Health Risk Assessment

Guideline document

Table of Contents

Index of Tables

Index of Figures

1 INTRODUCTION TO HEALTH RISK ASSESSMENT

Occupational Health is a preventive discipline, dedicated to reducing the likelihood of adverse events leading to injuries, illness or material losses. Central to this is the science of Risk Assessment. This is at the core of Occupational Health, from which every subsequent action is derived.

Health Risk Assessment is the systematic examination of activities and processes in the workplace, to determine the probability of harmful events, and the extent of the potential damage. This evaluation comprises a careful evaluation of the level of probability that an adverse event may occur, and the potential consequence(s) of the event.

There are many ways in which risk assessments can be performed. This guideline will cover the key concepts, so that the reader can use this information to develop his/her own style. After the key concepts, the guideline will provide a suggested approach to implementing a health risk assessment program.

The reader must gain the following understanding:

- The full meaning of the terms “Hazard”, “Exposure” and “Risk”.
- How Hazards and Exposures are allocated scores to enable the calculation of Risk.
- How Risk is calculated and ranked in order of priority
- What broad interventions are available for controlling risk?

2 DEFINITIONS

1. **The term “HAZARD”** refers to the workplace circumstances that have a capacity to do harm.

   The hazards each have inherent degrees of “harmfulness”, “consequences”, or “toxicities”, which are determined by the inherent characteristics of the hazards.

2. **The term “EXPOSURE”** refers to the degree to which there is contact with hazards. The degree of exposure is determined by duration, frequency, and intensity of the concentration of the exposure. It is determined by estimation (“professional judgement”) or by direct measurement (occupational hygiene surveys).

3. **The term “RISK”** refers to the probability of harmful events, and the extent of the potential damage. There is only a Risk where there is an Exposure to a Hazard. Hence the risk is directly proportional to:

   - the Harmfulness of the Hazard
   - the degree of Exposure to the Hazard

   Hence:

   RISK = HAZARD X EXPOSURE
   or

RISK = HARMFULNESS X EXPOSURE

4. **The term "IMPACT"** refers to the types of consequences that potentially occur as a result of exposure to hazards. Besides the risks of injury and illness, the consequences of excessive exposures to hazardous workplace environments include property or asset damage, direct financial losses and industrial relations problems. The risks of litigation from non-employees (the public, customers, etc.) should also be borne in mind. Broadly, these are grouped as follows:

- The degree of human injury or illness that could occur
- The degree of environmental damage that could occur
- The degree of financial loss (material damage, business down-time)
- The degree of negative public perception is caused by the incident

3 MORE ABOUT HAZARDS & HARMFULNESS

The main forms of hazard of interest to occupational health programmes are listed in Appendix 1.

Broadly, these are grouped as follows:

- Health Hazards, being those hazards that are capable of causing occupational diseases
- Safety Hazards, being those hazards that are capable of causing accidents & injury.

Table 1: Summary List of Types of Hazard

• Health Hazards, which include: ○ Hazardous Agents: (Chemical, Biological, and Physical) ○ Health Hazards related to Workplace Conditions: (Ergonomic, Psychosocial)	SUITABLE FOR MEDICAL SURVEILLANCE
• Safety Hazards, which include: ○ Worker Capability:	
○ Mechanical (work equipment): ○ Fire & Explosion: ○ Gravity: ○ Environmental: ○ Electricity: ○ Behavioural: ○ Miscellaneous	NOT SUITABLE FOR MEDICAL SURVEILLANCE

The degrees of Harmfulness are expressed as follows: (low, medium, high, etc). In order to make it possible to calculate the risks posed by hazards, these terms have to be converted to numbers – or "Harmfulness Scores". This is done as follows:

Table 2: The relationship between the harmfulness scores and their meaning

SCORE	MEANING (ABILITY TO CAUSE INJURY)	MEANING (ABILITY TO CAUSE ILLNESS)
VERY LOW (1)	Minor Injuries (Medical Treatment, no lost time)	Reversible Mild/transient Health Effects
LOW (2)	Minor Injuries (Lost Time)	Reversible Significant Health Effects
MEDIUM (3)	Single Major Injury (Hospitalised) or Multiple Disabling Injuries	Irreversible Significant Health Effects
HIGH (4)	Multiple Major Injuries or Disabilities or Single Fatality	Life-threatening illness
VERY HIGH (5)	Multiple Fatalities	Multiple Fatalities

These general rules are sometimes not specific enough to classify the harmfulness of hazards. For instance, what about chemicals that can cause asthma, cancer or burns? What about hazardous biological agents that can cause life-threatening diseases? The next two sections cover these issues.

3.1 How do we score the harmfulness of chemicals?

Determining the toxicity of chemicals, and allocating them to harmfulness scores can be quite complicated. Unfortunately, it is an essential part of the Health Risk Assessment, and is required in order to calculate the risks to employees.

This is done using "Control Bands". This is a term used internationally, to describe the categories of toxicity of chemicals. They are called "Control Bands" because they require a particular type of **Control** (such as general ventilation, or containment) across the category, or **Band**.

The tables below list the key characteristics of chemicals that are used to determine their Control Band. Note that toxicity is broadly divided into Acute Toxicity and Chronic Toxicity. Different aspects of toxicity apply to acute versus chronic toxicity. (eg. Asbestos dust has a low degree of acute toxicity, but a very high degree of chronic toxicity)

For BOTH tables, the highest score from the sub-components is carried forward as the Control Band.

Table 3: Scoring short-term ("acute") Toxicity.

Scores ⇨	1 (Low)	2 (Med)	3 (High)	4 (Very High)	5 (Extreme)
HAZARD PROPERTY	CONTROL BAND 1 (OEL ≥ 1000 µg/m³)	CONTROL BAND 2 (OEL ≥ 100 µg/m³)	CONTROL BAND 3 (OEL ≥ 10 µg/m³)	CONTROL BAND 4 (OEL ≥ 1 µg/m³)	CONTROL BAND 5 (OEL < 1 µg/m³)

Table 3: Scoring short-term ("acute") Toxicity.

Scores ⇨	1 (Low)	2 (Med)	3 (High)	4 (Very High)	5 (Extreme)
IRRITANT	Transient or no eye, skin & respiratory irritation.	Mild eye, skin & respiratory irritation.	Moderate eye, skin & respiratory burns.	Serious eye, skin & respiratory burns. Corrosive.	Life-threatening. Very Corrosive.
SENSITISER	Not a sensitiser.	Low incidence mild allergy. (Skin only)	Known, definite sensitiser. (Skin, eyes & upper respiratory tract only)	More severe allergy (Respiratory tract)	High incidence sensitiser. Potentially serious. (Respiratory & systemic organs).
ORGAN EFFECTS	Reversible mild or transient effects. (eg. raised enzymes). Significant volume required (ingestion)	Reversible significant effects (eg. blindness, anaemia) Ingestion (even low volume).	Irreversible (even potentially) effects (eg. neuropathy) Inhalation route.	Irreversible (even potentially) severe effects (eg. Asthma, hepatitis) Skin absorption.	Life-threatening. Impaired fertility. (eg. aplastic anaemia, agranulocytosis. Skin absorption.

Table 4: Scoring long-term ("chronic") Toxicity.

Scores ⇨	1 (Low)	2 (Med)	3 (High)	4 (Very High)	5 (Extreme)
HAZARD PROPERTY	**CONTROL BAND 1** (OEL ≥ 1000 µg/m³)	**CONTROL BAND 2** (OEL ≥ 100 µg/m³)	**CONTROL BAND 3** (OEL ≥ 10 µg/m³)	**CONTROL BAND 4** (OEL ≥ 1 µg/m³)	**CONTROL BAND 5** (OEL < 1 µg/m³)
MUTAGEN[1]			Category 3.	Category 2.	Category 1.
TERATOGEN[2]			Category 3.	Category 2.	Category 1.
CARCINOGEN	Not a carcinogen.	**IARC Cat 3** Suspected. (Animal studies only)	**IARC Cat 2B** Suspected. (Laboratory only)	**IARC Cat 2A** Known. (Human studies)	**IARC Cat 1** Known. (Case studies exist).

Other criteria to be used in applying professional judgement in assigning compounds to a particular OEB would include:

- Structure-activity relationship(s), class effects, mechanism of action
- Pharmacokinetic / pharmacodynamic considerations (eg. plasma half life (T ½))
- Warning properties
- Reversibility of effects

1 Criteria for Mutagenicity Categorisation (in Table)

Category 1: Substances for which there is positive evidence from human mutagenicity epidemiology studies (corresponding to EU phrase R46: May cause heritable genetic damage.).

Category 2: Substances for which there are positive results from assays showing mutagenic effects or other cellular interactions relevant to mutagenicity in germ cells of mammals *in vivo* or mutagenic effects in somatic cells in mammals *in vivo* in combination with clear evidence that the substance or relevant metabolite reaches the germ cells (corresponding to EU phrase R46: May cause heritable genetic damage.).

Category 3: Substances for which there are positive results from assays showing mutagenic effects or other cellular interactions relevant to mutagenicity in somatic cells of mammals *in vivo*, supported by positive results from *in vitro* mutagenicity assays (corresponding to EU phrase R40: Possible risk of irreversible effects.).

2 Criteria for Teratogenicity Categorisation (in Table)

Category 1: Substances known to impair fertility or cause developmental toxicity in humans (corresponding to EU phrase R60: May impair fertility or R61: May cause harm to the unborn child, respectively.).

Category 2: Substances that should be regarded as if they impair fertility or cause developmental toxicity in humans on the basis of clear evidence of impaired fertility or developmental toxicity in animal studies in the absence of toxic effects, or evidence of same at around the same dose levels as other toxic effects but which is not a secondary, non-specific consequence of the other effect(s) (Corresponding to EU Phrase R60: May impair fertility or R61: May cause harm to the unborn child, respectively.).

Category 3: Substances that cause concern for human fertility or developmental toxicity in humans on the basis of appropriate animal studies that provide sufficient evidence to cause a strong suspicion of impaired fertility or developmental toxicity in the absence of toxic effects, or evidence of same at around the same dose levels as other toxic effects but which is not a secondary, non-specific consequence of the other effect(s), but where the evidence is insufficient to place the substance in Category 2 (corresponding to EU phrase R62: Possible risk of impaired fertility, or R63: Possible risk of harm to the unborn child.

3.2 How do we score the harmfulness of hazardous biological agents?

This is done using the "Containment Categories" of the micro-organisms. These categories are published in the Hazardous Biological Regulations, as below:

Table 5: Scoring HBA virulence.

CONTAINMENT CATEGORY (HBA Regulations)	1	2	3	4
LIKELIHOOD FOR CAUSING HUMAN DISEASE	UNLIKELY	YES HEALTH RISK PRESENT	YES SERIOUS HEALTH RISK	YES SERIOUS HEALTH RISK
LIKELIHOOD TO SPREAD INTO COMMUNITY	NO	UNLIKELY	YES - MAY	YES – HIGH RISK
PROPHYLLAXIS & TREATMENT AVAILABLE	YES	YES	YES	NO

This same scoring exercise can be done for all the business "Impacts" (see definitions), as follows:

Table 6: Scoring all the kinds of risk that hazards pose to business ("Impacts")

SCORE	HUMAN HEALTH & SAFETY	ENVIRONMENT	FINANCIAL	PUBLIC PERCEPTION
1	Minor Injuries. (No lost time) Or Reversible Health Effects (eg. awkward posture) Chemicals: CONTROL BAND 1. - ACGIH A4 & IARC 3. - irritants, defatting agents, mild skin sensitisers - OEL >50 PPM ; OEL >1 mg/m3.	Local Off-Site Effects, Reversible (<6mnths)	Loss < R100'000	Local
2	Moderate Injuries (Lost Time) Or Reversible Significant Health Effects (eg. repetitive tasks (WRULDs), Heat stress)	Locally Significant Long-Term Effect (Reversible In >6mnths) Or	Loss R100'000-R1m	City

Table 6: Scoring all the kinds of risk that hazards pose to business ("Impacts")

SCORE	HUMAN HEALTH & SAFETY	ENVIRONMENT	FINANCIAL	PUBLIC PERCEPTION
	Chemicals: CONTROL BAND 2. - ACGIH A3 & IARC 2B - severe dermatitis, reversible organ effects - OEL 5 - 50 PPM; OEL 0.1-1mg/m3 (dust)	Regionally Significant Effect, (Reversible In <6mnths)		
3	Single Major Injury (Hosp) Or Multiple Disabling Injuries Or Irreversible Significant Health Effects (eg. Noise, poor manual handling) Chemicals: CONTROL BAND 3. - ACGIH A2 IARC 2A - irreversible organ effects (eg. lung fibrosis), respiratory sensitisers, (eg asthma) - OEL 0.5 - 4.9 PPM; OEL< 0.01mg/m3 (dust)	Regionally Significant Long-Term Effect (Reversible In >6mnths)	Loss R1m - R10m	Region
4	Multiple Major Injuries / Disabilities Or Life-threatening Health Effects. (eg. Ionizing radiat'n, heat stroke, avian flu). Chemicals: CONTROL BAND 4. - ACGIH A1 & IARC 1 - Potent respiratory sensitizers (ie at low exposures) - OEL <0.5 PPM; OEL <0.01 mg/m3	National Significant Reversible Effect (>1year)	Loss R10m - R100m	National
5	Multiple Fatalities Or Extreme Health Hazard. Chemicals: CONTROL BAND 5. - ACGIH A1 & IARC 1. - Mutagens, Teratogens. - OEL <0.5 PPM; OEL <0.01 mg/m3 (dust)	Internationally Significant Effect (Irreversible)	Loss > R100m.	International

4 MORE ABOUT DEGREES OF EXPOSURE

The degree of exposure is determined by:

- The duration (over what time span does the exposure take place?)

- The frequency (how often does the exposure take place?)
- The intensity of the concentration of the exposure.

The degree of exposure is expressed in two ways:

- Estimation of the exposure, using terms such as “low”, “medium” and “high”. This is called QUALITATIVE exposure assessment.
- Direct measurement of the exposure, accounting for the duration frequency and intensity, by qualified personnel (Occupational Hygienists, Approved Inspection Authorities)). This is called QUANTITATIVE exposure assessment. It is the format used in air monitoring, or occupational hygiene surveys.

Qualitative assessment is the most commonly used format for exposure assessment. Quantitative assessment is only applicable where the agent can actually be measured (certain chemicals, dusts, heat, cold, noise, radiation, etc.).

In order to use the exposure to calculate the risks posed by hazards, the degrees of exposure have to be converted to numbers – or “Exposure Scores”. This is done by converting the terms “low”, “medium” and “high” to numbers (ie. values from 1 to 5).

This is done by using tables that allow one to convert the estimated or measured exposure, as follows.

Table 7: Converting estimated (qualitative exposure) to exposure scores.

EXPOSURE SCORE	1	2	3	4	5
EXPOSURE FREQUENCY	Once /Year.	Quarterly.	Monthly	Weekly	Daily
EXPOSURE DURATION	< 1 Hours / Week (<10%)	1-5 Hours / Week (10%)	5-19 Hours / Week (10-50%)	20-40 Hours / Week (50-100%)	>40 Hours / Week (>100%)

Frequency: to choose the appropriate score, the assessor should determine how often, on average over a year, the employee performs work that could result in exposure to the hazard under evaluation. This requires a judgement call, as the exposure pattern could be quite variable. Options include anything from “Daily” to “Yearly”.

Duration: to choose the appropriate score, the assessor should determine the length of time, on average over a year, the employee performs work that could result in exposure to the hazard under evaluation. This time span should be described in terms of a standard work week. ie. the number of hours in the work week, during which the employee could be exposed.

How do we calculate an exposure score from TWO variables? The answer is by taking the average of the two scores. (eg. An employee is exposed to repetitive movements of the wrist once a month; each time for about 24 hours over the week whilst she was doing the job. This equates to score of 3 (monthly) and 4 (24 hours total duration). The average for the two is 3,5. Usually we round off up to the next category, if scores end up with a “.5”. Hence this would be allocated a score of 4.

Table 8: Converting measured (quantitative exposure) to exposure scores.

EXPOSURE SCORE	1	2	3	4	5
EXPOSURE INTENSITY (Measured, as relevant)	As Per Table, Or < 50%* Of Prescribed Limits	As Per Table, Or 50-75% Of Prescribed Limits	As Per Table, Or 75-100% Of Prescribed Limits	As Per Table, Or 101-200% Of Prescribed Limits	As Per Table, Or >200% Of Prescribed Limits

Note that the exposure intensity is measured, then expressed as a percentage of the Occupational Exposure Limit (OEL). (eg. The OEL of Toluene is 188 mg/m^3. If the Occupational Hygienist had measured the Toluene and found it to be 94mg/m^3, this is the equivalent of 50% of the OEL. Hence this would be allocated a score of 2.

By way of illustration, the following table expands on this concept:

Table 9: Scoring Exposure Intensity: Guidelines for Physical Hazards

HAZARD	1 (Low) +	2 (Med) ++	3 (High) +++	4 (V-High) ++++	5 (Extreme) ++++	Aggravating Factors
Noise	75-79dB(A) (TWA – 8hrs)	80 – 84.9dB(A) (TWA – 8hrs)	85 – 95dB(A) (TWA – 8hrs)	96 – 105dB(A) (TWA – 8hrs)	over 105dB(A) (TWA – 8hrs)	Percussion / Impact Noise
Heat	WBGT index exceeds 25.	WBGT index exceeds 27.5.	WBGT index exceeds 30.0.	WBGT index exceeds 32.5.	WBGT index exceeds 35.0.	Heavy work rates
Cold	Dry bulb temp +5 to 0^{o}C (OEL = no limit)	Dry bulb temp 0 to –18^{o}C (OEL = no limit)	Dry bulb temp –18 to –34^{o}C (OEL = 50 min / hour)	Dry bulb temp –34 to –57^{o}C (OEL = 60min / day)	Dry bulb temp < –57^{o}C (OEL = 5min / 8hr period)	Wetness, wind, lack of cover.
Vibration (Segmental)	50-75% of prescribed limits (TLV*) Low amplitude, high frequency (>2kHz) Eg. Hand-held electric percussion drill.	75-100% of prescribed limits (TLV*) Moderate amplitude, moderate frequency (1-2kHz)	101-150% of prescribed limits (TLV*) High amplitude, low frequency (<1kHz) Eg. Pneumatic drilling machine.	150 - 200% of prescribed limits (TLV*)	>200% of prescribed limits (TLV*)	Cold exposure.
Vibration (Whole body)	50-75% of prescribed limits (TLV*) Low amplitude, high frequency (>2kHz) Eg. Electric motors.	75-100% of prescribed limits (TLV*) Moderate amplitude, moderate frequency (1-2kHz) Eg. Diesel engines.	101-150% of prescribed limits (TLV*) High amplitude, low frequency (<1kHz) Eg. Vibrating platform on a rig.	150 - 200% of prescribed limits (TLV*)	>200% of prescribed limits (TLV*)	
Hazardous Chemical Substances	50-75% of prescribed limits (OEL/TLV).	75-100% of prescribed limits (OEL/TLV)	101-150% of prescribed limits (OEL/TLV)	150-200% of prescribed limits (OEL/TLV)	>200% of prescribed limits (OEL/TLV)	Presence of synergistic chemicals
Radiation (Ionising)	50-75% of prescribed limits	75-100% of prescribed limits	101-150% of prescribed limits (**5mSv/year**)	150-200% of prescribed limits	>200% of prescribed limits	
Radiation (Non-ionising)	50-75% of prescribed limits	75-100% of prescribed limits	101-150% of prescribed limits	150-200% of prescribed limits	>200% of prescribed limits	
Ergonomic	Low demand	Moderate demand	Mod – High demand	High demand	Extreme demand	High work demand / short rest periods).

Table 9: Scoring Exposure Intensity: Guidelines for Physical Hazards

HAZARD	1 (Low) +	2 (Med) ++	3 (High) +++	4 (V-High) ++++	5 (Extreme) ++++	Aggravating Factors
						Coexistent cold & vibration.

*: *The "TLV" (Threshold Limit Value) is quoted here because these limits are published by the American Conference of Governmental Hygienists (ACGH), and are easily available in the ACGIH publications. South African Standards ("OEL's") are to be used as these are gazetted.*

5 TYPES OF RISK ASSESSMENT

5.1 Qualitative Risk Assessment:

This is the term given to Risk Assessments where the exposures are estimated ("Low", "Medium", "High") – see "More about exposures" above.

5.2 Quantitative Risk Assessment:

This is the term given to Risk Assessments where the exposures are actually measured (Occupational Hygiene surveys) – see "More about exposures" above.

5.3 The Baseline Risk Assessment:

This process covers all the risks in all business processes and activities. It is wide-ranging, aims at producing a broad overview, as a starting point, and against which to compare future assessments.

5.4 The Issue-Based Risk Assessment:

This process provides a detailed assessment of specific risks associated with particular hazards, including:

- A new machine is introduced into a factory;
- A system of work is altered or operations change;
- An accident or a "near miss" has occurred;
- New production methods are implemented;
- Contractors carry out a capital/turnkey project.

5.5 The Continuous Risk Assessment:

This process provides a mechanism for continued monitoring and maintenance of the risks at an acceptable level. This may be by regular scheduled and periodic reviews to verify that the workplace conditions have remained the same. Examples include:

- Planned job observations
- Planned workplace inspections
- Critical task analysis
- Critical parts analysis
- Occupational Hygiene Surveys
- Medical surveillance

Point to Note: Occupational Risk Assessment and Epidemiology

Epidemiology is the study of the occurrence of adverse health events in given populations, over time. It is a complex discipline, which makes use of mathematical models of risk evaluation, biostatistics, and various techniques to verify the integrity of the findings. It is the "gold standard" of risk assessment. However, it has a number of drawbacks, severely limiting its application in daily Occupational Health practice. These include:

Time: Epidemiological studies often take time to establish, run, and to draw a conclusion, which is not available to conventional occupational health practice.

Controls: The absence of easily available control groups, against which to make comparative analyses.

Complexity: Whilst biostatistical analysis is not always complicated, many of the questions that require statistical answers demand a superior knowledge of the field.

Nevertheless, epidemiology remains central to occupational health practice – but not directly. Rather, the results of epidemiological investigations, which are published in the medical literature, are used as supportive data. In other words, the published literature is full of valuable studies with epidemiological findings, which can be used to the benefit of our own programmes. This is reflected in the Synergee approach to Health Risk Assessment, where literature review forms the very first step in the procedure.

6 FORMATS FOR CONDUCTING HRA's

Health Risk Assessments can be conducted:

- By related business processes ("Risk Areas") and the Tasks that are performed there
- By an occupational exposure group (such as a job category)
- By a particular physical location (such as a laboratory or workshop).

When approaching HRA's by Tasks, consider organising the company into the following areas ("Risk Areas"):

- Logistical Activities
  - Receiving (raw materials or intermediates)
  - Storage
  - Product distribution
  - Fleet maintenance
- Production Activities
  - Product manufacture: Mixing, blending, grinding, etc.
  - Product packaging.
- Ancillary Services & functions
  - Engineering
  - Building maintenance, construction & demolition
  - Grounds and gardening
  - Waste management
  - Canteen
  - Health & Safety
  - Laboratories
  - Admin (offices, sales, procurement)
- Other Activities
  - Travel (business, or even between home & work)
  - Off-site business-related activities
  - Volunteer community service
  - Hobbies

Note that the Health Risk Assessment should consider different operating conditions, namely:

- Normal operating conditions
- Abnormal operating conditions (at start-up, shut-down, planned maintenance and shut-down)
- Reasonably foreseeable emergency situations (major spills, fire)

7 TYPES OF "RISK" RELEVANT TO MEDICAL SURVEILLANCE

In occupational health, there are two core types of "risk" that are of direct relevance to medical surveillance:

- The risk of injury or illness associated with ***exposure to a particular health hazard*** (hazardous agents and environmental hazards) – for the purposes of this guideline, this shall be known as "EXPOSURE RISK"

- This risk of injury or illness associated with work being conducted by employees who do not meet the ***inherent capability requirements*** commensurate with that work (capability hazards) – for the purposes of this guideline, this shall be known as "CAPABILITY RISK"

These two terms require further definition and clarification:

7.1 Exposure Risk

This refers to risk of employee injury or illness. Exposure risk can be magnified by certain factors, including employee vulnerability. The effects of employee vulnerability are reduced by establishing minimum standards of fitness for the tasks or occupations, and ensuring that these standards of fitness are applied and maintained, by means of a medical surveillance programme.

Inherent employee vulnerabilities cannot be accounted for in the Health Risk Assessment – instead, these illnesses (vulnerabilities) are identified and listed as exclusions ("relative" or "absolute") for the relevant occupations, in accordance with the exposure profiles. (eg. Asthma in a plant with high potential exposures to allergens).
The risk reduction strategy here is the identification of those at risk (medical surveillance), and treating or removing employees who at unacceptable risk of harm.

7.2 Capability Risk

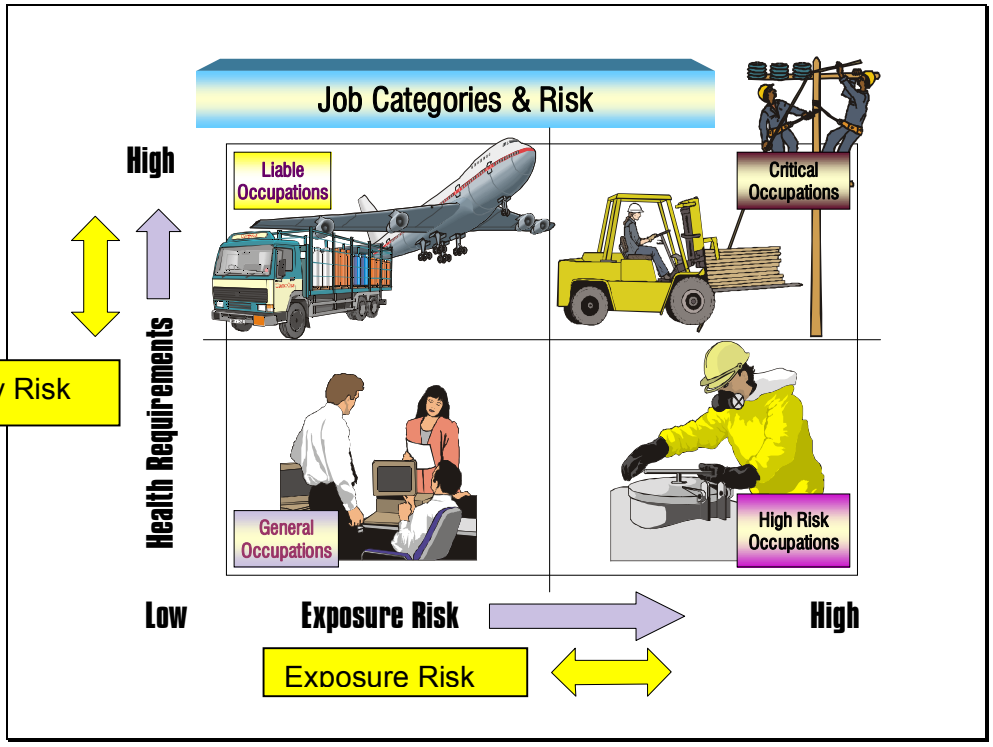
This refers to the risk associated with the deployment of an employee who does not meet the occupation's capability requirements, thereby increasing the likelihood of operator error, with consequential accident or illness, involving themselves or others. This raises employer liability for claims from both outside and inside the company (accidents caused by employees physically inadequately equipped for the job).

As for exposure risk above, operator error is reduced by establishing minimum standards of fitness for the tasks, and ensuring that these standards of fitness are applied and maintained, by means of a medical surveillance programme.

Point to Note:

The Capability Requirements and Hazard Exposures for the company's occupations are established during Health Risk Assessment, whereas the medical Standards of Fitness for the company's occupations are established during the design phase of the Medical Surveillance Programme.

Figure 1: The two axes of Occupations and Risk.



This illustrates the two basic axes of risk – the vertical axis represents increasing health requirements and the horizontal axis represents increasing potential exposure to hazards.

<u>This leads to four main “risk-groups” of occupations:</u>

1. Those with high health requirements, but low hazard exposure – the “liable occupations”. (eg. bulk truck drivers, heavy passenger vehicle drivers)
2. Those with high health requirements, and high hazard exposure – the “critical occupations”. (eg. crane operators, forklift drivers, certain machine operators).
3. Those with low health requirements, but high hazard exposure – the “hazardous occupations”. (eg. welding, maintenance, or any work entailing exposure to significant hazards).
4. Those with low health requirements, and low hazard exposure – the “general occupations”. (eg. general workers, office and admin staff, etc.).

This model shows the dual requirement of the Medical Surveillance Programme to evaluate employees for both of these axes of risk. It should ensure that minimum medical requirements are met and that any adverse health effects from the exposure to hazards in the workplace are detected at an early stage, enabling effective remedial action to be taken.

8 GENERAL APPROACH TO IMPLEMENTING AN HRA STRATEGY

Three main steps are involved, which are remembered by their phonic similarity:

HEALTH RISK **ASSESSMENT**	HEALTH RISK **MANAGEMENT**
• Step 1: Hazard Identification ("**Enumerate**") • Step 2: Exposure Evaluation ("**Evaluate**") • Step 3: Risk Prioritisation ("**Risk Rate**")	**"MITIGATE OR ERADICATE"**

Hazard Identification and Exposure Evaluation can occur simultaneously.

8.1 Hazard Identification Phase:

Objective: Provide an overview of the hazards associated with the workplace, thereby appropriately directing the more detailed risk evaluation phase.

Important data gathering resources include:

- Literature reviews: journals, the Internet, encyclopaedias, assessments at other (similar) sites, etc.
- Company data review: previous assessments, accident records, chemical inventories, purchasing inventories, absenteeism records.
- Physical review: walk-through inspections, interviews with workers, supervisors, company experts, such as laboratory staff, etc.

This phase comprises gathering of data that "scopes" the hazards of relevance at the facility. These hazards are firstly identified, then allocated "harmfulness" and "probability" scores in accordance with the tables provided.

NOTE:

The term, "Probability score" is unique to the Hazard Identification Phase of the Health Risk Assessment. It is used to estimate the likelihood of an adverse event (accident, illness, damage to property, etc.) associated with the presence of the hazard. This is NOT the same as the exposure score. It is not a description of exposure, but of chance / likelihood. Its purpose is to help rank the identified hazards in order of priority for the net phase of the Health Risk Assessment (in the next phase, exposure is evaluated).

Table 10: Converting likelihood of adverse events to "Probability Scores".

PROBABILITY	**1**	**2**	**3**	**4**	**5**
LIKELIHOOD (INCIDENT FREQ)	**Unlikely Ever.**	**1 Incident / 10Years**	**1 Incident / Year**	**1 Incident / Month**	**1 Incident / Week**

Steps:

1. Organise the company into related groups of Business Processes, known as “Risk Areas”. (See section above, covering “Formats for conducting HRA’s”.)
2. Decide which Business Process (Risk Area) is to be assessed.
3. Establish the Tasks that are performed in the Risk Area, and the occupations of the people who perform these tasks.
4. Identify the Hazards (& their harmfulness scores) that apply to these Tasks
5. Estimate the probability scores that apply to these hazards (Table above)
6. Calculate the Risks associated with these hazards, as follows:

RISK = HARMFULNESS X PROBABILITY

7. Rank the Hazards, by their Risk Scores, so as to identify the Hazards requiring urgent action first.

Figure 2: Image of the kind of collection tool suggested for Task-based HRA’s; (Phase One)

PHASE ONE: HAZARD IDENTIFICATION ==========>											
OCCUPATIONS	HAZARDS CATEGORY	HAZARD SUBCATEGORY	SCORE	SOURCE OF HAZARD	PROB SCORE	RISK	N	ABN	EMERG	PAST	PLAN'D
Printers	Chemicals	Toluene	3	Printing Inks	3	9	x				
Artisans	Physical	Noise	4	Engines	4	16	x				
Artisans	Ergonomic	Repetitive Tasks	3	Working with tools	5	15		x			

8.2 Exposure Evaluation Phase:

Objective: Provide the exposure values to the identified hazards, and record the findings.

This phase comprises a detailed assessment of the exposures to the hazards – by Task or by Occupation (OREP). These are scored as described in the section above, covering “More about Exposures”.

This includes the length of time of the exposure, as well as the intensity of the exposure. Hence the components of exposure include:

- time components
  - frequency (how often does this take place in a given period of time, such as a year)
  - duration (what is the length of time during which the exposure takes place)

- intensity components
  - the concentration of the agent in the air (if measured)
  - the degree of contact with the agent (direct, indirect, body is completely covered, etc.)

Steps:

1. Decide which Business Process (Risk Area) is to be assessed. This may be a Risk Area in which the Hazard Scan identified hazards with high probability scores, high harmfulness scores, or both.
2. Verify the Tasks that are performed in the Risk Area, and the occupations of the people who perform these tasks.
3. Verify the Hazards (& their harmfulness scores) that apply to these Tasks
4. Estimate the exposure scores that apply to these hazards. If the hazards are actually measured (by an Occupational Hygienist), convert the measured values to exposure scores.
5. Evaluate existing control measures (or deficiencies!)
6. Calculate the Risks associated with these hazards, as follows:

RISK = HARMFULNESS X EXPOSURE

7. Rank the Hazards, by their Risk Scores, so as to identify the Hazards requiring urgent action first.

It is useful to draw a schematic process flow diagram (often these are already available from the company). If one is not available, draw one on a blank sheet, noting the following (the three "P's"!):

- **P**roduct info: Raw materials, by-products, waste products, final products, their quantities and their movement around the worksite.
- **P**rocess info: Machinery, equipment, their quantities and their movement around the worksite.
- **P**eople info: Job categories, their numbers and their movement around the worksite.

Figure 3: Image of the kind of collection tool suggested for Task-based HRA's.

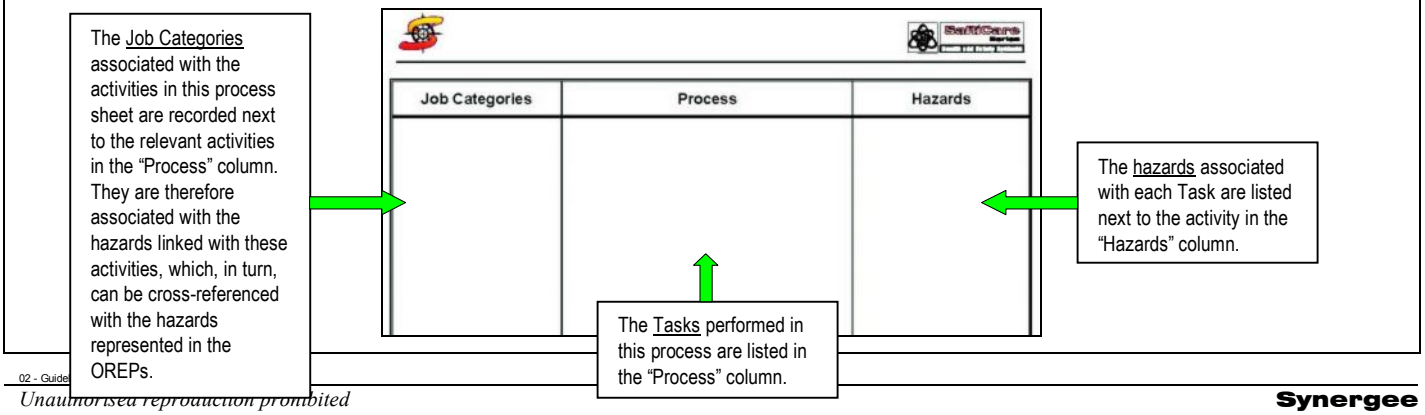


Figure 4: Image of the kind of collection tool suggested for Task-based HRA's; (Phase Two)

			PHASE TWO: DETAILED RISK ASSESSMENT ==========>						
HAZARDS CATEGORY	HAZARD SUBCATEGORY	SCORE	FREQUENCY	DURATION	INTENSITY (IF_MEASURED)	EXPOSURE SCORE	RISK RATING	CONTROLS IN PLACE	DEFICIENCIES
Chemicals	Toluene	3	3	4	4	4	12	PPE, Training	Extraction Ventilation.
Physical	Noise	4	4	4	4	4	16	PPE, Isolation.	None
Ergonomic	Repetitive Tasks	3	3	5		4	12	None	Task rotation, Training

8.3 Risk Prioritisation Phase:

Objective: Analysis of the hazards and their exposure values, to identify high-risk occupations and workplaces ("Risk ranking").

8.3.1 The Risk Matrix:

Therefore the final step is to construct a Risk Matrix in which the items to be risk ranked (the Occupations, Tasks, Workplaces, etc), are listed down the left margin, and their main hazards are flagged by their scores. Ideally, all the scores (Harmfulness, Exposure and Risk Scores) should be accessible for analysis. High-risk groups or areas are identified and intervention measures can be planned.

Table 11: Summary of Risk Factor Classification (5x5 technique):

The Risk Factors are classified as follows:

• Very High Risk	scores from 20 to 25.	Immediate action is required (discontinue?)
• High Risk	scores from 14, but less than 20.	Medium term action is required
• Medium Risk	score from 7, but less than 14.	Long-term action is required
• Low Risk	scores of less than 7.	Careful incident monitoring only.

8.4 Actions Following Risk Assessment – Risk Management & "The Hierarchy of Controls"

On obtaining the Risk Indices, the risk assessment team can recommend the required risk reduction initiatives, giving remedial actions required to reduce (mitigate) or eliminate the risk. Risk Officers, occupational health sisters and doctors, industrial hygienist and management should plan and execute remedial actions, additional measurements/biological monitoring and medical surveillance as required.

Typical control measures include the following: (The "HEIRARCHY OF CONTROLS")

1. Engineering controls (elimination ⇨ substitution ⇨ isolation ⇨ ventilation (extraction / dilution)).
2. Training - standard operating procedures ("SOP's")
3. Administrative Controls (Job rotation, warning signs, recruitment strategy)
4. Personal Protective Equipment
5. Air monitoring, Biological monitoring
6. Medical examinations

9 THE OCCUPATIONAL RISK & EXPOSURE PROFILE ("OREP")

9.1 Introduction To OREPs:

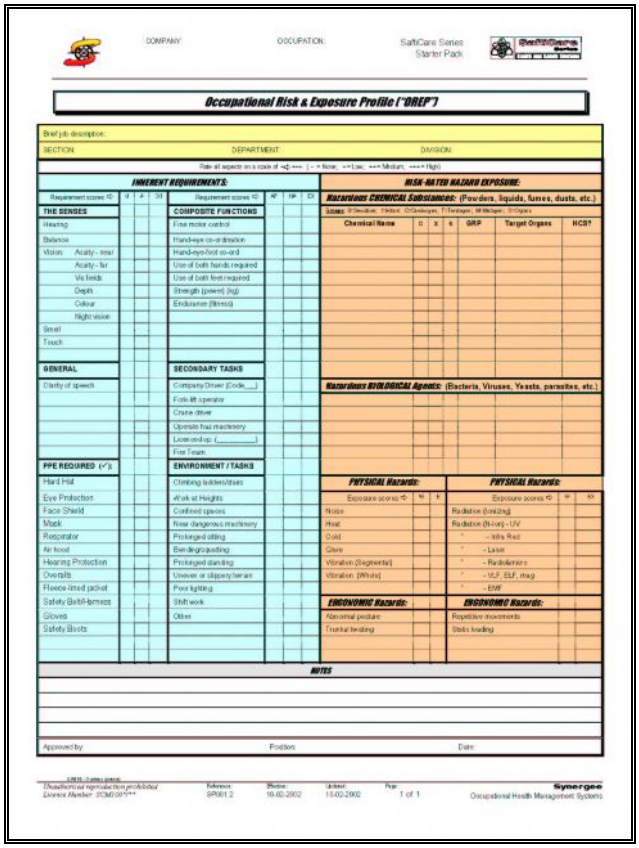
The Occupational Risk and Exposure Profile (OREP) is the formal documentation of the results of a Risk Assessment, for a single occupational exposure group (i.e. a job category). It comprises two main groups of data, all on one page:

- Data that defines the inherent capability requirements of the occupation are listed. Failure to meet these requirements increases the company's liability by increasing the risk of an accident.
- Data pertaining to the hazardous exposures unique to each occupational category

This document is the cornerstone of future action, providing key information for subsequent risk reduction strategies, Education and Training, Occupational Safety, Occupational Hygiene, Occupational Medicine and Recruitment Policy.

It is derived from the information obtained in the HRA's, and may be collected as a desk-top exercise (ie. by simply interviewing relevant people who know what the risks are for the relevant occupations).

Figure 5: Image of a blank OREP:



The information directs the components of the Occupational Health Programme by:

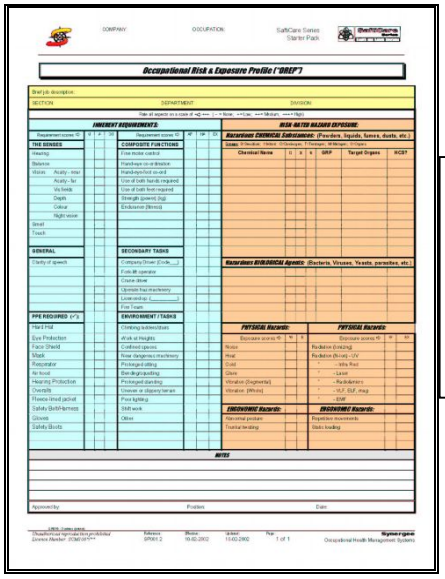
- Ensuring that hazard exposure information is available to all parties ("Risk Assessment beneficiaries")
- Minimum health requirements are agreed in advance.
- The information directs any training needs, as prescribed by the Hazardous Chemicals Substances regulations.
- The information determines placement requirements for the various occupations, improving the effectiveness of the Human Resources personnel. This provides protection from the Labour Relations and Employee Equity Acts, which require rational and defendable approaches to employment/placement strategies AND incapacity management.
- Presenting the required data for all the beneficiaries of the Risk assessment in a manner that enables rapid implementation

Point to Note:

Given that one of the methods for initial data collection is by job category, the simplest way to do so is by using the OREPs as data collection sheets.

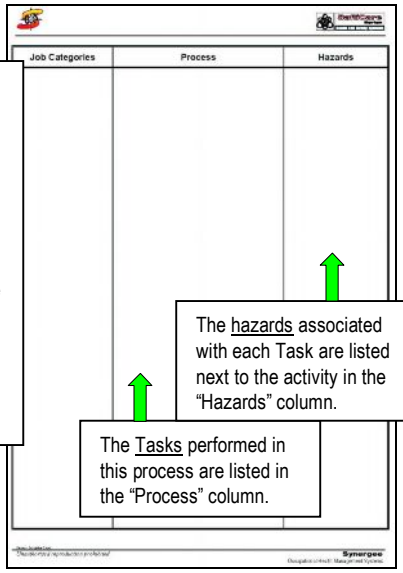
Figure 6: Relationship between OREPs and HRA's:

Image of a blank OREP



The OREPs represent a composite profile of the risks associated with the relevant occupation. These can be correlated with the hazards linked to the occupation in the Process Assessment Sheet (opposite)

Image of a blank WREP



The Job Categories associated with the activities in this process sheet are recorded next to the relevant activities in the "Process" column. They are therefore associated with the hazards linked with these activities, which, in turn, can be cross-referenced with the hazards represented in the OREP (opposite).

The hazards associated with each Task are listed next to the activity in the "Hazards" column.

The Tasks performed in this process are listed in the "Process" column.

Point to Note:

The advantages of collecting the data by occupation, are as follows:

- The data collected is immediately structured according to the risks associated with "homogenous exposure groups" (HEG's), which is the universal requirement of Risk Management programmes. Homogenous exposure groups are simply employee groups that have identical OREP's. These are usually in the form of Job Categories, or derivatives of these.
- The data is collected in a way that enables the rapid design of targeted Medical Surveillance Programmes, in a standardised manner. This advantage should not be under-emphasised. Without a careful and well-considered design strategy, these surveillance programmes are fraught with ad-hoc decisions, with potentially adverse industrial relations consequences, should they be implemented without relevance to the overall programme. This is especially important in the presence of the stringent requirements of current South African labour law.
- The data is presented in such a way that all the beneficiaries of the Health Risk Assessment process are well placed to receive the information they require for immediate programme implementation. The beneficiaries are depicted graphically in the section on OREPs.
- The data collection process requires the input of the employees, which improves the precision of the collective information, by avoiding "blanket" risk allocation to entire workplaces. Whilst it may be true that the composite sum of the hazard exposure data for a group of employees in a workplace may be a true reflection of the hazards in that workplace, it is rarely true for the converse.
- The "snap-shot bias" of interval workplace assessments is avoided by the gathering of data that is time-sensitive. OREPs carry greater precision regarding the actual risk, rather than the assumed risk. ("Snapshot" bias refers to the error that occurs with evaluations based in single visits by outside experts. This includes over-emphasis of hazards that happened to be prominent at the time of the inspection, and under-emphasis of hazards that were not visible at the time of the inspection.)

10 THE APPENDICES

The appendices attached to this document are:

1. Summary of Health and Safety Hazards
2. Approach to the allocation of Hazard Scores
3. Approach to the allocation of Exposure Scores
4. Step-wise approach to Health Risk Assessment

Appendix 1: Summary of types of Health and Safety Hazards

Health Hazards include:

Hazardous Agents:	Workplace Health Hazards:

• Chemical (HCS): (Liquids, fumes, gases, dusts, etc.)
  ○ Irritants, Sensitisers, Carcinogens, Teratogens, Mutagens, Target Organ effects.
  ○ Raw materials, active / inactive ingredients, intermediates, final products.
  ○ Laboratory chemicals.
  ○ Welding fumes, Building materials.
  ○ Animal and plant products.
  ○ Workplace smoking
• Biological (HBA):
  ○ Viruses, bacteria, fungi, etc.
• Physical:
  ○ Noise
  ○ Temperature (hot & cold)
  ○ Radiation
  ▪ Ionising (x-rays, γ-rays, α&β emitters)
  ▪ Non-ionising (bright light, UV & infrared, electromagnetic fields (EMF), microwaves & radio frequency, lasers.).
	• Ergonomic
	  ○ Repetitive movements
	  ○ Vibration
	  ○ Abnormal posture.
	  ○ Material & equipment handling (lifting, pulling, etc.)
	  ○ Illumination (lighting) (dark & light)
	  ○ Humidity & air quality.
	• Psychosocial
	  ○ Shift patterns
	  ○ Organisational stress.

Safety Hazards include:

• Worker Capability:
  ○ Non-compliance with medical standards.
  ○ Lack of required skills/competencies.
• Mechanical (work equipment):
  ○ Dangerous machinery, (moving parts, etc.)
  ○ Sharp edges
  ○ Releases (sparks, chips, fume, dust)
  ○ Pressurised vessels (air, gas, hydraulics)
  ○ Failure or collapse of parts
  ○ Overturning of machine or object
  ○ Transport hazards (overhead cranes, forklifts, pallet trucks, vehicles).
• Fire & Explosion:
  ○ Flammable gases, vapours, liquids.
  ○ Combustible dusts or solids.
  ○ Chemical reaction
  ○ Hot work, flame or spark.
  ○ Access and egress
• Gravity:
  ○ Work at heights (ladders, scaffolding)
  ○ Falling materials or objects (incl. stacking)
	• Environmental:
	  ○ Uneven or slippery terrain.
	  ○ Sharp edges
	  ○ Extreme weather conditions
	  ○ Hot surfaces, liquids, steam.
	  ○ Oxygen deficiency (asphyxiation)
	• Electricity:
	  ○ High voltage electricity.
	  ○ Static electricity.
	  ○ Exposed conductors.
	  ○ Defective wiring / plugs.
	  ○ Overloaded circuits.
	• Behavioural:
	  ○ Non-compliance to safe work standards
	  ○ Violent behaviour
	  ○ Lone working conditions
	• Miscellaneous:
	  ○ Inadequate safety equipment
	  ○ Animals (bites, stings, kicks, etc)
	  ○ Construction & demolition.

10.1 Appendix 2: Summary Guideline for allocation of Scores

Figure 7: Summary Guideline for the allocation of scores.

RISK ASSESSMENT MATRIX

HAZARD CONSEQUENCE CRITERIA					PROBABILITY CRITERIA				
TYPES OF IMPACT					INCREASING PROBABILITY SCORE ⇨				
INCREASING SEVERITY SCORE (CONSEQUENCE) ⇨ SCORE	HUMAN HEALTH & SAFETY (GENERIC)	ENVIRONMENT	FINANCIAL	PUBLIC PERCEPTION	1	2	3	4	5
0	None (No toxic, harmful, corrosive, irritant or asphyxiant effects) (Chemicals: ACGIH A5 carcinogens. Those with no OEL's.)	-	-	-	VL (0)	VL (0)	VL (0)	VL (0)	VL (0)
1	Minor Injuries. (No lost time) Or Reversible Health Effects (eg. awkward posture) Chemicals: CONTROL BAND 1. - ACGIH A4 & IARC 3. - irritants, defatting agents, mild skin sensitisers - OEL >50 PPM; OEL >1 mg/m3.	Local Off-Site Effects, Reversible (<6mnths)	Loss < R100'000	Local	VL (1)	VL (2)	L (3)	L (4)	M (5)
2	Moderate Injuries (Lost Time) Or Reversible Significant Health Effects (eg. repetitive tasks (WRULDs), Heat stress) Chemicals: CONTROL BAND 2. - ACGIH A3 & IARC 2B - severe dermatitis, reversible organ effects - OEL 5 - 50 PPM; OEL 0.1-1 mg/m3 (dust)	Locally Significant Long-Term Effect (Reversible In >6mnths) Or Regionally Significant Effect, (Reversible In <6mnths)	Loss R100'000-R1m	City	VL (2)	L (4)	M (6)	M (8)	M (10)
3	Single Major Injury (Hosp) Or Multiple Disabling Injuries Or Irreversible Significant Health Effects (eg. Noise, poor manual handling) Chemicals: CONTROL BAND 3. - ACGIH A2 IARC 2A - irreversible organ effects (eg. lung fibrosis), respiratory sensitisers, (eg asthma) - OEL 0.5 - 4.9 PPM; OEL< 0.01mg/m3 (dust)	Regionally Significant Long-Term Effect (Reversible In >6mnths)	Loss R1m - R10m	Region	L (3)	M (6)	M (9)	M (12)	H (15)
4	Multiple Major Injuries / Disabilities Or Life-threatening Health Effects. (eg. Ionizing radiat'n, heat stroke, avian flu). Chemicals: CONTROL BAND 4. - ACGIH A1 & IARC 1 - Potent respiratory sensitizers (ie at low exposures) - OEL <0.5 PPM; OEL <0.01 mg/m3	National Significant Reversible Effect (>1year)	Loss R10m - R100m	National	L (4)	M (8)	H (12)	H (16)	VH (20)
5	Multiple Fatalities Or Extreme Health Hazard. Chemicals: CONTROL BAND 5. - ACGIH A1 & IARC 1. - Mutagens, Teratogens. - OEL <0.5 PPM; OEL <0.01 mg/m3 (dust)	Internationally Significant Effect (Irreversible)	Loss > R100m.	International	M (5)	H (10)	H (15)	VH (20)	VH (25)

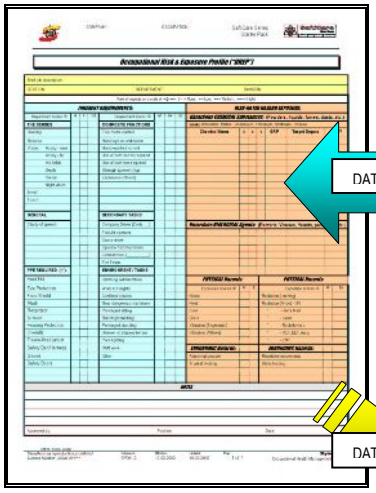
NOTES:	RISK = CONSEQUENCES X PROBABILITY (or EXPOSURE) (OUT OF 25)					
Use "LIKELIHOOD" in Phase One of HRA (Hazard Identification).	LIKELIHOOD.	Unlikely Ever.	1 Incident / 10Yrs	1 Incident / Year	1 Incident / Month	1 Incident / Week
Use "EXPOSURE SCORE" (Freq x Duration x Intensity)/3 in Phase Two of HRA.(Detailed HRA).	EXPOSURE FREQUENCY	Once /Year.	Quarterly.	Monthly	Weekly	Daily
	EXPOSURE DURATION	< 1 Hours / Week (<10%)	1-5 Hours / Week (10%)	5-19 Hours / Week (10-50%)	20-40 Hours / Week (50-100%)	>40 Hours / Week (>100%)
Use MEASURED TWA instead of "Exposure Score", if the value has been measured.	EXPOSURE INTENSITY	(Enclosed/ Sealed Process)	(Manual Work With Local Exhaust)	(Semi-Enclosed Process)	(Manual Application, Protected (PPE), Safe Work Practices)	(Manual Application, Unprotected)
	MEASURED TWA EXPOSURE (Where known)	As Per Table, Or < 50% Of Prescribed Limits	As Per Table, Or 50-75% Of Prescribed Limits	As Per Table, Or 75-100% Of Prescribed Limits	As Per Table, Or 101-200% Of Prescribed Limits	As Per Table, Or >200% Of Prescribed Limits

Appendix:3: Step-wise approach to Health Risk Assessment (Summary).

Step 2: Construct the OREPs.

Identify all Occupations. Determine the Tasks they do, and the associated Health Risks.

Thro' careful interviews, determine the Inherent Requirements of the Job. This is conducted by the line staff, after receiving the appropriate training.

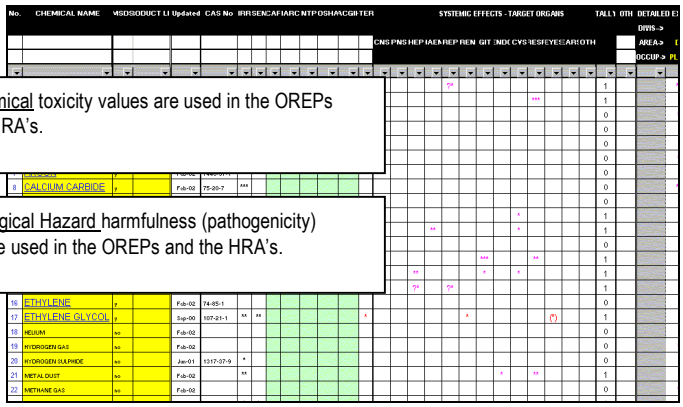


DATA FLOW

DATA FLOW

Step 3: Construct the HCS & HBA Inventories.

Identify all HCS's & HBA's in the company. Research their toxicology and allocate harmfulness scores. Use this information to populate the toxicity fields in the chemical and biological hazards sections of the OREPs and the HRA's.



The Chemical toxicity values are used in the OREPs and the HRA's.

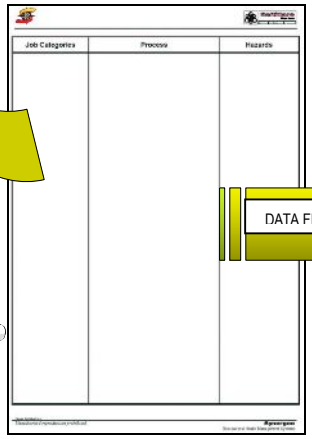
The Biological Hazard harmfulness (pathogenicity) values are used in the OREPs and the HRA's.

DATA FLOW

Step 1: Conduct Facility Walk-through's.

Examine the Tasks, Hazards and Occupations by visiting the workplaces throughout the Company in a structured and systematic way. Phase One: Identify the Hazards & Probability scores, then calculate the Risks, & rank them.

Phase two: Closely assess the exposures, controls, and score them. Re-calculate the Risks



DATA FLOW

Step 4: Construct the Risk Matrix:

The final Risk Matrix provides all the information to enable analysis and planning. This includes the following:

Hazard exposures, by occupations and Risk Areas

Group sizes, intended surveillance, etc.