Advanced Risk Assessment

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1. Introduction

This discussion paper aims to help you recognise and conduct more effective risk assessments by explaining some of the more advanced principles of Risk Quantification and cost effective risk reduction.

This paper follows on from the Riskcentral on line training module "How to do a Risk Assessment". It is recommended that you complete this training module before reading this paper. You can complete this module for fee at riskcentral.com.au.

For important, larger or complex risk issues please consult a professional risk consultant or relevant references.

2. The Purpose of a Risk Assessment

In your working life you have, no doubt, experienced a large number of situations where you have been exposed to the idea of risk reduction or risk control. In these situations the phrases "Risk Assessment" and "Risk Management" may have been used but these terms are used far too loosely. In order to understand why, we will need to understand the real meaning of these terms.

The history of managing risk has been about:

- Relying on personal experience to determine how important individual risks are – ie. Making sure you don't make the same mistake twice.
- Subjective assessment of how big or important risks are.

- Relying on personal experience to determine what the appropriate controls are – ie. I have been doing it this way for 10 years and nothing has ever gone wrong.
- Subjective assessment of how acceptable risk levels are or how effective controls are.
- Make sure everything is insured – ie. Risk Management = Insurance.
- Have an Emergency Response Plan - ie. Re-active rather than preventive.
- Comply with all statutory requirements – ie. Rely on the government tell you how to manage your business risks.
- Rely on prescriptive controls or industry norms rather than performance based controls – ie. If we do what everyone else does we can't get in too much trouble.

The reliance on only these types of approaches led to ad hoc, fragmented and inefficient risk management systems that often overlooked some of the biggest risks to business objectives. These approaches lead to over control of some risks and under control or ineffective control of others.

The individual approaches themselves where not to blame. There is nothing inherently wrong with any of the individual approaches above and they all have their part to play in a risk management system. They simply lack an overseeing system or principle to ensure that:

- All significant risks are identified.
- Resources are appropriately allocated to manage risks based on size or their importance to the business.
- The best controls are selected and implemented to cost effectively reduce risks to acceptable levels.

In other words, a system which will direct resources to the areas of most need and spend them in ways that do the most good, to get the best possible outcomes.

The new phrases invented to name this overseeing system or principle was "Risk Assessment" and "Risk Management". These are relatively new terms in the English language. This new idea was about objectively determining the most cost effective way of ensuring that risk levels and therefore controls, are acceptable and appropriate. This process has a number of steps outlined below but the two most important steps are risk quantification and determining appropriate controls.

Quantification is the step by which we measure how large and important each risk is, relative to each other. This allows us to prioritise risks for attention and appropriately allocate resources between the risks to manage them. Determining appropriate controls for each risk involves a process which considers what would be an acceptable level of risk and which controls would most cost effectively reduce risk.

Most of the situations where you have experienced the phrases "Risk Assessment" and "Risk Management" have not involved a creditable or accurate quantification or control selection process and so these terms have not been properly used. This discussion paper will allow you to recognise and develop more valuable "Risk Assessments" and "Risk Management" processes.

The purpose or objective of a risk assessment is a very important place to start. The purpose of a risk assessment is to objectively determine the most cost effective way of ensuring that risk levels, and therefore controls, are acceptable and appropriate.

A lot of so called Risk Assessment processes have very little chance of ever delivering any real value because the real objectives have little to do with effectively managing risk. Some examples that are regularly seen are:

- Objective of Risk Assessment is to achieve compliance, compulsory procedure or prerequisite – to get the tick in the box.
- Objective of Risk Assessment is to cover some ones back side. Something to point to if something goes wrong.
- Objective of Risk Assessment is to obtain funds for a pet project, for a department, for more staff, to keep some ones job or to increase the importance of some ones job or department.
- Objective of Risk Assessment is to validate some ones pre existing opinion.

Companies regularly waste millions of dollars, waste peoples time and stifle productivity because risk assessments have the wrong objectives. These inappropriate risk assessment processes also have the effect of leaving a bad taste in people's mouths. If someone has been made to use or subjected to a bad risk assessment processes they will associate this bad process with the phrase "Risk Assessment", thus making it more difficult to get them interested in participating in a more productive risk assessment process next time.

The good news is these bad outcomes, caused by the wrong objectives, are remarkably easy to avoid by using the right risk quantification and control selection tools. The appropriate tools will make it much harder for a risk assessment to support an improper agenda and will have risk assessments delivering value, even if the only reason they are being done is for compliance.

Even better news is with a little bit of experience and practice the right tools are easier to use and definitely make more sense than the tools you are probably using now.

A Risk Assessment should include the following steps:

Step 1 - Context	Before we start we must set the Context of the Risk Assessment.
Step 2 – Identification	Identify all significant risks to objectives or goals. (In order to do this you must first identify what are the relevant objectives, then what are the risks to these objectives.)
Step 3 - Quantification	Estimate the size of risks. (This will allow us to compare and prioritize risks for attention and reduction, based on size.)
Step 4 - Control	Decide on the most effective, acceptable and appropriate controls for each risk, based on: ▪ the size of the risk ▪ the acceptable or tolerable levels of risk ▪ how much each proposed control will reduce the risk ▪ and how the cost of the control compares with the potential risk reduction. Ie.- the cost benefit ratio of the control.
Step 5 – Responsibility	Nominate a person to be responsible for managing each significant risk.

As stated earlier, the two most important steps are risk quantification (Step 3) and determining appropriate controls (Step 4). These steps are also normally the least understood and most poorly conceived steps in most risk assessments. The next two sections will discuss the right methods and tools to use in your risk assessments.

3. Better Risk Quantification

3.1. The nature of a Risk Profile

Risk of a possible event occurring equals the consequence of that event occurring multiplied by the likelihood of that event occurring.

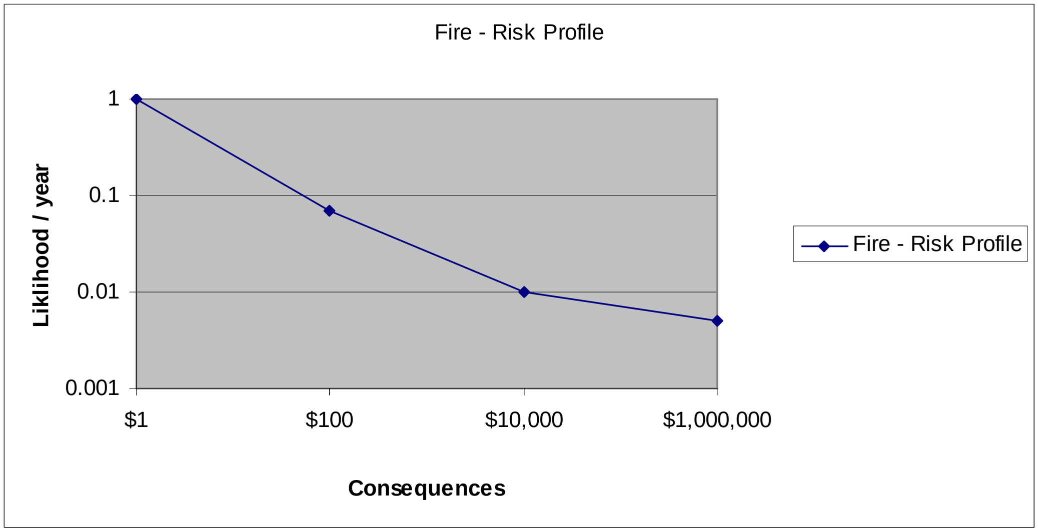
Risk level = Consequence x Likelihood

This equation is derived from natural science much like "Speed x Time = Distance". If the risk quantification tool used is not based on this equation than it will not be accurate.

So in order to estimate the risk level of a particular scenario we need to estimate the consequences of that scenario and the likelihood of that particular consequence occurring. The product of these two estimates is the estimated risk level.

> **Example Calculation:** Risk of burning down a $1,000,000 building.
>
> Consequences of burning the building = $1,000,000.
>
> Likelihood of $1,000,000 consequence (fire), lets say = 0.005 per year (0.5% per year).
>
> Therefore Risk = C x L = $1,000,000 x 0.005/y = $5,000/y.

This is called a single point risk estimation or quantification. However, most risks are not a point but are actually a curve on a Consequences Vs Likelihood graph or a risk profile. To illustrate this point, if we were to more accurately quantify the risk of fire to a $1,000,000 building, we would have to quantify the likelihood of a fire doing $100 damage to the building, $10,000 damage to the building, $1,000,000 damage to the building and every possible consequence in between. If we developed this profile it might look something like below.



This type of graph agrees with our personal experience of risk and loss – ie. That a possible risk scenario can have multiple outcomes ranging from a small loss to a large loss and that typically the smaller losses are more likely than the larger losses. For example a fire in a building is more likely to be extinguished when it is small, than burn down the whole building.

In this risk profile the risk level is actually represented by the area under the curve. This leaves us with a bit of a problem because not only is the curve a much more time consuming to estimate than a point but it is also much harder to estimate the area under the curve than the simple C x L calculation for a point.

3.2. The Value Proposition

If we are to cost effectively manage risk, than we can't spend large amounts of time quantifying every risk. On the other hand we have to quantify risks accurately enough to appropriately allocate resources between them and help us make decisions on which controls cost effectively reduce the risks to acceptable levels.

This is where the value proposition comes in. In general, the business value proposition is "Not to invest more in something than you are going to get back out of it" – ie. The value you get out has to be bigger than the value you put in. In the context of risk quantification this means the time and effort you send estimating the size of a risk should be proportionate to the value you can get back from conducting the risk assessment.

If risks are very large or potential controls are expensive, than you could potentially justify conducting a more sophisticated risk assessment because you could save a lot of money (or gain a lot of value). As risks and control costs get smaller, than only simpler risk assessments can be justified. Until risks get so small that a risk assessment can not be justified at all.

Value Proposition - The sophistication of any risk assessment must be proportionate to the size of risk, cost of controls or the value which could be gained from conducting the risk assessment.

3.3. Choosing the Right Quantification Method

There are lots of methods to quantify a risk. These different methods deliver different levels of accuracy. The objective is to use the method that delivers a level of accuracy, appropriate for the risk at hand, with the least amount of effort.

We can break up the various methods into two groups:

- Single point on the curve estimations – where we only estimate one point on the risk profile curve and use this as an estimation of the area under the curve.
- Multiple point estimations – where we estimate multiple points on the curve to approximate the curve and then estimate the area under the approximate curve.

In practice, single point estimations are normally accurate enough for most risks except for some very large risks or risks with expensive potential controls. In any case, it is a good idea to start with a single point risk quantification to filter the large risks from the smaller ones. You can then use more sophisticated methods on the larger risks if warranted.

3.4. Increasing Quantification Accuracy with No Extra Effort.

There are an endless variety of risk quantification methods being used. The accuracy of most of these methods, even those used by most risk consultants, is very disappointing. Risk quantification is designed to intelligently allocate resources based on need. If the risk quantification method used delivers inaccurate, misleading or incorrect results, this will lead to a misallocation of resources. Exactly the same problem we were tying to avoid by conducting a risk assessment in the first place.

Even more frustrating, is that most of time, with the right training, it takes no longer to do a good risk assessment, than it takes to do a bad risk one. It is therefore of primary importance that the method used is as accurate as we can reasonably make it.

The most accurate single point method is the use of a number and unit to estimate consequences ($ is recommended) and a number and unit to estimate likelihood (likelihood per year is recommended). The estimates are then placed in the equation C x L = R. The unit for risk then becomes $/y. This method, after a little bit of training, is also the easiest to use and does not require any additional tools such as a Matrix.

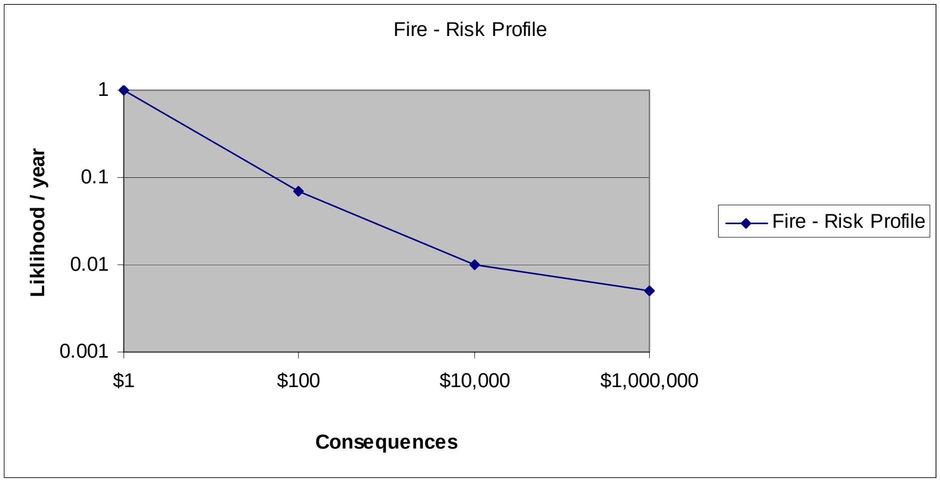
The previous example calculation is repeated below as an example.

> **Example Calculation:** Risk of burning down a $1,000,000 building.
>
> Consequences of burning the building = $1,000,000.
>
> Likelihood of $1,000,000 consequence (fire), lets say = 0.005 per year (0.5% per year).
>
> Therefore Risk = C x L = $1,000,000 x 0.005/y = $5,000/y.

Having risk estimated risk in terms of $/y is obviously very useful as it size is easily compared with other risks and other business expenses and revenues. It also allows for quantitative cost benefit analysis and the inclusion of risk as a real number into numerous other accounting and financial models.

For example, using the method above, it is easy to see if a risk is 2 times or 1,000 times bigger than another risk. This allows for more accurate allocation of resources to manage and control the risk. Other quantification methods would give you no idea of the absolute size of a risk nor its size compared to other risks.

Because we are using one point to approximate the area under the risk profile curve, the point with the highest risk value should be used – ie. the highest product of consequence and likelihood value. For example, should we pick the point with a $1,000,000 consequence or the point with a $10,000 consequence to approximate the risk profile. It may take a bit of practice to develop an intuition as to which point will have the highest risk level but if you are in doubt and the risk is important enough (remember the value proposition) estimate other points on the curve to determine which has the highest risk value.



3.5. Fundamental Quantification Method Errors

Estimating the Likelihood of a Lesser Consequence

A common reason for over estimation of risk levels is estimating the likelihood of a scenario before estimating the consequences of a scenario. This often causes over estimation because you may not be estimating the likelihood of a lesser consequence.

For example the likelihood of a fire (a minor fire) in the building maybe 20% per year, while the likelihood of a fire which destroys the building maybe 1% per year. If we used the likelihood of a fire (20%) in our calculations rather than the likelihood of fire burning down the building (1%) we would be over estimating the fire risk level by a factor of 20. Only use the likelihood of incurring the consequences you have previously estimated.

Over estimation of the likelihood will lead to over estimation of the risk. To avoid this always estimate the consequence before the likelihood as described previously.

Measuring Inherent Risk

Inherent risk is defined as the risk level without controls in place. In the past trying to quantify Inherent Risk was a popular method of conducting risk assessments but it is now much less popular as people have come to understand it is flawed.

The Inherent Risk method is flawed for a number of reasons including:

- The purpose of a Risk Assessment is to help allocated resources based on the needs of the actual business environment. If we artificially remove controls, we are not measuring the actual environment. We are measuring an artificial one, which then doesn't resemble the actual one.

- The past proponents of this method argued that because controls could fail, the inherent risk gave a better picture of what would happen if controls failed. But again this is not the real world. If you are quantifying the current (actual) risk level correctly the estimation of the likelihood of incurring a particular consequence should take into account the probability of controls failing.
- In practice it was difficult to decide which controls to remove because each risk has a large number of tangible, less tangible, direct and indirect controls. How many controls do we remove? For example peoples' common sense is a control for a lot of risks. Do we remove that as a control?

Not Including all Areas of Impact

Make sure all the consequences of a possible event are included in the estimation of the consequences. For example: injuries, lost assets, lost revenue, loss of reputation, environmental losses and legal losses. If you leave any consequences out you will understate the consequences and the risk level.

In order for the consequences to be added together they must all be measured in the same units. Some of these consequences are not easily measured in $ but this is essential if the assessment is to help allocate resources between all types of risks.

A table is provided in the appendix as a guide to measuring different types of impacts in terms of dollars. Also there is a technique which maybe helpful. For consequences like reputation you can ask yourself how much your organisation would pay for the event or consequence not to occur.

The issue of valuing human risk will be discussed in the next section.

3.6. The Risk Quantification Matrix

The risk quantification matrix is a very popular risk quantification tool. The matrix can be reasonably accurate or very inaccurate depending on how the matrix is designed. This is because an improperly designed matrix can easily introduce a number of significant mathematical errors. Most of the time, the designers and users of the matrix are unaware of these errors and so this leads to a misallocation of resources. Some potential matrix errors include:

Qualitative matrix – These matrixes measure consequences and likelihood in terms of words only, without defining the words with units. Measuring consequences and likelihood in terms of words is highly subjective. This type of matrix is widely used and is so inaccurate it is likely to lead to misallocation of resources and is of little value in control selection.

Example Qualitative Matrix

Likelihood		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
	Almost Certain	5	6	7	8	9
	Likely	4	5	6	7	8
	Possible	3	4	5	6	7
	Unlikely	2	3	4	5	6
	Rare	1	2	3	4	5

- Extreme
- High
- Moderate
- Low

Scaling errors – These errors are introduced if the matrix has uneven or inconsistent consequences and likelihood scales. The errors are also introduced if the risks are positioned on the boundaries of the consequence and likelihood scales. These are due to mathematical inconsistencies introduced by mis-designed scales. This problem is present in most matrixes. Please see the matrix listed in the appendix of this document for an example matrix which eliminates these errors in most cases.

Scaling band width approximations – These inaccuracies are due to the band width of the consequence and likelihood categories – eg from below - Moderate = $250k to $1M. This band width means that risks, which maybe orders of magnitude different in size, are given the same risk ranking. For example using the matrix below it is possible that a $50,000 per year risk ($1M x 1/20y) and a $50 per year risk ($250k x 1/5,000y) are both called a level 3 risk.

Example Matrix with Scaling and Band Width Approximation Errors

Likelihood		Insignificant <$100k	Minor $100k-$250M	Moderate $250k - $1M	Major $1M - $5M	Catastrophic > $5M
	Almost Certain > 1 : 1y	5	6	7	8	9
	Likely 1 : 1y	4	5	6	7	8
	Possible 1 : 5y	3	4	5	6	7
	Unlikely 1 : 10y	2	3	4	5	6
	Rare < 1 : 30y	1	2	3	4	5
		Consequence				

- Extreme
- High
- Moderate
- Low

Because of these problems a Matrix should not be used for large or important risk issues. If a matrix is to be used it should not be a Qualitative Matrix and it should be designed to reduce scaling errors.

Risk Quantification has a number of inaccuracies and uncertainties that can not be overcome, like the estimation of the likelihood of an event occurring. Intentionally introducing more error and less accuracy with the use of a Matrix has to be considered carefully because the results from the Matrix may be in accurate and lead to a misallocation of resources.

4. Determining the Most Appropriate Controls

Before we can determine what Controls are appropriate we must first define what “Appropriate” means. This is not a simple question in some instances, but in this section we will give some guidelines to determine what “Appropriate” should mean.

In general if controls are considered appropriate then it follows that risk levels should be considered appropriate and vica versa. In order to be considered appropriate a risk level and controls have to pass the two criteria given below in the order shown.

1. The risk level has to be considered generally acceptable or tolerable by the stakeholders.
2. The risk level can not be reasonably (cost effectively) reduced any further.

4.1. Types of Risk Controls

Risk Controls can be split into four groups based upon how they control risk:

- Risk Reduction – altering consequences or likelihood.
- Risk Transfer – via insurance or other contracts.
- Risk Finance – hedging or putting money away for a rainy day.
- Avoid or postpone – that is to say, actively avoid a risk. Ignoring a risk is not an appropriate option.

Risk reduction or avoiding a risk should generally be the first controls to be considered, with the other types of controls being used only when risk reduction or avoiding is not effective or economic.

This is because, theoretically insurance does not actually reduce the cost of risk, it just makes the costs more predictable – ie. smooths out cash flow. Insurance is still a very important part of the risk management process but it should normally only be considered after the risk assessment process is complete. Ie. - a umbrella over the risk assessment and control selection process in case everything else goes wrong and catastrophe occurs. Also worth noting, the actual costs to your business of a loss are normally much greater than what is covered by insurance and if you do have a loss, insurance companies will normally rase premiums in an effort to get their money back.

Risk controls can be preventive, responsive or recovery in nature.

- Preventive – prevent the event from occurring.
- Responsive – reducing initial impact if an event does occur. Eg. - Fire suppression systems.

- Recovery - Plans to improve recovery and reduce impact. Eg. - Business continuity plans.

Care should be taken to ensure that all control options are considered. Only then should the most appropriate mix of controls be determined.

4.2. Appropriate Business Risk Controls

In most instances, for Business Risk, the stakeholders will find the risk level acceptable or tolerable if the risk level can not be cost effectively reduced any further. This is assuming of course that the return for bearing the risk is acceptable.

Therefore appropriate business risk controls can be defined as controls which cost effectively reduce risk – ie the value of the risk reduction is more than the cost of the control. Quantifying risk in terms of $/y makes it easy to objectively develop a cost benefit analysis on a potential control. An example is outlined below.

Example Cost Benefit Calculation:

Example Calculation: Risk of burning down a $1,000,000 building.

Consequences of burning the building = $1,000,000.

Likelihood of $1,000,000 consequence (fire), lets say = 0.005 per year (0.5% per year).

Therefore Risk = C x L = $1,000,000 x 0.005/y = $5,000/y.

Potential Control: Sprinkler fire suppression system costing $200,000.

Hypothetical Risk Level if Sprinkler system was installed:
Sprinkler system would reduce the likelihood of burning down the building from 0.005 per year to 0.0001 per year (0.01%).

Therefore Risk if sprinkler system was installed
= C x L = $1,000,000 x 0.0001/y = $100/y.

Potential Risk Reduction = $5,000/y - $100/y = $4,900/y.

Cost benefit Analysis: Payback Period
Cost / Benefit = $200,000 / $4,900/y = about 40 years.

Analysis suggests, in this imaginary situation, sprinklers may not be a cost effective control. We should consider and test other more cost effective control options.

Note: In a real life situation it maybe worth while conducting a multiple point risk estimation and cost benefit analysis because the potential control is a high value - eg. $200,000.

In a situation when we are dealing with multiple risks and multiple potential controls, the payback period can be used in a number of ways to help make expenditure decisions. For instance a payback period cut off could be used –eg. any potential control with a payback period under 2 year would be implemented. Over 2 year would not.

Alternatively, if there is a set budget for expenditure on risk reduction the potential controls could be listed in order from smallest payback period to longest. Then starting at the top of the list, work down adding up the cost of controls until the budget has been exhausted. This would ensure the biggest risk reduction for the money spent.

There are many other ways which a list of controls and payback periods can be used to help make decisions on what controls are appropriate.

4.3. Appropriate Safety Controls

The objective of any heath and safety system should be to have no fatalities and no injuries. In reality there is always going to be risk of a fatality or injury at a work site. So the best chance of reaching a zero injury objective is to make the probability of injury as low as possible. In any case this will give use the best possible outcome – ie the lowest injury rate. In order to get the best possible outcome we must use the principles of Risk Assessment which will direct resources to the areas of most need and where they can do the most good. This requires a more effective approach to safety risk assessment and safety risk quantification than most businesses use at the moment.

What is an acceptable safety level?

We have a moral and statutory obligation not to subject employees and the public to unacceptable or intolerable injury and fatality risk. The problem becomes dealing with the question of what is acceptable or tolerable. The Heath and Safety Commission of the UK and the New South Wales – Department of Urban Affairs and Planning have published guidelines as to what risk levels are generally acceptable for different individual members of the community. These are summarised below.

Table: Acceptable Risk Levels – NSW DUAP

Land Use	Acceptable Individual Fatality Risk Levels – Guide
Hospitals, schools, child-care, old age housing	Half in a million chance per year - 0.5×10^{-6} per year
Residential, hotels, resorts	One in a million chance per year - 1×10^{-6} per year
Commercial properties, offices, retail, showrooms, restaurants, entertainment centres	5 in a million chance per year - 5×10^{-6} per year
Sporting complexes, active open spaces	10 in a million chance per year - 10×10^{-6} per year
Industrial Sites	50 in a million chance per year - 50×10^{-6} per year

Table: Acceptable Risk Levels – UK HSC

Land Use	Acceptable Individual Fatally Risk Levels – Guide
Any area	One in a million chance per year - 1×10^{-6} per year

In order to put the above risk levels into perspective the table below shows some risk levels to the general population and to specific workers.

Table: Average Actual Risks to Individuals in the Community

Risk	Acceptable Individual Fatally Risk Levels – Guide (chances in a million per year)	Acceptable Individual Fatally Risk Levels – Guide (Chance per year)
Voluntary Risks		
Smoking	5,000	1 in **200**
Drinking	380	1 in **2,632**
Swimming	50	1 in **20,000**
Transportation Risks		
Driving	145	1 in **6,897**
Flying	10	1 in **100,000**
General Risks to Population		
Cancer	1800	1 in **556**
Being at Home	110	1 in **9,091**
Run over	35	1 in **28,571**
Murdered	20	1 in **50,000**
Fire	10	1 in **100,000**
Electrocution (non industrial)	3	1 in **333,333**
Lightning	0.1	1 in **10,000,000**
Employment Risks		
All employment	55	1 in **18,182**
Truck Drivers	470	1 in **2,128**
Miners	450	1 in **2,222**
Farmers	250	1 in **4,000**
Forestry	1130	1 in **885**
Construction	100	1 in **10,000**

You can see from these figures the actual risk levels are generally much higher than acceptable risk guidelines. This is to be expected because these acceptable levels are targets meant to inspire improvements in safety levels. If risks are actually lower than these guidelines it is unlikely that the risks can be cost effectively reduced further so in general risks this small should not be subject to an analysis to see if the risk can be reasonably reduced further.

The UK HSC also publishes tolerable risk levels which are listed in the table below.

Table: Tolerable Risk Levels – UK HSC

Activity	Acceptable Individual Fatally Risk Levels – Guide
Workers	One thousand in a million chance per year - $1{,}000 \times 10^{-6}$ per year
Members of the Public	One hundred in a million chance per year - 100×10^{-6} per year

These levels are an estimate of the level at which the general community will not tolerate any additional (non voluntary) risk. These levels are more in line with actual risk values.

So in general, individual safety risks which are higher than these tolerable levels should be avoided at any cost. Risk which are smaller than these tolerable levels but larger than the acceptable levels, should be subject of further analysis to determine if they can be cost effectively reduced. Risks which are smaller than the acceptable levels are unlikely to be reduced any further cost effectively.

NOTE: Individual risk above refers to the probability of a particular individual suffering a fatality or injury. This should not be confused with the probability of someone in a group suffering a fatality. This is called Societal Risk. The probability of someone in a group suffering a fatality is higher, because there are more people exposed, than the probability of an individual in that group suffering a fatality. There is no generally agreed Societal Risk tolerability levels and the development of such levels for individual sites and companies is complex and beyond the scope of this document.

Cost Benefit Analysis for Safety Controls

In most businesses, most safety controls are not subject to cost benefit analysis except for perhaps a subjective process. Because there is no objective process to determine where resources will do the most good, it is inevitable that resources will be misallocated. This means that safety risk levels will be higher than they would be if the resources were spent to most effectively reduce risk.

In order to objectively conduct cost benefit analysis on safety controls we must quantify risk in terms of dollars per year. This also allows us to objectively allocate money between business risks and safety risk issues.

To calculate a safety risk in terms of dollars per year we need to establish dollar values for injuries and fatalities. By doing this we are not trying to value a human life, we are valuing a safety risk. We have already established that it is unacceptable to place individuals at a high probability of injury or fatality and so we are only trying to value safety risks at low probability levels. The high probability risks are not acceptable and should generally be reduced or avoided at any cost.

Traditionally, when doing risk quantifications like this, government organisations and other businesses, have used a dollar value of between $1,000,000 and $5,000,000 for a fatality. Injuries are valued according to there seriousness. The "Risk Assessment Guide" in the appendix can be used as a guide to valuing safety risk.

NOTE: Safety risk is the risk inherent in human life and health. Additional dollar consequences associated with injuries such as fines, hospital costs, rehabilitation costs, legal costs, etc should be added to the safety value to calculate the entire consequence of the potential loss scenario.

5. Appendix

Over "Risk Assessment Guide" – from Riskcentral on line training module – "How to do a Risk Assessment" – located at www.riskcentral.com.au

"Risk Assessment Guide" for the training module "How to do a risk assessment"

Use the riskcentral "How to Complete a Risk Assessment" training module for instruction on completing a risk register. The primary document outcome of the a risk assessment is a risk register. An example risk register template is located below. An excel version of the template is also available from the riskcentral.com.au.

Example Risk Register Template

Risk Register [Name]							
Objectives at Risk			Who's Perspective			Scope	
Risk ID.	Risk Description (what could possibly happen) -Scenario -Consequences -Timing / Timeframes	Existing Controls	Consequences ($)	Likelihood (1/y) (eg. 1 in 100 each year)	Risk Level ($ each year)	Potential Risk Controls (Controls, Studies for Consideration or implementation)	Responsibility

Directions for evaluating a risk level:

1. Estimate the appropriate consequence level of the loss scenario being evaluated, using the "Consequence Estimation Table' as a guide.
2. Estimate the likelihood of the loss scenario being evaluated – ie. the likelihood of chosen consequences occurring.
3. Use the Risk Matrix to determine the estimated level of risk

The following table can be used as a guide to estimating and combining the consequences of different impacts of a loss scenario. In this way we can estimate the total impact of an event and determine the appropriate consequence level in the "Risk Matrix". **NOTE:** The use of the matrix to calculate **injury risk levels** is only appropriate when the likelihoods of an event is appropriately low. Risks with higher likelihoods may not be tolerable. **Injury risks which are not considered tolerable should be reduced to acceptable levels or avoided.**

Consequence Estimation Table

Area of Impact	Consequence Level					
	$1,000	**$10,000**	**$100,000**	**$1M**	**$10M**	**$100M**
Injury (Note – Safety risks which are not tolerable should be reduced or avoided at any cost)	• Minor disabling injuries for <3 days • eg sprained ankle • First aid treatment • **NOTE** if the likelihood of this consequence is higher than appropriate, the risk may **not be tolerable**	• Minor disabling injuries for > 3 days < 60days • Medical treatment required • **NOTE** if the likelihood of this consequence is higher than appropriate, the risk may **not be tolerable**	• Permanent minor injuries • Major disabling injuries for > 60 days • **NOTE** if the likelihood of this consequence is higher than appropriate, the risk may **not be tolerable**	• Death • Permanent major disabling injuries • Multiple permanent minor injuries • **NOTE** if the likelihood of this consequence is higher than appropriate, the risk may **not be tolerable**	• Multiple deaths • Multiple permanent major injuries • **NOTE** if the likelihood of this consequence is higher than appropriate, the risk may **not be tolerable**	• Ten's of deaths • Ten's of permanent major injuries • **NOTE** if the likelihood of this consequence is higher than appropriate, the risk may **not be tolerable**
Assets and Profit	• Financial loss of $1000	• Financial loss of $10,000	• Financial loss of $100,000	• Financial loss of $1M	• Financial loss of $10M	• Financial loss of $100M
Community / Reputation / Political	• Isolated adverse local media reference • Public (telephone) complaints • General query by a government department	• Repeated adverse local media coverage • Subject to adverse critical political reference • Specific query by government easily answered	• Sustained adverse local / national media campaign • Subject to political criticism • Specific query by government requiring business judgement	• Forced shutdown of major project site • Extended national adverse media campaign • Parliamentary inquiry	• Abandonment of project • Permanent closure by government • Extended international / national adverse media campaign	• Major international scandal • Collapse of Organisation / Corporation
Environmental	• Transient situations under control eg. waste material awaiting disposal	• Unlicensed and unplanned on-site release immediately contained1	• Any on-site release contained with outside assistance • Unlicensed off-site release with no detrimental effects	• Unlicensed off-site release with detrimental effects • Unlicensed off-site release with detrimental effects and but no residual impact	• Unlicensed toxic release off site with detrimental effects and residual impact • Serious breach of License conditions	• Major toxic release off site • Destruction of a major ecosystem
Legal	• Civil claims of $1,000	• Corporate fine of $10,000 • Civil claims of $10,000	• Corporate fine of $100,000 • Civil claims of $100,000	• Corporate fine of $1M • Personal fine • Civil claims of $1M	• Company officer jailed • Corporate fine of $10M • Civil claims of $10M	• Company officers jailed • Corporate fine of $100M • Civil claims of $100M

Risk Matrix

Guide to Likelihood Ratings	Likelihood Rating	Consequence Level					
		$1,000	$10,000	$100,000	$1M	$10M	$100M
This event / scenario is expected to occur in most circumstances whilst doing this or a similar job/activity. Expected about 10 times a year on site.	10 times each year	$10,000 each year	$100,000 each year	$1M each year	$10M each year	$100M each year	$1,000M each year
This event / scenario would be expected to occur on site about once a year. Expected about once a year on site.	Once each year	$1,000 each year	$10,000 each year	$100,000 each year	$1M each year	$10M each year	$100M each year
This event / scenario should occur a few times in your career. Expected about once every 10 years on site. (10% chance of occurring on site every year)	1/10 each year	$100 each year	$1,000 each year	$10,000 each year	$100,000 each year	$1M each year	$10M each year
This event / scenario could occur in your career. Expected about once every 100 years on site. (1% chance of occurring on site every year)	1/100 each year	$10 each year	$100 each year	$1,000 each year	$10,000 each year	$100,000 each year	$1M each year
This event / scenario should occur some where in the world from time to time. Expected about once every 1000 years on site. (0.1% chance of occurring on site every year)	1/1,000 each year	$1 each year	$10 each year	$100 each year	$1,000 each year	$10,000 each year	$100,000 each year
This event / scenario could occur some where in the world during your career. Expected about once every 10,000 years on site. (0.01% chance of occurring on site every year)	1/10,000 each year	$0 each year	$1 each year	$10 each year	$100 each year	$1,000 each year	$10,000 each year

NOTE: The use of the matrix to calculate **injury risk levels** is only appropriate when the likelihoods of an event is appropriately low. Risks with higher likelihoods may not be tolerable. **Injury risks which are not considered tolerable should be reduced to acceptable levels or avoided.**