

# Application of Chemical Health Risk Assessment (CHRA) in an Industry

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**Abstract-** Occupational Safety and Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulation 2000 requires Chemical Health Risk Assessment (CHRA) to be carried out at all work places where chemical been produced, processed, used, stored, transported, disposed and treated. An employer shall not carry out any work which may expose or is likely to expose any chemical hazardous to health unless he has made written assessment of risks created by the chemical to the health of the employees from adverse health effect due to exposure to the chemicals used at work places. This paper describes how CHRA was conducted in an industry and how to determine the degree of hazard and exposures evaluation in order to identify the risk rating. This CHRA was practiced at a metal company located in Nilai, Negeri Sembilan.

**Keywords-** Chemical Health Risk Assessment, Degree of Hazard and Exposures Evaluation

## I. 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 of 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 procedures and protocol for conducting an assessment, hereinafter referred to as chemical health risk assessment or in short CHRA.

## II. OBJECTIVE

This paper is mainly developed to study how CHRA was being conducted in industry and how to determine the degree of hazard and exposures evaluation in order to identify the risk rating. The CHRA from metal company located in Negeri Sembilan has been selected for studied.

## III. PURPOSES OF CONDUCTING CHRA

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:

1. To identify the hazards posed by each chemical substance used, stored, handled or transported within the place of work
2. To evaluate the degree of exposure of employees to the chemicals hazardous to health, either through inhalation, skin absorption or ingestion
3. To evaluate the adequacy of existing control measures
4. To conclude on the significance of the health risk posed by the chemicals hazardous to health
5. To recommend further appropriate control measures to prevent or reduce risks

## IV. PROCEDURE OF CHRA

### A. Deciding the assessor

The appointed assessor must have the knowledge and basic scale in doing the assessment. He/She must be given the authority to do the work and should have enough resources to gather information consult the appropriate people, review record and examined the workplace. 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. The assessment for that company has been conducted by M. Jayabala Muniandi, CHRA Registration No: JKPP IH 127/171-2 (180).

### B. Gather information

The assessment begins with the gathering of the following information:

1. Chemical hazardous to health used or released in the workplace

2. Employees at risk
3. Control equipment design parameter and maintenance
4. Monitoring record

*C. Divide into work unit*

In the evaluation of exposure to a particular chemical, the worker expose to the risk should be identified and they should be assigned work unit for evaluation based on similar risk. A work unit is a group of workers having similar potential for exposure to the same chemical hazardous to health. There are eleven work units assessed at that metal company. The table 5.1 shows the work unit assessed and the respective normal working hours. From this table, one work unit has randomly selected to be studied in detail which is B, milling operator.

Table 5.1: Work unit assessed and the respective normal working hours

	WORKUNIT	SHIFT	WORKING HOURS
A	Metal cutting operator	1	8.00am to 5.30pm
B	Milling operator	2	8.00am to 5.30pm 10.15am to 7.30pm
C	Straightening operator	2	8.00am to 5.30pm 10.15am to 7.30pm
D	Brazing operator	1	8.00am to 5.30pm
E	Grinding operator	2	8.00am to 5.30pm 10.15am to 7.30pm
F	Maintenance operator	1	8.00am to 5.30pm
G	Sand blasting operator	1	8.00am to 5.30pm
H	Colour check operator	1	8.00am to 5.30pm
I	Taping operator	1	8.00am to 5.30pm
J	Diamond grinding operator	2	8.00am to 5.30pm 10.15am to 7.30pm
K	Quality control operator	1	8.00am to 5.30pm
L	Packing operator	1	8.00am to 5.30pm

*D. Determine degree of hazard*

The hazard rating is used to prioritize hazard based on the potential health effect of the chemical. The hazard 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. A complete Chemical Safety Data Sheet (CSDS) provides useful information such as the hazard description, the toxicity data, and the risk phrases. Based on these data, the hazard of each chemical can be evaluated and assigned a hazard rating. The procedure to assign the hazard rating to the chemical is as follows:

1. Get information on the hazard categories, hazard classification and risk phrases for the chemical substance or preparation.

2. Use Table 5.2 to get hazard rating based on the health effect description or use Table 5.3 to get hazard rating based on the hazard classification or hazard categories or risk phrases.
3. Assign a single hazard rating based on the greatest degree of hazard from the tables

For the CHRA at the company, Table 5.3 was used as a reference based on the risk phrases obtained from the CSDS.

Table 5.2: 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, 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: Cause severe burn) *Toxic chemicals:- -LD50: 25-200mg/kg(oral) -LD50: 50-400 mg/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 sensitizers *Irritant-serious eye damage *Harmful chemicals:- -LD50: 200-500mg/kg(oral) -LD50: 400-2000 mg/kg(skin) -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 sensitizers *Skin irritants
1	No known adverse health effects	Not classified as hazardous effects

Table 5.3: Hazard Rating Based on Risk Phrases

EFFECT	ACUTE/ CHRONIC	ROUTES OF EXPOSURE					H R
		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		Inhalation	Skin	Eyes	Ingestion	All Routes	

E. Evaluate exposure

The purpose is to assess the potential of the chemical hazardous to health, entering the body through the various route of entry or potential for contact with their eyes, skin, or the respiratory. Estimation of the degree of exposure is primarily based on these parameters:

1. Frequency of exposure (F)

The frequency of exposure is determined as the frequency of exposure has a significant effect on the degree of exposure. Frequency rating is used and determined from Table 5.4

Table 5.4: 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 time per year

2. Duration of exposure (D)

The total exposure duration is the product of the number of exposures and the average duration for each exposure.

Table 5.5: Duration rating

RATING	TOTAL DURATION OF EXPOSURE	
	% WORK HOUR	DURATION PER 8-HR SHIFT OR 40-HR WEEK
5	>87.5%	>7 hrs/shift or >35 hrs/week
4	50-87.5%	4-7 hrs/shift or 20-35hrs/week
3	25-50%	2-4 hrs/shift or 10-20 hrs/week
2	12.5-25%	1-2 hrs/shift or 5-10 hrs/week
1	<12.5%	<1 hr/shift or <5hrs/week

3. Magnitude of exposure (M)

Magnitude of exposure rating is assigned based on degree of chemical release or presence and degree of chemical absorb or contact.

Table 5.6: 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

Table 5.7: Degree of chemical absorbs or contact

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 <sup>2</sup> 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, sensitizers or chemicals capable of skin penetration, except those described under “High” Moderate area of contact- one or both hands up to elbows. Skin area >2% or 0.04m <sup>2</sup> 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, sensitizers 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 >5% or 1 m <sup>2</sup> Follicle rich areas Skin damaged Severe drying, peeling and cracking

Table 5.8: Magnitude rating

DEGREE OF RELEASE	DEGREE OF ABSORPTION	MR
LOW	LOW	1
	MODERATE	2
	HIGH	3
MODERATE	LOW	2
	MODERATE	3
	HIGH	4
HIGH	LOW	3
	MODERATE	4
	HIGH	5

Based on the frequency on duration rating the magnitude rating, an exposure rating may be assigned.

Table 5.9: Exposure rating

		MAGNITUDE RATING (MR)				
		1	2	3	4	5
FREQUENCY RATING/ DURATION	1	1	2	2	2	2
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

F. Control measures

Control measures are all the steps taken to prevent or minimize risk. In trying to control the identified risk, the measures taken should be in order of priority and an assessment of the adequacy of the control measures need to be met. The existing control measures need to be assessed whether they are adequate or not. By observing the following the effectiveness of control measures can be assessed:

1. In general
  - Minimal contamination of the air, work clothing or work surfaces, irritating sensation
  - Minimal or no-release or emission of chemical into the working environment
  - Minimal or no exposure or contact of workers to chemical
2. For local exhaust ventilation system
  - No accumulation of substances 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
  - The positioning of hood is such that it is very close to or enclosing the source
3. For personal protective equipment
  - Use of correct type with adequate degree of protection
  - Properly worn- have undergone instruction or training session
  - Correctly fitted – have been carefully chosen and fit tested
  - Worn continuously at the designated work area with constant supervision
  - Equipment still functioning properly

G. Concluding the assessment

Risk is evaluated as either “significant” or “not significant”. Risk rating can be calculated from the following equation:

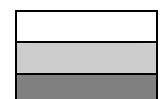
$$RR = \sqrt{(HR \times ER)}$$

Or it can compute by using the risk matrix

Table 5.10: 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  
Risk Significant – Category 2



Based on the risk decision and the assessment of existing control measures, conclusion that could be reaching from the assessment are denoted by C1, C2, C3, C4, or C5.

Table 5.11: Conclusion of risk

C1	Risks not significant and not likely to increase in future <ul style="list-style-type: none"> <li>• There is no significant health risk</li> <li>• Already controlled</li> </ul>
C2	Risks significant and already adequately controlled could increase in future <ul style="list-style-type: none"> <li>• Adverse health effect could increase in future due to control measures failure or deterioration</li> </ul>
C3	Risks significant now and not adequately controlled <ul style="list-style-type: none"> <li>• Workers are at risk of adverse health effects since their exposure to the hazardous chemicals not adequately controlled</li> </ul>
C4	Uncertain about risk: Insufficient information <ul style="list-style-type: none"> <li>• Insufficient information to determine the hazard</li> </ul>
C5	Uncertain about risk: Uncertain about degree and extend of exposure <ul style="list-style-type: none"> <li>• Exposure level cannot be estimated with confidence</li> </ul>

#### IV. RESULTS AND FINDING

##### A. Hazard rating and exposure rating determination

Table 6.1: Hazard rating and exposure rating determination for milling operator

NO	NAME OF CHEMICAL	RISK PHRASE	SKIN NOTATION	HAZARD RATING	EXPOSURE RATING
B1	Coolubric A160 (Lubricus)	R43	sk	2	3
B2	Hyspin AWS 68 (Castrol)	R43	sk	2	2
B3	Mobile Gear 626	R43	sk	2	2
B4	Rustillo DWX 32 (Castrol)	R20/22		3	3
B5	WD40	R36/37/38	sk	3	2

From the CSDS, chemical B1, B2 and B3 is sensitizing to skin. For chemical B4, it is harmful through inhalation and ingestion. Chemical B5 are irritants to inhalation and to skin and eyes. From Table 5.3, the hazard ratings are as follows:

- B1, B2, B3 – HR 2
- B4, B5 – HR 3

Since this chemical with sk notation, it is mandatory to control the skin or eyes contact of these chemicals. The exposure

assessment based on the qualitative observation at the work unit during assessment. There was evidence of chemical contamination of workplace, workers clothing and detectable odour of the chemical. Frequency of exposure (Table 5.4) to chemical B1 and B4 were rated 5 and B2 and B3 were rated 4 and B5 were rated 3. Degrees of chemical release (Table 5.6) and chemical contact (Table 5.7), or inhale are low for all the chemicals. So, from table 5.8, the magnitude rating for all the chemicals is 1. Based on the frequency of exposure and the magnitude rating, the exposure rate for chemicals B1, B2, B3, B5 were rated 2 and for B4 the exposure rate is 3. Workers were found using goggles, cotton gloves, and safety shoes while at work.

##### B. Significant of risk and control measure

From Table 5.10, the risk ratings were determined as follows:

- B1, B4, B5 – RR3
- B2, B3 – RR2

##### C. Conclusion of CHRA

Based on the risk decision and the assessment on the existing control measures, these are the conclusion derives for milling operators

Table 6.2: Conclusions of CHRA for chemical used by milling operators

NO	CHEMICAL HAZARDOUS TO HEALTH	CONTROL ADEQUACY	CONCLUSION	CONTROL MEASURE
B1	Coolubric A160 (Lubricus)	No	C3	<b>Monitoring</b> To monitor for oil mist exposure for this work unit.  <b>Personal protective equipment</b> To provide and ensure workers using chemical glove and goggle whenever handling/ directly exposed to the chemicals. To keep record on ppe issuance and maintenance To ensure training, enforcement and
B2	Hyspin AWS 68 (Castrol)		C1	

B3	Mobil gear 626		C1	supervision by line supervisor  <b>Administrative control</b> To develop safe work instruction on the handling of chemicals at work area including emergency response method.
B4	Rustilo DWX 32 (Castrol)	No	C3	To ensure workers are given instruction and information on the chemicals they use at workplace. To ensure CSDS for all available in Malay and English language at work area.
B5	WD 40	No	C3	To include arrangement on chemical spillage and chemical splash including providing eyewash/ shower near the work area.

	operator	adequately controlled (C3)
K	Quality control operator	Risks significant now and not adequately controlled (C3)
L	Packing operator	Risks significant now and not adequately controlled (C3)

## V. CONCLUSION

CHRA is compulsory for any company that expose to the chemical substances in their workplace due to provide the safe and health working environment. By this assessment the hazards posed by chemical substances, degree of exposure and adequacy of existing control measures can be identified. From these three parameters, the preventive action can be recommended in order to reduce the risk.

CHRA has been conducted at Hardmetal Knives Sdn Bhd by following these 7 main procedures:

1. Deciding the assessor
2. Gathering information
3. Divide into work unit
4. Determine degree of hazards
5. Evaluate exposures
6. Assess adequacy of control measure
7. Conclude assessment

Determining the degree of hazard and evaluate exposures in order to identify the risk rating was done by referring to the Table 1, Table 2, Table 3, Table 4, Table 7, Table 8, Table 9, Table 11, and Table 12 that are stated in the manual of recommended practice 2nd edition for Assessment of the Health Risk Arising from the Use of Hazardous Chemicals in the Workplace (Department of Occupational Safety and Health Ministry of Human Resources Malaysia 2000)

From table of conclusion of CHRA for chemical used by each work unit, the finding can be concluded as Table 6.3 below.

Table 6.3: Conclusion of CHRA for each work unit

	WORKUNIT	CONCLUSION
A	Metal cutting operator	Risks are not significant and not likely to increase in future (C1)
B	Milling operator	Risks significant now and not adequately controlled (C3)
C	Straightening operator	Risks significant now and not adequately controlled (C3)
D	Brazing operator	Risks significant now and not adequately controlled (C3)
E	Grinding operator	Risks significant and already adequately controlled could increase in future
F	Maintenance operator	Risks significant now and not adequately controlled (C3)
G	Sand blasting operator	Risks significant now and not adequately controlled (C3)
H	Colour check operator	Risks significant now and not adequately controlled (C3)
I	Taping operator	Risks are not significant and not likely to increase in future (C1)
J	Diamond grinding	Risks significant now and not

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