

Striking the Balance

Getting Value Out of Bowtie Diagrams



Lachlan Dreher ProSafe 22 August 2019

R4Risk

L14, 222 Kings Way (PO Box 5023) South Melbourne VIC 3205 P: (03) 9268 9700 F: (03) 8678 0650 E: solutions@r4risk.com.au www.r4risk.com.au



- 1. What are we trying to achieve?
- 2. What is a bowtie diagram?
- 3. What makes a good bowtie?
- 4. What are some common problems?
- 5. Conclusions



- Manage our risk issues
 - Major hazard safety
 - Material risks etc.
- Achieve this by identifying:
 - Hazards
 - Causes and outcomes
 - Controls
 - Relationship between the controls and causes / outcomes







- Simple, clear and easy to understand
- Can be used to analyse a wide range of scenarios
- Clear linkages between controls and the causes / consequences
- Good communication tool





• Simplicity (or at least, not undue complexity)



- Top Events that are not significant
- Trivial or vague causes
- Poor control selection



- Exclude causes that cannot result in the Top Event
- Ensure that causes are excluded on consequence and not likelihood

Tube Corrosion	-
Rejected	
Rejected - Under normal conditions it is unlikely that the pitting corrosion mechanism would sufficiently weaken the tube to result in a rupture.	

Tube Corrosion

Rejected

A pinhole leak would result rather than a tube rupture in the Absorber (A-001). A pinhole leak is not of a sufficient magnitude to result in an MI. Therefore, this scenario has been rejected as a cause of an MI.



- Avoid vague cause descriptions
- Ensure that the cause description is clear and direct

All credible causes (non specific)

Curr Lh: Likely (4)

Causes include leaks, corrosion, etc. Assume leak/spray from flange or valve packing, open valve, sample point, etc. Expected to be a 1 in 2 year event. Tank (T-101) overfill due to inlet valve (V001) passing

Curr Lh: Very unlikely (1)

This cause refers to the inlet valve (V001) on Tank (T-101) passing and leading to overflow of Chemical X from the tank's overflow pipe. The overfill of Tank (T-101) is contained within a bunded area.

The likelihood of the valve passing is based on industry failure data of 1/10 years. An additional factor of 1/10 is applied for an operator to be in the bund during the event. Therefore, the likelihood of an MI occurring is 1/100 years.



• Avoid defining a cause as the "failure of a control"



Causes – Failure of a Control



- Redefine the cause
- May often relate to the failure of primary equipment
- If unavoidable, include the control as a barrier (without risk reduction credit)



Causes – Numbers of Causes

 POLICIAN INVESTIGATION NUMBER NATIONAL INVESTIGATION INVESTIGATO INVESTIGATION INVESTIGATION INVESTIGATO INVESTI ANTE I



• Avoidance of excessively large number of causes

• Consider using a "General" or "Site-wide" bowtie



- More controls is not better
- Limit things to "real" controls





Controls - Characteristics of "Real" Controls

- Implemented The control must be fully implemented, i.e. the control must be in place.
- Effective If the control functions as intended, it should prevent the Top Event or significantly mitigate its consequences.
- Reliability The control should be sufficiently reliable, i.e. it should have a low probability of failure on demand.
 - Auditable It should be practical to audit the control so that its performance may be established.
- Monitored Systems should be in place to monitor the performance of the control, to ensure that it remains functional.



• Be specific!

• Linkages to the cause / outcome

Chemical X Storage Tank	Chemical X Storage Tank	Local E-stop on Tanker
and Operator Action	[LS-1001]	Curr Incmg Lh: Unlikely (2)
Curr Incmg Lh: Likely (4)	Curr Incmg Lh: Possible (3)	Curr Outgn Lh: Very unlikely (1)
Curr Outgn Lh: Possible (3)	Curr Outgn Lh: Unlikely (2)	Adequate
	Chemical X Storage Tank High Level Alarm [LI-1001] and Operator Action Curr Incmg Lh: Likely (4) Curr Outgn Lh: Possible (3) Adequate	Chemical X Storage Tank High Level Alarm [LI-1001] and Operator ActionChemical X Storage Tank High Level Switch



• Definition of the Top Event as an outcome









• Some tools used will have limitations, some will be powerful

"All modelling is wrong, it's just that some modelling is useful"

- A bowtie may not be able to precisely represent every hazard OR
- A perfect representation of a hazard may result in an overly complex bowtie



- Powerful bowtie software tools are available
- Able to undertake complex analysis



• Just because you can, doesn't mean you should





- Develop a clearly defined ruleset
- Use it to test the suitability of causes, controls etc.
- Should cover:
 - Study Boundaries
 - Minimum impact threshold
 - Controls
 - Control criteria
 - Control adequacy (quantitative / semi-quantitative analysis)
 - Risk assessment
 - Methodology
 - Tolerability criteria



Rule #1 – Keep your eye on the prize!

- Keep things as simple as practical
- Add complexity only where it adds value
- Be specific in descriptions
- Ensure linkages are clear
- Everything must have a purpose