency situation (e.g. the use of eye wash, spill kit)

10.3 SPECIFIC ACTIONS TO BE TAKEN

Apart from the general line of action to be taken under 10.2, exposures to the following chemicals warrant special attention and action:

a) Known or presumed human carcinogens and respiratory sensitizers (refer to paragraph 7.3.1 and 7.3.2 for guidance);
b) Immediate danger to life or property; and
c) Where level of risk could not be determined.

10.3.1 Immediate danger to life or property

If the assessor comes across a situation likely to cause immediate danger arising from the place of work, plant, or process; or arising from the use of chemicals, the assessor must inform the employer immediately. This is in line with the requirement under USECHH Regulations.

10.3.2 Where level of risk could not be determined

If HR or ER could not be established, the level of risk could not be determined. In the case of HR could not be established, the assessor should recommend:

- Employer to obtain the hazard information from supplier;
- Chemical(s) not to be used until such information is obtained.

If ER could not be established, anticipate worst case scenario and recommend the highest level of protection practicable for the workers. For intermediate chemical mixtures and chemical release during process, obtain specialist advice, if necessary. Meanwhile, implement best work practices and practicable level of protection to minimise exposure.

Reassessment needs to be conducted once the information is available.

10.4 ACTION PRIORITY

The assessor should assign the action priority on each identified action to be taken. The employer should use the action priority assigned in preparing the action plan for the implementation of the identified control measures.

Use **Table 18** to assign action priority based on the level of risk and adequacy of control measures.

Table 18: Action Priority Determination

Level of Risk	Adequacy of Control	Action Priority (AP)
High	Inadequate	1
HR or ER could not be determined	-	
Moderate/Low	Inadequate	2
High/Moderate/Low	Adequate	3

There are 3 levels of action priority that could be concluded from the risk rating. These levels of action are denoted by:

a) Action Priority 1 (AP-1) where the RR is at or above 15 (RR ≥ 15) and inadequate control measures or where the HR or ER could not be determined.
b) Action Priority 2 (AP-2) where the RR is less than 15 (RR < 15) and inadequate control measures.
c) Action Priority 3 (AP-3) where there is adequate control measures irrespective of the RR.

In the event when the action priority is the same, the employer should consider priority based on:

- risk rating for inhalation;
- level of risk for dermal.

Example for action priority 2, risk rating of 12 is of higher priority than risk rating of 5.
Example for action priority 1, level of risk H2 is higher priority than H1.

10.4.1 Action priority 1 (AP-1)

Immediate action is required to rectify the technical control with emphasis on elimination, substitution, isolation and containment. Meanwhile, implement good work practices and use PPE as a short-term measure to minimise worker exposure until permanent control is in place. Risk is to be controlled to as low as reasonably practicable (ALARP).

The employer should establish the need to stop the task, activity or process, if necessary.

10.4.2 Action priority 2 (AP-2)

Actions to control risk under AP-2 are considered to be of lower priority as compared to AP-1. However, remedial actions still need to be taken.

10.4.3 Action priority 3 (AP-3)

Employer has to maintain existing technical control.

CHAPTER 11

REPORT WRITING

This chapter is meant as a guide for assessors under USECHH Regulations to write the CHRA report as required by the DOSH. It is important to complete the CHRA work by providing a clear and concise report that describes the objectives, assessment work done, justification of the conclusions and recommendations provided. A well-written report will be a meaningful and effective communication tool to the target audiences (Employer, Safety & Health Practitioner, Law Enforcer, etc.) to quickly understand what was accomplished and provide way forward towards worker's health protection.

The recommended structure of the assessment report should contain the following section at minimum:

- Report title page
- Executive summary
- Table of contents
- Introduction
- Process and work unit description
- Assessment methodology
- Assessment findings
- Discussion
- Recommendations on action to be taken
- References
- Appendices

A report that is well organized with logical sequence will make it easy for the reader to quickly obtain an overview of the contents.

11.1 REPORT TITLE PAGE

The front page of the report should serve as the title page and contain the following information:

a) The title of the report, for example: "CHEMICAL HEALTH RISK ASSESSMENT REPORT"
b) Assigned report reference number that contains assessor registration number, year assessment conducted and serial number of the assessment done for the year. Example is as follow:
Report Reference Number: HQ/17/ASS/00/00002-2017/001
c) Date of submission to employer
d) Assessor's Name and Competency Registration Number
e) Company's Name, Registration of Company Number (ROC) and DOSH Registration Number where applicable
f) Premise address where CHRA is conducted

The report should be signed off by the assessor and employer. This can be done on the notification form as evidence that the report has been submitted and presented to the employer (refer to **Appendix 14**).

11.2 EXECUTIVE SUMMARY

Executive summary should provide brief overview of the CHRA conducted preferably not more than one page. It is not an introduction to the report. The executive summary should outline:

a) location and date of assessment
b) main objective of the assessment
c) main activities of the assessment (work unit selected, total number of chemicals assessed)
d) summary of findings (total level of risk and action priority)
e) main recommendation to the employer

This section should be written after the rest of the report has been prepared.

11.3 TABLE OF CONTENTS

Include all the report sections, subsections, figures and tables (if applicable), appendices.

11.4 INTRODUCTION

The introduction provides background information needed to make the remaining of the report easily understandable. The purpose is to set the context of the report and provide sufficient background information. The introduction should contain the following information:

- Introduction to the company and work site
- Objective and scope of assessment
- Summary of previous assessment and findings (if applicable)

11.4.1 Introduction to the Company and Work Site

This section provides introduction of the company operation where the assessment was carried out.

11.4.2 Objective and Scope of Assessment

Describe the objectives of assessment. Objectives should refer specifically to the intent of the CHRA, e.g. re-assess effectiveness of newly implemented control measures installed at work area.

State the scope covered in the assessment and any boundaries or limitation of the assessment work.

If this is reassessment due to significant changes, or new or improved control measures, state the changes assessed.

11.4.3 Summary of previous assessment and findings (if applicable)

If there was a previous assessment done on the worksite, include a short write up on the assessment finding and recommendation.

If assessment has been done previously but the report not accessible, the assessor should state in the report.

11.5 PROCESS AND WORK UNIT DESCRIPTION

Describe briefly the processes carried out at the workplace. Include process flow chart or process description which may provide visual explanation of the process. Indicate which processes that may have potential exposures to CHTH and are included in the assessment scope.

Describe how the work unit(s) were selected, structured, categorized and or determined as similar exposure group. Include information on routine and non-routine work pattern of the selected work unit(s), shift pattern, job rotation, category and number of workers, etc., if applicable.

11.6 ASSESSMENT METHODOLOGY

For this section of the report, describe:

a) The assessment methodology used. If the assessment methodology is based on this manual, DO NOT reproduce extracts of the steps or procedures directly from the manual. Describe briefly how the methodology was applied in the assessment;
b) For other assessment methods, declare details of the methodology and describe the procedures involved based on the adopted methodology.

If monitoring data is available and assessor decided to do Quantitative Assessment, describe how the data was analysed and the conclusion obtained.

This manual provides suggested methodology in conducting CHRA and is endorsed by the Director General. Assessors are expected to use this manual to conduct CHRA. If other methodology is used, the assessor has to ensure that the alternative methodology has been endorsed by the Director General.

11.7 ASSESSMENT FINDINGS

This section correlates the findings on the level of risk and adequacy of existing control measures for each work unit assessed. The findings may be presented in many ways but it is best to organize via labelled tables and or graphs where feasible. The findings may be tabulated based on work units against the level of risk and adequacy of existing control measures. Highlight the significant results, describes the results presented in the table and mention the significant results that will be discussed in the discussion section.

11.8 DISCUSSION

The assessor should discuss all the factors that may contribute to the significant risk of the work unit mentioned in findings section. Relate the factors discussed to the level of risk and adequacy of control measures. Include discussion on adequacy of any control measures that has been implemented e.g. substitution, elimination, installation of LEV and their effectiveness.

Address any positive and or negative observations on work practices, procedures, controls measures, etc., that may influence the results of the assessment. If there are any workers' health feedbacks, discuss if there is any association with their exposure at the work unit.

The **Forms A** to **D** are used to capture the relevant data that are useful for the assessment. They are meant to guide assessors in following the steps in conducting the assessment as per this manual's methodology. They may also serve as assessor's notes in gathering and tabulating data during the assessment. Use the forms as references to write the discussion on the findings. Do not refer the readers to the filled-up forms without writing any discussion.

When conducting re-assessment, the report should discuss:

a) any significant change on the hazards;
b) new or improved control measures;
c) actions taken from previous assessment.

11.9 RECOMMENDATIONS ON ACTION TO BE TAKEN

Where there are areas of improvement in the control of health risk from the chemicals assessed and compliance to regulatory requirements, assessor should make recommendations to the employer. The recommendations should be Specific, Measurable, Achievable, Realistic or Relevant and Time-Bound (SMART). Each recommendation should have objective to achieve, either to control exposure to the chemical hazards, comply with legal requirements or for assurance purposes. The assessor should consider the practicability of the recommendations.

The recommendations should contain the proposed actions based on the interpretation of the findings made and should include the following:

- Actions to be taken on technical control;
- Actions to be taken on organisational control emphasis on training and retraining;
- Actions to be taken on emergency response preparedness;
- Actions to be taken on exposure monitoring; and
- Actions to be taken on medical surveillance.

Actions to be taken will depend on the level of risk; the acute or chronic nature of the effects; and the necessary protection. Make references to Sections 10.2 and 10.3 and the filled **Form D** when formulating the recommendations. Do not ask the reader to go to **Form D** to get the recommendation, rather, it should be mentioned and listed in this section. Where there is possibility of abnormal exposures occurring, the assessor should recommend appropriate action to minimise the risk.

Assign AP to each of the recommendations made. AP was meant to guide the employer in preparing the implementation plan of the recommendation given.

If a recommendation is made to comply with a legal requirement, state the regulation and title of the regulation mentioned. It is not advisable to copy the said regulation into recommendation statement.

11.10 REFERENCES

List down literature or documentations referred to in writing the report.

11.11 APPENDICES

Append all relevant information and should including but not limited to:

- **Forms A**, **B**, **C** and **D**;
- Layout plan and the location of the workers selected for assessment (where applicable);
- Process flowchart;
- Valid assessor's competency slip; and
- Other relevant information (such as laboratory analytical results).

Note:
It is not necessary to append SDS and or chemical register.

CHAPTER 12

REASSESSMENT

Reassessment is necessary to check whether the risk situation has changed or there is a need to change the control strategies or alter exposure parameters.

Reassessment is to be carried out in any of the following condition:

a) There has been a significant change in the work that could affect the outcome of the assessment;
b) New or improved control measures are implemented where the assessor should be engaged to reassess the exposure and control on the affected work units;
c) More than five years have elapsed since the last assessment; or
d) Directed by the Director General, Deputy Director General or the Director of DOSH.

Significant change in the work means changes that may affect the risk decisions, the adequacy of control measures or the conclusion of an assessment. This may include:

- Changes in the chemicals used or handled;
- Increasing or decreasing utilisation of CHTH used;
- Changes in the methods or rate of work;
- Deterioration in the efficiency of control equipment;
- Plant failure or process failure; or
- New information on the hazards of the chemical becomes available.

The employer is responsible to identify the significant changes which may affect the outcome of the assessment. The assessor should be engaged to carry out the reassessment on the affected work units.

For requirement (a) & (b) assessor should state the changes assessed and the results related to the changes. The report for this reassessment should be appended to the previous report.

For requirement (c) & (d) full report should be produced.

CHAPTER 13

CONTROL OF RECORDS

Records are important documents that show conformance to requirements. They can either be in hard copies (for example bound reports) or electronic copies (for example softcopies or computer files).

In maintaining records, the employers must ensure that all records remain legible, identifiable and traceable to the work units involved in the assessment. All records should be stored and maintained in such a way that they are readily retrievable and protected against damage, deterioration or loss. The retention period and disposition of records should be in accordance to the USECHH Regulations.

For the purpose of the assessment, the following records should be maintained by the employers:

Table 19: Retention Period

Records	Retention period
CHRA reports	30 years
Records of design and construction of engineering control equipment	Life time of usage
Personal exposure monitoring report by the hygiene technician	30 years
Area monitoring reports	5 years
Medical surveillance programmes	30 years
Training programmes	Defined by employer
Records of monthly inspection of engineering control equipment	5 years from the date it was made
Engineering control equipment examination report by the hygiene technician	5 years from the date it was made
PPE programme	2 years
Chemical register	Updated list

13.1 MEDICAL SURVEILLANCE PROGRAMMES

Records generated from medical surveillance programme includes, but not limited to the followings:

a) Certificate of fitness
b) Summary report for medical surveillance
c) Medical removal protection

Take note on preserving medical confidentiality of worker's medical information. Records that contain medical sensitive and confidential information should not be released by OHD to anyone without worker's consent. As best practice, employer should only keep fitness certificate provided by OHD. All other medical records should only be kept by worker and or examining OHD.

13.2 TRAINING PROGRAMMES

Records generated from training programmes that may have to be made available for inspection or audits includes but not limited to:

a) Training attendance and tracking records
b) Training programme syllabus
c) Training effectiveness evaluation form
d) Individual post-training evaluation/assessment record

13.3 PPE PROGRAMMES

Records generated from PPE programmes includes but not limited to the followings:

a) PPE selection records, inclusive assessment or basis of selection
b) PPE issuance and re-issuance records
c) PPE training and information records
d) PPE inspection and maintenance records

A general PPE programme that outlines the management and procedures of the above records may be established as guidance to the PPE committees or coordinator.

REFERENCES

1. DOSH (2000). Guidelines for the Registration of Assessors, Hygiene Technician and Occupational Health Doctor. Malaysia: DOSH.

2. DOSH (2001). Guidelines on the Control of Chemicals Hazardous to Health. Malaysia: DOSH.

3. DOSH (2005). Guidelines on the Use of Personal Protective Equipment against Chemicals Hazards. Malaysia: DOSH.

4. DOSH (2006). *Panduan Memohon Bagi Menggunapakai Penaksiran Risiko Bahan Kimia Berbahaya Kepada Kesihatan (CHRA)* Secara Generik. Malaysia: DOSH.

5. Dr. Rajadurai Sithamparanadarajah (2008). Controlling Skin Exposure to Chemicals and Wet-Work.

6. Health and Safety Executive (2013). Approved Code of Practice and Guidance on Control of Substances Hazardous to Health, 6th edition. UK: HSE.

7. Safe Work Australia (2013). Health Monitoring for Exposure to Hazardous Chemicals, Guide for Person Conducting a Business or Undertaking. Australia.

8. The American Conference of Governmental Industrial Hygienists (ACGIH) (2016). TLVs® and BEIs® Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices. US.

9. The Federal Institute for Occupational Safety and Health (BAuA) (2008). Technical Rules for Hazardous Substances (TRGS) 401. German.

10. US EPA (2007). Review of Worker Exposure Assessment Method. US.

FORM A: WORK UNIT DESCRIPTION

1. Work unit		**2. Date of assessment**				
3. Work area		**4. Number of worker**	**Male:**		**Female:**	
5. Working hours	Working Arrangement: Normal ☐ Shift work ☐					
6. Worker health feedbacks		**9. Possibility of abnormal exposures**				
7. Report on health effects		**10. Possibility of mixed exposures**				
8. Susceptible conditions related to chemical(s) in use		**11. Possibility of ingestion**				
12. Other information						

Guidance Notes on Filling Form A (Work Unit Description)

Field Name	Instructions
1. Work unit	Name of the work unit.
3. Work area	Name of the location where work is performed.
5. Working hours	Tick the working hours either normal or shift or both. State the actual working hours. Example: 2 workers working 9am–5pm. 3 workers rotating shift 7am–3pm, 3pm–11pm, 11pm–7am. State the actual shift pattern. Example: 2 weeks on and 2 weeks off or 2 weeks night shift or 2 weeks day shift, 5-days a week. The working hours must include potential over time, if any done.
6. Worker health feedbacks	Potential question to ask worker(s): a) Is there any significant changes on your health since you started working in this area? What kind of symptoms are you experiencing (related to the hazard of the chemical)? b) Does the symptoms go away after long leaves? Does it recur? Note: Avoid asking lead question, i.e. do you have headache often? Let the worker explain their symptom, if any and assessor assess later on if it is a potentially related to the chemical handled.
7. Report on health effects	Refer to available documents, i.e. recorded worker complaint, JKKP 7 &8, etc. If there is no such documents, record “No information available” or “No Reports Made”

Field Name	Instructions
8. Susceptible conditions related to chemical(s) in use	Determine if there is any susceptible condition that may relate to the chemicals handled. This should be added once hazard classification has been reviewed. Examples of susceptible conditions: chronic liver and kidney conditions, bronchial asthma, smokers, alcoholics, asthmatic, allergies, pregnant workers. **Note:** If there are susceptible conditions related to the chemicals in use, control measures should be addressed or recommended in **Form D**.
9. Possibility of abnormal exposures	Example: Spill/ leak / splash which may occur at workplace, workplace contamination, strong odours, and abnormal presence of chemical mists or vapours. **Note:** If there is possibility of abnormal exposure, must give recommendation in **Form D**.
10. Possibility of mixed exposures	If a worker is exposed to different chemicals that may affect the same target organ (systemic effect). Example: Toluene and Xylene have the same effect i.e. depression of central nervous system (CNS).
11. Possibility of ingestion	Ask and observe whether food and drinks are allowed at workplace. Ask the workers whether they practice good personal hygiene.
12. Other information	Observe and record any conditions at the workplace that may increase potential exposure to the workers, for example, incorrect PPE usage, safety hazards, potential Immediate. Danger to Life and Health (IDLH), non-routine entry, confined space entry. Insert any other information pertaining to the chemical exposure.

Note:
Do not leave any entry blank. State NOT APPLICABLE, NOT AVAILABLE or NONE.
NOT APPLICABLE refers to items that are not related to work unit being assessed.
NOT AVAILABLE refers to items that are not presented during the assessment.
NONE refers to items that are non-existent.

FORM B: LIST OF CHEMICALS HAZARDOUS TO HEALTH ASSESSED

WORK UNIT: **DATE OF ASSESSMENT:**

Table B1: Chemicals Used in Work Unit

No.	Name of chemical	Hazardous ingredient	Physical form	Hazard classification	H-code	Source of information	HR	Dermal (Y/N)	Ingestion (Y/N)

Table B2: Chemicals Released by the Processes or Work Activities

No.	Name of chemical	Hazardous ingredient	Physical form	Hazard classification	H-code	Source of information	HR	Dermal (Y/N)	Ingestion (Y/N)

Guidance Notes on Filling Form B (List of Chemicals Hazardous to Health Assessed)

Table B1: Chemicals Used in Work Unit

Field Name	Instructions
Name of chemical	Chemical name; or product name; or product identifier.
Hazardous ingredient	List hazardous ingredients stated in the SDS. This may help to determine the necessity of exposure monitoring (airborne/biological).
Physical form	Physical form of the product (e.g. solid/ pellet/ paste/ powder/ liquid/ mist/ vapour/ gas/ dust).
Hazard classification	List classification of hazard (obtain information from SDS/label). Refer to section 2-Hazard Identification for SDS that complies with CLASS Regulations. For chemicals with inadequate information, refer to **Chapter 4**.
H-code	List H-code for the chemical. Convert R-phrase using **Appendix 1**.
Source of information	State the source where the information obtained, e.g. SDS or ICOP CHC. If source of information is SDS, state effective date (MM/YY) of the document.
HR	Assign hazard rating based on highest rating of hazard classification and H-code for inhalation route of exposure.
Dermal	Identify if hazard through dermal is present.
Ingestion	Identify if hazard through ingestion (oral) is present.

Table B2: Chemicals Released by the Processes or Work Activities

Fill in **Table B2** if chemical release, normally in its pure form, is known and information for hazard classification is available. Otherwise, state as not applicable, not available or none.
Chemical without SDS, either released, mixed during process or by product must be listed in **Table B2**. Note that Scheduled Waste can be addressed in either **Table B1** or **Table B2**.
For mixture where, re-classification is done by assessor, fill in the information in this table.
For example, likelihood of an increase in exposure such as change in the physical form of the chemical as a result of the task (e.g. grinding, spraying, welding).

Note:
Do not leave any entry blank. State NOT APPLICABLE, NOT AVAILABLE or NONE.
NOT APPLICABLE refers to items that are not related to work unit being assessed.
NOT AVAILABLE refers to items that are not presented during the assessment.
NONE refers to items that are non-existent.

FORM C: WORK UNIT ASSESSMENT

WORK UNIT: **DATE OF ASSESSMENT:**

Table C1: Inhalation Exposure Assessment

Job or task	Name of chemical	FR	DR	FDR	PEL	Degree of release or exposure level	Degree of chemical inhaled	MR	ER	HR	RR

Table C2: Dermal Assessment

Job or task	Name of chemical	Hazardous properties	Extent of dermal contact	Duration of exposure		Level of risk
				Short term (<15min/shift)	Long term (≥15min/shift)	

Guidance Notes on Filling Form C (Work Unit Assessment)

Table C1: Inhalation Exposure Assessment

Field Name	Instructions
Job or task	State the detail task assessed. Use action words.
Name of chemical	State the name of chemical assessed. Ensure the chemical listed in **Form B** and **Form C** are the same.
FR	Refer to **Table 5** to obtain the frequency rating.
DR	Refer to **Table 6** to obtain the duration rating.
FDR	Refer to **Table 7** to obtain the frequency - duration rating.
PEL	State this column for quantitative assessment only. Refer to Schedule I of USECHH Regulations to obtain PEL. In the absence of a Malaysian PEL, other exposure limits may be adopted.
Degree of release or exposure level	Refer to **Table 8** or **9** to obtain the degree of release. Refer to the monitoring data to obtain the exposure level.
Degree of chemical inhaled	Refer to **Table 10** to obtain the degree of chemical inhaled.
MR	Refer to **Table 12** to obtain the magnitude rating. If modifying factor is used, state (+1) or (-1) to indicate the adjustment. Justify this in discussion of findings.
ER	Refer to **Table 14** to obtain the exposure rating if monitoring data is not available. Refer to **Table 3** to obtain the exposure rating if monitoring data is available. Mixed exposure ER* must be used in **Form C** instead of the individual ER.
HR	Refer to **Form B** to obtain the hazard rating.
RR	Refer to **Table 16** to obtain the risk rating.

Table C2: Dermal Contact Assessment

Field Name	Instructions
Job or task	State the detail task assessed. Use action words.
Name of chemical	State the name of chemical assessed.
Hazardous properties	State the category of effect based on **Table 2**.
Extent of dermal contact	Refer to **Table 15** to obtain the extent of dermal contact.
Duration of exposure	Tick the applicable duration of exposure (short term or long term).
Level of risk	Refer to **Table 17** to obtain the level of risk. Example: Moderate risk (M1)

Note:
Do not leave any entry blank. State NOT APPLICABLE, NOT AVAILABLE or NONE.
NOT APPLICABLE refers to items that are not related to work unit being assessed.
NOT AVAILABLE refers to items that are not presented during the assessment.
NONE refers to items that are non-existent.

FORM D: CONTROL MEASURES AND RECOMMENDATIONS

WORK UNIT: **DATE OF ASSESSMENT:**

Table D1: Technical Controls (TC)

Job or task	Name of chemical	ROE	Existing technical controls (TC)						Overall adequacy (Y/N)	Recommendation on TC	AP
			Isolation or enclosure		Engineering control & ventilation		PPE				
			Specify	Adequacy (Y/N/NA)	Specify	Adequacy (Y/N/NA)	Specify	Adequacy (Y/N/NA)			

Table D2: Organisational Control (OC)

Existing organisational control (OC)	Adequacy (Y/N/NA)	Recommendation
(a) Adoption of safe work systems and practices *(please specify)*:		
(b) Providing information, instruction and training to workers *(please specify)*:		
(c) Personal hygiene *(please specify)*:		

Table D3: Emergency Response Preparedness		
Emergency response preparedness	**Adequacy (Y/N/NA)**	**Recommendation**

Table D4: Exposure Monitoring and Medical Surveilance	
Existing Programme	**Recommendation (indicate necessary)**
(a) Exposure monitoring (air monitoring and or biological monitoring) *(please specify)*:	
(b) Medical surveillance *(please specify)*:	

Table D5: Specific Action to be Taken	
Specific action to be taken	
Name of chemical	**Recommendation**

Guidance Notes on Filling Form D (Control Measures and Recommendation)

Table D1: Technical Controls (TC)

Field Name	Instructions
Job or task	State the detail task assessed. Use action words.
Name of chemical	State the name of chemical assessed.
ROE (route of exposure)	State all possible routes of exposure (inhalation, dermal, ingestion). Refer to **Appendix 2**.
Existing technical controls (TC)	Adequacy of the technical control measures are assessed according to the following criteria: (a) Suitability; (b) Use and Effectiveness; and (c) Maintenance. State Yes (Y), No (N) or Not Applicable (NA) for adequacy of each control applied. State the actual control measure in use. Obtain information on existing control measure at the work unit through observation and or interviews. • **Isolation or enclosure**: State any isolation or enclosure control measure that is adopted at work unit for example by distance or physical barrier. • **Engineering control and ventilation**: State any engineering control adopted for example the use of LEV, general ventilation, use of fume hoods, etc. If work relies on natural ventilation, indicate type, i.e. Outdoors, Open windows, Reinforced Wire Mesh. • **PPE**: State the PPE that are used for respiratory protection, skin and eye.
Overall Adequacy	Overall adequacy is No (N), if any of the technical control is No (N).
Recommendation on TC	Recommend further controls if existing controls are not adequate. Recommend chemical monitoring for specific parameters if necessary.
AP	Assign AP based on adequacy of TC only.

Table D2: Organisational Control (OC)

Field Name	Instructions
Existing organisational control (OC)	List down applicable organisational controls under each header/topic.
Adequacy (Y/N/NA)	State Yes (Y), No (N) or Not Applicable (NA).
Recommendation	State actual recommendations if adequacy is No (N). • **Safe work system**: e.g. Safe Work Procedures, PTW/JHA (Permit to Work/Job Hazard Analysis), Work Instructions, PPE Issuance and maintenance programme. Recommendations should state the actual Safe Work System or improvement to existing safe work system required for this work unit. • **Information, instruction & training**: e.g. review training programme and record availability of such trainings, hazard communication including warning sign as per USECHH Regulations, availability of SDS and chemical labelling as specified in CLASS Regulations format. • **Personal hygiene**: State hygiene facilities or rules in place, e.g. changing rooms, no eating and drinking at production area, dedicated workers rest area, short fingernails.

Table D3: Emergency Response Preparedness

Field Name	Instructions
Emergency response preparedness	State existing chemical emergency procedures, medical emergency procedures, etc.
Adequacy (Y/N/NA)	State Yes (Y), No (N) or Not Applicable (NA).
Recommendation	Recommendations must be given if adequacy is No (N).

Table D4: Exposure Monitoring and Medical Surveillance

Field Name	Instructions
Existing Programme	List down applicable existing programme under each header/topic.
Recommendation	Recommend actual actions to be taken. • **Monitoring**: State necessity to conduct exposure monitoring. If exposure monitoring is necessary, specify the chemical identity or chemical name. Recommendation for air and or biological monitoring should include PEL and or BEL of each chemical to be monitored. • **Medical surveillance**: State necessity to conduct medical surveillance. If medical surveillance is necessary, specify the chemical identity or chemical name. Recommendation to establish medical removal programme should be addressed here in line with USECHH Regulations.

Table D5: Specific Action to be Taken

Field Name	Instructions
Name of chemical	Chemical name; or product name; or product identifier
Recommendation	**Known human carcinogens and respiratory sensitisers – refer to Chapter 10**. Recommend actual actions to be taken to control the exposure to chemicals. Any of the following measures can be adopted: (a) Substitute hazardous chemicals with less hazardous materials (b) Review/design appropriate work processes, systems and engineering controls (c) Use effective local exhaust ventilation and other engineering controls (d) Provide suitable work equipment and materials (e) Limit exposure at source. Contain, enclose or isolate the chemical (closed handling system preferred) (f) Consider personal protective equipment as a last resort or for special situations, e.g. a spill clean-up operation (g) Clean floors, walls and other surfaces at regular interval (h) Establish specific Organisational Controls for example safe work procedures, training, exposure monitoring, medical surveillance, medical removal protection programme (i) Use suitable and sufficient warning signs (j) Storing, handling and disposing of carcinogens safely, including using closed and clearly label containers

Field Name	Instructions
	Level of risk could not be determined If HR could not be established due to unavailability of data, recommend: (a) employer to make available SDS or hazard information where applicable. Where SDS are required but not available, stop using the chemical and obtain information from supplier. (b) employer to obtain specialist advice for intermediate chemical mixtures and chemical release during process. (c) employer to implement good work practices to minimise exposure. Reassessment needs to be conducted once the information becomes available. If ER could not be established, anticipate worst case scenario and recommend the highest level of protection practicable for the workers.

APPENDICES

APPENDIX 1 (CHAPTER 4)

Conversion Table from R-phrase to H-code

Classification under Directive 67/ 548/EEC	Classification under the CLASS Regulations	
	Hazard Classification	H-Code: Hazard statement
Xn; R20	Acute toxicity category 4	H332: Harmful if inhaled
Xn; R21	Acute toxicity category 4	H312: Harmful if in contact with skin
Xn; R22	Acute toxicity category 4	H302: Harmful if swallowed
T; R23 (gas)	Acute toxicity category 3	H331: Toxic if inhaled
T; R23 (vapour)	Acute toxicity category 2	H330: Fatal if inhaled
T; R23 (dust/mist)	Acute toxicity category 3	H331: Toxic if inhaled
T; R24	Acute toxicity category 3	H311: Toxic if in contact with skin
T; R25	Acute toxicity category 3	H301: Toxic if swallowed
T+; R26 (gas)	Acute toxicity category 2	H330: Fatal if inhaled
T+; R26 (vapour)	Acute toxicity category 1	H330: Fatal if inhaled
T+; R26 (dust/mist)	Acute toxicity category 2	H330: Fatal if inhaled
T+; R27	Acute toxicity category 1	H310: Fatal if in contact with skin
T+; R28	Acute toxicity category 2	H300: Fatal if swallowed
R33	Specific target organ toxicity – repeated exposure category 2	H373: May cause damage to organs through prolonged or repeated exposure
C; R34	Skin corrosion or irritation category 1B	H314: Causes severe skin burns and eye damage
C; R35	Skin corrosion or irritation category 1A	H314: Causes severe skin burns and eye damage
Xi; R36	Serious eye damage or eye irritation category 2	H319: Causes serious eye irritation
Xi; R37	Specific target organ toxicity – single exposure category 3	H335: May cause respiratory irritation
Xi; R38	Skin corrosion or irritation category 2	H315: Causes skin irritation

Classification under Directive 67/ 548/EEC	Classification under the CLASS Regulations	
	Hazard Classification	H-Code: Hazard statement
T; R39/23	Specific target organ toxicity – single exposure category 1	H370: Causes damage to organs *(or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T; R39/24	Specific target organ toxicity – single exposure category 1	H370: Causes damage to organs *(or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T; R39/25	Specific target organ toxicity – single exposure category 1	*H370: Causes damage to organs (or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T+; R39/26	Specific target organ toxicity – single exposure category 1	H370: Causes damage to organs *(or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T+; R39/27	Specific target organ toxicity – single exposure category 1	*H370: Causes damage to organs (or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T+; R39/28	Specific target organ toxicity – single exposure category 1	H370: Causes damage to organs *(or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Xi; R41	Serious eye damage or eye irritation category 1	H318: Causes serious eye damage
R42	Respiratory sensitisation category 1	H334: May cause allergic or asthma symptoms or breathing difficulties if inhaled

Classification under Directive 67/548/EEC	Classification under the CLASS Regulations	
	Hazard Classification	**H-Code: Hazard statement**
R43	Skin sensitisation category 1	H317: May cause allergic skin reaction
Xn; R48/20	Specific target organ toxicity – repeated exposure category 2	H373: May cause damage to organs *(or state all organs effected, if known) through prolonged or repeated exposure (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Xn; R48/21	Specific target organ toxicity – repeated exposure category 2	H373: May cause damage to organs *(or state all organs effected, if known) through prolonged or repeated exposure (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Xn; R48/22	Specific target organ toxicity – repeated exposure category 2	H373: May cause damage to organs *(or state all organs effected, if known) through prolonged or repeated exposure (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T; R48/23	Specific target organ toxicity – repeated exposure category 1	H372: Causes damage to organs (*or state all organs effected, if known) through prolonged or repeated exposure (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T; R48/24	Specific target organ toxicity – repeated exposure category 1	H372: Causes damage to organs *(or state all organs effected, if known) through prolonged or repeated exposure (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
T; R48/25	Specific target organ toxicity – repeated exposure category 1	H372: Causes damage to organs *(or state all organs effected, if known) through prolonged or repeated exposure (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*

Classification under Directive 67/548/EEC	Classification under the CLASS Regulations	
	Hazard Classification	**H-Code: Hazard statement**
R64	Effect on or via lactation	H362: May cause harm to breast-fed children
Xn; R65	Aspiration hazard category 1	H304: May be fatal if swallowed and enters airways
R67	Specific target organ toxicity- single exposure category 3	H336: May cause drowsiness or dizziness
Xn; R68/20	Specific target organ toxicity – single exposure category 2	H371: May cause damage to organs *(or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Xn; R68/21	Specific target organ toxicity – single exposure category 2	H371: May cause damage to organs *(or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Xn; R68/22	Specific target organ toxicity – single exposure category 2	*H371: May cause damage to organs (or state all organs effected, if known) (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Carc. cat. 1; R45	Carcinogenicity category 1A	H350: May cause cancer *(state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Carc. cat. 2; R45	Carcinogenicity category 1B	H350: May cause cancer *(state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Carc. cat. 1; R49	Carcinogenicity category 1A	H350i: May cause cancer by inhalation
Carc. cat. 2; R49	Carcinogenicity category 1B	H350i: May cause cancer by inhalation

Classification under Directive 67/548/EEC	Classification under the CLASS Regulations 2013	
	Hazard Classification	**H-Code: Hazard statement**
Carc. cat. 3; R40	Carcinogenicity category 2	H351: Suspected of causing cancer *(state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Muta. cat. 2; R46	Germ cell mutagenicity category 1B	H340: May cause genetic defects (state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)
Muta. cat. 3; R68	Germ cell mutagenicity category 2	H341: Suspected of causing genetic defects *(state route of exposure, if it is conclusively proven that no other routes of exposure cause the hazard)*
Repr. cat. 1; R60	Reproductive toxicity category 1A	H360F: May damage fertility
Repr. cat. 2; R60	Reproductive toxicity category 1B	H360F: May damage fertility
Repr. cat. 1; R61	Reproductive toxicity category 1A	H360D: May damage the unborn child
Repr. cat. 2; R61	Reproductive toxicity category 1B	H360D: May damage the unborn child
Repr. cat. 3; R62	Reproductive toxicity category 2	H361f: Suspected of damaging fertility
Repr. cat. 3; R63	Reproductive toxicity category 2	H361d: Suspected of damaging the unborn child
Repr. cat. 1; R60-61	Reproductive toxicity category 1A	H360FD: May damage fertility. May damage the unborn child.
Repr. cat. 1; R60 Repr. cat. 2; R61	Reproductive toxicity category 1A	H360FD: May damage fertility. May damage the unborn child.
Repr. cat. 2; R60 Repr. cat. 1; R61	Reproductive toxicity category 1A	H360FD: May damage fertility. May damage the unborn child.

Classification under Directive 67/548/EEC	Classification under the CLASS Regulations 2013	
	Hazard Classification	H-Code: Hazard statement
Repr. cat. 2; R60-61	Reproductive toxicity category 1B	H360FD: May damage fertility. May damage the unborn child.
Repr. cat. 3; R62-63	Reproductive toxicity category 2	H361fd: Suspected of damaging fertility. Suspected of damaging the unborn child.
Repr. cat. 1; R60 Repr. cat. 3; R63	Reproductive toxicity category 1A	H360Fd: May damage fertility. Suspected of damaging the unborn child
Repr. cat. 2; R60 Repr. cat. 3; R63	Reproductive toxicity category 1B	H360Fd: May damage fertility. Suspected of damaging the unborn child
Repr. cat. 1; R61 Repr. cat. 3; R62	Reproductive toxicity category 1A	H360Df: May damage the unborn child. Suspected of damaging fertility.
Repr. cat. 2; R61 Repr. cat. 3; R62	Reproductive toxicity category 1B	H360Df: May damage the unborn child. Suspected of damaging fertility.

Note:

T+ : Very toxic
T : Toxic
Xn : Harmful
C : Corrosive
Xi : Irritant
R42 and or R43 : Sensitising
Carc. cat. : Carcinogenic
Muta. cat. : Mutagenic
Repr. cat. : Toxic for reproduction
D : Damaging the unborn child (known)
F : Damaging the fertility (known)
d : Damaging the unborn child (suspected)
f : Damaging the fertility (suspected)
i : Exposure through inhalation

APPENDIX 2 (CHAPTER 4)

Routes of Exposure

The route of exposure is a way a chemical enters the body or in contact with workers during work activity involving use of CHTH. The route of exposure will determine whether the chemicals could cause adverse health effects to the exposed worker depending on the hazard of the chemical. For example, breathing or swallowing lead can result in health effects, but touching lead is not harmful because lead is not absorbed through the skin.
In work situation involving the use of CHTH, three routes of exposure considered are inhalation, dermal and or oral/ingestion. In industry, inhalation is the most significant route of exposure.

Inhalation

For most chemicals in the form of vapours, gases, mists, or particulates, inhalation is the major route of exposure. Once inhaled, chemicals are either exhaled or deposited in the respiratory tract. If deposited, damage can occur through direct contact with tissue or the chemical may diffuse into the blood through the lung-blood interface. Upon contact with tissue in the upper respiratory tract or lungs, chemicals may cause health effects ranging from simple irritation to severe tissue destruction.

The respiratory system consists of the upper respiratory tract (nose, mouth and throat), the air passage ways (trachea, bronchi, bronchioles, and respiratory bronchioles) and the gas exchange area (alveoli). The total surface area of the alveoli in a healthy adult is 90 square metres. A worker performing a moderate task inhales about 8.5 cubic metres of air in the course of an 8-hour shift.

For inhaled liquid or solid particulate, size and shape of the particles are among the key factors that influence the site of deposition, retention, distribution and ultimate health effect. Generally, how particles enter the respiratory system based on their sizes can be described as follows:

- Particles larger than 50 µm aerodynamic diameter are prevented from entering the system as a result of inadequate suction power.
- Particles between 10 and 50 µm are effectively filtered in the nose.
- Particles of 7-10 µm on impact with the mucous surface are carried outwards by the ciliary escalator up the pharynx within a few hours where they are either coughed out or swallowed.
- Particles of 0.5-7 µm aerodynamic diameter are deposited in the respiratory bronchioles and alveoli. Very soluble particles pass through the lungs in minutes. Less soluble matter trapped in the alveolar region is scavenged by large phagocytic cells which either cross the alveolar membrane or exit via the ciliary escalator to be ultimately swallowed or coughed out.
- Particles smaller than 0.5 µm and gases remain airborne and are exhaled out.

Dermal

Dermal which cover skin and eyes is the second most important route of exposure. One of the prime functions of the skin is to provide a protective barrier for the body against invasion by foreign substances. The skin is not a perfect barrier and its large surface area (about 1.7 square metres for the average adult) and its direct contact with the external milieu render it vulnerable to hostile environment.

Effect of dermal exposure to chemicals can be either local or systemic or both. Local effects that typically occur at the point of chemical contact, ranges from irritation, redness or mild dermatitis to more severe effects such as destruction of skin tissue or other worse conditions.

Chemicals can penetrate the intact skin and be absorbed into the blood system, which cause systemic effect. Other chemicals may enter the body through cuts or damaged skin. Different parts of the body have different skin structure and thickness and hence different resistance to chemical penetration. The eyes are particularly sensitive to chemicals. Even a short exposure can cause severe effects to the eyes or the chemical can be absorbed through the eyes and be transported to other parts of the body causing harmful effects. Entry through the skin applies most frequently to chemicals in liquid form, however some vapour or gases can also enter through the skin, resulting in significant absorption and distribution through the body. Once absorbed, they may produce systemic damage to internal organs.

Example of penetration of organophosphates and carbamate insecticides through human skin is given in table.

Rates of Pesticide Exposure Through the Skin (USDA)
[Source: https://www.ars.usda.gov/northeast-area/docs/safety-health-and-environmental-training/field-pesticide-work/]

Sites	Relative rates of absorption of pesticides through the skin
Scalp	3.7
Forehead	4.2
Ear canal	5.4
Abdomen	2.1
Forearm	1.0
Palm of hand	1.3
Scrotum	11.8
Ball of foot	1.6

Ingestion (Oral)

Ingestion (oral) of chemicals is usually a minor route of exposure. Chemicals that inadvertently get into the mouth and are swallowed do not generally harm the gastrointestinal tract itself unless they are irritating or corrosive. Chemicals that are insoluble in the fluids of the gastrointestinal tract (stomach, small, and large intestines) are generally excreted. Others that are soluble are absorbed through the lining of the gastrointestinal tract. They are then transported by the blood to internal organs where they can cause damage.

Ingestion does not constitute a significant route of exposure of industrial chemicals because:

- Fewer chemicals can enter via this route.
- The duration of exposure via ingestion is usually shorter than by any other routes.
- For many chemicals, oral toxicity is lower than inhalation toxicity or skin penetration.
- The hazard can be significantly reduced by the prohibition of eating or drinking in the workplace and good personal hygiene.

For some chemicals ingestion can become problematic when personal hygiene is poor. Awareness of this hazard is essential to minimise accidental contact by contaminated skin or protective gloves. Accidental, careless or irresponsible contamination of the food chain can also lead to ingestion hazard.

APPENDIX 3 (CHAPTER 4)

Pesticides Classification

The classification for pesticides in Malaysia is based on the "*WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2009*". The WHO Hazard Classes have been aligned in an appropriate way with the GHS's classification criteria for acute toxicity hazard categories for oral and dermal toxicity as the starting point for allocating pesticides to a WHO Hazard Class. In practice, the majority of classifications will be made on the acute oral LD_{50} value. However, dermal toxicity must always be considered since it has been found that, under most conditions of handling pesticides, a high proportion of the total exposure is dermal. Classification based on dermal data in a class indicating a great risk is necessary when the dermal LD_{50} values indicate greater hazard than oral LD_{50} values.

WHO Recommended Hazard Classification Criteria for Pesticides

WHO Class		LD_{50} for the rat (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	< 5	< 50
Ib	Highly hazardous	5 - 50	50 - 200
II	Moderately hazardous	50 - 2000	200 - 2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to present acute hazard	5000 or higher	

Note that the pesticide classification is based on the intrinsic properties of the active ingredients and acute toxicity data for oral and dermal only. Therefore, the hazard class stated on the pesticide's label cannot be used to determine hazard rating. For other health hazard of pesticides, reference must be made to the toxicological data provided in SDS. Some SDS of pesticides may provide the GHS's classification which incorporate the hazard of the pesticide as a whole, which can then be used for hazard determination of the pesticide.

The pesticide classification and the corresponding classification under CLASS Regulations is given in the following table:

WHO Classification		Pesticides Hazard Class	CLASS Regulations		
LD_{50} for the rat (mg/kg body weight)			Acute Toxicity Hazard Category	LD_{50} (mg/kg body weight)	
Oral	Dermal			Oral	Dermal
< 5	< 50	Ia	Category 1	≤ 5	≤ 50
5 - 50	50 - 200	Ib	Category 2	$5 < LD_{50} \leq 50$	$50 < LD_{50} \leq 200$
50 - 2000	200-2000	II	Category 3	$50 < LD_{50} \leq 300$	$200 < LD_{50} \leq 1000$
			Category 4	$300 < LD_{50} \leq 2000$	$1000 < LD_{50} \leq 2000$
> 2000	> 2000	III	Not Classified (GHS Cat. 5)	> 2000	> 2000
≥ 5000	≥ 5000	IV			

Note:
Pesticides label uses coloured bands to distinguish between the four hazard classes:

- Black : Class Ia
- Red : Class Ib
- Yellow : Class II
- Blue : Class III
- White : Class IV

APPENDIX 4 (CHAPTER 4)

Example of Hazard Determination

This Appendix provides an example on how to determine hazard and fill in the hazard information in **Form B**.

A work unit consisting of 4 male operators carrying out task of preparing paint by mixing paint and thinner (mixing ratio 4:1), spraying paint mixture onto product and cleaning spraying equipment and working area using thinner. The hazard information extracted from the safety data sheet of each chemical is as the following:

Chemicals	Hazard Information
Paint	Hazard classification: Acute toxicity category 4 (oral); Skin corrosion or irritation category 2; Serious eye damage or eye irritation category 2; Reproductive toxicity category 2; Specific target organ toxicity – single exposure (Resp. irritation) category 3; Specific target organ toxicity – single exposure (Narcosis) category 3; Specific target organ toxicity – repeated exposure category 2 and Aspiration hazard category 1
Thinner	Hazard classification: Acute toxicity category 4 (oral); Skin corrosion or irritation category 2; Reproductive toxicity category 2 and Specific target organ toxicity – repeated exposure category 1 (CNS, kidney and liver) Toxicological data: LD_{50} (oral): 636 mg/kg (rat); LD_{50} (dermal): 12124 mg/kg (rabbit); LC_{50} (inhalation): > 26700 ppm (rat)

1. CHTH identified for this work unit are:

Task	Chemical
(i) Preparing paint	Paint, thinner and paint mixture
(ii) Spraying	Paint mixture
(iii) Cleaning	Paint mixture, thinner

2. For the paint mixture, assessor have to classify the hazard classification based on hazard information of paint and thinner. The classification is done according to the methodology and classification criteria specified in the Industry Code of Practice on Chemical Classification and Hazard Communication (ICOP CHC). Result of classification for the paint mixture is as follow:

Chemical	Paint	Thinner	Hazard category for paint mixture
Hazard class/ Composition	**80%**	**20%**	
Acute toxicity (oral)	Cat. 4	Cat. 4	Cat. 4
LD_{50} (oral) mg/kg	500*	636	526[a]
Skin corrosion or irritation	Cat. 2	Cat. 2	Cat. 2[b]
Serious eye damage or eye irritation	Cat. 2	NC	Cat. 2[c]
Reproductive toxicity (Repr.)	Cat. 2	Cat. 2	Cat. 2[d]
Specific target organ toxicity – single exposure (STOT-SE)	Cat. 3 (resp. irritation, narcosis)	NC	Cat. 3 (resp. irritation, narcosis)[e]
Specific target organ toxicity – repeated exposure (STOT-RE)	Cat. 2	Cat. 1 (CNS, kidney and liver)	Cat. 1[f] (CNS, kidney and liver)
Aspiration hazard	Cat. 1	NC	Cat. 1[g]

Note:

Cat. : Category
*LD_{50} data is not provided in SDS, converted acute toxicity point estimate is used (refer Table 2.26, ICOP CHC)

a) Determination of acute toxicity for the paint mixture using additivity formula (refer to ICOP CHC, paragraph 2.5.1.7):

$$\frac{100}{\text{ATE}mix} = \sum \frac{Ci}{\text{ATE}i}$$

$$\frac{100}{\text{ATE}mix\ (\text{oral})} = \frac{80}{500} + \frac{20}{636}$$

$$\text{ATE}mix\ (\text{oral}) = 526\ mg/kg \text{ which is cat. 4}$$

Determination of hazard classification for paint mixture based on concentration limit for:

b) Skin corrosion or irritation (Paragraph 2.5.2.4, ICOP CHC):
- ► Total concentration for cat. 2 = 100% which is > 10%, so mixture is classified as cat. 2 (refer to Table 2.30)

c) Serious eye damage or eye irritation (Paragraph 2.5.3.4, ICOP CHC):
- ► Total concentration for cat. 2 = 80% which is > 10%, so mixture is classified as cat. 2 (refer to Table 2.35)

d) Reproductive toxicity (Paragraph 2.5.8.4, ICOP CHC):
- ► Concentration of chemicals classified as cat. 2 = 20% and 80% which are > 3%, so mixture is classified as cat. 2 (refer to Table 2.52)

e) Specific target organ toxicity – single exposure (Paragraph 2.5.9.4, ICOP CHC):
- ► Concentration of chemical classified as cat. 3 = 80% which is > 20%, so mixture is classified as cat. 3 (refer to paragraph 2.5.9.4.3.5)

f) Specific target organ toxicity – repeated exposure (Paragraph 2.5.10.5, ICOP CHC):
- ► Concentration of chemical classified as cat. 1 = 20% which is > 10%, so mixture is classified as cat. 1. If there is data provided indicating different target organ (other than CNS, kidney and liver) for cat. 2, the mixture is also classified as cat. 2 for the specified target organ for cat. 2.

g) Aspiration hazard (Paragraph 2.5.11.4, ICOP CHC):
- ► Concentration of chemical classified as cat. 1 = 80%, which is ≥ 10% so the mixture is classified as cat. 1 (paragraph 2.5.11.4.2.1)

3. (i) For inhalation, hazard rating for each of the chemicals involved in the work unit is as follow:

Chemical	Hazard classification	H-code	Assigned hazard rating*	Hazard Rating**
Paint	Repr. cat. 2	H361	3	3
	STOT – SE cat. 3	H335	3	
		H336	2	
	STOT – RE cat. 2	H373	3	
Thinner	Repr. cat. 2	H361	3	4
	STOT – RE cat. 1 (CNS, 4 kidney and liver)	H372	4	
Paint mixture	Repr. cat. 2	H361	3	4
	STOT – SE cat. 3	H335	3	
		H336	2	
	STOT – RE cat. 1 (CNS, kidney and liver)	H372	4	

Note:
*Assigned hazard rating: Hazard rating assigned for each relevance hazard classification (use **Table 1**)
**Hazard rating: Hazard rating conclude for the chemical, taking the highest hazard rating for that chemical.

ii) For dermal, hazardous properties by dermal for each chemical is as follow:

Chemical	Hazard classification	H-code
Paint	Skin corrosion or irritation cat. 2	Irritation
	Serious eye damage or eye irritation cat. 2	Irritation
	Repr. cat. 2	Other properties
	STOT – RE cat. 2	Other properties
Thinner	Skin corrosion or irritation cat. 2	Irritation
	Repr. cat. 2	Other properties
	STOT – RE cat. 1 (CNS, kidney and liver)	Other properties
Paint mixture	Skin corrosion or irritation cat. 2	Irritation
	Serious eye damage or eye irritation cat. 2	Irritation
	Repr. cat. 2	Other properties
	STOT – RE cat. 1 (CNS, kidney and liver)	Other properties

4. Record the finding in **Form B** (refer to the sample of filled **Form B** provided).

SAMPLE OF FILLED FORM B

FORM B: LIST OF CHEMICALS HAZARDOUS TO HEALTH ASSESSED

WORK UNIT: Painting Operator **DATE OF ASSESSMENT:** 29/8/2017

Table B1: Chemicals Used in Work Unit

No.	Name of chemical	Hazardous ingredient	Physical form	Hazard classification	H-code	Source of information	HR	Dermal (Y/N)	Ingestion (Y/N)
1.	Paint	Mineral turpentine	Liquid	Repr. cat. 2 STOT – SE cat. 3 STOT – RE cat. 2 Skin corr./irr. cat. 2 Eye dam. cat. 2 Acute toxicity cat. 4 (oral) Aspiration hazard cat. 1	H361 H335, H336 H373 H315 H319 H302 H304	SDS	3	Y	Y
2.	Thinner	Toluene, Naphtha petroleum, Light aliphatic solvent	Liquid	Repr. cat. 2 STOT– RE cat. 1 (CNS, kidney and liver) Skin corr./irr. cat. 2 Acute toxicity cat. 4 (oral)	H361 H372 H315 H302	SDS	4	Y	Y

Table B2: Chemicals Released by the Processes or Work Activities

No.	Name of chemical	Hazardous ingredient	Physical form	Hazard classification	H-code	Source of information	HR	Dermal (Y/N)	Ingestion (Y/N)
1.	Paint mixture	Paint, Thinner	Liquid	Repr. cat. 2 STOT – SE cat. 3 STOT–RE cat. 1 (CNS, kidney and liver) Skin corr./irr. cat. 2 Eye dam. cat. 2 Acute toxicity cat. 4 (oral) Aspiration hazard cat. 1	H361 H335, H336 H372 H315 H319 H302 H304	SDS, ICOP CHC (Classification of mixture)	4	Y	Y

Note:

Repr.	:	Reproductive toxicity
STOT-SE	:	Specific target organ toxicity – single exposure
STOT-RE	:	Specific target organ toxicity – repeated exposure
Skin corr./irr.	:	Skin corrosion or irritation
Eye dam.	:	Serious eye damage or eye irritation
cat.	:	category
HR	:	Hazard Rating
Y	:	Yes
N	:	No

APPENDIX 5 (CHAPTER 5)

Geometric Mean and Geometric Standard Deviation

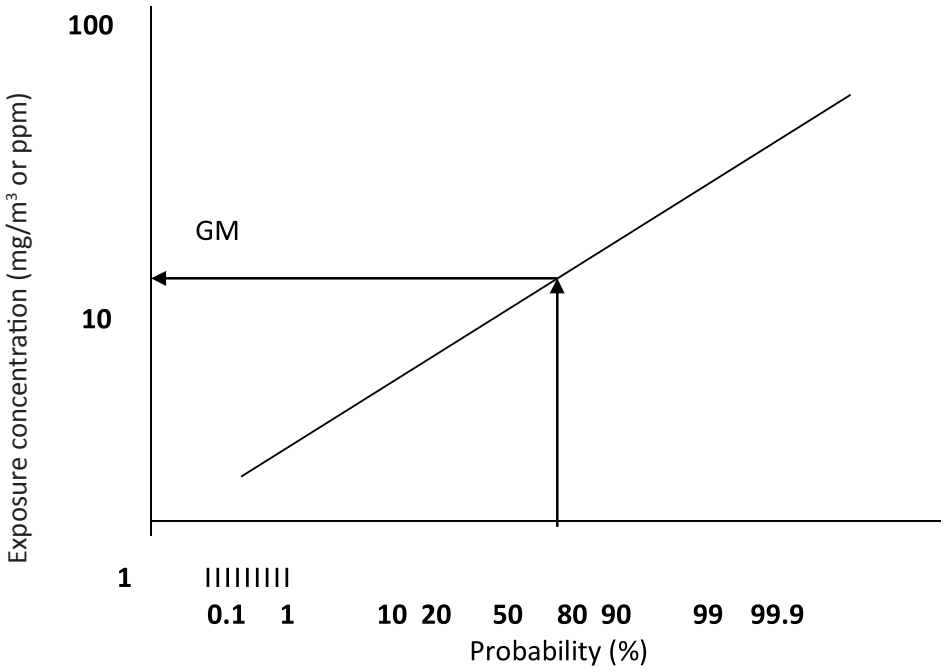
Distribution of Exposure Concentration

Worker exposure concentration is fluctuating in a lognormal manner either within any particular work shift or between day-to-day. Log normally distributed data is completely determined by the geometric mean (GM) and the geometric standard deviation (GSD). GSD greater than 2 represent high variation.

Probability Plots

The graphical method commonly used to summarise exposure data is the log-probability plot (cumulative frequency plot). This method is based on the fact that almost all air sampling data are best described by a lognormal distribution, i.e. the logarithms of the data are distributed normally. A log-probability plot is a plot of the individual data points as a cumulative frequency curve, where the percentage scale has been adjusted so that lognormally distributed data will produce a straight line. The drawn straight line will summarise the characteristics of the population from which the samples were taken and will enable generalisations and predictions to be made.

The GSD could be determined by reading up from the 50th percentile. The GM is determined by dividing the value gained from the 84th percentile by that gained from the 50th percentile.



Probability plot of a lognormal distribution

The GM can be calculated by using the following formula:

$GM = (TWA_1 \times TWA_2 \times TWA_3 \times .... TWA_n)^{1/n}$

There are statistical tools available that can provide descriptive statistics for data distribution.

APPENDIX 6 (CHAPTER 5)

Quantitative Determination of Inhalation Exposure Magnitude from Airborne Measurement Result

Formula to calculate time-weighted average concentration:

$$\text{Time-weighted average concentration (TWA)} = \frac{C_1t_1 + C_2t_2 + ... + C_nt_n}{t_1 + t_2 + ... + t_n}$$

where C_i is the concentration of each sample
t_i is the sampling time for that sample

Example 1: Full Period Single Sample

A worker is exposed to toluene a whole day for a five-day working week. The shift duration is 8 hours. The average duration of exposure to toluene is about 6.5 hours per day. Exposure monitoring result showed that the average concentration of toluene is 25 ppm (PEL for toluene = 50 ppm). Assuming there is no exposure during the remainder of the shift.

$$\text{TWA concentration} = \frac{(25 \times 6.5) + (0 \times 1.5)}{8}$$

$$= \mathbf{20.3\ ppm}$$

$$\approx \mathbf{0.4\ PEL}$$

Therefore, **ER** = **2** (Refer **Table 3** in **Chapter 5**)

Example 2: Full Period Consecutive Samples

A worker is exposed to lead during his 8 hours shift. The results from air monitoring taken during these his working shift are as follows:

0. 1 mg/m^3 for 2 hours, 0.02 mg/m^3 for 2 hours, 0.15 mg/m^3 for 3 hours (PEL for lead = 0.05 mg/m^3).
Assuming there is no exposure during the remainder of the shift.

$$\text{TWA concentration} = \frac{(0.01 \times 2) + (0.02 \times 2) + (0.1 \times 3) + (0x1)}{8}$$

$$= \mathbf{0.04\ mg/m^3}$$

$$\approx \mathbf{0.9\ PEL}$$

Therefore, **ER** = **4** (Refer **Table 3** in **Chapter 5**)

Example 3: Partial Period Consecutive Samples

A worker is exposed to asbestos fibres and results of two samples taken over an 8- hour period are:

Duration	Results
200 minutes	1.1 fibre/ml
230 minutes	1.3 fibre/ml

(PEL for asbestos = 0.1 fibre/ml)

His degree of exposure is:

(a) Assuming similar exposure for the unmeasured time period

$$\text{TWA concentration} = \frac{(1.1 \times 200) + (1.3 \times 230)}{200 + 230}$$

$$= \frac{519}{430}$$

$$= 1.2 \text{ fibre/ml}$$

$$\approx 12 \times \text{PEL}$$

Assign, **ER** = **5** (Refer to **Table 3** in **Chapter 5**)

(b) Assuming zero exposure for the unmeasured time period

$$\text{TWA concentration} = \frac{(1.1 \times 200) + (1.3 \times 230) + (0 \times 50)}{200 + 230 + 50}$$

$$= \frac{519}{480}$$

$$= 1.08 \text{ fibre/ml}$$

$$\approx 10.8 \times \text{PEL}$$

Assign, **ER** = **5** (Refer to **Table 3** in **Chapter 5**)

Example 4: Use of Geometric Mean (GM) to determine ER

A work unit exposed to benzene has been monitored for full shift exposure. Six monitoring data were collected as follows:

0.148 ppm, 0.155 ppm, 0.21 ppm, 0.39 ppm, 0.61 ppm, 0.65 ppm

Using statistical analysis:

Statistical Result	
Arithmetic mean	0.361
Geometric mean	0.301
Geometric standard deviation	1.951

PEL for benzene = 0.5 ppm

Geometric mean (GM) of the data = 0.301 ppm;

≈ 0.6 PEL

Assign, **ER** = **3** (Refer to **Table 3** in **Chapter 5**)

APPENDIX 7 (CHAPTER 5)

Occupational Exposure Limits

Occupational Exposure Limits (OEL) is defined as a level of exposure to specific health hazard agents that is believe to be protective of most workers who are exposed. In Malaysia, OEL is termed as Permissible Exposure Limits (PEL) and these are found in various Regulations gazetted by the Government. For the purpose of this manual, the OEL to be used is the Malaysian PEL specified in the USECHH Regulations.

There are three types of PEL:

- **Time-Weighted Average Limit (TWA)**
  - ◊ the time-weighted average airborne concentration for a normal eight- hour workday, to which nearly all workers may be repeatedly exposed, day after day, without any adverse effect.

- **Ceiling Limit**
  - ◊ the airborne concentration that should not be exceeded during any part of the working day.

- **Maximum Exposure Limit (MEL)**
  - ◊ fifteen-minute time-weighted average airborne concentration which is three times the eight-hour time-weighted average airborne concentration of the chemicals specified in Schedule 1 of USECHH Regulations;

Where a PEL is not available for a chemical, the assessor may use other OEL such as the Threshold Limit Values (TLV) published by the American Conference of Governmental Industrial Hygienists (ACGIH) or OEL used in other developed countries as a reference. Different countries used different terms for legally binding OEL.

The following table shows the term used in selected countries.

Country	Term Used
UK	Workplace Exposure Limits (WEL)
Japan	Control Level
New Zealand	Workplace Exposure Standards (WES)
Australia	Exposure Standards
Germany	Maximum Concentration Values (MAK)
United States America (OSHA)	Permissible Exposure Limits (PEL)

OEL for liquid mixtures

The OEL for a liquid mixture where the atmospheric composition of the vapour above the mixture is similar to that of the mixture, may be determined by the use of the following formula if the percentage weight composition and OEL of individual components are known:

$$1/\ OEL = f_1/OEL_1 + f_2/OEL_2 + \ldots + f_n/OEL_n$$

Where f_n is the fraction by weight of component n in the mixture.

An application of this formula to calculate the 'in-house' OEL is for an organic solvent mixture such as white spirit that contained alkanes, cycloalkanes, and aromatics.

Exposure of chemicals with additive effects

Where chemicals are known to have additive effects, the following formula has to be used to determine over exposure:

$$\text{Combined exposure index} = C_1/OEL_1 + C_2/OEL_2 + C_3/OEL_3 + \ldots C_n/OEL_n$$

Where,

$C_1, C_2, C_3 \ldots C_n$ = actual airborne concentrations of each chemical and

$OEL_1, OEL_2, OEL_3 \ldots OEL_n$ = 8 hours OEL for respective chemical

To prevent overexposure, the sum of the combined exposures ratios must not exceed 1.

Extended working hours

For work shifts longer than eight hours adjustment has to be made to the OEL since the longer the day over which the contaminant is absorbed, the shorter the period of recovery before the next insult. The adjusted exposure limit is calculated as follows:

Adjusted exposure limit = eight-hour time-weighted average limit x $\left\{\frac{8}{h} \times \left(\frac{(24-h)}{16}\right)\right\}$
where, *h* is hours worked per day

For example, a worker working on a 12-hour work shift will be working for 12 hours and then rest for the next 12 hours (the recovery period) before the next 12 hours exposure. The adjustment factor is 0.5, meaning that the OEL for this worker is half that for a worker working an 8-hour shift.

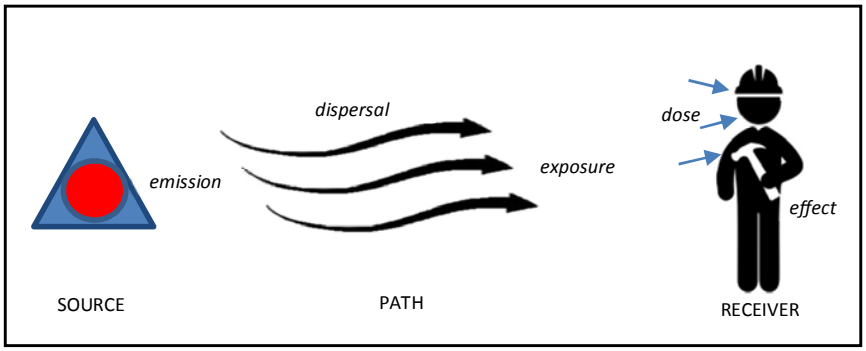
The limitation of this formula is that it does not apply to the following:

a) continuous 24-hour exposure;
b) work periods of less than 8 hours per day or 35 hours per week; or
c) chemicals for which the PEL is based on irritation effects.

APPENDIX 8 (CHAPTER 5)

Qualitative Estimation of Exposures

The qualitative estimation of exposure is based on an exposure model that consists of a source, a transmission path and a receiver (the worker). The dose and effect resulting from exposure is also taken into account. An outline of the model is given below:



It should be noted that exposure modelling is subject to considerable uncertainty (C.N. Gray, 1999)

The qualitative exposure assessment is based on industrial hygiene professional judgement. This generally involves the comparison of observed exposure situation with other operations the assessor has experienced, and for which measured exposure data are available.

It is based on the concept that the amount of chemical absorbed or contacted or in contact with the body depends on degree of chemical release or presence and the degree of reception or retention at the boundary of contact.

Factors Affecting Inhalation Exposure

The intensity or magnitude of exposure from its source can be estimated by looking at the various parameters that contribute toward the accumulation or build-up of the chemical at the boundaries of exposure (e.g. breathing zone for inhalation exposure).

Degree of Chemical Release

a) Contaminant release rate
   - physical form of chemical, size and density
     - ◊ whether gas, vapour, airborne particulate i.e. gas & vapour release and disperse more easily into air
   - volatility & evaporation rate
     - ◊ more volatile (high vapour pressure & low boiling point) more easily vapourized and released into air
     - ◊ high evaporation rate i.e. faster release rate

b) Quantity
- amount used or handled
- larger amount, more will be released

c) Contamination
- contamination of surrounding area, clothing or work surfaces
- presence in air (visually, odour, sensation)
- type of release
  - ◊ hot or cold process – hot process generally higher release
  - ◊ batch or continuous process- batch process generally higher release

d) Vicinity of source
- closeness to point of emission
  - ◊ source/contamination within or outside breathing zone
  - ◊ direct contact or handling

e) Enclosed/confine space where contaminant is present
- ventilation rate/accumulation in working environment
  - ◊ enclosed or open work area/space
  - ◊ well ventilated or not

Degree of Chemical Absorbed or Contacted

The degree of chemical absorbed or contacted is influenced by the following factors:

a) Work practice
- nature of handling / work practice
  - ◊ manual or mechanised operation
  - ◊ good or bad work practice

(b) Air intake
- rate of breathing, metabolic work rate
  - ◊ carrying out light, moderate or heavy work

c) Contaminated clothing and surfaces
- degree of contamination

d) Workers awareness
- information, instruction and training

e) Personal hygiene
- cleanliness of face and hands

Factors Affecting Dermal Exposure

Dermal exposure may be described as the amount of CHTH contacted by the outer layer of the skin and being available for dermal uptake (absorption) via the unbroken skin and or for producing an effect on the skin. The effect on the skin may be at the point of contact or elsewhere.

Dermal exposure may occur through various pathways, including direct contact or immersion, splash, deposition or contact with contaminated surfaces.

The degree of dermal exposure to hazardous chemicals is influenced by the following factors:

Chemical Agent Factors:

a) Concentration of chemical on the skin
- Concentration gradient facilitates skin absorption or dermal uptake.
- Higher concentration of the chemical in solution or in air, the higher the damage potential.
- Chemical with 'skin' notation means that it can be easily absorbed through the skin.

b) Duration and area of exposure
- The longer the contact with chemical the higher the potential for absorption or injury.
- The larger the contact area the higher the degree of chemical absorption or injury.

c) Frequency of contact
- Repeated and prolonged contact with chemicals can lead to health effects on the skin and elsewhere in the body.
- Single exposure for fast acting chemicals like corrosives can cause extensive damage at the point of contact.

d) Physicochemical properties of chemical agent
- Chemicals with a higher boiling point is likely to remain on the skin longer and effect degree of surface damage, as well as amount absorbed.
- The higher the fat solubility, the higher the skin penetrability.
- The higher the molecular weight, the slower the skin absorption rate.

Personal Factors

a) Skin condition and health
- Dry or dehydrated skin may damage easily.
- Scarred, cracked skin or damaged skin resulting from cuts or abrasions will allow chemicals to attack skin more readily and penetrate easily.
- Skin disorders such as eruptions, infections, dry and scaly skin can severely compromise the barrier properties of the skin.

b) Skin area
- Chemicals diffuse more rapidly through thinner skin areas such as the eyelids, head, neck and genital areas.
- Certain parts of the body allow greater penetration of chemicals e.g. follicle-rich sites of the scalp, the angle of jaw and the forehead.

c) Personal hygiene
- Contaminated skin and dirty clothing, including PPE can contribute to skin irritation or damage as well as uptake of chemicals via skin.

APPENDIX 9 (CHAPTER 5)

Solvent Drying Time

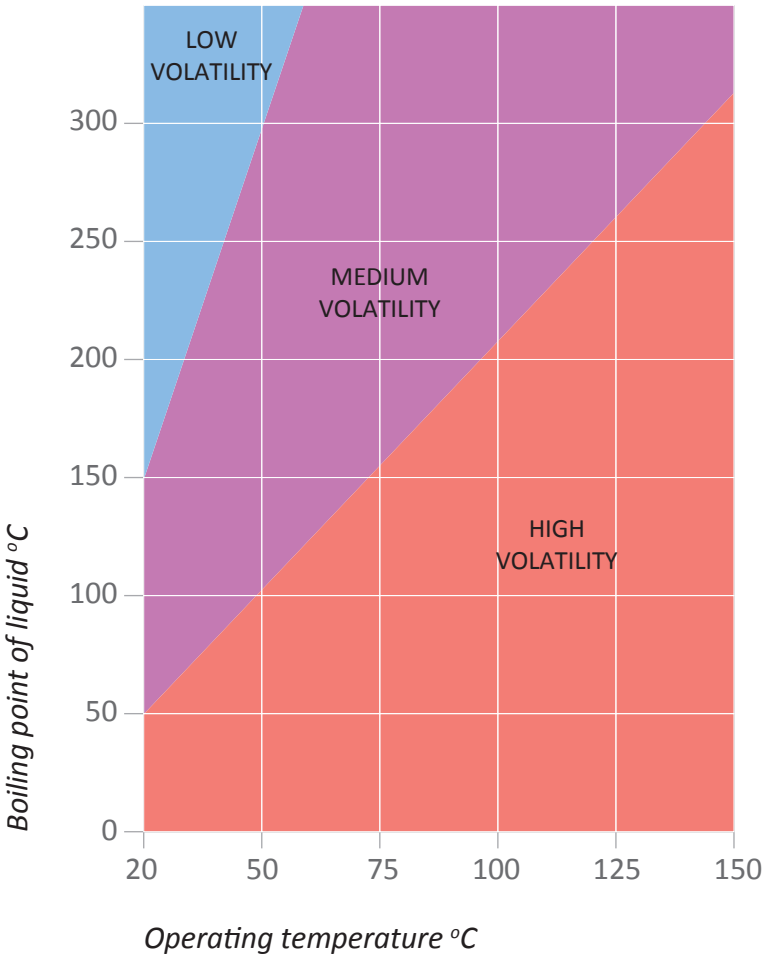
SOLVENT	Dry Time Relation	Degree of Drying
Ethyl Ether C.P	1.0	Fast
Petrolene	1.8	
Carbon Tetrachloride	1.9	
Acetone	2.0	
Methyl Acetate	2.2	
Ethyl Acetate 85-88%	2.5	
Trichlorethylene	2.5	
Benzol (Industrial)	2.6	
Methyl Ethyl Ketone	2.7	
Isopropyl Acetate 85%	2.7	
Ethylene Dichloride	3.0	
Solvsol 19/27	3.7	
Ethylene Chloride	4.0	
Propylene Dichloride	4.1	
Troluoil	4.1	
Methanol	5.0	Medium
Toluol (Industrial)	5.0	
Methyl Propyl Ketone	5.2	
V.M & P	5.8	
Perchlorethylene	6.0	
Nor. Propyl Acetate	6.1	
Sec. Butyl Acetate	6.5	
Solox (Anhydrous)	6.5	
Isobutyl Acetate 90%	7.0	
Apco thinner	7.0	
Ethyl Alcohol, Den. No. 1	7.7	
Solox	8.0	
Isoproply Alcohol 99%	8.6	
Nor. Propyl Alcohol	9.1	
Solvsol 24/34	9.4	
Nor. Butyl Acetate	9.6	
Diethyl Carbonate	9.6	
Methyl Butyl Ketone	9.7	
Xylol (Industrial)	9.7	
MonochlorBenzol	10.0	
Tertiary Butyl Alcohol	11.9	
Sec. Butyl Alcohol	14.0	

SOLVENT	Dry Time Relation	Degree of Drying
Sec. Amyl Acetate	16.9	Slow
Amyl Acetate	17.4	
Isobutyl Alcohol	17.7	
Methyl Cellosoive	18.0	
Butyl Propionate	18.0	
Pentacetate	20.0	
Turpentine	20.0	
Butanol	21.0	
Sec. Amyl Alcohol	25.0	
2-50- W Hi-Flash Naphtha	27.5	
Amyl Alcohol (Fusel Oil)	32.1	
Di Isopropyl Ketone	33.9	
Ethyl Cellosolve	36.2	
Odorless Mineral Spirits	38.6	
Ethyl Lactate	40.0	
Sec. Hexyl Alcohol	41.7	
Solvsol 30/40	43.2	
Pentasol	45.0	
Hi-Solvency Mineral Spirits	46.7	
No. 380 Mineral Spirits	47.0	
No. 10 Mineral Spirits	55.0	
Distilled Water	60.0	
Apco No. 125	60.5	
Cellosolve Acetate	65.0	
Sec. Butyl Lactate	73.0	
Sec. Hexyl Acetate	76.5	Nil
Butyl Cellosolve	88.5	
Dipentene	89.2	
No. 140 Thinner	91.0	
Octyl Acetate	152.5	
Isobutyl Lactate	156.5	
Hexalin	177.5	
Solvsol 40/50	270.0	
Methyl Hexalin	276.5	
Butyl Lactate	339.0	
Excellence	384.0	
Special Heavy Naphtha	403.0	
Dispersol	425.0	
No. 50 Kerosene	626.7	
Triethylene Glycol	Over 5200.0	
Dibutyl Phthalate	Over 5200.0	

APPENDIX 10 (CHAPTER 5)

Volatility Chart

Graph to select volatility of liquid



APPENDIX 11 (CHAPTER 5)

Direct Reading Instrument

Direct reading instruments are useful for detecting and measuring gases, vapours, aerosols and fine particulates. Direct reading instruments are useful for field exposure screening, tracing sources of contaminant emission, immediate detection of unacceptable conditions and quick assessment of the efficacy of hazard control procedures.

Direct reading instruments, also known as real time instruments give instantaneous read-out of measurements made. There are many types of direct reading instruments available and proper operation of instruments is important to ensure that accurate information is obtained when evaluating air contaminants. The advantage of direct reading instruments includes immediate estimation of concentration of a contaminant, permitting on-site evaluation.

Calibration is extremely important in gas or vapours and particulates measurements when using direct reading instruments. The use of direct reading instruments requires performance of standard procedures for calibration which includes records on maintenance and calibration of the instruments. Check with the equipment manufacturer or user manual on the pre-use testing and periodic calibration requirement.

Direct Reading Instruments for Gases or Vapours

a) Photo Ionisation Detector (PID)

A PID is an ion detector which uses high-energy photons, typically in the ultraviolet (UV) range, to break molecules into positively charged ions. They are capable of giving instantaneous readings and monitoring continuously. Typical PID measure volatile organic compounds (VOC) and other gases in concentrations from sub parts per billion (ppb) to 10 000 parts per million (ppm). The advantage of PID is it detects a wide range of VOCs. However, it does have disadvantages i.e. it is nonselective among organic vapours below ionisation potential of UV lamp and can be affected by high humidity.

b) Flame Ionisation Detector (FID)

FIDs are best for detecting hydrocarbons and other easily flammable components. Sampled gas is burned in a hydrogen flame where organic compounds will produce positively charged ions which are collected at an electrode above the flame. FID is very sensitive and linear over many orders of magnitude. However, instruments are complex (need hydrogen and stable environment for the flame) and nonselective among organic compounds.

c) Non-Dispersive Infrared (NDIR)

A non-dispersive infrared sensor (or NDIR) is a simple spectroscopic device often used as a gas detector. Gas is pumped (or diffuses) into the sample chamber and gas concentration is measured electro-optically by its absorption of a specific wavelength in the infrared (IR). The IR light is directed through the sample chamber towards the detector. NDIR sensors can be used to measure practically all inorganic and organic gases, but are most often used for measuring carbon dioxide because no other sensing method works as simply and reliably for this gas. The advantage of this sensor is it lasts longer than electrochemical sensors. However, it could also detect compounds that absorb IR light in the same band as carbon dioxide.

d) Portable Gas Chromatograph (PID, FID, MS, ECD)

Portable gas chromatograph (GC) refers to any gas chromatograph not requiring external electrical connections. The portable GC may range in size and portability from a self-contained unit the size of a small suitcase easily carried by one person to a much larger unit requiring auxiliary gas supply and requiring more than one person to transport. In gas chromatograph, mixtures of chemical compounds are separated from one another by selective partition between a stationary liquid phase and a mobile phase. Many gases can be measured using portable GC including inorganics, VOCs, BTEX, etc. The disadvantages of this instrument are it is expensive and complicated.

e) Colorimetric tubes/badges

A measured volume of gas (or air) is drawn through a tube which contains chemicals which change in colour in response to the presence of a specific target gas (or range of gases) present in the sample. By knowing the volume of gas or air sampled, the amount of colour change read on a linear scale on the colorimetric gas detection tube can be translated into a very accurate measurement of level of gas present, described in percentage of the total air or in parts per million (ppm). The advantage of using colorimetric detector tubes is they can be used to measure many gases that cannot be measured by other direct-reading instruments. Disadvantages of colorimetric detector tubes include ±25% accuracy under ideal conditions and not capable to conduct continuous monitoring or sampling.

Direct Reading Instruments for Particulates

There are several methods used for detecting and measuring particle size or size distribution; Light Blocking, Light Scattering and direct imaging. An optical particle counter (OPC) uses the light scattering principles, where a laser light source is used, the viewing volume is controlled, and a high-sensitivity photodetector is employed to detect light that the particle scatters. Some aerosol monitors have gravimetric sampling capability using a 37-mm filter cassette which can be inserted in-line with the aerosol stream allowing you to perform an integral gravimetric analysis. There is also aerosol monitor with laser photometers that simultaneously measure mass and size fraction. They combine both particle cloud (total area of scattered light) and single particle detection to achieve mass fraction measurements. This size-segregated mass fraction measurement technique is superior to either a basic photometer or optical particle counter (OPC). It delivers the mass concentration of a photometer and the size resolution of an OPC.

APPENDIX 12 (CHAPTER 7)

Checklist on Adequacy of Control Measures

This is a sample of questions that would be helpful in determining the adequacy of existing control measures. Some control measures may be not applicable to the hazard or task for the work unit. However, if one or more of the applicable control measures is not adequate, then the assessor should recommend appropriate remedial actions.

1. TECHNICAL CONTROLS

No.	Control Measures
1	**Elimination or substitution** • Is there any possibility to eliminate or substitute? • Is there a plan to eliminate or substitute the CHTH?
2	**Enclosure and isolation** • Is the process or chemical handling system totally enclosed (e.g. compartmentalised, closed loop piping)? • If there's enclosure, is ventilation required? If yes, refer to item no. 4. • Is the process or work isolated by distance or by physical barriers? If yes, is it suitable for the risk posed by the CHTH?
3	**Modification of process parameters** Have process parameters such as temperature or pressure been modified to minimise release of CHTH into the workplace environment?
4	**Engineering controls** • If engineering control is required, has it been provided? (e.g. LEV, general ventilation, dilution, extraction, water spray, etc.) • Is the type of engineering control suitable for the chemicals? • Are the engineering controls operated at all times during operation? • Is design of the LEV approved by Professional Engineer (PE)? • Is physical examination of engineering control routinely performed at least once a month and the records are maintained? If there is break down of the equipment that may affect the effectiveness, has immediate repair been done and the equipment retested after the repair? • It is examined and tested yearly by registered Hygiene Technician? If yes, does it meet recommended criteria? Have actions required for improvement been implemented? • Has training on the proper use of the engineering control been given?

No.	Control Measures
5	**PPE** • Is chemical PPE required? • Is it provided and used? • Does it provide adequate protection? • Is the PPE certified by conformity assessment body? • Is the equipment properly fit tested for the worker? Is it user friendly? • Is PPE programme established? • Is there any provision for PPE storage? • Does it create a hazard in itself e.g. poor visibility, thermal stress, reduced hand dexterity, etc.?

2. ORGANISATIONAL CONTROLS

No.	Control Measures
1	**Hygiene facilities and practices** • Are there any washing facilities? • Is personal hygiene being practiced (e.g. wash hands before partaking of food, keep fingernails short and clean)? • Are adequate changing rooms, lockers, washing and shower facilities provided (mandatory for asbestos, lead, mercury, pesticides and silica)? • Are food, drinks and smoking prohibited at the work area where chemical being used?
2	**Risk Communication** • Has training programme conducted once in every two years? • Has the worker has been informed of: ◦ results of monitoring of exposure; ◦ results of monitoring of medical surveillance; and ◦ medical removal and return? • Are hazards of the chemical and the safe handling of chemicals communicated to the worker? • Are information on hazards, risks and controls readily available: ◦ chemical register; ◦ SDS; ◦ label; ◦ warning signs; ◦ safe operating procedures? **Note:** Interview worker to seek their knowledge of the task, associated hazards and measure for controlling exposure.

No.	Control Measures
3	**Adoption of safe work systems and procedures** • Are safe work systems documented, implemented and reviewed? • Are the written procedures adequate? Is the actual practice consistent with written procedures? • Is housekeeping satisfactory? **Note:** • Observe aspects of the task which may increase exposure potential e.g. overtime work or shift patterns which increase exposure time, spillage and leakage, manual decanting of material, heated products, dusty materials, high ambient temperature in work area, lack of air movement in work area, spraying of liquids, manual movement of materials/equipment and repetitive tasks. • Consider workers not directly involved in a particular task but present in the vicinity and potentially exposed to the hazard e.g. workers adjacent to someone doing spray painting, chemical cleaning etc. • Review non-routine and intermittent activities or unplanned activities e.g. maintenance operations, loading and unloading, changes in production cycles, process or plant shutdown, etc.

3. EMERGENCY RESPONSE PREPAREDNESS

No.	Control Measures
1	**Emergency procedures** • Are chemical emergency response procedures, plans or emergency response team available? • Is emergency eyewash and shower available and in working order? • Are chemical spill kits available and complete? • Has training been given for the emergency response team?
2	**Medical emergency response** • Is first aid e.g. room, clinic, and first aid box available? • Are the first aiders trained? • Are there any arrangements with external clinics, hospital?

4. DERMAL

No.	Control Measures
1	**Technical Control** • Is there any possibility to substitute a more hazardous chemical with a safer alternative? • Can the process be automated? • Any possibility to enclose the process? • Are there any equipment/tools being use for handling chemicals rather than using hands? • Does the worker apply safe working distance? • Are appropriate protective clothing/gloves provided to the workers?
2	**Organisational Control** • Is there any training conducted on care and protection of the skin? • Is there any procedure on personal hygiene such as to wash hand? • Any wash area available? • Any need to supply moisturising pre-work and after-work creams?

5. INGESTION

No.	Control Measures
1	Are these organisational controls being practices? • safe work procedure • good work practice • housekeeping • training • remove contaminated clothing in the area away from work activity • practice good personal hygiene e.g. wash hand, face and under fingernails before eating, drinking or smoking • prohibition of eating, drinking and smoking in the work area

APPENDIX 13 (CHAPTER 8)

Biological Monitoring

Biological monitoring is a measurement and assessment of chemical or their metabolite in workers that exposed to the chemical at workplace. Samples of breath, urine or blood, or any combination of these can be used as the monitoring biomarkers and the biomarkers will depend on the chemical assessed. Biological monitoring measurements reflect the total uptake of a chemical by an individual by all routes which are inhalation, ingestion, through the skin or by a combination of these routes. Thus, it differs from air monitoring which measures an individual's inhalation exposure and it is often used to complement personal air monitoring, which measures the concentration of a chemical in the air in a person's breathing zone. The result of biological monitoring can also contribute to determine the efficiency of control measures implemented at the workplace. Therefore, biological monitoring may be particularly useful for those chemicals where:

- there is likelihood of significant skin absorption;
- there is likelihood of significant exposure following ingestion of the chemical; or
- the control of exposure depends solely on personal protective equipment.

Biological monitoring can be considered without the needs for medical surveillance programme provided there are internal expertise who can interpret the results generated from the monitoring. Else employer may seek advice from qualified industrial hygienist.

The necessity of conducting the biological monitoring is shown in **Figure 7**.

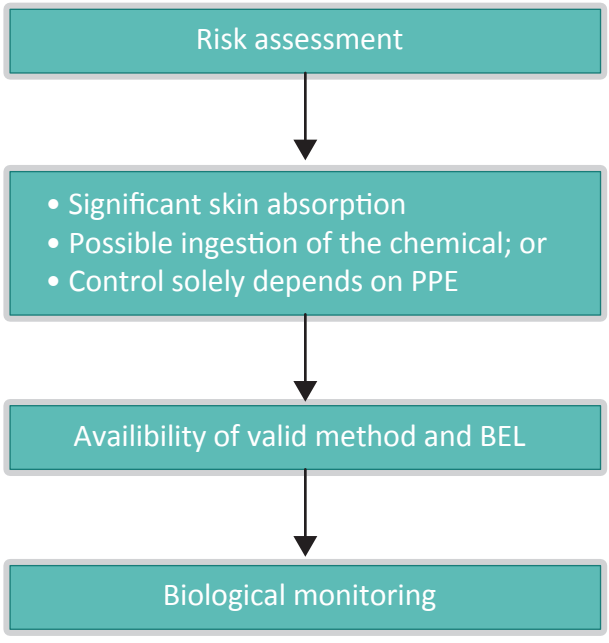


Figure 7: The Necessity of Conducting the Biological Monitoring

Analysis of biological monitoring sample should be performed by accredited laboratory where available.

APPENDIX 14 (CHAPTER 11)

CHRA Notification Form

Date:
Workplace:
Contact Person:

Ref: CHEMICAL HEALTH RISK ASSESSMENT REPORT

This is to certify that I have conducted CHRA for the above workplace on _____.

2. In compliance to Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations 2000, the CHRA report has been submitted, presented and explained to the employer on _____.

3. The employer has been informed to take action to control exposure of workers to chemicals hazardous to health as indicated in the CHRA report within one month after receiving the report.

_____

Name of assessor
DOSH registration No. :
Date of assessment :
Date of completion :

CHRA report received by :
Name :
Designation :
Date of receipt report :
Signature : _____

Note:
The form is subject to changes if necessary from time to time. The assessor should refer to the Department of Occupational Safety and Health on latest directive.

Department of Occupational Safety and Health
Ministry of Human Resources
Malaysia

Level 1, 3, 4 & 5, Block D4, Complex D,
Federal Government Administrative Centre,
62530 Putrajaya

Tel : +603 8886 5000
Fax : +603 8889 2352
Email : jkkp@mohr.gov.my

www.dosh.gov.my

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