Session No. 613

How to Make Matrix Methods of Risk Analysis More Effective and Accurate

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Introduction

This paper highlights measures that can be taken to improve both the tools and the methods of use of 2-dimensional L*C matrix approaches to semi-quantitative risk analysis. The improvement measures described will maximise the confidence in objectivity and minimise the variability of the results of analysis. The efficacy of these measures has not been rigorously tested in a formal, controlled experiment, but the improvements in objectivity and variability of results have been consistently achieved by the author over the past 14 years. Because of these improvements, management decisions can now be made with more confidence that the estimated risk levels are more objective measures of the real risks. The paper describes the problems being encountered with the current miss-uses of matrix tools and discusses successful ways of reducing risk analysis concerns.

The Current Situation

As an important and appropriate component of their H&S management systems, many organisations use 2d Risk Matrices for calculating risk levels/ scores. These comparative scores allow better prioritisation of H&S issues, development of JSAs/procedures/work method statements, decisions re choices of risk control options, applications of risk tolerability criteria, etc. However there is wide-spread dissatisfaction and lack of confidence regarding the reliability and accuracy of the risk scoring results which these methods currently achieve.

It is recognized that *Semi-Quantitative Risk Analysis* with 2 dimensional L*C Matrices or 3 dimensional C*E*P Tie-line Methods can provide a very useful intermediate tool between very crude *Qualitative Risk Analysis* and the more comprehensive [but significantly more time-hungry method] of *full Quantitative Risk Analysis QRA*.

L*C = Likelihood * Consequence

C*E*P = Consequence * Exposure * Probability

The single greatest problem is implementing Semi-Q matrix methods without adequate training of the users. There is a commonly held - but very wrong - belief that Semi-Q matrix tools are so simple and intuitive, there is no need for comprehensive competency training. The tools look deceptively straightforward and therefore very little time is spent explaining the most effective and reliable methods of their use - as well as their limitations.

One significant training deficiency is failure to get risk assessors to successfully recognize that the process of *risk identification* before *risk analysis* starts with the need to choose a Consequence of interest or concern - one at a time. The common traditional arguments within a risk assessment team re the range of "possible" consequences while considering a single hazardous event or a incompletely defined scenario need to be shown to be illogical as well unnecessarily divisive . Poorly-trained risk assessors have problems with the confusing myth that *"the same scenario can lead to different consequences*". The confusion originates from the lack of distinction between a single "event" and a whole "scenario" of events and circumstances.

Part 1. What is Risk Analysis?

The new international Risk Management standard ISO 31000:2009 and its predecessors such as AS/NZS 4360:2004 have clarified the meaning and purpose of the term "risk analysis" in the Risk Assessment stage of the overall risk management process shown in Exhibits 1A, 1B, and 1C.

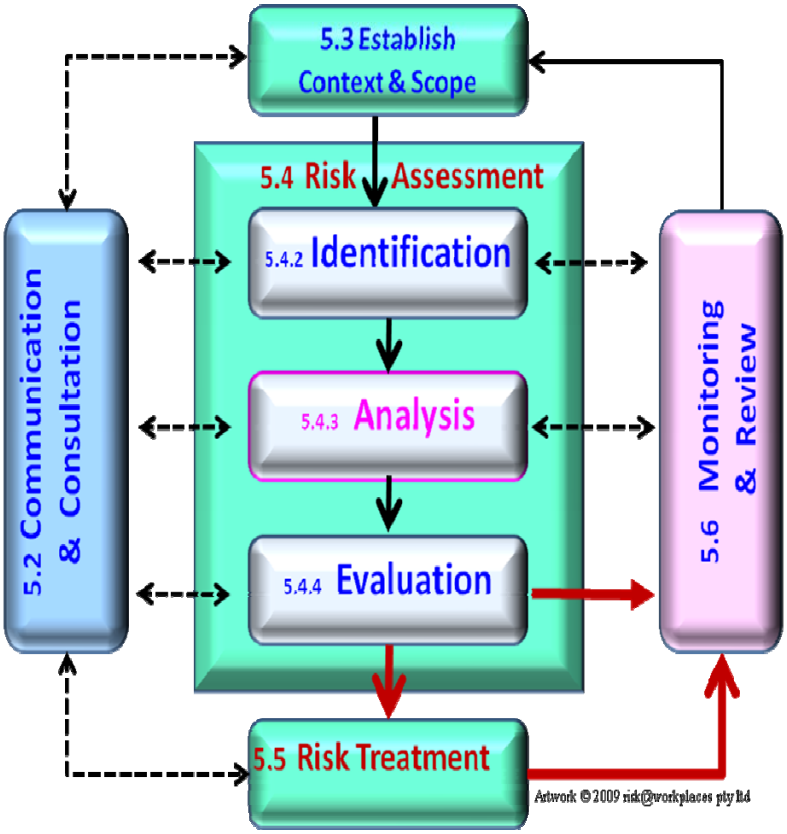

Exhibit 1A. Risk Management Process – adapted from ISO 31000: 2009 Fig 3, Clause 5.

Essentially, risk analysis is about estimating the level of risk for the stated agreed risk question which includes a risk scenario of all the events / circumstances / risk factors needed to lead to the chosen Consequence of most interest or concern. To quote ISO 31000,

"Risk analysis can be undertaken with varying degrees of detail, depending on the risk, the purpose of the analysis, and the information, data and resources available. Analysis can be qualitative, semi-quantitative or quantitative, or a combination of these, depending on the circumstances"

Also,

"The way in which consequences and likelihood are expressed and the way in which they are combined to determine a level of risk should reflect the type of risk, the information available and the purpose for which the risk assessment output is to be used. These should all be consistent with the risk criteria."

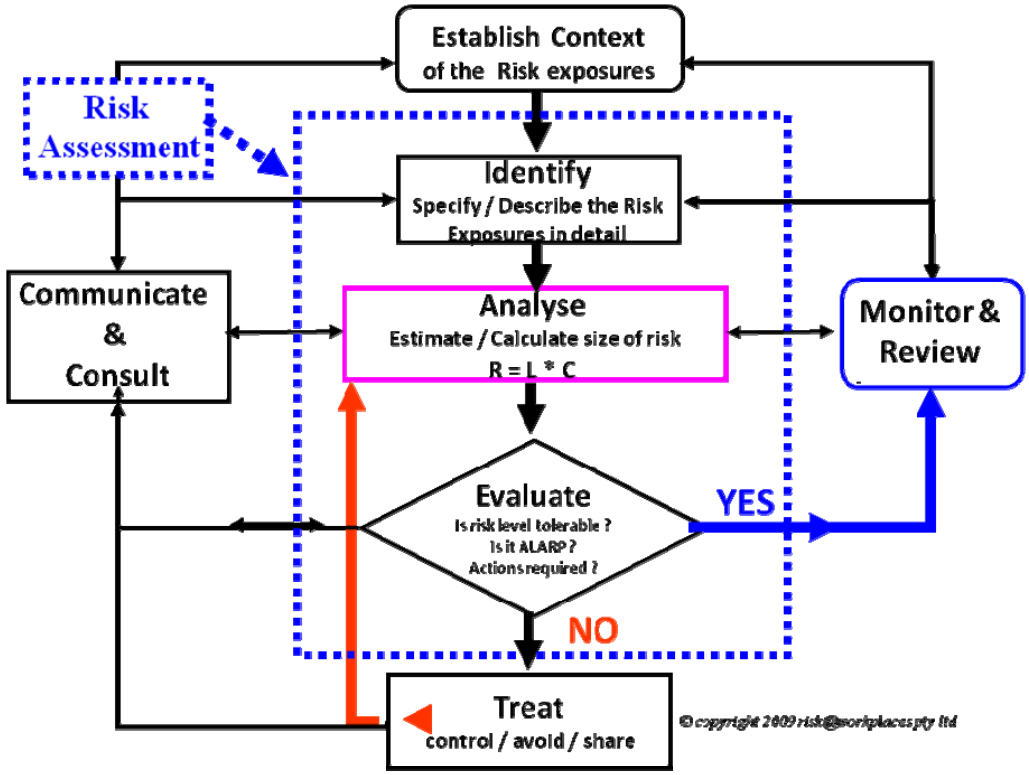

Exhibit 1B. Risk Management Process – adapted from ISO 31000: 2009.

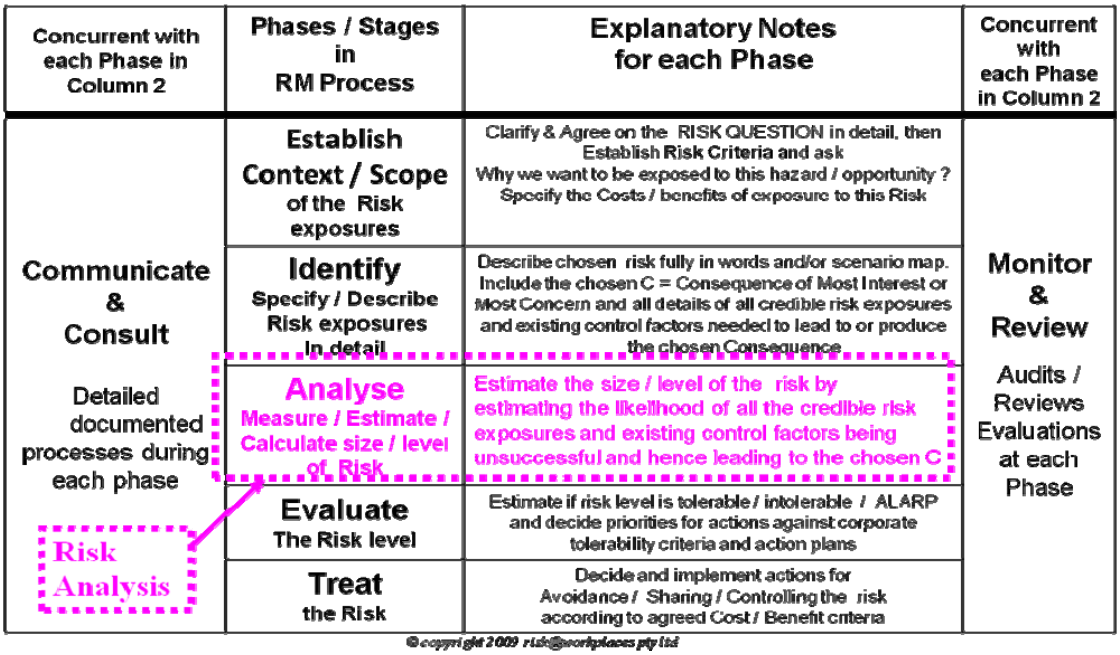

Exhibit 1C. Risk Management Process – adapted from ISO 31000: 2009.

Exhibit 2 shows the normal formal approach used by many organizations to choose which forms of risk analysis are be used in a staged filtering process. Starting with Qualitative analysis and progressively moving [if needed and justified] to full QRA Quantified Risk Analysis. Progressing to each stage with increasing time, money and effort can only be justified by size of risk.

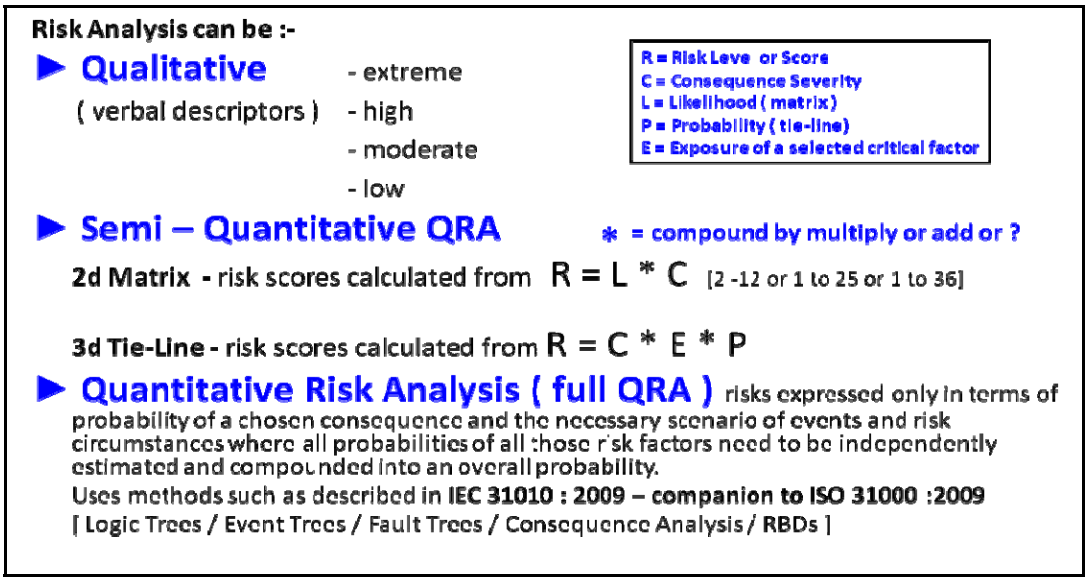

Exhibit 2. Types of Risk Analysis

Risk Analysis measures / calculates / estimates the *size / level* of risks and hence allows them to be *ranked* and *prioritised.*

Risk Analysis measures the sizes/levels of:

- **Inherent** Risk *(risk level without any risk controls)*
- **Current Residual** Risk *(current residual risk level with existing risk controls in place / effective)*
- **Target Residual** Risk *(new proposed residual risk level with new / different risk controls in place and effective)*

Note: If the assumed existing risk controls are NOT in place and effective as planned, then the actual risk level is still the Inherent Risk Level, NOT the estimated Residual Risk Level.

Part 2. Inadequate Training in Use of Semi-Q Methods

The author has found that many organisations assume that risk analysis tools such as the 2 dimensional L*C matrix method appears to be so simple and straightforward that most provide little or no competency training in their use.

There is a tendency to over-estimate the intuitive nature of the matrix method.

Recognising the need for a full description of the risk question [Part 3] - Choosing Consequences rather than arguing about them [Part 4] and using more detailed guidance in estimating Likelihood [Part 5] all need full explanation, extensive practice and experience before there can be any confidence in the reliability and accuracy of the results of using the tools.

Part 3. Establishing Exactly What is the "Risk Question" Being Asked BEFORE Rushing into Risk Analysis

Every time the author has been involved in a risk assessment process where the results of the risk estimation stage are widely different and inconsistent, it is necessary to go back to the risk context and identification process because it will have been almost certainly incomplete and inadequate. Probing discussion with the assessors always reveals their lack of agreement on what risk question / scenario they were originally considering when they made their different estimates.

In Exhibit 3A, each of the 3 risk questions based on the associated pictorial sequence of events is valid but which one leads to meaningful results which can assist understanding and ultimately decision-making re choice of related risk management actions.

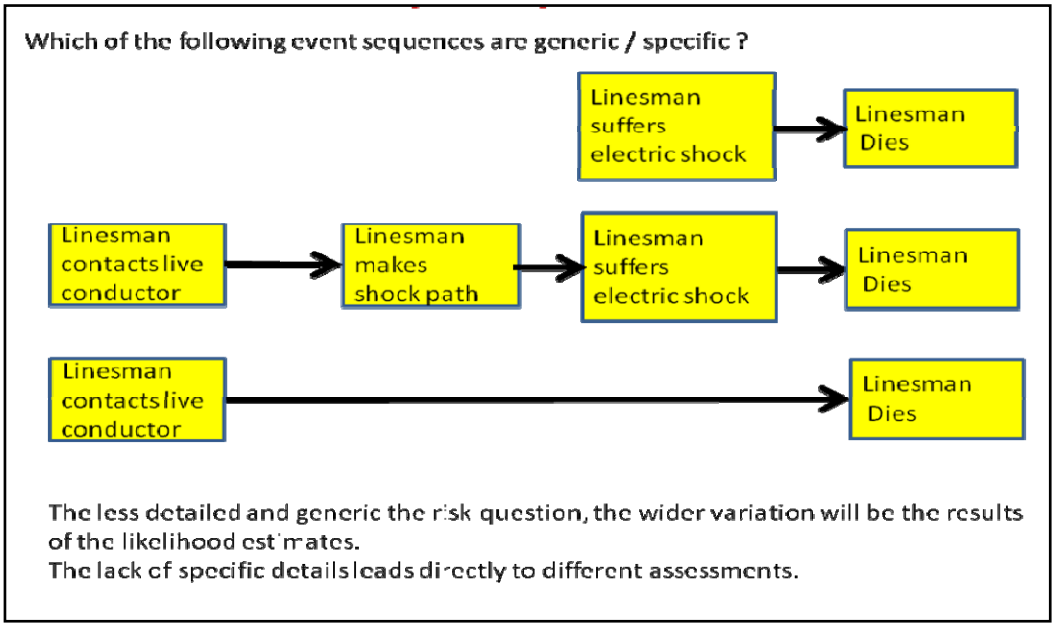

Exhibit 3A. Generic / Specific Risk Questions will give different answers.

Any H&S risk consideration usually requires all or nearly all the details following:-

What is the risk of ……***person exposed***…...experiencing **…….*Consequence* of Interest or Concern** ….. while doing **…..*action / job / task***……exposed to**…….. *hazard / risk factor***…….at a …..***location*** …… using ……***plant / equipment / tool***….. with a……***method***……..under …….***adverse circumstances***……?

Examples *[also see sample templates – **Appendix 1**]*

Person exposed	*Employee / operator / contractor / visitor / member of the public / neighbor / passer-by*
Consequence	*Choose H&S Consequence Severity Scale*
Action / job / task	*Moving between decks*
Hazard / risk factor	*Falling down stairs*
Location	*On vessel MV22 / at position AAA*
Plant / equipment / tool /	*Ladder Type BBB*
Method	*Going front first – not backwards*
Adverse circumstances	*External Wet and Slippery – worn non-slip edges – inappropriate lighting – inappropriate footwear – carrying objects – no 3 point contact – inadequate hand-rail design - maintenance - impaired [sight / neuro-muscular control / reaction times / hand strength etc..]*

The following risk questions illustrate varying degrees of specificity for--*exposed person – type of action – location – type of agency etc.*

What is the risk of:

i) any person being killed due to falling down any stairs on any site?
ii) an employee being killed due to falling down any stairs on any site?
iii) a crew member being killed due to falling down any stairs on any site?
iv) Fred Smith being killed due to falling down any stairs on any site?
v) an employee being killed due to falling down stairwell Type Q23 on any site?
vi) an employee being killed due to falling down stairwell Type Q23 on site MV22?
vii) a crew member being killed due to falling down stairwell Type Q23 on any site?
viii) a crew member being killed due to falling down stairwell Type Q23 on site MV22?

ix) Fred Smith being killed due to falling down stairwell Type Q23 on any site?
x) Fred Smith being killed due to falling down stairwell Type Q23 on site MV22?
xi) an employee being killed due to falling down stairwell # NNN of Type Q23 on site MV22 [at entrance 4 between Floors A & B]?

Etc……

All the risk questions above are valid risk questions but different!

The assessment of the magnitude of each risk may or may not be helpful in decision-making re stair safety onboard a vessel. By far the most common problem in getting agreement with the risk question being assessed has been confusion between the terms *"event"* and *"scenario."*

This confusion is at the core of the problem of "generic" risk questions.

A *"scenario"* is the combination of multiple events and circumstances [risk factors etc] plus the Consequence itself that the assessors in the group consider as a credible way which can lead to the chosen Consequence of interest or concern. Stating one single event and a consequence as in Exhibit 3A is usually too generic and does not allow consistent meaningful risk assessment because of the unknown unstated risk factors being considered. If they remain unstated then individual assessors will interpret them as they please with resulting disagreements re likelihood and hence risk level. Unless each of a group of assessors is satisfied that they are considering the same risk scenario by formally – verbally and/or graphically – stating the agreed details of the risk scenario then the group cannot be confident that they will estimate similar risk levels.

The author continually reminds groups that if they assume without confirmation that other assessors are thinking about the same events and risk factors as being included then almost certainly they are not. Part 7 highlights the importance of objective discussion between group members whose first Likelihood estimates can differ significantly. That discussion almost always reveals that the variations are due to differences in interpretation of unspecified non-agreed– events and circumstances – of the considered risk scenario.

Exhibits 3B and 3C give examples of "scenarios," not just single "events". There is no time dimension in the vertical dimension – only logical linkages of cause / risk / effect.

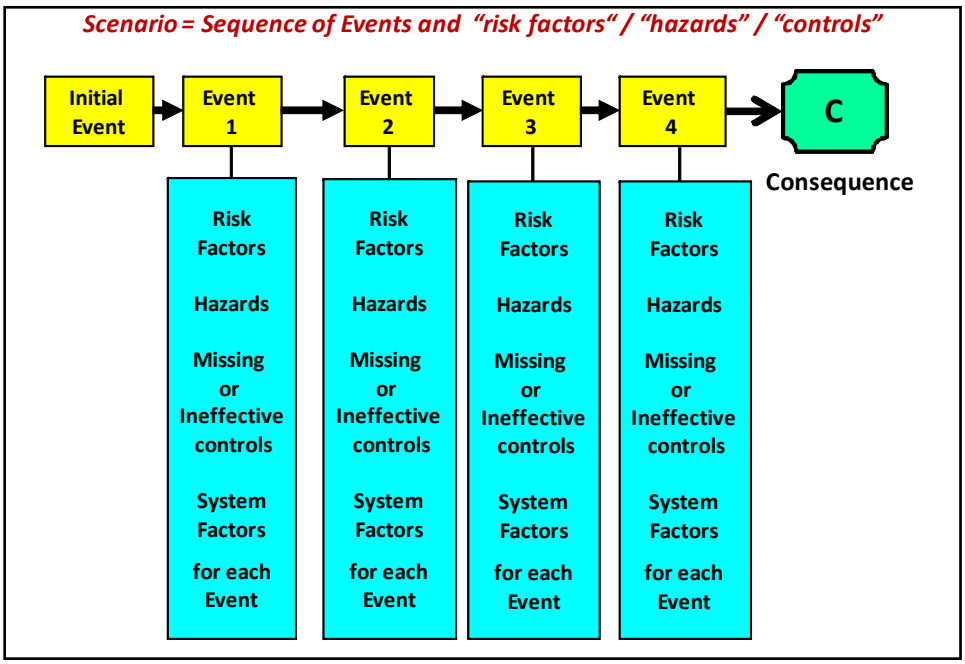

Exhibit 3B. Risk Scenario Map – Graphical Description of Scenario.

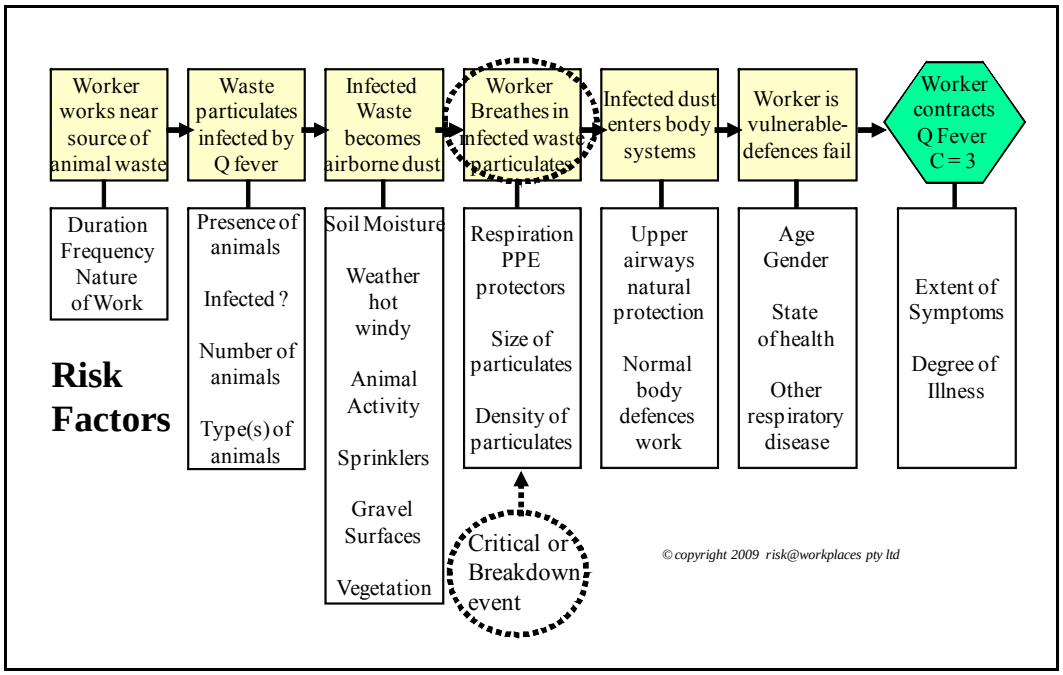

Exhibit 3C. Risk Scenario Map – Graphical Description of Scenario.

Part 4. Choosing – not Arguing about - a Consequence

In the Context / Scope / Identification stages of the risk management process, the risk question and risk criteria for the whole process need to be established. A common problem is "arguing about Consequences" – particularly in generic risk questions. This problem is related to lack of understanding and recognition that a single event may lead to different Consequences by following different subsequent events and circumstances-; but the same given scenario – by definition - cannot lead to different Consequences. A scenario includes all the events and circumstances and also the chosen Consequence. Any Consequence of Interest or Concern can be stated / chosen. If more than one Consequence of Interest or Concern is put forward by any member of the assessment team, then each must be analysed separately by agreeing on the risk scenario for each.

Different Consequences require different events and circumstances i.e. different scenarios.

Exhibit 4A shows an organisation's selection of a 6 point severity scale for different risk domains. Note that the author finds less variation of risk estimates by using only a numerical scale 1 → 6 for C and avoiding emotive verbal descriptors for its Severity. This approach reduces the chances of over-estimates of risk levels for high severity Consequences. As well, assessors are discouraged from rushing ahead to risk evaluation where questions of risk tolerability and response actions are considered solely on the basis of the emotive verbal descriptors for Consequence only rather the tolerability of a risk [both L and C]. It is not only the consequence that determines tolerability but also likelihood L of the scenario leading to that C. If L can be made low enough, then a risk involving a C of even 5 or 6 could be tolerable.

Category Rating		Cost ($) Property Damage/ Financial Loss	Personal Injury / Illness	Environment	Legal Liability	Public Perception
Score	Verbal					
6	Catastrophic	> $100 Million	Multiple fatalities / fatal illnesses	Large scale irreversible environmental harm.	Officer jailed. Corporate fine >$10M. Multiple third party claims totaling >$50M.	Forced shut down of major installation or curtailment of operations.
5	Disaster	$10 to 100 Million	Single fatality tal illness	Major release of pollutants. Significant, long term environmental harm. Release of pollutants to an extremely sensitive area.	Corporate fine $1-10M. Personnel fine. Multiple third party claims totaling $5M-50M.	Extended national/ international adverse media campaign. Parliamentary inquiry.
4	Major	$1 - 10 Million	Multiple serious injuries illnesses	Release of pollutants to sensitive areas. Immediate offsite contamination which is beyond the normal combatant resources available at site.	Corporate fine $100K-1M. Third party claim(s) $500K-5M.	Adverse national media coverage.
3	Serious	$100K To $1Million	Serious injury / illness (hospitalisation)	Contamination of property that may cause environmental harm minor off site contamination.	Corporate fine <$100K. Third party claim (s) $100K-500K.	Adverse capital city media coverage.
2	Minor	$10,000 to $100K	Medical (doctor Treatment	Contamination of property that does not constitute a threat to the environment.	Third party claim <$100K.	Local media coverage. Public (telephone) complaints.
1	Low	< $10,000	First Aid or less	Contamination occurs within the confines of protected areas and can be managed through normal operations.	Third party claim <$10,000.	Public normally unaware.

Avoid verbal descriptors for C – Use only for Risk

Exhibit 4A. Sample Consequence Scales for different risk domains. [Arbitrary, to be decided by the top policy making body in the organization. Be careful re comparison across domains.]

Exhibit 4B shows a particularly useful tool for assessors to agree on the H&S severity scale to be selected for various nominated Consequences of Interest or Concern [1 at a time].
The most common approach is to choose a C= 5 or C=3 as the first C of Interest / Concern.
N.B. There is no meaning to the term "the most likely Consequence." A Consequence is chosen; then a scenario needed to lead to that C is agreed and documented. Then an L likelihood of that scenario is estimated qualitatively or Semi-Q or full QRA as required.

C Scale	Nature of Harmful Effects					Response to Harm	
	Degree of Personal Harm	Examples of Types of Harm	Degree of Non-Fatal Harmful Effects Incapacity Disability Impairment	Duration of Non-Fatal Harmful Effects Discomfort / Pain Disability Impairment	Duration of Business Effects Disabling / Reduced Productivity / Alternate work / Lost time	Treatment Required	Required Administrative/ Regulatory Response
6	Multiple Fatalities / Incurable Fatal Illnesses			Where would estimate "extensive NIHL" - Industrial deafness - be classified ?			
5	Single Fatality / Incurable Fatal Illness		Irreversible TOTAL 100%	Indefinite / years	Indefinite / years		
4	Multiple Serious Injuries / Illnesses	Quadriplegia / complete loss of vision / hearing/ mobility	Irreversible partial > 30%	Enduring for months	Enduring for months	Hospitalisation – In-patient / long term / months extensive rehabilitation	
3	Single Serious Injury / Illness	Amputation / paralysis of a limb / severe burns loss of vision / hearing / mobility loss	Irreversible partial < 30%	Long term / >1 day < 1 week	Long Term >1 day < 1 week	Hospitalisation – In-patient / short term / days some rehabilitation	External Record & Report Required
2	Minor Injury / Illness	Cuts / burns / Strains / Sprains	Reversible partial > 30%	Short term < 1 day	Short Term < 1 day	Medical / Outpatient [Doctor] / limited rehabilitation	
1	Low Level Injury / Illness	Scratches / Bruises	Reversible partial < 30%	Temporary / Approx minutes	Temporary / Approx minutes	First Aid or Less	Internal Record Required

Exhibit 4B. Sample Consequence Scales for OH&S risk domain. [Arbitrary, to be decided by the top policy-making body in the organization. Always use first columns and others only on a needs basis.]

Part 5. Multi-Dimensional Likelihood Guidance

The author finds that most variation in likelihood estimates result from:

- lack of agreement on / and definition of the exact risk question / scenario being considered
- ignoring a number of events and factors just before the Consequence
- inadequate guidance on how to estimate L
- likelihood scales that confuse the difference between ***"possible"*** and ***"probable"***
- overemphasis on past history and bias due to personal / local experience – 2nd column below
- lack of identifying the critical, most sensitive risk factors and their probabilities
- lack of identifying all the existing risk controls – even if they are inadequate
- lack of recognition that many existing risk controls are not in place nor effective
- over-estimation of L – "*Murphy pessimism*" - due to lack of assessor experience

Most organisations using matrix methods usually use only a 3 or 4 or 5 level scale for L. The author finds that a 6 level scale gives a reasonable compromise that achieves reasonable discrimination. Often L scales try to include the word *"Possible"* e.g. *"Quite Possible*". This causes problems in estimation. The principle is adopted that ALL things are usually *"possible"* but whether the specified scenario to get there is *"probable"* or not is the actual risk question. Also *"possible"* is a 2 state YES / NO absolute term whereas *"probable"* or *"likely"* is the appropriate relative variable term needed. There are no degrees or ranges of *possibility* only degrees or ranges of *probability* or *likelihood.*

L Scale Estimate **L**	**VERBAL DESCRIPTORS** Defined sequence or scenario is the credible combination of events and risk factors / circumstances required to lead to the chosen Consequence. Likelihood estimate must consider the whole scenario including the chosen C	**PAST HISTORY / EXPERIENCE** **[refer to databases and risk registers]**	**EXPOSURE** **to Risk Factors** **measured in their effects and exposure time period – job duration or task time or operational time or lifetime**	**LIKELIHOOD** expressed as a **FREQUENCY** per year per climb per hour per km …. **The whole scenario including the chosen C could occur.....**	**LIKELIHOOD** expressed as a **PROBABILITY** 1 in 100 0.01 1 % 1E-02 **The whole scenario including the chosen C could occur.....**
6	**ALMOST CERTAIN** the defined sequence or scenario **can happen** because **ALL** risk events / risk factors would be **ALMOST CERTAIN** to occur or be present	Whole scenario incl C has been occurring **ALMOST ALL the time** in ours or similar organisations industries	**EXTREME EXPOSURE** because **ALL** Risk factors are present and **poorly** controlled throughout the **whole** of the time period	**AT LEAST DAILY** - or more often ~ **500 times per year** or more often	**Approx 1 chance in 1** **Or very close to every time** **100%**
5	**VERY LIKELY** **MOST risk factors** **VERY LIKELY to occur**	**Has been occurring VERY REGULARLY**	**VERY HIGH Exposure** **Most present** **not well controlled** **Most of the time period**	as often as **WEEKLY** ~ **50 times per year**	**Approx 1 chance in 10** **10% of the times**
4	**LIKELY** **MANY risk factors** **LIKELY to occur**	**Has been occurring REGULARLY**	**HIGH Exposure** **Many** present **only partly controlled** **Much** of the time period	as often as **MONTHLY** **~ 10 times per year**	**Approx 1 chance in 100 / 1%**
3	**UNLIKELY** **MANY risk factors** **UNLIKELY to occur**	**Has been occurring NOW AND THEN**	**MODERATE Exposure** **Many not present** **Well controlled** **Many** parts of the time	**as infrequently as ONCE PER YEAR**	**Approx 1 chance in 1000**
2	**VERY UNLIKELY** **MOST risk factors** **VERY UNLIKELY to occur**	**Has been occurring RARELY**	**LOW Exposure** **Most not present** **Well controlled** **most of the time period**	**as infrequently as ONCE IN 10 YEARS**	**Approx 1 chance in 10 000**
1	**ALMOST NO LIKELIHOOD** **ALMOST ALL risk factors** **VERY EXCEPTIONAL AND RARE to occur**	**Has been occurring ALMOST NEVER**	**VERY LOW Exposure** **Nearly ALL not present** **Well controlled** **Nearly ALL of the time**	**as infrequently as ONCE IN 100 YEARS** or even less	**Approx 1 chance in 100 000** **Or even less**

Exhibit 5. Multi-Dimensional L Scale for Guidance in Estimating L. Always use the first 2 columns and any others that may apply.

Part 6. Potential Confusion with Use of Colour in a Matrix

Consequence Scales can be ranked solely by number 1 → 6 in terms of different levels of Severity. Introducing colour and emotive verbal descriptors for C as well as Risk Levels can confuse assessors who start thinking tolerability – is risk tolerable ? Is risk ALARP? and other Risk Evaluation processes even BEFORE L likelihood and hence R = L*C has been estimated. It is best to keep colour out of even the matrix as in **Exhibit 6A.** Otherwise the matrix is being used for both "risk analysis" and "risk evaluation" stages of the process. Reserve colour for the tolerability/ action framework of **Exhibit 6B** as an indicator of risk ranking / prioritisation. Colours also can be helpful in indicating urgency of response actions required to match risk levels.

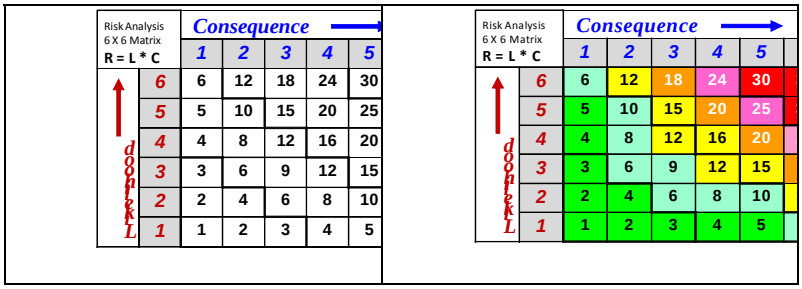

Exhibit 6A. 2d Matrix for Semi-Q Estimation of R = L * C.

Risk Score	*Risk* Descriptor	Risk Tolerability Criteria & Action Requirements		
30 - 36	*Extreme Risk*	***Intolerable*** *(stop exposure immediately)*		
24 - 29	*Very High Risk*	Specific PRA Programme/Plans & KSIR	Executive / Safety Council Approval *(required to continue risk exposure)*	May need full QRA Establish & implement appropriate mix of hard and soft controls according to the Hierarchy of *Risk* Controls and Cost-Benefit Analysis. Review their effectiveness.
18 - 23	*High Risk*		Divisional Manager/ General Manager Approval *(required to continue risk exposure)*	Establish & implement appropriate mix of hard and soft controls according to the Hierarchy of *Risk* Controls and Cost-Benefit Analysis. Review their effectiveness.
11 - 17	*Medium Risk*		Group Manager / Process Owner Approval *(required to continue risk exposure)*	Review existing controls for effectiveness Introduce new or changed *risk* controls if cost -benefit justifiable
6 - 10	*Low Risk*		Line Manager / Field Distribution Manager (or equivalent) Approval *(required to continue risk exposure)*	Continual Review of existing controls for effectiveness Introduce new or changed *risk* controls if cost -benefit justifiable
1 - 5	*Very Low Risk*		Supervisor/Coordinator (or equivalent) Approval *required to continue risk exposure)*	Continual Review of existing controls for effectiveness

Exhibit 6B. H&S Risk Tolerability & Action Framework.

Part 7. Facilitation Techniques for the Assessment Process

Consistency and reliability of risk assessment results are heavily reliant on the facilitation of the process. The author has found that the non-exhaustive list below represent the most important attributes of a successful facilitation process:

- maintain openness and intellectual honesty *avoid presumptions of outcomes]*
- as far as possible ensure maximum objectivity
- minimise negative personality effects *–e.g. seniority dominance*
- to include all stake-holder inputs, schedule multiple sessions if necessary
- ensure risk assessment group is a minimum of 3 participants *[< 6 at any one session]*
- ensure risk assessment group involves *"intelligent ignorants"* as well as *"knowledge experts"*
- allow open nomination of consequences of interest and concern without filtering *[Never allow arguments about Consequences – simply allow all – but explain how each one needs to be assessed separately – 1 at a time.]*
- spend as long as necessary on the context / scoping and identification stages as necessary before rushing into the analysis / estimation stage which can be brief if set up correctly
- Encourage *[when time and seriousness of risk allows]* the use of graphical risk scenario mapping as well as or instead of verbal description of the risk *[On-the-wall mapping really encourages participation and group agreement.]*
- ask for original individual written-down estimates of Likelihood BEFORE open discussion *[no right or wrong answers]*
- if first estimates of L are widely variable devote as much time as necessary for the group discussion needed to clarify what risk factors and words on the L Guidance Scale influenced the high / low estimators *[the Delphi technique works well and any variation always decreases as divergent interpretations of the risk question are resolved. The subsequent changes are not always towards the centre of the range.*
  ]
- clarify past historical data, personal experience / inexperience as well as *"Murphy pessimism"*
- emphasise that apparently small numbers such as 1% or 1 in 100 are actually large likelihoods *[avoid mathematical jargon such as exponential expressions]*
- ensure everyone agrees re difference between *"possible"* and *"probable"*

- remind group that scenarios ending in the most severe consequences usually require more risk controls to fail and/or be missing simultaneously and hence they are usually less likely

- Keep group focused on the objective – the sole use of risk scoring is for risk ranking and prioritization.

Part 8. Conclusion

The reliability and accuracy of the results of Semi-Quantitative Risk Analysis with 2 dimensional L*C Matrices and/or 3 dimensional C*E*P Tie-line Methods can be significantly improved by attention to the design of the tools themselves and the facilitation methods being used in the risk assessment process.

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Appendix 1. Risk Management Process Template

No task / activity can be commenced if risks to you and others are not managed to ALARP level.	
Risk Title (decide after Step1)	**Risk ID**
Assessors' Names	**Date**

Step 1 Establish the Context & Risk Question [START at any part of Step 1]

1.1 Business Activity		**1.2 Risk Category / Domain**	*CLICK Drop Down Selection*
1.3 Task / Job		**1.4 Specific Plant / Tool / Equipment**	
1.5 Exposed Persons / Property	*CLICK Drop Down Selection*	**1.6 Work Area**	
1.7 Relevant to other Organisation / areas	☐ Yes ☐ No	**1.8 Organisation Site / Location**	

Step 1B Communication & Consultation NOT a sequential Step – Communicating and Consulting with all stakeholders and involved / exposed persons at every stage of the process	
1B.1. Does a Communication & Consultation Plan exist for all stakeholders / involved persons?	☐ Yes ☐ No
1B.2. Does Communication & Consultation Plan include participation at commencement of process	☐ Yes ☐ No
1B.3. Does Communication & Consultation Plan cover every Step 1→6 of the process	☐ Yes ☐ No
1B.4. Who is responsible for implementing the Communication & Consultation Plan?	

Step 2 Risk Identification - the more detail here means the better / more accurate - the analysis later

2.1 Risk Consequence Of Most Interest or Concern	**in words**	**2.2 Select C** from Consequence Scale C= 1→ 6

2.3 Hazard Categories / Elements [Use brainstorming or checklists or memory aids]

CLICK Drop Down Selection.

2.4 Risk Description [verbal – in as much detail as possible regarding risk scenario consisting of all the events, hazard exposures, risk factors and failures of existing risk controls needed to credibly lead to the chosen Consequence] Use "due to"s and "because of" s]

Different consequences need different scenarios

2.5 Existing Risk Controls [always some existing controls - however weak or ineffective]

2.6 Sensitivity Analysis	Which existing risk controls are least effective?	Which hazard exposures are greatest?

2.7 File Links including Risk Scenario Map / Photos / Sketches / Diagrams / Logic Trees

[Draw a Risk Scenario Map definitely if above detail in 2.4 and 2.5 is inadequate for Group agreement]

Step 3 Risk Analysis of Risk Scenario which could lead to the chosen C with existing risk controls. Estimate is for the **Current Residual Risk Level.** Needs to be repeated at Step 5.10 later for new or improved risk controls i.e. the **Target Residual Risk Level**

NB estimate needs to include whole scenario including C. Some events and factors in the scenario could have high likelihoods but the estimate is for ALL of the scenario. One low likelihood for one dominant risk factor can make the overall Likelihood of the whole scenario quite small and vice versa. Don't allow personal past experiences - or lack of them – to dominate your estimate of future Likelihood. Past experiences have only predictive use fullness if circumstances have not changed.

3.1 Initial Qualitative Estimate of Risk –

Select **HIGH / MEDIUM / LOW** by group Delphi method

3.2 If all Qualitative estimates are LOW and 2.4 is thorough , you may choose to jump to Step 4 Risk Evaluation

3.3 Semi-Quantitative Analysis

Estimate L likelihood using Procedure #123 on how to use L Guidance Notes. [Use group Delphi method.] **L =**

If wide disagreement within group's estimates, return to Step 2 and refine and agree on all of Steps 2.4 – 2.5 and 2.6 above.. Is the whole group asking the same risk question?

3.4 Sensitivity Analysis

Which existing risk controls are least effective?	Which hazard exposures are greatest?	Are estimates in 3.3 realistic?
		☐ Yes ☐ No

3.5 Calculate Risk Score / Level

Using Matrix method **R = L * C** = [Part 3.3 X Part 2.2]

Step 4 Risk Evaluation

Refer to the organisation's **Risk Tolerability Criteria / Action Framework**

4.1 Is Risk Score = > intolerable risk?	☐ Yes ☐ No	If YES stop risk exposure immediately refer to your manager.
4.2 Is Risk Score enough to justify full QRA?	☐ Yes ☐ No	Refer to Appropriate level of manager.
4.3 Do all agree that Risk Level is ALARP? **A**s **L**ow **A**s **R**easonably **P**racticable**?**	☐ Yes	Refer to your manager. Appropriate level of manager needs to agree and sign off that risk level is ALARP. If YES – proceed to STEP 6 – Monitor & Review.
	☐ No	If NO – proceed to Step 5.

Step 5 Risk Control / Treatment

Refer to the **Risk Control Hierarchy** and any agreed **Cost-Benefit Criteria**

5.1 Date of Review of Risk Control Measures	/ /	**5.2 Repeat Step 3.4. Determine if the risk factors could change easily and need better controls.**	☐ Yes ☐ No

Step 5 Risk Control / Treatment

Refer to the **Risk Control Hierarchy** and any agreed **Cost-Benefit Criteria**

5.3 Summary of new or improved control measure options;

Include the nature of the effects of each option – will it affect Exposure? Probability? or Consequences C ? Or all 3? Control Measures which reduce Consequence [e.g. most PPE] are always necessary but measures which reduce Exposure and / or Probability are always needed and preferred as well.

5.4 Allocate a **Control ID** # for each Control Measure	**5.5** What is its **Category** in the Hierarchy of Controls?	**5.6** What is its **Element** in the Hierarchy of Controls?	**5.7** What is **Control Status**?
	CLICK Drop Down Selection.	*CLICK Drop Down Selection*.	*CLICK Drop Down Selection*.
	CLICK Drop Down Selection.	*CLICK Drop Down Selection*.	*CLICK Drop Down Selection*.
	CLICK Drop Down Selection.	*CLICK Drop Down Selection*.	*CLICK Drop Down Selection*.

Step 5 Risk Control / Treatment

Refer to the **Risk Control Hierarchy** and any agreed **Cost-Benefit Criteria**

5.8 Final Chosen Control Measures - Detailed Descriptions – for new or improved control measures **as agreed with manager.**

5.9 For each Control Measure, detail any **File Links to Related Items** such as Cost – Benefit Comparisons / Specifications / Photos / Sketches of the Control Measures.

Step 5 Risk Control / Treatment

Refer to the **Risk Control Hierarchy** and any agreed **Cost-Benefit Criteria**

5.10 Before final planning and implementation- remember that new or changed controls can introduce new and often unintended risks of their own.

Return to Steps 2.4 → 2.6 to start to re-assess new risk levels with assumption that new improved control measures are in place. What is the new answer to Question 3.5?

The new **proposed Target Residual Level** R= L * C

The new **Proposed Target Residual Level** with the proposed new or improved control measures must be assessed before implementation. After any changed control measures are in place, any new assessment will give a new **Current Residual Risk level**.

What is the new answer to Question 4.3? ☐ Yes ☐ No

The process needs to loop back to 2.4 as often as necessary and cannot be finished until there is a YES answer to Question 4.3.

5.11 Risk Control / Treatment Plan with **Action Priorities** for each Control Measure**, Implementations / Action checks** assigned - [This information could be entered directly into ACTION MODULE of the group's Risk Register.]

By Whom?	By When?	Is control in use and effective?	Suggested Review Frequency

Step 6 Record, Monitor & Review

[This information could be entered directly into your Risk Register]

Precautionary Note: Situations / events / circumstances / risk factors are continuously changing. Even a LOW risk can become HIGH quickly such as in the period between writing a **Work Procedure** and a **pre-job** review on-site. Similarly **during** any task/activity, risk circumstances need monitoring. Hence no risk can ever be regarded and referred to as **static** or **negligible** or even **passively acceptable**. Diligent / vigilant / comprehensive review of risks is everyone's responsibility and challenge.

6.1. Is each control measure continuing to be in use and effective?

Verification and **Validation Action** checks assigned.

By Whom?	By When?	Is control in use and effective?	Suggested Review Frequency