ASSESSMENT OF THE HEALTH RISKS ARISING FROM THE USE OF HAZARDOUS CHEMICALS IN THE WORKPLACE

(A Manual of Recommended Practice 2nd Edition)

UNDER THE OCCUPATIONAL SAFETY AND HEALTH
(USE AND STANDARD OF EXPOSURE OF CHEMICALS HAZARDOUS TO HEALTH)
REGULATIONS 2000 [P.U. (A) 131]

DEPARTMENT OF OCCUPATIONAL SAFETY AND HEALTH
MINISTRY OF HUMAN RESOURCES
MALAYSIA
2000

TABLE OF CONTENT

LIST OF APPENDICES & FORMS

APPENDICES

FORMS

PREFACE

These guidelines may be cited as the Manual for the Assessment of the Health Risks arising from the use of Hazardous Chemicals in the Workplace: Second Edition (hereinafter referred to as "the Manual"). The purpose of this Manual is to provide guidance for assessors to conduct an assessment of the health risks arising from the use, handling, storage or transportation of chemicals hazardous to health at the workplace as required by the Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulation 2000 [P.U.(A) 131].

This is the revised edition of the 1996 manual. This revision is necessary due to the enforcement of the Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations in 1997 and the Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations in 2000.

Among the changes to the first edition are :

- Hazard rating standardized with classification under Occupational Safety and Health (Classification , Packaging and Labelling of Hazardous Chemical) Regulations1997
- Changes sequence of t opics and topics now follow closely assessment steps
- Use of risk matrix to ease risk making decision & to prioritise control actions
- Additional information e.g toxicological principles, sampling strategies, exposure limits, etc

To keep it up to date, it will be review from time to time

I would like to thanks the staffs of the Division of Industrial Health for their effort in the preparation and publication of this Manual.

Director General
Depatment of Occupational Safety and Health
Malaysia

December 2000

Chapter 1

INTRODUCTION

Protecting employees 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 Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulations 2000, hereinafter referred to as USECHH Regulations 2000, the duty to perform an assessment of health risks arising from the use of chemicals hazardous to health at the place of work is mandatory whereby employers are not permitted to use any chemicals hazardous to health unless an assessment has been conducted. To provide guidelines for employers and safety and health practitioners, this manual has been compiled to assist them on the procedures and protocol for conducting an assessment, hereinafter referred to as chemical health risk assessment or in short CHRA.

1.1. Purpose and Objectives of a Chemical Health Risk Assessment

A ***CHRA*** is conducted with the purpose of enabling decisions to be made on appropriate control measures, induction and training of employees, monitoring and health surveillance activities as may be required to protect the health of employees who may be exposed to chemicals hazardous to health at work.

A ***CHRA*** has the following objectives:

a) To identify the hazards posed by each chemical substance used, stored, handled or transported within the place of work;
b) To evaluate the degree of exposure of employees to the chemicals hazardous to health, either through inhalation, skin absorption or ingestion;
c) To evaluate the adequacy of existing control measures;
d) To conclude on the significance of the health risk posed by the chemicals hazardous to health; and
e) To recommend further appropriate control measures to prevent or reduce risks.

1.2. Content of Assessment

The USECHH Regulations 2000 stipulates that the assessment conducted must contain the following: -

(a) The potential risks to an employee as a result of exposure to chemicals hazardous to health;

(b) The method and procedures adopted in the use of the chemicals hazardous to health;

(c) The nature of the hazard to health;

(d) The degree of exposure to such chemicals hazardous to health;

(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 an employee to chemicals hazardous to health;

(g) The measures, procedures, and equipment necessary to control any accidental emission of a chemical hazardous to health as a result of leakage, spillage, or process or equipment failure;

(h) The necessity for employee monitoring programme;

(i) The necessity for health surveillance programme; and

(j) The requirement for the training and retraining of employees.

1.3. Application

This manual had been prepared to provide guidance for assessors to conduct a ***CHRA*** by going through a step-by-step procedure and using prescribed techniques and format. This manual is to be used by an assessor for the purpose of conducting assessment of health risks arising from the use, handling, storage or transportation of chemicals hazardous to health in the place of work as required by the USECHH Regulations 2000.

1.4. Types of Assessment

The steps described in this Manual are appropriate for all type of assessment. However the amount of work and detail of a particular assessment will depend on the chemicals hazardous to health involved and the complexity of the work processes in which there are used. There are basically two types of assessments depending on the chemical use situation and the complexity of the work process: -

a) Generic assessment; and
b) Full assessment

1.4.1. Generic Assessment

A generic assessment may be used where a chemical hazardous to health or a group of chemicals hazardous to health are used in the same way in several workplaces provided that the control measures in place are similar. In generic assessment, an assessment is made of a representative workplace or job, and this assessment is then used for the similar work activities that involve comparable risks.

Generic assessments may be done for a number of similar workplaces such as a chain of fast-food outlets or service stations.

It should be emphasized that generic assessment is only valid for work activities that are clearly similar, with comparable levels of risk, and which have the same type of control measures to control those risks.

1.4.2. Full Assessment

For other situations, a full assessment should be conducted for each and every workplace where chemicals hazardous to health are used. A report must be made of the assessment and presented to the employer.

Chapter 2

CONCEPTS

Before going into assessment there are a few basic concepts that the assessor must understand. These are:

a) Hazard, exposure and risk
b) Rating hazard, exposure and risk
c) Similar risk groupings or Work units

2.1. Hazard, Exposure and Risk

2.1.1. Hazard

Chemical health hazard is the potential of a chemical to cause harm or adversely affect health of people in the workplace. Adverse health effect ranges from fatality, permanent and serious health impairment to mild skin irritation at the other end. For example, the hazard of cyanides is that they are very toxic and a small quantity, if ingested, can cause death. Chemicals that can adversely affect the health of an exposed person is termed as chemicals hazardous to health. Under the USECHH Regulations 2000, a chemical hazardous to health is defined as any:

a) Chemical listed in Schedule I to USECHH Regulations 2000;
b) Chemical categorised under Part B of the CPL Regulations 1997;
   - those classified as very toxic, toxic, harmful, corrosive and irritant (and sensitising); and include carcinogens, mutagens, and teratogens.
c) Pesticide as defined under the Pesticides Act 1974; and
d) Scheduled waste listed in the First Schedule to the Environmental Quality (Scheduled Wastes) Regulations 1989.

For further discussion on the health effects of chemicals, please refer to Appendix 2.

2.1.2. Exposure

A worker is exposed to a chemical if there is a possibility of the chemical being breathed in; getting it on the eye or skin or absorbed through the skin; or being swallowed. A chemical may exert its effect either at the site of contact; or at a site away from the initial point of contact and takes place after it has entered the body through the various routes of entry. Exposure through inhalation is most common, especially for airborne chemicals such as gases, vapours and particulate. Skin absorption is common for lipid soluble chemical especially in the form of liquid or mist. Ingestion is not as common as inhalation or skin absorption, but nevertheless through poor personal hygiene and work practices it could be an important route of exposure. Injection through the skin can also occur, for example, when syringes are used. **Refer to Appendix 1 for further discussion.**

2.1.3. Risk

Risk is the likelihood that a substance 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, and the duration and frequency of exposure.
Mesch and Kugele (1992) have suggested a risk equation as follows:

$$\text{Risk} = [\text{How} \times \text{How Bad} \times \text{How Much}] \quad \text{----------} \quad (1)$$

Which proposes that health risk is a function of three (3) things, i.e.:

a) The likelihood of exposure or contact with the chemical (How);
b) The potential of the chemical to cause harm or its hazard (How Bad); and
c) The degree of exposure to the chemical (How Much).

Risk has also 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 also be defined as

$$\text{Risk} = \text{Hazard} \times \text{Exposure} \quad \text{----------} \quad (2)$$

The hazard component will take into consideration the nature of hazard and the potential adverse health effects from the possible routes of entry or contact,.
The exposure component looks at the chance of overexposure occurring by taking into account the frequency of exposure, the duration of exposure, and the intensity or magnitude of exposure.

Before any risk conclusion is made one has to take into account the work practices and personal factors including individual susceptibility.

2.2. Rating Hazard, Exposure & Risk

The approach adopted by this manual is qualitative with a rating system, in that the severity of hazard and the chance of overexposure are rated on a five- (5) scale rating. To ensure that the risk rating value is consistent with the hazard or exposure rating, the above equation (2) is redefined thus:

$$RR = \sqrt{(HR \times ER)} \quad \text{----------} \quad (3)$$

Where RR is the **risk rating** (1 to 5) 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 chemical hazardous to health.
(Note the scale of 1 to 5 is in an increasing order of magnitude, i.e. a rating of 1 means very low and 5 means very high and 3 is medium)

2.3. Similar Risk Groupings or Work Units for Assessment

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 chemical hazardous to health 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 chemical hazardous to health. This manual describes such grouping of workers as a work unit.

A **work unit** must fulfil two basic requirements: -

i) Work similarity
   - Workers in the work unit must perform similar tasks

ii) Similarity with respect to the hazardous agent
   - Workers using or are exposed to the same chemicals hazardous to health.

Similar tasks means that the workers are having similar potential for exposure. *Exposed to the same chemical hazardous to health* means that the workers are potentially exposed to the same hazard. Even though the workers are exposed to the same chemical hazardous to health 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.

Chapter 3

STEPS IN ASSESSMENT

3.1. Steps in Chemical Health Risk Assessment

The procedures in carrying out a ***CHRA*** is given in **Appendix 3**, which consists of ten steps:

Step 1: Deciding the assessor
Step 2: Gather information about chemicals, work & work practices
Step 3: Divide into work units
Step 4: Determine degree of hazards
Step 5: Evaluate exposure
Step 6: Assess adequacy of control measures
Step 7: Conclude the assessment
Step 8: Identify actions to be taken
Step 9: Reporting the assessment
Step 10: Review assessment

3.1.1. Step 1: Deciding the Assessor

The employer of a place of work is to appoint an assessor who has the knowledge and basic skills in doing an assessment. The appointed assessor must be given the authority to do the work, and should have enough resources to gather information, consult the appropriate people, review existing records and examine the workplace. The employer should be aware of the limitations in the experience and knowledge of the personnel conducting an assessment and should be willing to engage specialist assistance, if necessary. **Refer Chapter 4.**

3.1.2. Step 2: Gather Information about Chemicals, the Work and Work Practices

The purpose of this step is to identify all chemicals hazardous to health found in the workplace and to gather information about the work and work practices involving chemicals hazardous to health. **Refer Chapter 5.**

3.1.3. Step 3: Divide into Work Units

An inspection of the work areas where chemicals are used, handled, or released into the working environment is necessary before the workers is divided into work units for assessment.

During this inspection identify where and how chemicals hazardous to health are used or handled or released; who are exposed to the chemicals hazardous to health; and how they are exposed. **Refer Chapter 6.**

3.1.4. Step 4: Determine Degree of Hazard

Identify all the chemicals hazardous to health to which the work unit is exposed to, either from the chemicals used or handled by the work unit or chemicals released from the work activities. **Refer Chapter 7.**

3.1.5. Step 5: Evaluate Exposure

The purposes of this step are to assess the exposure of the work unit to each of the chemical hazardous to health used/handled by or exposed to the work unit and at the same time assess the adequacy of the existing control measures (Step 6). **Refer to Chapter 8.**

3.1.6. Step 6: Assess Adequacy of Control Measures

The presence and adequacy of existing control measures are evaluated for each work unit. This assessment is to be conducted simultaneously with the exposure assessment. The adequacy of existing control measures is assessed by inspecting the existing control measures; checking records of air sampling, biological monitoring; and checking records on the inspection, testing and examination of control equipment. **Refer to Chapter 9.**

3.1.7. Step 7: Concluding the Assessment

Conclude the assessment for each work unit. This will be useful in determining whether actions to control risk need to be identified. Before concluding the assessment the assessor needs to consider the following:

a) Whether there is sufficient information to decide on the degree of hazard
b) Whether there is certainty in evaluating or estimating the degree of exposure;
c) Whether the risk is “significant” or “not significant”; and
d) Whether the existing control measures are adequate.

The risk to each hazardous chemical is evaluated by combining the hazard rating and the exposure rating to give the risk rating. A risk rating of 3 or greater is considered to be significant while below that the risk is considered as not significant. **Refer to Chapter 10.**

3.1.8. Step 8: Identify Actions to be taken

Identify possible action to be taken including suggesting further precautions and control measures based on the conclusion of assessment from Step 7. **Refer to Chapter 11.**

3.1.9. Step 9: Reporting the Assessment

Recording of an assessment is important because it will be useful for the purpose of follow-up action, review and compliance with legal requirements. The USECHH Regulations 2000 stipulates that the assessor must submit a report to the employer within one month of the completion of the assessment. The information to be recorded in the report include:

a) Name and address of the workplace;
b) Particulars of chemicals being assessed including their hazard description and hazard rating;
c) Description of work units;
d) Particulars of the workplace assessment including exposure description and rating and adequacy of existing control measures;
e) Risk evaluation and conclusion of assessment;
f) Recommendations for further action;
g) Date of the ***CHRA***; and
h) Name and position of the assessor/assessor team.

The assessor should not only submit but also present his assessment report to the employer so as to inform and highlight him on his findings and recommendations. **Refer Chapter 12 for details of the records to be kept.**

3.1.10.Step 10: Review Assessment

The assessment made will not be applicable for all times or changing situations. Therefore the assessment needs to be reviewed from time to time. The USECHH Regulations 2000 stipulate the requirements for reviewing an assessment. An assessment needs to be reviewed:

1. When there has been a significant change in the work to which the assessment relates. A *significant change in the work* means that the risk situation has changed, such as due to:
   - Changes in the chemicals used or handled;
   - A significant change in the quantity of chemicals hazardous to health used;
   - Changes in methods or rate of work
   - Deterioration in the efficiency of control equipment; or
   - Plant failure or system failure.

2. Every five years;

3. When so directed by the Director General, Deputy Director General, or the Director of Occupational Safety and Health.

Chapter 4

DECIDING THE ASSESSOR

In carrying an assessment involving a large number of chemical substances, chemical mixtures or preparations or complex chemical processes, a team comprising of assessors or comprising an assessor and specialists or competent person is recommended. However, for a simple assessment formation of a team may not be necessary.

4.1. The Assessment Team

It is recommended that an assessment team be set up to ensure that the assessment can run smoothly. This team is to be headed by a registered assessor and assisted by one or more of the following team members where appropriate:

a) The company's safety and health officer or safety engineer;
b) The company's doctor, preferably a registered occupational health doctor;
c) The company's process/chemical engineer or chemist;
d) An experienced and knowledgeable member of the safety and health committee;
e) An industrial/occupational health nurse.

4.2. Competency of an Assessor

The would-be assessor should have the abilities to:

a) Interpret the information in the Chemical Safety Data Sheets (CSDS) and labels;
b) To understand the hazard classification as prescribed by the Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997;
c) Observe the conditions of work and foresee potential problems;
d) Communicate effectively with employees, contract workers, managers, specialists and others;
e) Draw all the information together in a systematic way to form valid conclusions about exposures and risks;
f) Report the findings accurately to all parties concerned.

For the purpose of complying with the USECHH Regulations 2000, the appointed assessor must be **registered** with the Director General of Occupational Safety and Health, Malaysia. For details please refer to the Guidelines for the Registration of Assessors, Hygiene Technician and Occupational Health Doctor (ISBN:983-2014-06-9). **Refer to Appendix 4.**

4.3. Duties of an Assessor

The Assessor is expected to: -

a) Carry out assessment of health risks arising from the use of chemicals hazardous to health at the workplace;

b) Furnish a report of the assessment to the employer of a place of work appointing him as the registered assessor within one month of the completion of the assessment;

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

d) Make recommendations on the necessity to: -
   i) make changes or institute a programme to control exposure of employees to chemical hazardous to health;
   ii) control any accidental emission of a chemical hazardous to health as a result of leakage, spillage, or process or equipment failure;
   iii) carry out a health surveillance programme;
   iv) conduct exposure monitoring programme; and
   v) institute a training programme for employees.

e) Present his findings and recommendations to the employer upon completion of the assessment report; and

f) Submit, within thirty (30) calendar days upon completion of the assessment, a summary to the Director of the nearest DOSH office and forward a copy to the Director General. The format of this summary is set out in **Appendix 4b.**

4.4. Specialist Advice

In certain cases, an assessor may not be able to conclude the assessment due to lack of expertise or information. The assessor is not expected to conduct employee exposure monitoring, biological monitoring or health surveillance unless he/she is competent to do so. The assistance of a specialist may be required. The common specialist who may be consulted upon may include, but is not limited to, the following:

a) An industrial hygienist – an expert on the exposure evaluation and control

b) An occupational health physician – expertise on health surveillance programme.

c) A hygiene technician –expertise on the inspection and testing of local exhaust ventilation system and the monitoring of airborne contaminants; and

d) A toxicologist – an expert on chemical toxicity.

Chapter 5

GATHER INFORMATION

5.1. Information to be gathered

The assessment begins with the gathering of the following information:

a) Chemicals hazardous to health used or released in the workplace
b) Layout plan of work area
c) Process flow chart
d) Employees at risk
e) Control equipment design parameter and maintenance
f) Accident and incidence
g) Monitoring record
h) Health surveillance programme
i) Training programme
j) Personal protective equipment programme

5.1.1. Chemical Hazardous to Health

The information required on the chemical hazardous to health are: -

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

Create an inventory of all chemicals hazardous to health used or released in each work area and obtain health hazard information on each. Use Form A to capture the necessary information. This information may be obtained from the chemical register, which is mandatory to be kept by the employer under the USECHH Regulations 2000. A detailed discussion on the register is found under paragraph 5.2.1.

5.1.2. Layout Plan

Obtain the layout plan for each work area where chemicals hazardous to health 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 equipments, barriers or enclosures, the locations of chemicals hazardous to health and the locations of employees.

5.1.3. 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.

5.1.4. Employees at Risk

Obtain information on those employees that are exposed to chemicals hazardous to health and should include the following: -

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

5.1.5. Engineering Control Equipment

Obtain information on the design parameters of the engineering control equipments 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 inspection by the employer;
c) Record of examination and testing of the control equipment by a registered hygiene technician;

5.1.6. Accident and Incidences

Obtain the accident and incidence records. This record gives information on the nature of accidents or incidences occurring.

5.1.7. Monitoring Programme

Obtain monitoring reports by competent persons, if such monitoring was carried out.

5.1.8. Health Surveillance

Obtain health surveillance records. This record should include the biological monitoring results, biological effect monitoring results, and summary of complaints and cases of occupational illnesses diagnosed.

5.1.9. Training Programme

Obtain records of training conducted. The record should include the training syllabus, training schedules and attendance.

5.1.10.PPE Programme

Obtain specifications on the personal protective equipments provided to employees, the issuance record of these equipments, and the record of personal protective equipment training provided.

5.2. Sources of Information

5.2.1. Information on Chemicals

An important source of information is the chemical register kept by the enterprise. Under the USECHH Regulations 2000, it is mandatory to keep a chemical register of the chemicals used, handled or stored at the workplace. The chemical register in the workplace will provide information on the trade and common names, chemical compositions, quantities used or stored and locations where chemicals are used or stored. The register must include the Chemical Safety Data Sheets (CSDS) for each of the chemicals hazardous to health listed. **Refer to Appendix 5.**

Where a CSDS is not available, the supplier should be contacted to get a copy of the CSDS. Under the OSH (Classification, Packaging & Labelling of Hazardous Chemicals) Regulations 1997 it is the supplier's duty to furnish an up-to-date CSDS. **Refer to Appendix 6 for explanation on the CSDS requirements**.

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

a) Chemical hazard or toxicity reference book;
b) Material safety data sheets (MSDS) from the national CIS centre (currently managed by the Department of Occupational Safety and Health);
c) The International Chemical Safety Data Card (ICS Card) published by the International Programme on Chemical Safety (IPCS);
d) Chemical information from the International Registry of Potentially Toxic Chemical (IRPTC) database (managed by the Department of Environment);
e) MSDS from Internet sites; and
f) National Poison Centre, Universiti Sains Malaysia (by subscribing to TELITA).

5.2.2. Other Information

For other information the sources of information will depend on the type of information. The Personnel or Human Resources Department will most probably keep the employees' particulars and training records; the Maintenance Department will probably have records on the maintenance of the engineering control equipment; the Medical Department or clinic will probably keep the health surveillance records, and the Production Department should have the plant layout and the process flow chart.

Chapter 6

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 chemical hazardous to health.

6.1 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. Workers should be assigned work units for evaluation based on similar risks. A **work unit** is essentially a group of workers doing similar tasks (i.e. having similar potential for exposure) whether in one work area covering several work areas and exposed to the same chemicals hazardous to health.

Identify all potential exposures by reviewing the various tasks carried out by the work unit in normal operations and any foreseeable abnormal exposures such as from leaks or accidental releases. 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), increase in exposure duration due to increased workload, heavy intake by doing heavy work or malfunctioning of control equipment need to be considered.

Assess how frequent job or task is carried out. Whether it is a routine or non-routine task; production of one-off items or isolated batches, trials; maintenance work, repair operations; etc.

For a complete assessment the work units should not only be limited to production or maintenance workers but those persons who may be in the work area and exposed to chemicals hazardous to health. Work units are to be considered from these groups of people:

- Production employees
- Ancillary or support employees (e.g. cleaners, maintenance staff, laboratory staff)
- Contractors on site
- Visitors
- Supervisors and managers
- Students
- Office workers

6.2. Work Unit Identification

This is where the assessor needs to identify and observe the tasks carried out by workers in a certain work area where workers are exposed to chemical hazardous to health and should be assigned work units for evaluation based on similar risks

Employees and other workers should be assigned work units based on the same chemical substances used or handled and carrying out similar job tasks. The steps to categorise a work unit is 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 chemical;
- 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 job title groups;

c) For each job title groups identify the chemical hazardous to health they were using or exposed to, the tasks carried out and the location within the work area;

d) Talk to supervisors and employees at each work location regarding practical information about work practices and procedures;

e) Characterise the work unit as follows:

Work area	+	work performed	=	work unit
(E.g. mixing area)		(E.g. operator)		(E.g. mixing operator)

f) Where the chemical hazardous to health used or exposed to and the tasks are similar for a number of job title groups, they may be group 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);

Chapter 7

DETERMINE DEGREE OF HAZARD

The hazard rating is used to prioritise hazard based on the potential health effect of the chemical. The hazard of a chemical is rated on a 1 to 5 scale with a rating of 1 implying not hazardous and a rating of 5 implying most hazardous to health. This hazard rating is harmonised with the classification of hazardous chemical for Part B hazardous chemicals (categories of hazard based on health effect) under the Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997, hereinafter referred to as CPL Regulations.

7.1 Hazard Information

Hazard information can be obtained from various sources. A complete CSDS provides useful information such as the hazard description, the toxicity data, and the acute and chronic health effects. Based on the toxicity data, the health effects and the risk phrases assigned to each hazardous, the hazard of each chemical can be evaluated and assigned a hazard rating (HR).

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 CSDS only provides information on the supplied products.

The sources of information have already been discussed under Chapter 5. However, a summary of the necessary information and its sources is given below:

Information	Source
Chemical classification	Label, CSDS, ICS card
Health effects, LC50 and LD50	CSDS, MSDS, ICS card, Poison centre, chemical safety literature
Risk phrases	Label, CSDS, ICS card

7.2 Hazard Rating Determination

For the purpose of assigning a hazard rating, chemicals hazardous to health need to be categorised into two groupings based on systemic effects and local effects. These groupings are meant to separate those chemicals that may be absorbed into the body and causing damage to organs or systems of the body and those that may cause effect at the site of contact either on the skin or eyes.

The procedure to assign a hazard rating to a pure chemical or a preparation containing a mixture of chemicals is as follows: -

a) Get information on the hazard categories, hazard classification; risk phrases, the acute and chronic effects, and the LD50 and LC50 for the chemical substance or preparation;

b) Use Table 1 to get hazard rating based on the health effect description or use Table 2 to get hazard rating based on the hazard classification or hazard categories, or risk phrases;

c) List the hazard ratings obtained in descending order;

d) Assign a single hazard rating based on the greatest degree of hazard from Group 1 hazard categories: -

Group 1:	Very toxic	R26-28, 39, 45(1), 46(1), 47(1), 49(1)
	Toxic	R23-25,39, 48, 45(2), 46(2), 47(2), 49(2)
	Harmful	R20-22, 40, 40(3), 40(M2), 48,
	Respiratory sensitiser	R42
	Respiratory irritant	R37

e) Assign an “sk” notation for those chemicals in Group 2 hazard categories: -

Group 2:	Corrosive to skin/eye	R34, 35
	Skin and eye irritants	R41, 38, 36

f) For a chemical substance or preparation that fall solely under Group 2, i.e. do not fall into Group 1, the hazard rating assigned is to be based on Group 2.

Note:

Tables 1 and 2 describe the assignment of hazard rating:

- Table 1 describes the assignment of hazard rating based on health effects and hazard categories.
- Table 2 describes the assignment of hazard rating based on risk phrases assigned to the hazardous chemical substance under the CPL Regulations.

The risk phrases used in Table 2 are:

Acute effects:

Acute lethal effects	(R20 to 28)
Non-lethal irreversible effects after single exposure	(R39, 40)
Corrosive	(R34, R35)
Irritant	(R36 to 38, R41)
Sensitiser	(R42, R43)

Chronic effects:

Severe effects after repeated or prolonged exposure	(R48)
Carcinogen	(R40, R45, R49)
Mutagen	(R46, R40)
Reproductive hazards	(R60 to 64) including
teratogen	(R47 – this r-phrase no longer in use in EU))

6.3. Example of Determining Hazard Rating

Example of Determining the Hazard of a Pure Chemical

As an example, ethyl dimethylamine is harmful through inhalation and if swallowed (R20/22) and at the same time corrosive to skin (R34).

According to the CPL Regulations, corrosive is of a higher degree of hazard as compared to harmful and so this chemical is classified as corrosive.

For assessment purposes these health hazard categories (i.e. harmful and corrosive) will be used to determine the hazard rating.

From Table 2, the hazard ratings are as follows: -

Group 1:	Harmful	R20/22	gives a hazard rating of 3
Group 2:	Corrosive	R34	gives a hazard rating of 3.

Assign a hazard rating of 3 (based on Group 1)
Assign a "sk" notation (based on Group 2)

Since this chemical is harmful if inhaled or ingested, the exposure through these two routes must be assessed. Even though exposure to skin is not assessed, control of skin contact is mandatory because of the "sk" notation.

Examples of determining the hazard rating for preparations or mixtures of chemicals hazardous to health are given in Appendix 7.

Table 1: Hazard Rating

HR	HEALTH EFFECTS	HAZARD CATEGORY
5	Local: Injury to the skin, eyes, or mucous membranes of sufficient severity to threaten life by single exposure Systemic: Severe irreversible effects (e.g. central nervous system effects, kidney necrosis, liver lesions, anemia or paralysis) after a single exposure	*Very Toxic chemicals:- -LD50<25 mg/kg (oral) -LD50<50 mg/kg (skin) -LC50<0.5 mg/litre
	Known human carcinogens, mutagens or teratogens	*Category 1 carcinogen, mutagen and teratogen
4	Local: Injury to the skin, eyes, or mucous membranes of sufficient severity to cause permanent impairment, disfigurement or irreversible change from single or repeated exposure Systemic: Very serious physical or health impairment by repeated or prolonged exposure	*Very Corrosive (R35: Causes severe burn) *Toxic chemicals:- -LD50: 25-200mg/kg(oral) -LD50: 50-400mg/kg(skin) -LC50: 0.5-2 mg/litre
	Probable human carcinogens, mutagens or teratogens based on animal studies	*Category 2 carcinogen, mutagen and teratogen
3	Local: Serious damage to skin, eyes or mucous membranes from single or repeated exposure Systemic: Severe effects after repeated or prolonged exposure	*Corrosive(R34:Cause burn) *Respiratory sensitisers *Irritant-serious eye damage *Harmful chemicals:- -LD50:200-500mg/kg(oral) -LD50:400-2000mg/kg(sk) -LC50: 2-20 mg/litre
	Possible human or animal carcinogens or mutagens, but for which data is inadequate	*Category 3 carcinogen and mutagen
2	Local: Reversible effects to the skin, eyes or mucous membranes not severe enough to cause serious health impairment Systemic: Changes readily reversible once exposure ceases	*Skin sensitisers *Skin irritants
1	No known adverse health effects	Not classified as hazardous

Table 2: Hazard Rating Based on Risk Phrases

EFFECT	ACUTE/ CHRONIC	ROUTES OF EXPOSURE					HAZARD RATING (HR)
		INH.	DERMAL		ING.	NOT SPECIFIED	
			SKIN	EYE			
Very Toxic	Acute	R26	R27		R28	R39	5
	Chronic	-	-		-	-	
Toxic	Acute	R23	R24		R25	R39	4
	Chronic	-	-		-	R48, R39	
Harmful	Acute	R20	R21		R22	R40	3
	Chronic	-	-		-	R48, R40	
Corrosive	Acute		R35				4
			R34				3
Irritant	Acute	R37	-	R41			3
		-	R38	R36			2
Sensitising	Acute	R42	-				3
		-	R43				2
Carcinogenic	Chronic	R49(1)				R45(1)	5
		R49(2)				R45(2)	4
		-				R40(3)	3
Mutagenic						R46(1)	5
						R46(2)	4
						R40(M2)	3
Teratogenic						R47(1)	5
						R47(2)	4
EXPOSURE ASSESSMENT REQUIRED		Inhala-tion	Skin	Eyes	Inges-tion	All Routes	

***Note**: For R39 and R48, the classification of the chemical or preparation need to be considered together in determining the hazard rating.*

Chapter 8

EVALUATE EXPOSURE

The purpose of determining exposure rating is to assess the potential of the chemical hazardous to health entering the body through the various routes of entry causing systemic effects or potential for contact with the eyes, skin or the respiratory tract causing localised effects.

8.1. Exposure Parameters

The first step is to identify who are exposed and what chemicals hazardous to health used or formed in the process carried out by the work unit.

The next step is to identify the tasks in which chemicals hazardous to health are being used or where there is likely exposure to chemicals hazardous to health during normal operation by going through their work procedures, observation of the various tasks performed and interviewing the members of the work unit.

Important considerations in the assessment of an exposure in the workplace are:

a) Degree of Exposure
   - Who is exposed?
   - How and in what circumstances is the exposure
   - Frequency of exposure
   - Duration of exposure; and
   - Intensity or magnitude of exposure

b) Other factors, such as training & information of employees, monitoring of exposure, and health surveillance.

Exposures are evaluated by assessing the likelihood of contact of the work unit with the hazardous chemical; how the chemicals are released into the work environment; the method of handling the chemical; the way the chemical enters the body; the frequency and duration of exposure; and the intensity or magnitude of each exposure.

Apart from assessing exposures during normal operation, the possibility of exposure due to spillage, leaks or accidental entry into the body such as through injection is to be considered.

Special consideration is required for some person 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.

8.2. Degree of Exposure

The degree of exposure is to be estimated for the various probable route(s) of exposure. The probable routes of entry or contact are decided by taking into consideration the physical form of the chemical and the effects it could have through the various routes of entry or contact, as described by the risk phrases assigned to it. This has been discussed under Chapter 5. Examples of decision to be taken with respect to which route of entry or contact to be assessed is given in Appendix 7.

Where a chemical exerts a direct effect on the skin or the eyes, such as corrosives and irritants, an 'Sk' notation should be made to indicate that skin and eye exposure needs control regardless of absorbed dose.

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 a hazardous chemical is used, the higher is the degree of exposure. The greater the amount of chemical being absorbed into or enters the body or in contact with the eye/skin the higher is the degree of exposure.

8.3. Frequency of Exposure

For assessing the likelihood of acute effects, the frequency of exposure is determined as 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 is used and is determined from Table 3:

Table 3: Frequency Rating

Rating	Description	Definition
5	**Frequent**	Potential 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 less than one per year

8.4. Duration of Exposure

A duration rating is used to assess chronic or routine exposures. Duration of exposure also has a significant effect on the exposure. Twice the exposure duration results in twice the exposure. For assessing chronic exposures use the total exposure duration rather than the frequency of exposure. The total exposure duration is the product of the number of exposures and the average duration of each exposure. Refer to Table 4 below.

Table 4: Duration Rating

Rating	Total Duration of Exposure*	
	% work hour	Duration per 8-hr shift or per 40-hr week
5	> 87.5 %	> 7 hrs/ shift or > 35 hours/ week
4	50-87.5 %	4 to 7 hrs/ shift or 20 to 35 hours/ week
3	25-50 %	2 to 4 hrs/ shift or 10 to 20 hours/ week
2	12.5-25 %	1 to 2 hrs/ shift or 5 to 10 hours/ week
1	< 12.5 %	< 1 hr/ 8 hr shift or < 5 hours/ week

***Note:** Total exposure duration per week (TD)
= (Number of exposure per week) x (Average duration of each exposure)

8.5. Intensity or Magnitude of Exposure

For estimating exposure intensity or magnitude there are two possible ways, either quantitatively or qualitatively. In the presence of quantitative inhalation exposure data, this will form the basis of the estimate.

In the absence of quantitative data, a qualitative estimate of exposure will be used.

8.5.1. Quantitative Evaluation- inhalation exposure

Quantitative evaluation of exposure is carried out for inhalation exposures if air-sampling data for the exposed employees are available. Where exposure data is limited or unavailable the assessor should assess the exposure qualitatively. The evaluation of inhalation exposure is without regards to the use of respirators.

Inhalation exposure evaluation is based on

- Current measurement of personal airborne exposure
- Estimation from previous measurement of personal airborne exposure
- Estimation of personal exposure from ambient or general air levels

Estimation of personal exposure can be made from breathing zone measurements by the use of direct reading instruments (such as multiple gas infrared analysers or respirable dust monitors). **Refer to Appendix 8 for discussion on sampling strategies.**

The flowchart for assigning an exposure rating by using quantitative data is given in Appendix 17.

8.5.1.1. Rating Acute Exposure

For chemicals with acute effects, the exposure will be based on instantaneous measurement result. The magnitude rating is assigned based on the fraction of the measurement result to the ceiling limit or the maximum exposure limit, whichever results in a higher exposure rating. Refer Table 5.

8.5.1.2. Rating Chronic Exposure

For chemicals with chronic exposures the time period for assessment period is one week and will be based on the 8 hours time-weighted-average (TWA) exposure. The magnitude rating is assigned based on the ratio of the TWA to the 8-hour TWA limit. Refer to Table 5.

The TWA is calculated as follows:

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

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

8.5.1.3. Estimation of 8-hour Exposure Using Direct-reading Instruments

For a work unit exposed to a particular chemical at various job tasks, estimation of the 8-hour exposure may be determined by measuring the average concentration for each task (C) and the average duration (D) for each task exposure.

$$TWA = \frac{(D_1 \times C_1) + (D_2 \times C_2) + ... + (D_n \times C_n)}{D_1 + D_2 + \ldots + D_n} \qquad \text{---------- (4)}$$

Where n = tasks involving exposure to the assessed chemical

Table 5: Inhalation Exposure based on Airborne Exposure Measurement

Time-weighted average (TWA) or Maximum Concentration	Magnitude Rating
≥ 3 x O.E.L*	**5**
≥ O.E.L but < 3 x O.E.L	**4**
≥ 0.5 O.E.L. but < O.E.L	**3**
≥ 0.1 O.E.L, but < 0.5 O.E.L.	**2**
< 0.1 O.E.L	**1**

**Note that (a) OEL is used because the limit used is not only limited to the Malaysian Permissible Exposure Limits (PEL) as in the absence of a Malaysian PEL, other exposure limits may be adopted;*

(b) 3xPEL is the Maximum Exposure Limit under the USECHH Regulations 2000

A discussion on the Occupational Exposure Limit (OEL) is given in Appendix 9.

8.5.1.4. Rating Exposure Immediately Dangerous to Life or Health (IDLH)

An exposure magnitude of 5 is assigned when the potential exists for an exposure at a concentration level that is immediately dangerous to life and health, such as entry into confined spaces or other workplaces where workers would be expected to don self-contained breathing apparatuses to prevent acute exposure. An exposure is rated 1 when no reasonable potential exposure exists. The basis for this determination is professional judgement and/or exposure measurement.

8.5.1.5. 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 OEL' can be made which should not exceed unity.

For example, toluene and methyl ethyl ketone (MEK) are common solvents that act on the same target organ i.e. the central nervous system. OEL of toluene is 100 ppm and MEK is 200 ppm. If 50 ppm of toluene and 80 ppm of MEK are present in the workplace air, then

$$50/100 + 120/200 = 0.5 + 0.6 = 1.1 > 1,$$

Which means that the combined exposure is above the OEL. From Table 6 below, the Magnitude Rating assigned for exposure to the MEK and toluene exposure is 4.

Table 6: Magnitude of Exposure rating for additive effects

Magnitude Rating	Sum of ratios of air concentration to OEL
5	> 3
4	1 - 3
3	0.5 - 1
2	0.1 - 0.5
1	< 0.1

Examples on how to use the exposure measurement results to determine the magnitude of exposure are given in Appendix 10.

If a chemical hazardous to health do not have an OEL, then the qualitative assessment method for estimating exposure should be used.

8.5.2. Qualitative Estimation Of Magnitude Of Exposure

The estimation of exposure is made for the two main routes of entry, i.e. the inhalation route and dermal route of exposure. If the contribution to the overall exposure by ingestion is significant, record the finding and suggest appropriate actions to be taken. **The flowchart to determine exposure is given in Appendix 17.**

The magnitude of exposure is assessed based on the estimated absorbed dose through inhalation and skin absorption. It must be borne in mind that skin or eye absorption is not only from direct contact with liquid substances but also from airborne gas, vapour or particulate. Where this is the case, the airborne chemical concentration may be considered when assessing the degree of skin or eye exposure.

For this estimation we can look at the degree of chemical release or presence and the degree of chemical absorbed or likely to be absorbed at the exposure boundary. As a rule of thumb, twice the volumes of material released will double the concentration.

8.5.2.1. Degree Of Chemical Release Or Presence

The degree of chemical release or presence in the environment can be estimated from the chemical's physicochemical properties, the process characteristics, the quantity used, the method of handling, and the atmospheric conditions. This information may be obtained from the Chemical Safety Data Sheet, process descriptions, and from observation of environmental conditions. **Refer to Appendix 11 and 12.**

Use Table 7 to determine the degree of release or presence for inhalation exposure. The degree of release assigned will be based on the observation resulting in the greatest degree of release.

For example a worker frequently contaminated his clothing while using Chemical B, a non-volatile liquid (i.e. low release into the air) but is lipophilic (high ability to dissolve fat and hence able to be absorbed through the skin). The degree of release is assigned is Moderate.

Table 7: 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 capable of skin absorption or causing irritation or corrosion.
Moderate	Moderate release such as a) Solvents with medium drying time* in uncovered containers or exposed to work environment; b) Detectable odour **of chemicals with odour thresholds exceeding the PELs. Evidence of contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion.
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) Strong odour of chemicals with odour thresholds exceeding the PELs. Gross contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion.

***Refer to Appendix 14 **Refer Appendix 15**

8.5.2.2. Degree Of Chemical Absorbed Or Contacted

Use Table 8 below to assess the degree of chemicals being inhaled and absorbed through skin. Chemical substances with the ability to be absorbed through the skin include organic solvents and many pesticides. The degree of chemical absorbed or contacted should be based on the observation resulting in the greatest degree.

Table 8: Degree of Chemical absorbed or contacted

DEGREE	OBSERVATION / CONDITION
Low	Low breathing rate (light work)* Source far from breathing zone Contact with chemical other than those described under "Moderate" and "High". Small area of contact with chemicals capable of skin absorption - limited to palm (intact skin). <2% or 0.04m^2 No indication of any skin conditions. Intact/normal skin No contamination of skin or eyes
Moderate	Moderate breathing rate (moderate work)*. Source close to breathing zone Contact with eye or skin irritants, sensitisers or chemicals capable of skin penetration, except those described under 'High'. Moderate area of contact- one or both hands up to the elbows. Skin area >2% or 0.04m^2 Skin dryness and detectable skin condition. Dry, red skin
High	High breathing rate (heavy work)*. Source within breathing zone. Gross contamination of eye or skin with skin or eye irritants, sensitisers or chemicals capable of skin absorption -skin soaked or immersed in chemical capable of skin penetration. Area of contact not only confined to hands but also other parts of body. Skin area>50% or 1m^2 Follicle rich areas. Skin damaged. Severe drying, peeling and cracking.

***Refer to Appendix 16**

8.5.2.3. Assigning Magnitude Rating (MR)

This table is to be used to assign the magnitude rating:

Table 9: Magnitude Rating

Degree of release	Degree of absorption	MR
LOW	LOW MODERATE HIGH	1 2 3
MODERATE	LOW MODERATE HIGH	2 3 4
HIGH	LOW MODERATE HIGH	3 4 5

The magnitude (MR) above 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 or confirmed cases of occupational disease or illness. Use Table 10 below to modify the magnitude rating before assigning the exposure rating.

Table 10: Modifying Factors

MR adjustment factor	MODIFYING FACTORS
+ 1 (maximum MR not to exceed 5)	Bad work practice or poor personal hygiene including partaking of food or drink in the work area or using contaminated hand. Reported cases of chemical exposure incidences- e.g. splashes Results of biological monitoring exceeds the Biological Exposure Index (such as those described by the ACGIH) Widespread complaints of ill effects related to the chemical being exposed, in the work unit. Reported cases of employees with pre-clinical symptoms related to the chemical exposure. Susceptible persons in work unit

8.6. Assigned Exposure Rating

Based on the frequency or duration rating and the magnitude rating, an exposure rating may be assigned. Use Table 11 below to assign the exposure rating:

Table 11: Exposure Rating

		MAGNITUDE RATING (MR)				
		1	**2**	**3**	**4**	**5**
FREQUENCY RATING/ DURATION RATING	**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: Assign ER=5 if confirmed case(s) of occupational disease due to exposure to the chemical hazardous to health have been reported for the particular work unit.

Chapter 9

CONTROL MEASURES

Control measures are all the steps taken to prevent or minimise risks. They include elimination of the hazardous chemical; substitution of the chemicals hazardous to health with a less hazardous chemical; isolation of the process releasing hazardous chemical; the use of engineering control equipment; adoption of safe work practices and procedures; and the use of personal protection. Control equipment is equipment used for controlling risks, such as a local exhaust ventilation system, water spray or enclosure. In trying to control the identified risks, the measures taken should be in a certain hierarchy or order of priority and an assessment of the adequacy of the control measures need to be made.

9.1. Hierarchy of Control Measures

Significant risk arising from the use of chemical hazardous to health is to be controlled, in this following order: -

a) Elimination of chemical hazardous to health from the workplace;

b) Substitution of chemical hazardous to health with a less hazardous chemical;

c) Total enclosure of process and handling systems;

d) Isolation of the work to control the emission of chemicals hazardous to health;

e) Modification of the process parameters;

f) Application of engineering control equipment;

g) Adoption of safe work systems and practices that eliminate or minimise the risk to health; and

h) Provision of approved personal protective equipment.

a) Elimination of chemicals hazardous to health

This includes the total removal of a hazardous chemical by the use of other processes not involving chemicals hazardous to health.

b) Substitution

The substitution here is the substitution of a chemical hazardous to health with a less hazardous substitute such as the use of a water-based detergent instead of the neurotoxic n-hexane.

c) Total enclosure of process and handling systems

Totally enclosing the process and handling systems emitting chemical hazardous to health can prevent or minimise their release into the work environment.

d) Isolation of the work to control the emission of chemicals hazardous to health

This can be achieved by segregation, either by distance or a physical barrier, of the hazardous work, process or chemical hazardous to health from workers.

e) Modification of the process parameters

Such as the use of lower operating temperature or pressure to minimise the release of chemical hazardous to health into the workplace environment.

f) Application of engineering control equipment

This is control through the application of engineering control equipment such as local exhaust system, general ventilation, and water spray.

g) Adoption of safe work systems and procedures

Safe work system and procedures that eliminate or minimises the risk to health can be adopted.

h) Provision of personal protective equipment

Provision of personal protective equipment and clothing includes the proper selection, correct fit, proper use, care and maintenance, and available replacement when required.

9.2. Other Control Measures

Other measures although do not directly remove or minimise the risk, are equally important as they support or strengthen the above control measures and are part of a chemical health risk management.

Such measures include: -

a) Personal hygiene;
- Washing hands before partaking of food by hand
- Keeping fingernails short and clean
- Bathing, where contamination is widespread

b) Maintenance of the control equipment;
- Regular inspection, examination and testing
- Immediate repair on breakdown of equipment

c) Providing information, instruction and training to workers;
- Those handling or exposed to chemicals hazardous to health
- Safe use and handling of chemicals
- Proper use and care of personal protective equipment

d) Monitoring of personal exposures and general air levels
- Personal exposures on those work units where an assessment indicates the necessity to determine personal exposure; and the availability of an approved method of sampling and analysis and an OEL
- General air levels, where appropriate, to check on the effectiveness of control measures;

e) Health surveillance on those workers handling any chemicals hazardous to health listed in schedule 2 of the USECHH Regulations 2000 and where an assessment shows that:
- There is an identifiable work-related disease or adverse health effects for that hazardous chemical used in the work;
- It is likely that the disease or condition might occur during the conduct of the work; and
- Valid techniques are available to detect early signs of the disease or condition.

f) Emergency procedures and first aid.
- To minimise the consequences of chemical accidents
- Availability of emergency response plan or procedures
- Emergency eye wash and shower
- First aid facilities

9.3. Adequacy of Control Measures

The existing control measures need to be assessed whether they are adequate or not. Taking into consideration the following factors we can assess whether the control measures are adequate or not: -

a) Suitability;
b) Use
c) Effectiveness; and
d) Maintenance.

A control measure is considered adequate if

a) It is suitable for protecting the employees, taking into consideration the physical form and toxicity of the chemical, the nature of work, the routes of entry of the chemical and not prejudice to the health of the employees;

b) It is used according to the manufacturers' instructions & recommendations;

c) It is effective in preventing or minimising exposure; and

d) It is regularly maintained in good working condition.

9.3.1. Suitability

Suitability of control measures depends on:

i) ***The toxicity of chemical***

- For high toxicity chemicals 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 chemical hazard
- For personal protective equipment, the degree of protection must match the level of risk.

ii) ***The physical and chemical properties of the chemical***

- The control equipment is designed to control the chemical in the physical form employees is exposed to.
  E.g. use of dust mask is not suitable to protect against organic solvent vapour.

iii) ***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.

iv) ***Adaptability***

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

v) ***Route of entry***

- Control measures selected prevent entry of the chemical through the probable entry route.

9.3.2. Use and Effectiveness

By observing the following, the effectiveness of control measures can be assessed:

i) ***In general***

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

ii) ***For local exhaust ventilation system (LEV)***

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

iii) ***For personal protective equipment***

- Use of correct type with adequate degree of protection;
- Properly worn - have undergone instruction or training session and
- Correctly fitted - have been carefully chosen and fit tested;
- Worn continuously at the designated work area - with constant supervision ; and
- Equipment still functioning properly - not defective or damaged or has not expired its shelf life

9.3.3. Maintenance

Maintenance of control equipment is an important aspect in ensuring that the health risks are continuously under control. This would entail the following: -

i) ***For 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.

ii) ***For personal protective equipment***

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

Chapter 10

CONCLUDING THE ASSESSMENT

10.1. Evaluation of Risk

Chapters 6 and 8 have described the procedures to estimate the values of hazard rating (HR) and exposure rating (ER), respectively. These values are used to compute the risk based on equation (3) below: -

$$RR = \sqrt{(HR \times ER)} \quad \text{----------} \quad (3)$$

When the square root is not a whole number, the next highest whole number is designated as the risk rating.

Example: HR = 3; ER = 4;

$\therefore$ RR $= \sqrt{(3 \times 4)}$

$= 3.46$

Thus assigned RR $= 4$

A fast and easy way to compute the risk rating is to use the risk matrix. Refer **Table 12.**

10.2. Significance of Risk

Risk is evaluated as either "significant" or "not significant". Risk is regarded as not significant if it is unlikely that the work exposure will adversely affect the health of the workers. This situation arises when either there is no likelihood of exposure or the chemical is least hazardous (HR=1) or the exposure is very low (ER=1).
Another situation is that the chemical is of low toxicity (HR=2) and the exposure level is below 0.5 PEL (i.e. ER=2). This situation is considered as presenting a non-significant risk. Hence those risk situations where RR is either 1 or 2 is considered as not significant.

Table 12 below summarises the decision for the risk evaluated.

To prioritise action to control risk is by using the risk matrix below. For each work unit, enter the name of the chemical in the appropriate cell.

Table 12: RISK MATRIX

		EXPOSURE RATING (ER)				
		1	2	3	4	5
HAZARD RATING	1	RR=1	RR=2	RR=2	RR=2	RR=3
	2	RR=2	RR=2	RR=3	RR=3	RR=4
	3	RR=2	RR=3	RR=3	RR=4	RR=4
	4	RR=2	RR=3	RR=4	RR=4	RR=5
	5	RR=3	RR=4	RR=4	RR=5	RR=5

RISK NOT SIGNIFICANT

RISK SIGNIFICANT

Category 1

Category 2

The above risk matrix may be used to identify and prioritise control strategies. Priority in implementing control measures will depend on the degree of risk, the number of person at risk, and the practicability of the control measures.

For the purpose of prioritising action to control risks, two categories can be assigned under significant risk:

Category 1

Risks to be controlled to below the permissible exposure limits or to as low as reasonably practicable (ALARP) where no limits are specified. Under the Occupational Safety and Health Act 1994, practicable means practicable after taking into considerations:

a) the severity of the risk;
b) the state of knowledge about the risk and the availability and suitability of ways of removing or mitigating the risk; and
c) the cost of removing or mitigating the risk.

Action to control risks under category 1 is considered to be of lower priority than controlling those risks under category 2.

Use **Form E** to summarise the risk conclusion for each chemical found in the work unit.

Category 2

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

For example,

A work unit J exposed to chemical Y with hazard rating of 5 and exposure rating of 1 (i.e. risk rating of 3). Another work unit K is exposed to chemical Z with hazard rating of 3 and exposure rating of 5 risk rating of 4.

This shows that the control strategies for J would be based on elimination of chemical Y, possibly by substituting Y with a less hazardous chemical (i.e. low hazard rating) so that the risk now will be not significant.
For K, the control strategies will be based on the reduction of exposures to a level where the exposure rating is 1.

10.3. Conclusions of CHRA

Based on the risk decision and the assessment of existing control measures there are 4 conclusions that could be reached from the assessment. These conclusions are denoted by C1, C2, C3, C4 or C5.

C1: Risks not significant now and not likely to increase in future

If the assessment shows that a hazardous chemical is: -

- Already controlled or can be readily controlled in accordance with the CSDS; and
- There is not a significant risk to health

then the assessment is complete. The likely conclusion is that the risks are not significant now and not likely to increase in future.

C2: Risk significant but already adequately controlled could increase in future.

This conclusion applies to conditions where adverse health effects could increase in future, due to control measures failure or deterioration. Risks, while at present adequately controlled, could increase in future due to, for example: -

- Undetected deterioration in the efficiency of control measures;
- Plant, equipment (including personal protective equipment) or system failure;
- Control measures not used properly;
- Human error, from lack of awareness, monitoring failure or inadequate training;
- Changes in methods or rate of work;
- A significant increase in the quantity of chemicals hazardous to health used.

C3: Risks significant now, and not adequately controlled

This conclusion applies to conditions where workers are at risk of adverse health effects since their exposure to the hazardous chemical is not adequately controlled.

C4: Uncertain about Risk: Insufficient information

This conclusion is arrived at if there is insufficient information to determine the degree of hazard.

C5: Uncertain about Risk: Uncertain about degree and extent of exposure

This conclusion is arrived at if the level of exposure cannot be estimated with confidence.

The conclusion of the assessment, taking into considerations the significance of risk and the adequacy of control measures, is summarised in Table 13 below:

Table 13: Conclusion of Assessment.

RISK DECISION	ADEQUACY OF CONTROL MEASURES	CONCLUSION
Risk Not Significant	-	C1
Risk Significant	Adequate	C2
	Not Adequate	C3
Insufficient Information	-	C4
Uncertain about exposure	-	C5

Chapter 11

ACTIONS TO BE TAKEN

The actions to be taken are based on the risk decision obtained at the end of the assessment. These actions include:

a) Taking appropriate measures to control overexposures;
b) Measures to eliminate the risk if the risk is intolerable;
c) Ending assessment and setting new date for reassessment or review of assessment;
d) Determining whether monitoring of exposures and health surveillance is necessary;
e) Planning out long term strategies to control exposure to as low as reasonably practicable;
f) Obtaining information or specialist advice on certain issues; and
g) Maintaining control equipment in good working order by implementing preventive maintenance programme.

11.1. Actions to be taken

For risk decision C1 the actions required are:

- End current assessment; and
- Review assessment every five years or when there is a change in circumstances or as directed by DOSH.

For risk decision C2 the actions required are:

- Determine precautions to maintain controls and minimise chances of higher exposure occurring;
- Determine additional measures for regaining control if a high-risk event occurs, despite precautions;
- Identify measures, procedures and equipment to prevent or control any accidental emission of chemical hazardous to health;
- Determine if monitoring or health surveillance is required to check on effectiveness of controls; and
- Review assessment every five years or when there is a change in circumstances or as directed by DOSH.

For risk decision C3 the actions required are:

- Identify and implement immediate measures and procedures for preventing or controlling exposure;
- Identify measures, procedures and equipment to prevent or control any accidental emission of chemical hazardous to health;
- Establish the need to stop the process;
- Begin review of longer terms control requirements;
- Re-evaluate exposure when the upgraded control measures are in place;
- Determine if monitoring or health surveillance is required;
- Determine if training and retraining of employees is required
- Review assessment every five years or when there is a change in circumstances or as directed by DOSH.

For risk decision C4 the actions required are:

- Obtain additional information. Obtain specialist advice if necessary;
- Meanwhile, implement good work practices to minimise exposure.

For risk decision C5 the actions required are:

- Conduct a more detailed assessment. Obtain specialist advice if necessary;
- Meanwhile, implement good work practices to minimise exposure.

11.2. Specific Actions to be Taken

Apart from the general line of action to be taken under 11.1 exposure to these chemical substances warrant special attention and action: -

a) Chemicals with 'sk' notation;
b) Carcinogens, respiratory sensitisers; and
c) Situations likely to cause immediate danger to life or property

11.2.1. Chemicals with 'sk' notation

Skin exposure needs control regardless of absorbed dose. Skin contact is to be prevented or minimised by the use of suitable personal protective equipment or clothing.

11.2.2. Carcinogens, respiratory sensitisers

Exposures to carcinogens or respiratory sensitisers are to be avoided or controlled to as low as is reasonably practicable. Respiratory protection to be made mandatory irrespective of absorbed dose or airborne concentration. For detailed actions for exposure to carcinogens, please refer to the "Guidelines for the Control of Chemicals Hazardous to Health".

11.2.1 Immediate danger to life or property

Under regulation 12(2) of USECHH Regulations 2000 the assessment must inform the employer immediately about the immediate danger arising from the place of work, plant, or process; or arising from the use of chemicals.

11.3. Necessity for Employee Exposure Monitoring Programme

Monitoring is to be conducted on employees exposed to chemicals hazardous to health listed in Schedule II of the USECHH Regulations 2000 and where an assessment shows that

- It is required to ensure that the employees exposure levels are maintained below the Permissible Exposure Limits; or
- It is requisite for ensuring the maintenance of adequate control of the employees to chemicals hazardous to health; and
- There is an approved method of sampling and analysis for the chemical hazardous to health

A hygiene technician who is registered with the Department of Occupational Safety and Health must conduct monitoring of exposure in order to comply with the law.

Therefore in recommending an employee exposure-monitoring programme, the identity of the chemical hazardous to health, the perceived exposure level, the availability of an occupational exposure standard and the availability of an approved method of sampling and analysis are to be considered.

11.4. Necessity for Health Surveillance Programme

Health surveillance programme is to be conducted on those workers handling any scheduled chemical (Schedule II to the USECHH Regulations 2000) and where an assessment shows that:

- There is an identifiable work-related disease or adverse health effects for that hazardous chemical used in the work;
- It is likely that the disease or condition might occur during the conduct of the work; and
- Valid techniques are available to detect early signs of the disease or condition.

A registered occupational health doctor must conduct medical surveillance, which form part of the health surveillance programme.

11.5. Necessity for Employee Training & Retraining

Training is necessary for those employees who are exposed or are likely to be exposed to chemicals hazardous to health. These include:

- Workers who may be exposed to a chemical hazardous to health
- Supervisors of workers at risk from exposure to a chemical hazardous to health
- Members of a safety and health committee
- Workers responsible for the purchasing of a chemical hazardous to health
- Those who have direct involvement in fire or other emergency action

The training provided is to enable them to know, as a minimum:
(a) The risk to health created by such exposure; and
(b) The precautions that should be taken.

The scope of training should include

- Legislative requirements
  - General duties of employer, chemical suppliers, and employees
  - Purpose and basic requirements for health surveillance
- Information on chemical hazardous to health
  - Recognise and interpret CSDS and labels
  - Ability to use chemical register and access the CSDS
  - Understanding of any work practice or procedure to be followed in the use of chemical hazardous to health
  - Understanding of control measure to be used in the workplace
- Personal safety
  - Understanding of routes of entry
  - Risks presented by chemical hazardous to health
  - Methods used to control risks
  - Precautions taken for a particular risk
  - Correct use, fit and maintenance of personal protective equipment and clothing
- Emergency procedures
  - Procedures to be followed in an emergency
  - First aid or incident reporting procedures to be followed in case of injury or illness

Retraining of employees should be carried out

- At least once a year
- Each time there is a change in
  - Information provided on a CSDS
  - Any hazard information available
  - A control measure
- Each time a worker is assigned to:
  - A new task; or
  - A new work area.

Chapter 12

REPORT WRITING

The assessor shall communicate the result of the assessment to the employer in the form of a report containing the following information:

Executive Summary

- One page summary of the purpose, main activities, findings and conclusions.

Background

Introduction

- Description of work site, processes carried out and workers
- Summary of previous assessments and findings

Assessment Methods

- Describe the assessment methodology

Findings

- Results of hazard determination for the chemicals used/exposed to
- Results of exposure assessment
- Adequacy of existing control measures
- Risk decisions

Conclusions

Discussion of findings

- Discuss factors that contribute to the significant health risks

Action to be taken

- List down the actions to be taken by the employer in accordance with The Occupational Safety and Health (Use and Standard Exposure of Chemicals Hazardous to Health) Regulations 2000Recommendations to minimize the health risks of workers to chemicals

Assessor's Particulars

- Name and DOSH Registration Reference
- Location and Date of Assessment

Appendices

- Forms A, B, C, D, E and F
- Machines lay-out and the location of the workers selected for assessment
- Process flow-chart
- Other relevant information

Chapter 13

REVIEW ASSESSMENT

Review of an assessment is necessary to check whether the risk situation has changed or there is a need to change the control strategies or alter exposure parameters. A review is to be carried out when

a) There has been a significant change in the work to which the assessment relates;
b) More than five years have elapsed since the last assessment; or
c) Directed by the Director General, Deputy Director General or the Director of Occupational Safety and Health.

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; or
- Increasing or decreasing utilisation of chemicals hazardous to health used; or
- Changes in the methods or rate of work; or
- Deterioration in the efficiency of control equipment; or
- Plant failure or system failure; or
- New information on the hazards of the chemical becomes available; or
- New or improved control measures become practicable.

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APPENDIX 1

ROUTES OF ENTRY

In industry inhalation is the most significant route of entry. 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 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 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 expectorated 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 expectorated. Particles smaller than 0.5 µm and gases remain airborne and are exhaled out.

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. Absorption through the skin is another important route of chemical entry, especially for chemicals that are lipid soluble such as pesticides. These chemical penetrated the intact skin and get into the blood stream. 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.

Penetration of organophosphates and carbamate insecticides through human skin:

Site	*Penetration potential
Forearm	1
Palm of hand	1
Dorsum of hand	2
Abdomen	2
Follicle-rich sites (e.g. scalp, forehead, angle of jaw)	4
Intergenious axilla	4 -7
Scrotum	almost complete

**Using the forearm as a frame of reference, i.e. penetration potential of 1*

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 2

HEALTH EFFECTS

Acute & Chronic Effects

Acute effects are effects that are caused by short periods of exposure (e.g. seconds or minutes) to high concentrations of a substance. An example of acute effect is carbon monoxide poisoning where a brief exposure to a high concentration of carbon monoxide causes asphyxiation.

Chronic effects or long-term effects are effects that resulted from repeated or prolonged exposure (continuing day after day or week after week), typically involving relatively low levels of a substance. An example of chronic effect is silicosis, where prolonged exposure over a number of years to crystalline silica causes fibrosis of the lungs.

Local & Systemic Effects

A local effect is one that occurs at the site of first contact with the chemical. An example is the corrosive action (chemical burn) on the skin caused by an acid spillage. Irritation of the eyes, skin or the respiratory system is another example of local effect.

A systemic effect occurs at a site distant from the initial point of contact, and takes place after a chemical has been absorbed into the body. An example is lead that enters the body either by inhalation of dust of fumes or by ingestion. It is then absorbed into the blood where it exerts its effect by interfering in the production of haemoglobin in red blood cells. Chronic lead poisoning may result in a reduced ability of the blood to distribute oxygen throughout the body, a condition known as anaemia.

Immediate & Delayed Effects

Immediate effects are toxic effects that develop soon after exposure occurs. An example is narcosis due to the inhalation of a high concentration of toluene vapour.

Delayed effects are effects occurring some time after exposure has taken place. An example is mesothelioma, a lung cancer that occurs many years after first exposure to asbestos fibres.

Target Organs

The target organ of target tissue is the organ or tissue where adverse effect occurs. This differs from chemical to chemical as different chemical substance may affect different organs in the body in different ways. The reason for this may be the tendency of a particular to accumulate in a specific tissue or organ. Cadmium, for example, can accumulate in the kidneys and, with repeated exposure can cause kidney failure. For some chemical substance there may be more than one target organ. For example, exposure to inorganic mercury compounds can lead to renal toxicity and central nervous system toxicity.

Reversible and Irreversible Effects

Reversible effects are effects that subside once exposure ceases. An example is the irritation or the eyes, skin and respiratory tract, resulting from exposure to chlorine gas. These effects recede once exposure ceases.

Irreversible effects are effects that remain following the cessation of exposure, and may even progress. Cancer is a typical example of an irreversible effect. n-Hexane is a chemical that demonstrates both reversible and irreversible effects, depending on the level and duration of exposure. Repeated exposure to n-hexane can cause peripheral neuropathy (disease of the peripheral nerves), an irreversible effect. Acute exposure to n-hexane can lead to narcosis, due to a repressive effect on the central nervous system.

Some Specific Effects

Carcinogenicity is a multistage process whereby exposure to a substance results in genetic damage within a cell, leading ultimately to uncontrolled proliferation of cells and the induction of tumour. Benzene is a carcinogen in that it causes leukaemia in exposed workers.

Mutagenicity refers to a permanent change in the genetic material of a cell, which may be passes to the next generation of cells. If a substance causes mutations in the genetic materials of germ cells (reproductive cells, including sperm or ova), the genetic damage may be passed to offspring. If a substance causes mutations in somatic cells (non-reproductive cells in the body), this could provide the basis for the development of cancer.

Teratogenicity is the process that induces the formation of developmental abnormalities in a foetus. Known teratogens include the drug thalidomide, ethyl glycol, and dimethyl formamide.

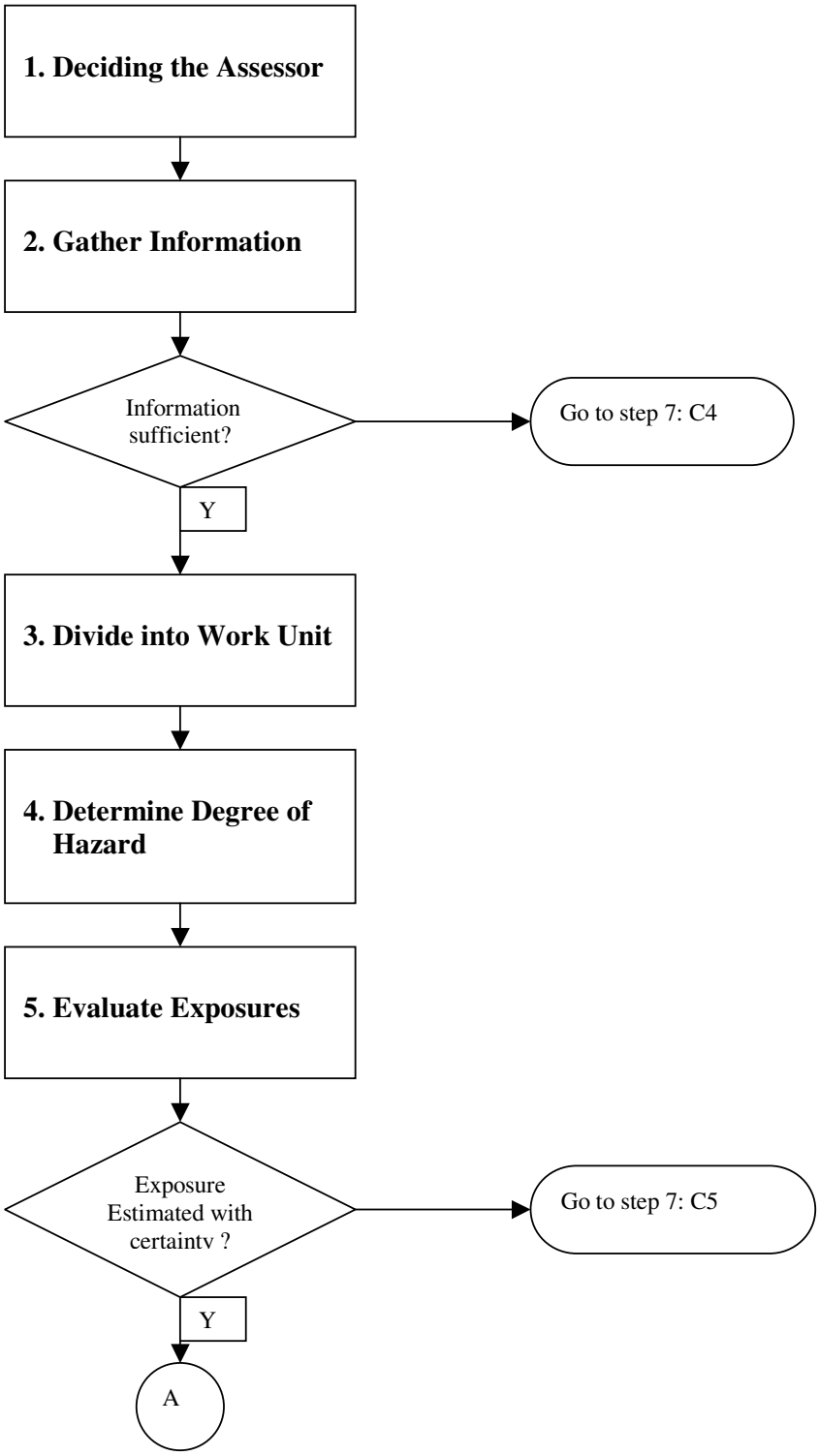
Sensitisation or allergic reaction is the immunological reaction of the body to the presence of a particular substance called allergen. Sensitisation may appear after repeated contact with an allergen. Once sensitisation has been induced, even low doses can provoke a reaction.

- Skin sensitisers are substances that induce an immunologically mediated skin reaction in certain individuals as a result of skin contact. Chromium compounds (trivalent and hexavalent compounds) is an example of a skin allergen or sensitiser.

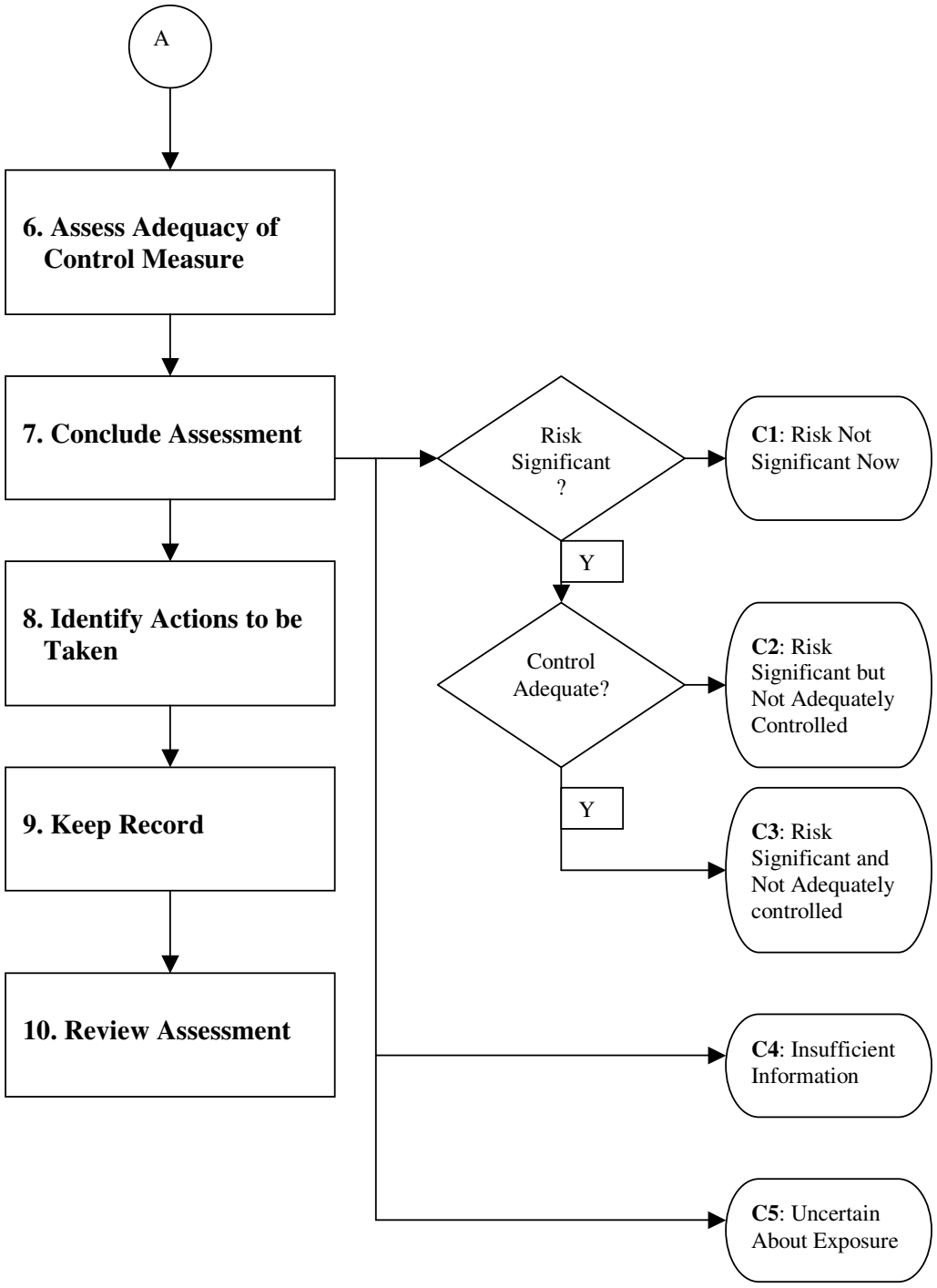
- Respiratory sensitisers (or asthmagens) are substances that induce a state of specific airway hyper-responsiveness in particular individuals. The mechanism involved in respiratory sensitisation may be immunological or irritant. Toluene diisocyanate is an example of a respiratory sensitiser that can cause occupational asthma to exposed person.

APPENDIX 3 -1

PROCEDURE FOR CHEMICAL HEALTH RISK ASSESSMENT



APPENDIX 3-2


A
6. Assess Adequacy of Control Measure
7. Conclude Assessment
8. Identify Actions to be Taken
9. Keep Record
10. Review Assessment
Risk Significant ?
Y
Control Adequate?
Y
C1: Risk Not Significant Now
C2: Risk Significant but Not Adequately Controlled
C3: Risk Significant and Not Adequately controlled
C4: Insufficient Information
C5: Uncertain About Exposure

APPENDIX 4

REGISTRATION AS AN ASSESSOR

General

Any person wishing to be registered, as an Assessor or a Hygiene Technician or an Occupational Health Doctor must fulfil the following requirements:

a) be a Malaysian citizen; or if a foreign resident, must hold a valid Malaysian working permit;
b) must not be less than twenty-one (21) years of age at the time of submitting application;
c) is a healthy person of good character;
d) has not been found guilty for any act or omission which amounts to professional negligence as a professional engineer or a medical practitioner;
e) has not been convicted of an offence under the Act or regulations made there under; and
f) has not been convicted of an offence under any law and sentenced to more than one year imprisonment or a fine of more than two thousand Malaysian ringgit.

Qualification & Training

A person applying to be registered with the Director General as an Assessor, in addition to the requirements of the above paragraph, must at least: -

a) be a *certified industrial hygienist* as recognised by the American Board of Industrial Hygiene or by any other accredited certification body recognised by DOSH;

OR

b)
(i) possess a *degree or postgraduate diploma* in occupational safety and health; occupational safety; occupational health; or industrial/occupational hygiene recognised* by the Government of Malaysia;
(ii) has a minimum of one (1) year practice in occupational safety and health; and
(iii) has conducted a chemical health risk assessment **or** has successfully attended the course for assessor on chemical health risk assessment conducted by NIOSH or by any training provider recognised by DOSH

OR

c)
(i) possess a *degree* in medicine, engineering, physics, chemistry, biochemistry, ergonomics or natural and applied sciences, recognised* by the Government of Malaysia; and
(ii) has a minimum of three (3) years practice in occupational safety and health; and
(iii) has conducted a chemical health risk assessment **or** has successfully attended the course for assessor on chemical health risk assessment conducted by NIOSH or by any training provider recognised by DOSH;

OR

d) (i) possess a *diploma* in engineering, physics, chemistry, biochemistry, ergonomics or natural and applied sciences recognised* by the Government of Malaysia; and

(ii) has a minimum of five (5) years practice in occupational safety and health;

(iii) has conducted a chemical health risk assessment **or** has successfully attended the course for assessor on chemical health risk assessment conducted by NIOSH or by any training provider recognised by DOSH;

OR

e) (i) possess the *Higher School Certificate / Sijil Tinggi Persekolahan Malaysia (STPM) , a Polytechnic certificate* or equivalent with at least a credit in chemistry at the Malaysian Certificate of Education (MCE) / the Sijil Persekolahan Malaysia (SPM) level;

(ii) has a minimum of seven (7) years practice in occupational safety and health;

(iii) has successfully attended the course for assessor on chemical health risk assessment conducted by NIOSH or by any training provider recognised by DOSH; and

(iv) has passed the examination for assessors conducted by NIOSH.

OR

f) (i) a registered safety and health officer;

(ii) has a minimum of ten (10) years practice in occupational safety and health;

(iii) has successfully attended the course for assessor on chemical health risk assessment conducted by NIOSH or by any training provider recognised by DOSH; and

(iv) has passed the examination for assessors conducted by NIOSH.

* However for those with qualifications not recognised by the Government of Malaysia they may be registered on condition that they, in addition to the respective conditions under paragraphs b), c) or d) had passed the examination for assessor conducted by NIOSH.

SUMMARY REPORT OF A CHEMICAL HEALTH RISK ASSESSMENT **APPENDIX 4b**

Name and Address of Company Assessed: ……

…….

Date of Assessment : ……..

Work Area/ Department	Work Unit	No. Workers in Work Unit	Chemicals hazardous to health in Work Unit	Assessment Conclusions	Recommendations

I hereby declare that the particulars in this report are accurate to the best of my knowledge.

Name:. ……. (Signature of Assessor)
Address:……
Registration No. : …… Date:
F5

APPENDIX 5

FORMAT OF THE CHEMICAL REGISTER

Disediakan oleh (nama dan tandatangan) : ….…… ***Tarikh disediakan:*** ___/ ___/ ____

Jawatan: ……..……..

DAFTAR BAHAN KIMIA MEMBAHAYAKAN KESIHATAN

A. MAKLUMAT TEMPAT KERJA

Nama dan Alamat Tempat Kerja: _____

_____ Poskod: _____

No. Telefon: _____ No. Fax: _____ No. Pendaftaran JKKP (*jika ada*): _____ Jumlah Pekerja: Lelaki _____ Perempuan: _____

B. MAKLUMAT BAHAN KIMIA MEMBAHAYAKAN KESIHATAN

Bilangan bahan kimia digunakan ☐ Bilangan bahan kimia yang dihasilkan ☐ Bilangan sisa bahan kimia yang dihasilkan ☐

C. SENARAI BAHAN KIMIA MEMBAHAYAKAN KESIHATAN

Bil.	Nama Bahan/ Produk	Nama Kimia/ Ramuan Aktif	Jenis *	CSDS **	Lokasi Kimia Digunakan/ Dihasilkan	Kuantiti ***			Nama dan Alamat Pembekal	No. CAS ****	Kelas #
						Penggunaan	Keluaran	Penstoran			

Nota:

* Jenis: **B** = Bahan keluaran sampingan **O** = Bahan selainnya P = Produk R = Bahan mentah **W**= Bahan buangan

** CSDS: Kewujudan Risalah Keselamatan Bahan Kimia; Tandakan **(Y)** jika ada; dan **(N)** jika tiada

*** Kuantiti: Nyatakan sama ada purata setahun atau sebulan

**** No. CAS: Nombor bahan kimia seperti yang didaftar dengan *'Chemical Abstract Service'* di Amerika Syarikat

\# Kelas: Pengelasan bahan kimia menurut Peraturan-Peraturan Keselamatan dan Kesihatan Pekerjaan (Pengelasan, Pembungkusan dan Perlabelan Bahan Kimia Berbahaya), 1997.

APPENDIX 6

CSDS REQUIREMENTS UNDER CPL REGULATIONS 1997

The duty to furnish an up-to-date CSDS for each hazardous chemical is on the supplier as stipulated under Regulation 9(1) of the Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997 [P.U. (A) 143], hereinafter referred to as the Regulations. A supplier is a person who supplies chemicals and includes a formulator, a manufacturer, an importer or a distributor.

The information that a supplier should provide on the CSDS is stipulated in Regulation 9(2) of the Regulations and consists of the following:

(a) The chemical product itself including the trade or common name of the chemical and the company identification with details of the supplier ;
(b) The composition of the ingredients that clearly identifies the hazardous chemical for the purpose of conducting a hazard evaluation;
(c) Hazard identification;
(d) First-aid measures;
(e) Fire-fighting measures;
(f) Accidental release measures
(g) Handling and storage;
(h) Exposure controls and personal protection (including possible methods of monitoring workplace exposure);
(i) Physical and chemical properties;
(j) Stability and reactivity;
(k) Toxicological information (including the potential routes of entry into the body and the possibility of synergism with other chemicals or hazards encountered at work);
(l) Ecological information;
(m) Disposal information;
(n) Transport information; and
(o) Date of preparation of the Chemical Safety Data Sheet.

The regulations also require that the supplier reviews and revises the CSDS whenever there are new information on the particular hazardous chemical.

APPENDIX 7

HAZARD RATING DETERMINATION & EXPOSURE

Example 1:

Preparation Z contains 20% benzene, 50% xylene, and 30% non-hazardous ingredients. This preparation has been categorised as carcinogenic (R45 (1)), toxic (R48, R23/24/25), harmful (R20/21), and irritant (R38). By referring to Table 2, preparation Z is reclassified for assessment purposes as below:

Group 1:	**Carcinogenic-R45 (1)**	**(HR=5)**
	Toxic-R48	(HR=4)
	Toxic-R23/24/25	(HR=4)
	Harmful-R20/21	(HR=3)
Group 2:	**Skin** irritant-R38	(HR=2)

Therefore

a) Hazard rating for preparation X is 5 based on its carcinogenic effect.
b) The exposure assessment necessary is on ALL routes of exposure since the chemical may be hazardous through any routes of entry or contact
c) Assign 'sk' notation due to skin irritant.

Example 2:

Preparation Y contains 45% sulphuric acid and 55% non-hazardous ingredients. This preparation has been classified as corrosive (R35). Referring to Table 2 Y is classified:

Group 2:	**Corrosive-R35**	**(HR=4)**

Therefore

a) Hazard rating for preparation Y is 4 (corrosive to skin & eyes).
a) The exposure assessment necessary is only for skin & eye contact.
b) Assign 'sk' notation since corrosive to eyes or skin.

Example 3:

A chemical preparation containing 30% xylene and 70% non-hazardous ingredients. This preparation has been determined to be harmful by inhalation and in contact with skin (R20/21) and irritating to skin (R38). Referring to Table 2, this preparation is reclassified for assessment as follows:

Group 1:	**Harmful-R20/21**	**(HR=3)**
Group 2:	**Skin** irritant-R38	(HR=2)

Therefore

a) Hazard rating for preparation is 3 (harmful through inhalation & skin contact)
b) The exposure assessment necessary is for inhalation & skin contact
c) Assign 'sk' notation.

APPENDIX 8

Sampling Strategy

Objective of Strategy

The objective of the sampling strategy is to reduce the variation in the sampling results so that a reliable estimate can be made of the time- weighted average exposure concentration.

Variations in Results

Estimates of occupational exposure averages are affected by a number of factors. Error in sampling can broadly be categorised as random error and systematic error.

Random errors cannot be prevented but can be accounted for statistically. Typical random errors are:

-random sampling device errors (as random fluctuations in pump flow rate)
-random analytical method errors (as random fluctuations in a chemical laboratory procedure)
-random intraday (within day) environmental fluctuations in a contaminant's concentration.
-random interday (between days) environmental fluctuations in a contaminants concentration

Systematic errors are errors cannot be accounted for statistically but can be prevented. These errors include:

-systematic errors in the measurement (improper calibration, improper use of equipment, erroneous recording of data, etc.) and
-systematic changes in a contaminant's airborne concentration (as due to the employee moving to a different exposure concentration or shutting off an exhaust fan)

Sampler Deployment

The deployment of samplers will depend on the purpose of sampling, whether concerning contaminant emissions or concerning contaminant exposures. For assessing emissions, the device is located at a fixed point and for assessing exposure, the sampler is placed within the breathing zone of the exposed worker.

Basically there is two type of sampling:

a) area sampling- located at fixed points in the vicinity of contaminant sources; and
b) personal sampling - attached to workers with the sampling head within the breathing zone.

The breathing zone is an ill-defined atmospheric region extending outwards from the face and chest within which it is assumed that the concentration of the contaminant is identical with that in which air actually enters the nose. In order to overcome the practical difficulties associated with measurement at the entrance to the nose, it is common practice to locate the sampler at an unspecified distance in front of the face or by attaching it at the worker's shirt collar or lapel.
(Although the commonest site is the lapel, studies have shown that sampler mounted at that location is capable of producing a result anywhere from one half to twice the actual exposure concentration).

Number and duration of samples

The results of exposure sampling are intended for eventual comparison with some form of hygiene standard such as Occupational Exposure Limits of Threshold Limit Values. These standards have been developed usually from dose-effect relationships where the dose is the estimated body burden of the contaminant accumulated over a short time for a substance producing acute effects or over a long period for a substance giving rise to chronic effects. In order to predict the biological effects of exposure to a fast acting contaminant, it is necessary to sample for brief periods of time so as to detect the transient concentration peaks. Conversely if the airborne substance only produces its effects in the long term after a build-up of a large body burden, then a series of measurements of atmospheric concentrations carried out over an extended time period will be appropriate.

The possible sampling systems are listed below in descending order of accuracy in estimating exposure:

a) Full period consecutive samples
- Obtaining several samples, whether equal or unequal time duration, obtained during the entire period appropriate to standard (e.g. 8 hours)

b) Full period single sample
- Involves taking of a single sample for full period of standard. It has the advantage of less analytical cost. This system is practical in situation where the dust concentration is low.

c) Partial period consecutive samples
-One or several samples, whether equal or unequal time duration are
Obtained for only a portion of the period appropriate to the standard.
This portion of the period should cover at least 70 to 80% of the full period.

d) Grab samples
-Samples taken over some number of short periods of time (less than 1 hour each-generally only minutes to seconds). These samples are taken at random intervals over the period of time for which the standard is defined.

Who to sample ?

The purpose is to get the highest exposure from a group of workers doing a similar job at the same work area. The highest exposed worker may be determined from observation of the workplace. These factors may be considered when selecting the highest risk worker:

a) nearness to source;
b) duration and frequency of exposure;
c) nature of work or work practice; and
d) availability of control measures

If it is not possible to identify the most exposed worker to be sampled due to the homogeneity of the exposure, then a random selection workers need to be carried out such that a least one of the randomly selected worker for sampling will represent the high exposure subgroup.

In random selection, the following steps are adopted:

a) a list of workers is prepared,;
b) number the worker consecutively 1,2,3, … ,***n*** ;
c) determine the sample size ***N*** from a statistical table to obtain a high probability of sampling a high risk employee (e.g. sample size for top 20% and confidence level of 95% given below)
d) randomly select the ***N*** workers by using a table of random numbers (or other generated random numbers) by selecting an arbitrary starting point, and from there, list the first ***N*** different integers between 1 and ***n***.

Table : Sample size for top 20% and confidence 0.95

Size of group	7-8	9-11	12-14	15-18	19-26	27-43	44-50	50-∝
Required no. of measured worker (***N***)	6	7	8	9	10	11	12	14

Air Sampling Procedures

The procedure for air sampling can be divided into 3 stages:

a) preparation
b) taking samples
c) analyse sample

Preparation

Preparation for monitoring of airborne contaminant is the crucial stage in deciding the best strategy to be adopted. It starts with the preliminary inspection and ends when samples are collected. Steps in the preparatory stage are:

- preliminary inspection is carried out to identify the air contaminants to be sampled and the high risk workers for exposure monitoring
- look up air sampling method (e.g. NIOSH Methods) to determine the instruments to be used; the appropriate sampling media; the pump flow rate; the number of samples to be prepared based on the minimum and maximum sample volume recommended; the number of blanks; and the sample handling and transport requirements
- discharging and charging of pump batteries
- calibration of pumps to desired flow rate
- preparation of sampling media
- e.g. filters to be conditioned inside the weighing room before initial weighing
- packing of sampling media
- check availability of monitoring forms, whirling hygrometer and other equipment

Taking samples

Taking samples involve various activities from the assembling of sampling instruments to the transportation of samples for chemical analysis. The steps involved are:

- assemble sampling instruments
- assemble selected workers & record their particular
- brief them on the purpose of monitoring & the do's and don'ts
- mount the sampling device on to the workers
- start pump & record start time
- during monitoring,
- check pump flow rate & condition of sampling device & sample
- measure & record the wet and dry bulb temperatures & the record weather conditions
- observe work routines and practices
- observe availability and effectiveness of control measures
- at the end of sampling period,
- collect the samples and packed properly so as not to dislodge particulate or escape of contaminant during handling & transportation of sample
- check pump flow rate - final flow rate to be within ± 10% of the initial flow rate
- sent sample for analysis

Analyse sample

Analysing of samples includes the chemical analysis and the determination of the sample concentration.

- for gravimetric analysis, condition the filter first before weighing
- determine the amount of sample collected
- determine the volume of air sampled (flow rate X sampling duration)
- determine contaminant concentration
- blanks correction

APPENDIX 9

OCCUPATIONAL EXPOSURE LIMITS

In Malaysia the occupational exposure limits (OEL) are termed 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.

There are three types of PEL found in the Regulations:

- TWA limit
  -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
  -a fifteen-minute time-weighted average airborne concentration that is defined as three times the TWA

Where a PEL is not available for a chemical substance, the assessor may use other OEL such as the Threshold Limit Values (TLV) published by the American Conference of Governmental Industrial Hygienists (ACGIH).

The OEL for a liquid mixtures 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.

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. This adjustment is by multiplying the OEL with the following factor (Brief and Scala, 1975):

$$\frac{8}{H} \times \left\lceil \frac{24 - H}{16} \right\rceil$$

where H is the number of hours worked.

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 continuous 24-hour exposure, work periods of less than 7-8 hours per day or 35 hours per week or for concentration-dependent acute toxicant.

APPENDIX 10

QUANTITATIVE DETERMINATION OF INHALATION EXPOSURE MAGNITUDE FROM AIRBORNE MEASUREMENT RESULT.

Example 1: Measurements from Direct Reading Instruments (e.g. MIRAN 1BX)- Similar exposures during each task

A worker is exposed to toluene once a day for a five-day working week. The average duration of exposure to toluene is about 3.5 hours per day. Measurement using direct reading equipment showed that the average concentration of toluene is 350 ppm (PEL = 200 ppm).

Computation: TWA concentration $= \frac{(3.5 \times 350) + (4.5 \times 0)}{8}$

$= \underline{153 \text{ ppm (or 0.8 PEL)}}$

Example 2: Integrated Sampling – Partial Period Consecutive Samples

A worker is exposed to asbestos fibres. 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 exposure is 1 fibre/ml)?

What is his degree of exposure assuming
a) similar exposure for the unmeasured time period?
b) zero exposure for the unmeasured time period?

Computation:

a) Similar exposure:

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

$= \underline{1.2 \text{ fibre/ml (or 1.2PEL)}}$

b) Zero exposure:

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

$= \frac{519}{480}$

$= \underline{1.08 \text{ fibre/ml (or 1.08PEL)}}$

APPENDIX 11

Estimation of Exposures

The qualitative estimation of exposure is based on an exposure model that consists essentially 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.

APPENDIX 12

FACTORS AFFECTING INHALATION EXPOSURE

The intensity or magnitude of exposure at the route of entry can be estimated by looking at the various parameters that contributes toward the accumulation or build-up of the chemical substance assessed at the boundaries of exposure (e.g. breathing zone for inhalation exposure).

DEGREE OF RELEASE

a) Contaminant Release Rate
- physical form of chemical, size and density
  - whether gas, vapour ,airborne particulate – gas & vapour more easily to be released to environment
- volatility & evaporation rate
  - ❖ more volatile (high vapour pressure & low boiling point) more easily vapour will be released into the air
  - ❖ high evaporation rate means faster release

b) Quantity Used or Handled
- quantity used or handled
  - ❖ more used, more will be generated

c) Air Contamination
- contamination of surrounding air, clothing or work surfaces
  - ❖ presence in air (visually, odour, sensation)
  - ❖ contamination of work clothing or on work surfaces
- type of release
  - ❖ hot or cold process – hot process usually high releases
  - ❖ batch or continuous process- batch process usually higher releases

d) In Vicinity of Source
- closeness to source
  - ❖ source/contamination within or outside breathing zone
  - ❖ direct handling

e) In 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 RECEPTION OR RETENTION

The degree of chemical reception and reception 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
  - ❖ carrying out light, moderate or heavy work

c) Contaminated Clothing & Surfaces
- degree of contamination

d) Workers Awareness
- information, instruction & training

e) Personal Hygiene
- cleanliness of face & hands

APPENDIX 13

FACTORS AFFECTING DERMAL EXPOSURE

The potential for skin or eye absorption is influenced by the following factors

- chemical characteristics
  - ❖ the higher the fat solubility the higher is the skin penetrability
  - ❖ the higher the molecular weight the slower is the absorption rate
  - ❖ chemical with 'skin' notation means that it can be easily absorbed through the skin

- condition of the skin
  - ❖ whether healthy, dry, cracked, scarred, damaged

- the surface area of contact
  - ❖ the larger the contact area the higher is the degree of chemical absorption or injury

- the site of contact
  - ❖ certain parts of the body are more penetrable than others, e.g. follicle-rich sites

The potential for skin/eye contact is influenced by these factors:

- concentration of chemical in solution or in air
  - ❖ higher concentration of the chemical in solution or in air, the higher is damage potential

- nature of contact
  - ❖ direct or indirect

- work practices
  - ❖ good or bad practices affect the degree of skin/eye contact

APPENDIX 14

SOLVENT DRYING TIME

SOLVENT	Dry Time Relation	Degree of Drying
Ethyl Ether C.P	1.0	
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	Fast
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	
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	Medium
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	
Monochlor Benzol	10.0	
Tertiary Butyl Alcohol	11.9	
Sec. Butyl Alcohol	14.0	

SOLVENT	Dry Time Relation	Degree of Drying
Sec. Amyl Acetate	16.9	
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	Slow
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	
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	Nil
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 15

ODOUR LEVEL THRESHOLDS

	**TLV (ppm)	*OT (ppm)	OT/TLV
Acetaldehyde	c25	0.5	0.02
Acetic acid (glacial)	10	2.0	0.2
Acetone	750	2.0	0.003
Acrolein	0.1	2.0	20
Acrylonitrile	2	20.0	10
Allyl alcohol	2	2.0	1
Ammonia	25	20.0	0.8
Aniline	2	1.0	0.5
Arsine	0.05	0.5	10
Benzene	10	2.0	0.2
Butane	800	5000	6.25
2-Butanone (MEK)	200	5.0	0.025
n-Butyl Acetate	150	10.0	0.07
Carbon disulphide	10	0.1	0.01
Carbon tetrachloride	5	70.0	14
Chlorine	0.5	3.0	6
Chloroform	10	100.0	10
Cyclohexane	300	300.0	1
Dioxane	25	150.0	6
Ethyl Acetate	400	10.0	0.025
Ethyl alcohol	1000	5.0	0.005
Ethyl ether	400	1.0	0.0025
Ethylene oxide	1	1.0	1
Formaldehyde	c0.3	1.0	3.3
Hexone (MIBK)	50	0.5	0.01
Hydrogen chloride	c5	10.0	2
Hydrogen cyanide	c4.7	1.0	0.2
Hydrogen selenide	0.05	0.5	10
Hydrogen sulphide	10	0.0002	0.00002
Isopropyl alcohol (IPA)	400	50.0	0.125
Methyl alcohol	200	10.0	0.05
Methyl methacrylate	100	0.2	0.002
Methylene chloride	50	200.0	4
Nitrobenzene	1	0.005	0.005
Nitrogen dioxide	3	1.0	0.3
Perchloroethylene (tetrachloroethene)	25	5.0	0.2
Phenol	5	0.3	0.06
Phosgene	0.1	0.5	5
Phosphine	0.3	0.02	0.07
Pyridine	5	0.01	0.002
Stibine	0.1	0.05	0.5
Styrene, monomer	50	0.05	0.001
Toluene	50	2.0	0.04
Toluene-2,4-diisocyanate	0.005	0.2	40
Trichloroethylene (TCE)	50	20.0	0.4
Vinyl toluene	50	25.0	0.5
Xylene	100	0.5	0.005

* Odour threshold (Ref.: Fundamentals of Industrial Hygiene)
** Threhold limit values (Ref.: TLV s and BEIs -ACGIH Handbook)

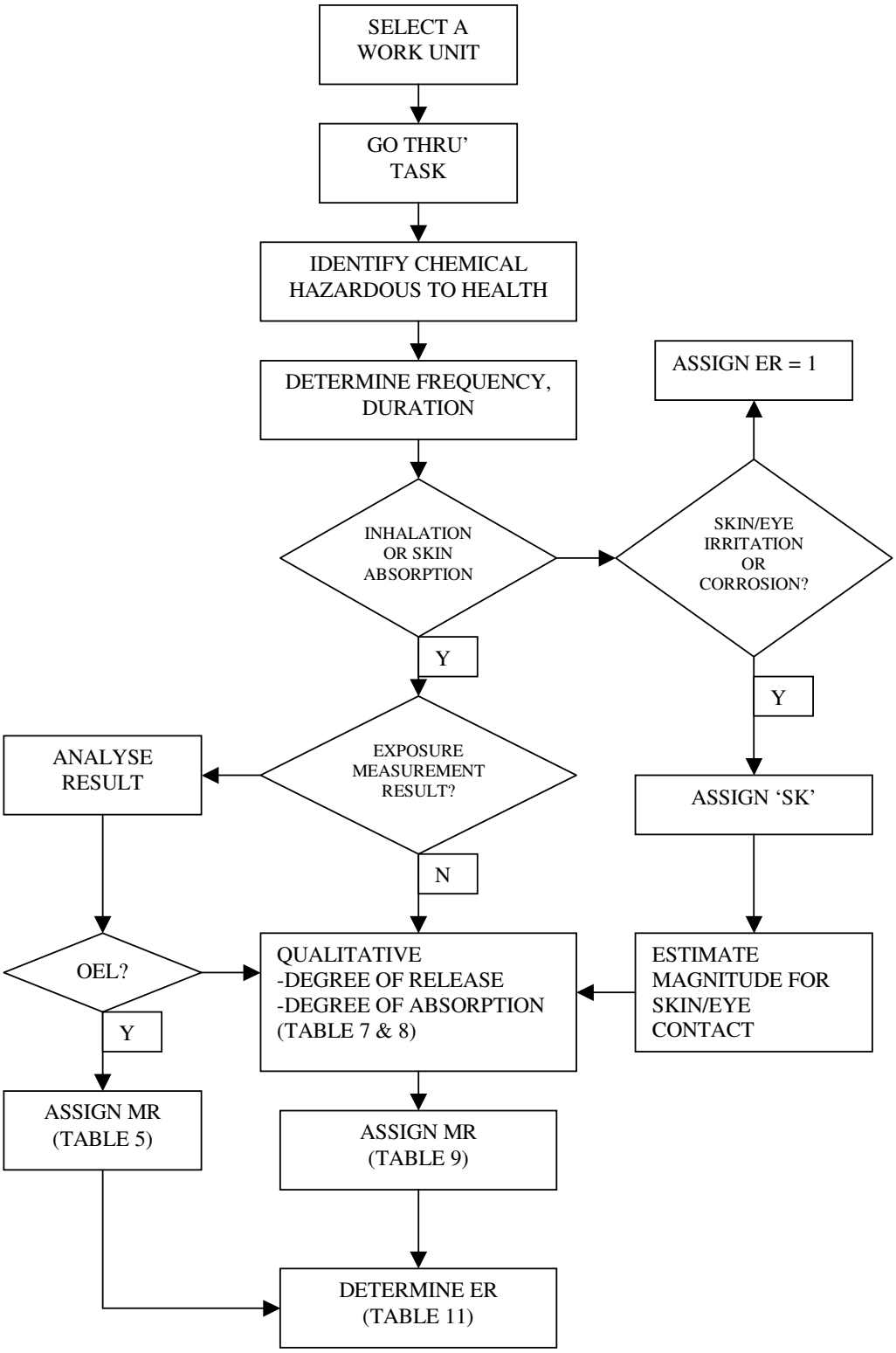
APPENDIX 16

DEGREE OF PHYSICAL ACTIVITIES & 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. playing organ, driving car in traffic) 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	Medium
Heavy Work	
Intermittent heavy lifting, pushing or pulling (E.g. pick and shovel work) Hardest sustained work	High

APPENDIX 17

PROCEDURE FOR ESTIMATING DEGREE OF EXPOSURE



FORM A: LIST OF CHEMICALS

WORK UNIT: _____

No.	Name of Chemical & Indicator ingredient	Physical form	Source of Information	Classification of hazard	Risk Phrases	Skin notation ?	Hazard Rating

CHEMICAL MOVEMENT Include the storage, movement, handling and use, transportation and disposal

FORM B: WORK UNIT DESCRIPTION

WORK UNIT: _____

1.WORK AREA				7.EMPLOYEE HEALTH FEEDBACKS Describe any ill-effects experienced by employees
2.JOB TITLE				
3.NUMBER OF EMPLOYEE (attach list of employees as appendix)				8.REPORT ON HEALTH EFFECTS Summarise cases of health effects reported to employer
Male:		Female:		
4.CATEGORY OF WORKERS IN WORK UNIT (TICK)				9.WORKERS WITH SUSCEPTIBLE CONDITIONS Describe conditions
Production workers		Maintenance workers		
Supervisors & managers		Cleaners		
Office workers		Storekeeper		10.POSSIBILITY OF ABNORMAL EXPOSURES Other than during normal work or operation
Contractors on site		R&D workers		
Visitors/students/ inspector		Forklift/Truck driver		11.POSSIBILITY OF MIXED EXPOSURES Presence of other chemicals affecting the same system/organ
Others		Crane operator		
5.WORKING HOURS				12.POSSIBILITY OF INGESTION EXPOSURE Describe exposure situations
From:		To:		
Work Arrangements (tick): Normal ☐ Shift work ☐				13.OTHER COMMENTS
6.BRIEF PROCESS DESCRIPTION				

FORM C: WORKPLACE ASSESSMENT

WORK UNIT (JOB):					**ASSESSMENT TEAM:**					**DATE:**	
WORK AREAS:					PERSONNEL:						
Chemical Hazardous To Health	Task	Frequency Duration	Routes Of Entry	Existing Controls	Suitable & Effective ***Yes/No***	Maint. Testing & Exam.	Adequate? ***Yes / No***	Degree Chemical Release	Degree Contact/ Inhale	MR	ER
COMMENTS:											
APPROVED BY/NAME:			**SIGNATURE:**			**DATE:**					

FORM D: WORKPLACE ASSESSMENT RESULT

WORK UNIT (JOB):				**ASSESSMENT TEAM:**			**DATE:**
WORK AREAS:				PERSONNEL:			
CHEMICAL HAZARDOUS TO HEALTH:	HAZARD RATING	TASK	ROUTES OF EXPOSURE	RISK DECISION	CONTROL ADEQUACY YES/NO	CONCLUSION	ACTION TO BE TAKEN
COMMENTS:							
APPROVED BY/NAME:			**SIGNATURE:**			**DATE:**	

FORM E: RISK MATRIX

		EXPOSURE RATINGS				
		1	**2**	**3**	**4**	**5**
HAZARD RATINGS	**1**	RISK NOT SIGNIFICANT				
	2			RISK SIGNIFICANT – CATEGORY 1		
	3					
	4					
	5					RISK SIGNIFICANT- CATEGORY 2

FORM F: ACTIONS TO BE TAKEN

WORK UNIT:	EXISTING MEASURES	ACTIONS TO BE TAKEN
1.TECHNICAL MEASURES (Comment on whether the control was appropriate and adequate) 1.1.Elimination/Substitution		
1.2.Isolation/Enclosures		
1.3.Ventilation		
1.4.Work practice/ System of work		
1.5.Personal protection		
2.MAINTENANCE OF CONTROL EQUIPMENT (Whether maintenance was appropriate & adequate)		
3.MONITORING OF AIR CONTAMINANT (Provide summary and attach details as appendix. Whether monitoring was appropriate & adequate)		
4.BIOLOGICAL MONITORING (Provide summary and attach details as appendix. Whether monitoring was appropriate & adequate)		
5.HEALTH SURVEILLANCE (Summarise the conclusions, and attach details as an appendix if appropriate)		
6.INFO, INSTRUCTION & TRAINING (Describe existing training procedures for work unit)		
7. EMERGENCY & FIRST AID PROCEDURES (Describe existing procedure)		
SUMMARY OF PREVIOUS ASSESSMENT DONE ON WORK UNIT		
ASSESSMENT DATE(S)	PREVIOUS:	CURRENT: / NEXT:
NAME OF ASSESSOR (S)		
NRIC No		
JKKP Registration Number		
Signature		
ACKNOWLEDGEMENT OF RECEIPT BY EMPLOYER (Name, IC No., Signature & Date)	I hereby declare that the assessor has briefed me on the report.	