A Prescriptive View of Risk

2004-5 SPE Distinguished Lecture

Peter Cockcroft
When you come to a fork in the road – take it!!
- What is risk?
- What is risk management?
- Why bother with it?
- Different perspectives of Risk
- A suggested process
  - Identify
  - Quantify (assess)
  - Response
    - Avoid (Terminate)
    - Transfer
    - Mitigate (Treat)
    - Accept (Take)
  - Monitoring and Review
Risk and Uncertainty Contrasted

The MIT dictionary of modern economics (1992) definitions:

- **Uncertainty**
  “A situation in which the likelihood of an event occurring is not known at all. That is, no probability distribution can be attached to the outcomes...”

- **Risk**
  “A context in which an event occurs with some probability or where the size of the event has a probability distribution...”
Risk ≠ Uncertainty
Risks are those factors which could influence the achievement of business objectives. This definition includes both the 'upside' opportunity and the 'downside' hazard.

It is important to identify, assess and determine appropriate ways of responding to upside risks in pursuit of opportunity and value. It is also important to identify, assess and determine appropriate ways of responding to downside risks which could hinder performance or result in losses.
The pleasure (utility) associated with winning is generally less than the displeasure of losing the same amount – it hurts more to lose than it feels good to win.

People will take a greater chance to avoid a loss than to make a gain of the same amount.
Increasing preference or desirability

Increasing amounts of money (or some other criterion)
WHAT IS RISK AND RISK MANAGEMENT?
Exploration Risk

- They may be looking in the wrong place
Geological Risk

- The Geological Interpretation may be wrong

ANOTHER DRY HOLE!

(WHY DRILL DEEPER WHEN YOU'RE OUT OF CLOSURE?)
Contract Risk

- The lawyers did a bad job
Government Risk

- The fiscal terms may be changed
Political Risk

- War
- Nationalisation
Development Risk

- The engineers get it wrong
Natural Risk

- The “hundred year” wave
Terrorist Risk

Piracy and Armed Robbery at Sea in SE Asia

No of Piracy Attacks 2003
Environment Risk
Operational Risk
Corporate Risk

- Their stock suffers, or they are subject to a takeover bid
**2004 Oil price movements**

($/bbl)

- **June 1** 42.33
- **June 29** 35.66
- **August 19** 48.70
- **October 22 & 26** 55.17

**Events**

- **Al-qaida’s threat to US presidential election**
- **OPEC Conference** (2.5 million b/d)
- **Growing concerns to Yukos oil production**
- **Expansion of Iraq struggle (Sadr)**
- **Halt of Iraq oil export from north Decrease of U.S. crude oil**
- **Saudi Oil Minister’s announcement to increase production capacities (to 11 million b/d)**
- **Resumption of Iraq oil export**
- **Concerns for Hurricane in Mexican Gulf growing concern to Yukos oil production**
- **Sadr agreed to withdraw its forces from Najaf**
- **Conceme for Nigerian Rebels Decrease of U.S. crude oil**
- **Longer halt of Mexican Gulf oil production**
- **Increase of US heating oil inventory**
- **2004 Oil price movements**

**Key Dates**

- 131OPEC Conference (+ 2.5 million b/d)
- **Nov 30th**
- 132OPEC Conf. (+ 1million b/d)
- **Oct 22 & 26** 55.17
- **November 11, 2004**
- **Winter Supply concerns**
- **President Bush’s re-election**
- **Nigerian General Strike**
- **Recovery of Mexican Gulf production, increase of US crude oil inventory, slow down of Chinese economy**
- **Sadr agreed to withdraw its forces from Najaf**
- **Terrorist attack at al-Khobar**
- **Expansion of Iraq struggle**
- **Resumption of Iraq oil export**
- **Return to normal level of Iraq oil export**
- **Sadr agreed to withdraw its forces from Najaf**
- **Concerns for Hurricane in Mexican Gulf growing concern to Yukos oil production**
- **Sadr agreed to withdraw its forces from Najaf**
- **Concerns for Nigerian Rebels Decrease of U.S. crude oil**
- **Longer halt of Mexican Gulf oil production**
- **Decrease of US heating oil inventory**
- **2004 Oil price movements**
Labor Risk

- The workers go on strike
What is Risk and Risk Management?

**Risk** can be defined as exposure to the consequences of uncertainty. This includes the possibility of economic or financial loss or gain, physical damage, injury to people, delay or non-achievement of planned objectives, as a consequence of uncertainty about the future. Risk thus has two elements:

- the likelihood of something happening,
- the consequences or impacts if it were to happen.

**Risk management** is the systematic application of management policies, processes and procedures to the tasks of identifying, analyzing, assessing, treating and monitoring risk.
WHY BOTHER WITH RISK MANAGEMENT?
Events can go wrong........

Image courtesy of Reuters
or better than expected
Risk Management ...

- So whether you are
  - Operating an airline
  - Running a bank
  - Transporting crude oil
  - Managing a cancer smear programme
  - Operating a production platform
  - Waiting for a train at a Station
- You need to understand the risks and have confidence in the controls and responses you employ
- You need to understand and accept any residual risk
The past is certain.....
….. But the future is uncertain
Can we predict the future?
Unfortunately our predictions are often wrong!

We woz wrong

Newspapers are quick to crow about their predictive triumphs. But what about when they are wrong? The editor of The Economist owns up to our recent, or, disappointments and explains why forecasts are so often wrong.
Can experience help?

“When anyone asks me how I can describe my experience of nearly forty years at sea, I merely say uneventful. In all my experience, I have never been in an accident of any sort worth speaking about.

I have seen but one vessel in distress in all my years at sea ... I never saw a wreck and have never been wrecked, nor was I ever in any predicament that threatened to end in disaster of any sort.”

From a paper presented in 1907 by EJ Smith, first captain of RMS Titanic, April 1912
Habitual Under-Delivery

8th to 14th Licensing Rounds Norwegian North Sea

Predictive Accuracy = 38%

Source: Rose and Associates
“As with most exploration companies, BP has tended to... overestimate the potential discovery volumes prior to drilling – this trend is even more pronounced for deep water prospects [where] volume estimation... remains significantly poorer than expected.”

*Francis Harper (BP) 1999*
Errors in Production Volume Estimates

For 159 of 160 (99.5%) projects, actual production was less than estimated production.
Industry Performance on Development Projects
(after Merrow, IPA, 2003)

Asset-cost growth

-10%
-5%
0%
5%
10%
15%
20%
25%
30%

Best practice
Industry average
Disasters

Schedule slip

-10%
-5%
0%
5%
10%
15%
20%
25%
30%
35%
40%

-10%
-5%
0%
5%
10%
15%
20%
25%
30%
35%

Best practice
Industry average
Disasters

Operability

95%
75%
55%
35%

Best practice
Industry average
Disasters

Worse Better
Worse Better
Different Perspectives of Risk

**Market**
Demand, alternatives, competition, transport distances, access to reliable export routes.

**Economic**
Product prices, strength of local currency, inflation, cost of capital, availability of capital.

**Fiscal**
Tax stability, regressive system, withholding/import taxes, respect of contract.

**Political**
Government stability, ethnic tension, corruption, national energy policy, bureaucracy, monopolies.

**Safety**
Process reliability, proximity to habitation, labour intensity & skills age of plant, corrosion, cultural attitude.

**Sub-surface**
Reserves, depth, product flow rates, geological uncertainty, compartmentalisation.

**Corporate**
Shareholder opinion, investor appetite, regulatory, remuneration.

**Technological**
Process engineering, unproved technology, deep water.

**Drilling**
Time uncertainty = cost uncertainty, Risks = twist-off, stuck pipe, kick, punch-through, etc.

**Quality**
High contaminant content (CO₂, H₂S, H₂O), process efficiency.

**Cost**
Capital expenditure, project management, operations & maintenance.

**Staff**
Management experience, labour intensity, skill levels relative to requirements, industrial relations, recruitment.

**Timing**
Delays in commissioning downtime, efficiency, project management, force majeure.

**Environmental**
Planning approvals, waste disposal, emissions, decommissioning.
Do we work together??
PHASES OF RISK MANAGEMENT
Step 1: Establish the Context: Understand The Business
What is the Business, and the Environment in which it operates?

Step 2: Identify Risks
What are the uncertainties associated with achieving the objectives?

Step 3: Analyse Risks
Utilise consistent analytical methods

Step 4: Assess Risks
Which risks are most significant?

Step 5: Respond to Risks
What do you choose to do about risks?
ESTABLISHING THE CONTEXT
- Environment
- Business Objectives
- Stakeholder Analysis
- Critical Success Factors
RISK IDENTIFICATION
Identify Risks: Areas of Risks

- Country
- Operations
- People
- Technology
- Systems
- Asset Integrity
- Stakeholders & Partners
- Reputation
- Authorisation
- Management
- Customers
- Financial
- Confusion

- Natural Events
- Fraud
- Group Interaction
- Communication
- Strategy & Decision Making
- Information
- Knowledge
- HSE
- Competition
- Organisation
- Markets
- Change
Risk Identification Tools and Techniques

- Documentation Reviews
- Information Gathering Techniques
  - Brainstorming
  - Delphi Technique
  - Interviewing
  - Root cause identification
  - SWOT analysis
- Checklist Analysis
- Assumptions Analysis
- Diagramming Techniques
  - Cause and Effect (Fishbone) diagrams
  - System or process flow charts
  - Influence diagrams
  - Stakeholder Identification and mapping
Community Perception of Risks

We all make judgments about risks according to our perceptions and beliefs. We undertake risk studies in a structured way, making use of information, judgments and experience from a range of sources, so we can have a degree of confidence in our conclusions.

However, not everyone can apply the same level of skills and resources as we have available. In particular, people in the broad community in which we operate must frequently make judgments about risks on the basis of far more limited information and analysis. In addition, and despite our best intentions, their aims and objectives are often different from ours.

All this means that the community’s perceptions of the risks associated with our activities may not correspond to ours, and we may meet unexpected opposition or resistance to our plans. We must be aware of this and incorporate community aims and objectives into our risk assessments.
Definition of Outcomes of Unfavorable Publicity

Outcomes

- Planned operations
  - Minor Modifications to Design
    - Development options as planned
    - No adverse publicity
    - No restrictions on freedom
    - Minor modifications
    - Approximately 10% increase in cost
    - Minor restrictions, negligible Corporate Cost
  - Redesign Development Options
  - Use Alternate Development Options
  - Abandon Project
    - Development option abandoned
    - All expenditure lost
    - Cost of new option & Abandonment cost
    - High corporate cost for managing negative publicity
    - Impact on share value
  - Corporate Disaster
    - Project abandoned
    - All expenditure and potential profit lost
    - Large corporate cost to manage negative publicity
    - Significant fall in share price
    - Project abandoned
    - Negative publicity threatens the existence of company
    - All expenditure and potential profit lost
    - Corporate cost equals total corporate value
RISK ANALYSIS
Risk analysis is the process of estimating the likelihood that things may turn out different and potential consequences for the objectives and critical success factors of the project.

The risk identification stage has generated a list of the risks that might impact on the project. Often the list will be extensive, and you will need to separate the important items from the less important ones. Risk analysis generates initial risk levels, a precursor to risk assessment and priority setting.
What Methods do we use to predict the future events?

- **Guess**
  Some call this intuition, or experienced-based hunches
- **Deterministic**
- **Probabilistic**
- **Scenarios**
53

Decision
Hierarchy

Spreadsheet
Model

Deterministic
Analysis

Probabilistic
Analysis

Appraisal

Initial Situation

Structure

Iteration

Decision

Influence
Diagram

Deterministic
Sensitivity

Decision
Tree

Probability
Distributions

Value of
Information

Iteration

Decision
Quality
Scenarios

A scenario is a description of how a risk might arise, the effect of controls, the responses that might be implemented and their consequences.

It is a way of describing the processes by which risks might occur and be dealt with, in a more wide-ranging and less structured approach than that described above.

Scenarios can be very useful for analyzing future events or events outside the usual experience, like changed economic circumstances, new industry structures or revised technological or environmental trends, and developing responses to them.
High Oil Prices: Sustainable or a Speculative Bubble?
The Answer Depends on the Lens Used to Evaluate Price

Four Lenses

- Inventory Levels
- Value of the Dollar and Inflation
- Spare Production Capacity
- Refining Margins

Source: Cambridge Energy Research Associates.
50305-1
2003–06 Oil Price Environment: Dated Brent

Quarterly Average Price (US Dollars per Barrel)

3-month Outlook

April 05  May 05  June 05
50.25  48.25  46.25

Source: Cambridge Energy Research Associates.
40914-7_031705
RISK ASSESSMENT AND PRIORITY SETTING
Uncertainties and dependencies are everywhere...

- Seismic
- Geology
- OOIP Model
- Petro-Physics
- Reservoir Simulation
- Production Data
- Decline
- Production Allocation
- Drilling
- Processing
- Predicted Production
- Export
- Taxes
- CapEx
- Prices
- OpEx
- Royalties/PSC
- Economics Asset A
- Portfolio
- Economics Asset 1
- Economics Asset n
...are frequently under-estimated
...and we spend a lot of money without always knowing which ones really matter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Uncertainty</th>
<th>Impact on NPV</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Rock Volume</td>
<td></td>
<td></td>
<td>Buy more seismic</td>
</tr>
<tr>
<td>Oil Price</td>
<td></td>
<td></td>
<td>Hedge with futures</td>
</tr>
<tr>
<td>Average Porosity</td>
<td></td>
<td></td>
<td>Take more core</td>
</tr>
<tr>
<td>Saturation</td>
<td></td>
<td></td>
<td>Different rock model</td>
</tr>
<tr>
<td>Facilities</td>
<td></td>
<td></td>
<td>Cheaper steel supply</td>
</tr>
<tr>
<td>Recovery Factor</td>
<td></td>
<td></td>
<td>Build simulator model</td>
</tr>
<tr>
<td>Rig Cost</td>
<td></td>
<td></td>
<td>Renegotiate contract</td>
</tr>
<tr>
<td>Net:Gross</td>
<td></td>
<td></td>
<td>More gamma logs</td>
</tr>
<tr>
<td>Continuity</td>
<td></td>
<td></td>
<td>Survey Analogues</td>
</tr>
<tr>
<td>Fiscal Terms</td>
<td></td>
<td></td>
<td>Fire lawyers</td>
</tr>
</tbody>
</table>
Likelihoods and Consequences

Risk analysis is based on the two components of risk; the likelihood or probability of the risk arising and its consequences. The forms of analysis may range from simple qualitative methods to highly quantitative approaches.

Likelihoods are difficult for many people to estimate, since few use them in their everyday activities, and consequences may not be easily quantified in the early stages of a procurement. Alternative approaches use indicators or indirect measures instead of direct likelihood or consequence estimates.
Risk Assessment Matrix

To enable a prioritisation of the risks to objectives, it is necessary to consider two key factors - likelihood and impact (or consequence). This is a qualitative rather than an objective assessment.

The priority given to the risk will ultimately determine the amount of effort and resources we put into managing it.

When rating the risk consider the ‘current residual risk’ ie after taking account of the current controls in place. We must first agree a consistent way of ranking the risks.....
Impact

High

Medium

Low

Likelihood

Low

Medium

High

Risk A

Risk B

Risk C

Risk D

Risk E

Risk F
Risk Matrix

One-off catastrophes
Contingencies - these risks have high impact but the probability of them happening is relatively low

Pressing concerns
Primary risks - these risks have both high impact and a high probability of happening

Routine
Housekeeping - these risks have a high likelihood of happening but do not have a high impact

Impact
H H M
L L M L
Likelihood
L M H H
Risk assessment determines the risks that should be accorded the highest priority in developing responses for risk treatment.

The risk analysis process generates a set of risk levels or risk factors that are used to set priorities. The aim of risk assessment is to partition key elements and their associated risks into three groups that determine the level of management response and effort.
<table>
<thead>
<tr>
<th>Severity</th>
<th>Consequences</th>
<th>Increasing Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>People</td>
<td>Assets</td>
</tr>
<tr>
<td>5</td>
<td>Multiple fatalities</td>
<td>Extensive damage</td>
</tr>
<tr>
<td>4</td>
<td>1-3 fatalities</td>
<td>Major damage</td>
</tr>
<tr>
<td>3</td>
<td>Major health effect or injury</td>
<td>Localised damage</td>
</tr>
<tr>
<td>2</td>
<td>Minor health effect or injury</td>
<td>Minor damage</td>
</tr>
<tr>
<td>1</td>
<td>Slight health effect or injury</td>
<td>Slight damage</td>
</tr>
<tr>
<td>0</td>
<td>No health effect / or injury</td>
<td>No damage</td>
</tr>
</tbody>
</table>

Source: Shell
Setting Priorities

Risk factors and the initial ranking in the risk profile can only be a guide to priorities for management attention, due to the constraints and limitations of the procedures used to generate them.

Accordingly, a two-stage process is commonly used to set priorities.

1. Sequence risks in decreasing order of risk factors and set cut-off levels to provide an initial indication of priorities. You may choose cut-off levels based on absolute criteria (for example, if safety issues are involved), pragmatic criteria related to the resources available for managing high-risk elements, or on more sophisticated trade-offs between the costs of developing detailed Risk Action Plans for major risks and the benefits of doing so.

2. Examine each risk in the sequenced list to determine whether it has been classified correctly, and modify the classification accordingly. In this stage, you may group similar risks to be managed together.
As we might expect, most of the uncertainty in the NPV comes from reserves, prices, and production rates.

Project NPV (US$MM)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Base</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserves (million barrels)</td>
<td>8.9</td>
<td>2</td>
<td>13</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>Oil Price (flat $/bbl)</td>
<td>20.0</td>
<td>13</td>
<td>250</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>Initial Production Rate (bbl/well-day)</td>
<td>375 Single 750 Dual</td>
<td>13</td>
<td>250</td>
<td>750</td>
<td>20</td>
</tr>
<tr>
<td>Capital Cost Scenario</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Downtime (days/year, external to hole)</td>
<td>55</td>
<td>75</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreman's Cost per Well ($/well-day)</td>
<td>525</td>
<td>655</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas-to-Oil Ratio (mcf/bbl)</td>
<td>0.6</td>
<td>29</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent Workover Required (%)</td>
<td>50</td>
<td>100</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year of Platform Start-up</td>
<td>1990</td>
<td>1992</td>
<td>1990</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Price ($/mcf)</td>
<td>1.6</td>
<td>1.30</td>
<td>2.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Useful Life (MTBF)</td>
<td>10</td>
<td>7</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Useful Life (MTBF)</td>
<td>7</td>
<td>5</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Dual Workover Costs ($ million/wells)</td>
<td>1.5</td>
<td>2.25</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Base Value = $29 million
Ranking of Risks

SO DOES THIS RISK COME INTO THE ‘ACCEPTABLE’, ‘UNACCEPTABLE’ OR ‘OH GOD!’ CATEGORY?
RISK RESPONSE AND HANDLING
“‘Be Careful’! All you can tell me is ‘Be Careful’?”
Risk Response Strategies

TAKE

TREAT

TRANSFER

TERMINATE

Source: INSEAD
Take

- intentionally pursue fully accept
- set reward/loss targets and tolerance levels
- establish and monitor key risk indicators
- charge premium price
- build in contingencies
- develop recovery plans
- investigate and take follow-up action
- develop fall-back arrangements
- finance the consequences

Risk acceptance occurs when risks cannot be avoided, reduced or transferred, or the costs of doing so would be high.

Nevertheless risk prevention, reduction, and impact mitigation measures and monitoring are usually recommended.
Transfer

- insure
- share (joint ventures, alliances, partnerships)
- contract out (outsource, assign)
- diversify/spread
- Hedge

Risk transfer shifts responsibility for a risk to another party, who ultimately bears the consequences if the risk arises.

Insurance and joint ventures are well-known risk transfer strategies.

Transferring a risk to another party will usually result in a cost (such as an insurance premium) or a reduced return.
<table>
<thead>
<tr>
<th>SCOPE OF WORK INFORMATION</th>
<th>very little</th>
<th>partial</th>
<th>complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNCERTAINTY</td>
<td>high</td>
<td>moderate</td>
<td>low</td>
</tr>
<tr>
<td>DEGREE OF RISK</td>
<td>high</td>
<td>medium</td>
<td>low</td>
</tr>
<tr>
<td>SUGGESTED RISK ALLOCATION</td>
<td><img src="image" alt="Risk Allocation Diagram" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTRACT TYPES</td>
<td>CPPF</td>
<td>CPIF</td>
<td>CPFF</td>
</tr>
</tbody>
</table>

CPPF - Cost Plus Percentage Fee  
CPIF - Cost Plus Incentive Fee  
CPFF - Cost Plus Fixed Fee  
FPPI - Fixed Price Plus Incentive  
FFP - Firm Fixed Price
Terminate

- cease activity
- pull out of market, divest
- redesign (e.g. business processes, systems, tools)
Treat

- Risk reduction (likelihood)
- Risk mitigation (consequences)
- change or recalibrate objective
- redesign (e.g. business processes, systems, tools)
- reduce scale
Risk reduction

- Risk reduction is directed to eliminating sources of risk or substantially reducing the likelihood of their occurrence.

- Examples include more detailed planning, careful selection of partners, involvement of multi-lateral agencies, choice of alternative approaches, design changes, quality assurance procedures, operations reviews, regular inspections, additional effort in design and engineering, training, market research, preventive maintenance and contract terms.
Impact mitigation

- Impact mitigation is directed to minimising the consequences of risks. Some risks, such as those associated with market variations or changes in Government policy, cannot be avoided, and although risk prevention may reduce the likelihood of them arising they may still occur. Risk management must then be directed to coping with their impacts.

- Impact reduction strategies include contingency planning, quality assurance, contract terms and conditions, regular audits to detect technical compliance or security breaches, and crisis management and disaster recovery programs.
IMPLEMENTING AND MONITORING RISK TREATMENT
Monitoring and Review

For most projects and major business initiatives, the nature of risks will change as the project or activity moves through different phases from concept to completion. Risk Action Plans can be developed for the higher priority moderate risks as resources become available for more detailed analysis or as the timing becomes more critical.

The RMP is not a static document. It should reflect the current analysis and thinking about risk in the project, and it will change as the project progresses and the risks change, are resolved or become more urgent.
Example of Risk Action Plan

- Recommend actions
  - Summary
  - Impact

- Risk identification and assessment
  - Activity description
  - Risk identification

- Responses to risks
  - Risk treatment options
  - Benefits and costs of options

- Implementation
  - Proposed actions
  - Responsibilities
  - Resource requirements
  - Timing
  - Reporting
## Typical Contents of a Risk Management Plan

<table>
<thead>
<tr>
<th>Recommend actions</th>
<th>Risk treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary</td>
<td>Major risks</td>
</tr>
<tr>
<td>Impact</td>
<td>Moderate risks</td>
</tr>
<tr>
<td></td>
<td>Minor risks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk identification, analysis and assessment</th>
<th>Implementation and monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of risks</td>
<td>The risk management organisation</td>
</tr>
<tr>
<td>Table of likelihoods, consequences and risk factors</td>
<td>Functions and responsibilities</td>
</tr>
<tr>
<td>Priority list of major, moderate and minor risks</td>
<td>Reporting structures</td>
</tr>
<tr>
<td></td>
<td>Implementation and monitoring plan</td>
</tr>
<tr>
<td></td>
<td>Review and evaluation plan</td>
</tr>
</tbody>
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TAKE

TREAT

TRANSFER

TERMINATE
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</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Multiple fatalities</td>
<td>Massively affected</td>
</tr>
<tr>
<td></td>
<td>People</td>
<td>Environment</td>
</tr>
<tr>
<td></td>
<td>Assets</td>
<td>Never heard of industry</td>
</tr>
<tr>
<td></td>
<td>Reputation</td>
<td>Heard of industry</td>
</tr>
<tr>
<td></td>
<td>Environment</td>
<td>Incident has occurred in our company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Happens several times a year in our company</td>
</tr>
<tr>
<td>4</td>
<td>1-3 fatalities</td>
<td>Major effect</td>
</tr>
<tr>
<td></td>
<td>People</td>
<td>Environment</td>
</tr>
<tr>
<td></td>
<td>Assets</td>
<td>Never heard of industry</td>
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<td></td>
<td>Environment</td>
<td>Incident has occurred in our company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Happens several times a year in a location</td>
</tr>
<tr>
<td>3</td>
<td>Major health effect or injury</td>
<td>Localised effect</td>
</tr>
<tr>
<td></td>
<td>People</td>
<td>Environment</td>
</tr>
<tr>
<td></td>
<td>Assets</td>
<td>Never heard of industry</td>
</tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Happens several times a year in our company</td>
</tr>
<tr>
<td>2</td>
<td>Minor health effect or injury</td>
<td>Minor effect</td>
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<tr>
<td></td>
<td>People</td>
<td>Environment</td>
</tr>
<tr>
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<td>Assets</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Happens several times a year in our company</td>
</tr>
<tr>
<td>1</td>
<td>Slight health effect or injury</td>
<td>Slight effect</td>
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<tr>
<td></td>
<td>People</td>
<td>Environment</td>
</tr>
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<td></td>
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<tr>
<td></td>
<td>Environment</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Happens several times a year in our company</td>
</tr>
<tr>
<td>0</td>
<td>No health effect / or injury</td>
<td>No effect</td>
</tr>
<tr>
<td></td>
<td>People</td>
<td>Environment</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Dealing with the Real World

“You want a valve that doesn’t leak and you try everything possible to develop one. But the real world provides you with a leaky valve. You have to determine how much leaking you can tolerate”

NASA Scientist from Columbia project
"There are risks and costs to a program of action. But they are far less than the long-range risks and costs of comfortable inaction."

John F Kennedy
Paralysis by Analysis
Extinction by Intuition

What - me worry?

Famous “Mad” magazine comic strip character
Merci