256th ACS National Meeting
Boston, MA
21 August 2018

Risk Management

Robert Lippman
Carob Associates, Inc.
A Start

"O.K., we get it—big and dangerous."
Risk Assessment = Risk \times Probability
## Risk Assessment Matrix

### Determining the Level of Risk

This document can be used to identify the level of risk and help to prioritise any control measures.

Consider the consequences and likelihood for each of the identified hazards and use the table to obtain the risk level.

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>A: Almost certain to occur in most circumstances</th>
<th>B: Likely to occur frequently</th>
<th>C: Possible and likely to occur at some time</th>
<th>D: Unlikely to occur but could happen</th>
<th>E: May occur but only in real and exceptional circumstances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consequences</td>
<td>High (H)</td>
<td>High (H)</td>
<td>Extreme (X)</td>
<td>Extreme (X)</td>
<td>Extreme (X)</td>
</tr>
<tr>
<td>1 – Insignificant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 – Minor</td>
<td>Medical help needed. Treatment by medical professional; hospitalisation required</td>
<td>Moderate (M)</td>
<td>High (H)</td>
<td>Extreme (X)</td>
<td>Extreme (X)</td>
</tr>
<tr>
<td>3 – Moderate</td>
<td>Significant non-permanent injury; hospitalisation; loss of time</td>
<td>Low (L)</td>
<td>Moderate (M)</td>
<td>High (H)</td>
<td>Extreme (X)</td>
</tr>
<tr>
<td>4 – Major</td>
<td>Severe injury; temporary permanent injury; hospitalisation; loss of income</td>
<td>Low (L)</td>
<td>Low (L)</td>
<td>Moderate (M)</td>
<td>High (H)</td>
</tr>
<tr>
<td>5 – Catastrophic</td>
<td>Death; permanent disability; major permanent injury; loss of income</td>
<td>Low (L)</td>
<td>Low (L)</td>
<td>Moderate (M)</td>
<td>High (H)</td>
</tr>
</tbody>
</table>

### How to Prioritise the Risk Rating

Once the level of risk has been determined the following table may be used in determining what actions to take to reduce the control measures.

<table>
<thead>
<tr>
<th>Extracts</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actions immediately mitigate the risk. Either eliminate, substitute or implement engineering control measures. If these controls are not immediately accessible, set a timeframe for their implementation and establish interim risk reduction strategies for the period of the non-compliance.</td>
<td>Take reasonable steps to mitigate the hazard, either eliminating, substituting or implementing engineering controls. These “hazard controls” must be considered permanent solutions. The time for which they are established may be based on risks. If the risk has not been addressed, implementation of engineering controls must be reviewed.</td>
<td>Take reasonable steps to mitigate the hazard and monitor the risk. Establish permanent controls to the workplace. Permanent controls may be administrative or technical. The hazard has low frequency, low likelihood and insignificant consequence.</td>
<td></td>
</tr>
</tbody>
</table>

### Interim measures until permanent solutions can be implemented:

- Provide administrative controls to limit the use or access.
- Provide supervision and specific training related to the issue of concern. (See Administrative Controls column)

### Hierarchy of Control

Controls identified may be a mixture of the hierarchy in order to provide minimum operator exposure.

| Elimination | Controls to the hazard. |
| Substitution | Provides an alternative that is capable of performing the same task and is safer to use. |
| Engineering Controls | Provide or construct a physical barrier or guard |
| Administrative Controls | Develop policies, procedures, practices and guidelines, in consultation with employees, to mitigate the risk. Provide training, instruction and supervision about the hazard |
| Personal Protective Equipment | Personal equipment designed to protect the individual from the hazard |

Health & Safety Services
June 2006
What's the Problem

Introduction to Risk Assessment – you have to know what can go wrong before you can start to manage it.

I have but one lamp by which my feet are guided, and that is the lamp of experience. I know no way of judging the future but by the past. --Patrick Henry, 1775

plus many other problems
Problems continued

- Recent study had more than 50% of published experimental information is not reproducible.
- Experimenters have limited experiences due to curriculum constraints (education v training)
  - the technological infrastructure
    - for example: glassblowers – are students using glassware aware of possible problems
- Using the internet
Approaches to a Solution

The beginning steps work in both academia and industry.

Teaching situational awareness:

- Start off with the very simple experiments
- For example: cabbage leaves as indicator then go to any flower as an indicator (usually add small about of MeOH or EtOH to boiling water)
- Have the student develop their own checklists.
Decision Based Upon???

Data → Information → Knowledge → Wisdom

(when used properly wrt problem) (and hopefully)
Dealing with the Future and New Materials - Another Major Problem

Made popular by Donald Rumsfeld -

There are questions we have that we have answers to -

There are questions we have that we do not have answers to -

and there is much we do not know enough about to realize we should have questions
and, Finally

Call it the human problem

We humans are terrible monitors. And we are at our least effective when assigned the task of looking constantly for something that almost never happens. Countless studies over the years have shown that people simple can’t maintain a high level of altertness when their attention is almost never rewarded by discovering danger, or at least something new. Whether it’s a sentry on guard for an enemy that never shows, or a pilot staring, or at least monitoring, a gauge that never moves, boredom and routine quickly rob us of the ability to spot a problem if it ever does occur.

--j.mac mcclellan
In summary

Situational awareness must be taught.

A lowering of the chance of an accident taking place occurs when one actually understands the risk.