Visual HAZOP

Exploiting the power of Bowties to improve study efficiency and enhance engagement

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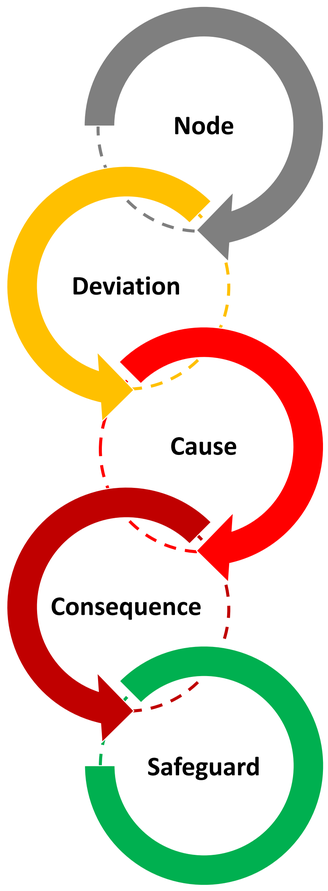
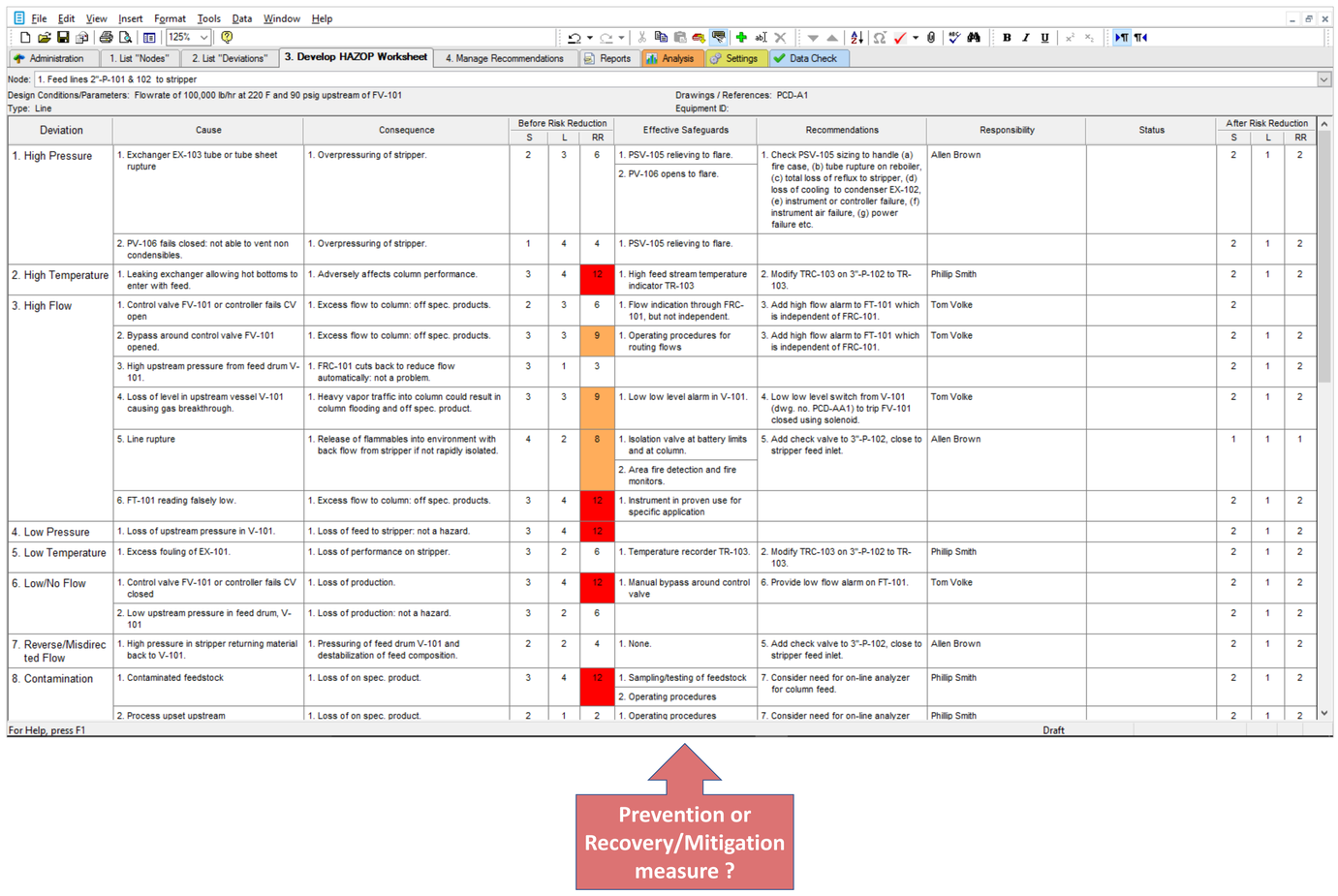


Current **HAZOP** practice utilises **software** to record the study as it happens and to display the worksheet on a screen to ensure all participants have the opportunity to view their contribution and, if necessary, correct or expand the notes.

However, the majority of HAZOP (PHA) tools (and customised spreadsheets) only show a **single column for Safeguards** (as per the 61882 standard) and often group protection measures into a single field - it is therefore **difficult to judge if these are separate measures and/or if they prevent or mitigate the hazard**.

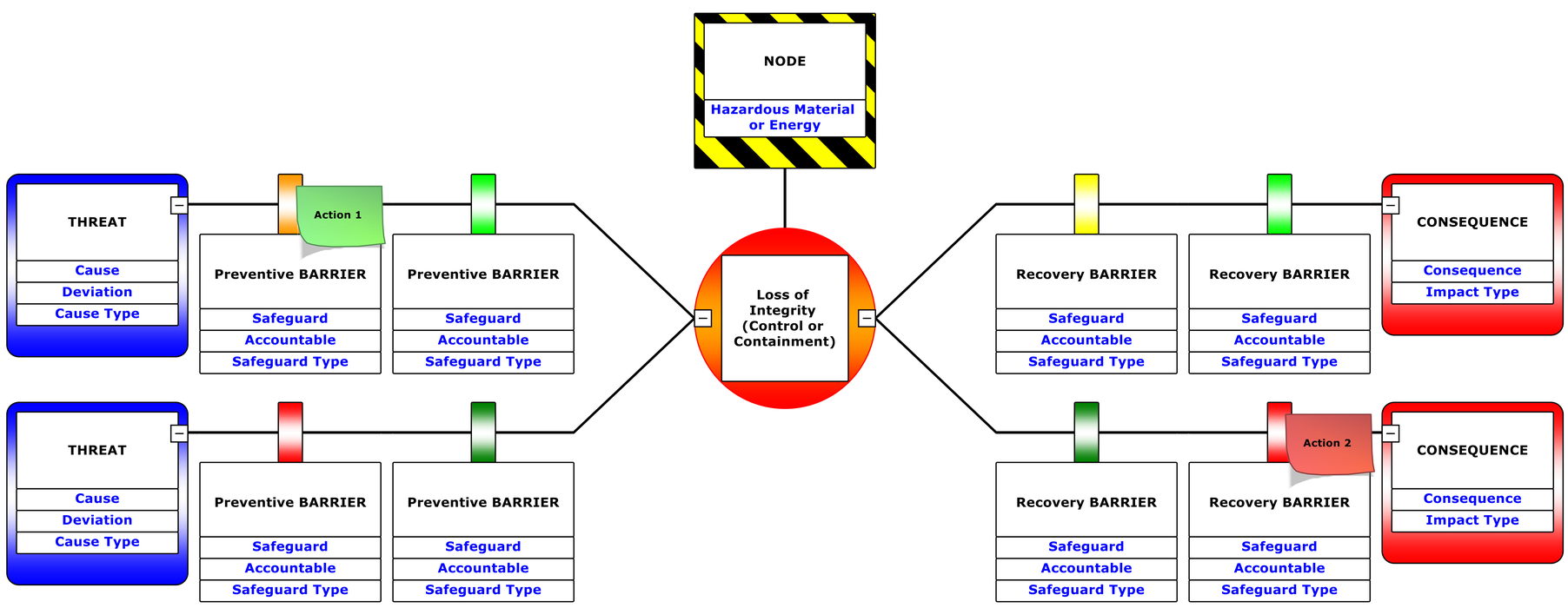


Deviation	Cause	Consequence	Before Risk Reduction S	L	RR	Effective Safeguards	Recommendations	Responsibility	Status	After Risk Reduction S	L	RR
1. High Pressure	1. Exchanger EX-103 tube or tube sheet rupture	1. Overpressuring of stripper.	2	3	6	1. PSV-105 relieving to flare. 2. PV-106 opens to flare.	1. Check PSV-105 sizing to handle (a) fire case, (b) tube rupture on reboiler, (c) total loss of reflux to stripper, (d) loss of cooling to condenser EX-102, (e) instrument or controller failure, (f) instrument air failure, (g) power failure etc.	Allen Brown		2	1	2
	2. PV-106 fails closed: not able to vent non condensibles.	1. Overpressuring of stripper.	1	4	4	1. PSV-105 relieving to flare.				2	1	2
2. High Temperature	1. Leaking exchanger allowing hot bottoms to enter with feed.	1. Adversely affects column performance.	3	4	12	1. High feed stream temperature indicator TR-103	2. Modify TRC-103 on 3"-P-102 to TR-103.	Phillip Smith		2	1	2
3. High Flow	1. Control valve FV-101 or controller fails CV open	1. Excess flow to column: off spec. products.	2	3	6	1. Flow indication through FRC-101, but not independent.	3. Add high flow alarm to FT-101 which is independent of FRC-101.	Tom Volke		2		
	2. Bypass around control valve FV-101 opened.	1. Excess flow to column: off spec. products.	3	3	9	1. Operating procedures for routing flows	3. Add high flow alarm to FT-101 which is independent of FRC-101.	Tom Volke		2	1	2
	3. High upstream pressure from feed drum V-101.	1. FRC-101 cuts back to reduce flow automatically: not a problem.	3	1	3					2	1	2
	4. Loss of level in upstream vessel V-101 causing gas breakthrough.	1. Heavy vapor traffic into column could result in column flooding and off spec. product.	3	3	9	1. Low low level alarm in V-101.	4. Low low level switch from V-101 (dwg. no. PCD-AA1) to trip FV-101 closed using solenoid.	Tom Volke		2	1	2
	5. Line rupture	1. Release of flammables into environment with back flow from stripper if not rapidly isolated.	4	2	8	1. Isolation valve at battery limits and at column. 2. Area fire detection and fire monitors.	5. Add check valve to 3"-P-102, close to stripper feed inlet.	Allen Brown		1	1	1
	6. FT-101 reading falsely low.	1. Excess flow to column: off spec. products.	3	4	12	1. Instrument in proven use for specific application				2	1	2
4. Low Pressure	1. Loss of upstream pressure in V-101.	1. Loss of feed to stripper: not a hazard.	3	4	12					2	1	2
5. Low Temperature	1. Excess fouling of EX-101.	1. Loss of performance on stripper.	3	2	6	1. Temperature recorder TR-103.	2. Modify TRC-103 on 3"-P-102 to TR-103.	Phillip Smith		2	1	2
6. Low/No Flow	1. Control valve FV-101 or controller fails CV closed	1. Loss of production.	3	4	12	1. Manual bypass around control valve	6. Provide low flow alarm on FT-101.	Tom Volke		2	1	2
	2. Low upstream pressure in feed drum, V-101	1. Loss of production: not a hazard.	3	2	6					2	1	2
7. Reverse/Misdirected Flow	1. High pressure in stripper returning material back to V-101.	1. Pressuring of feed drum V-101 and destabilization of feed composition.	2	2	4	1. None.	5. Add check valve to 3"-P-102, close to stripper feed inlet.	Allen Brown		2	1	2
8. Contamination	1. Contaminated feedstock	1. Loss of on spec. product.	3	4	12	1. Sampling/testing of feedstock 2. Operating procedures	7. Consider need for on-line analyzer for column feed.	Phillip Smith		2	1	2
	2. Process upset upstream	1. Loss of on spec. product.	2	1	2	1. Operating procedures	7. Consider need for on-line analyzer	Phillip Smith		2	1	2

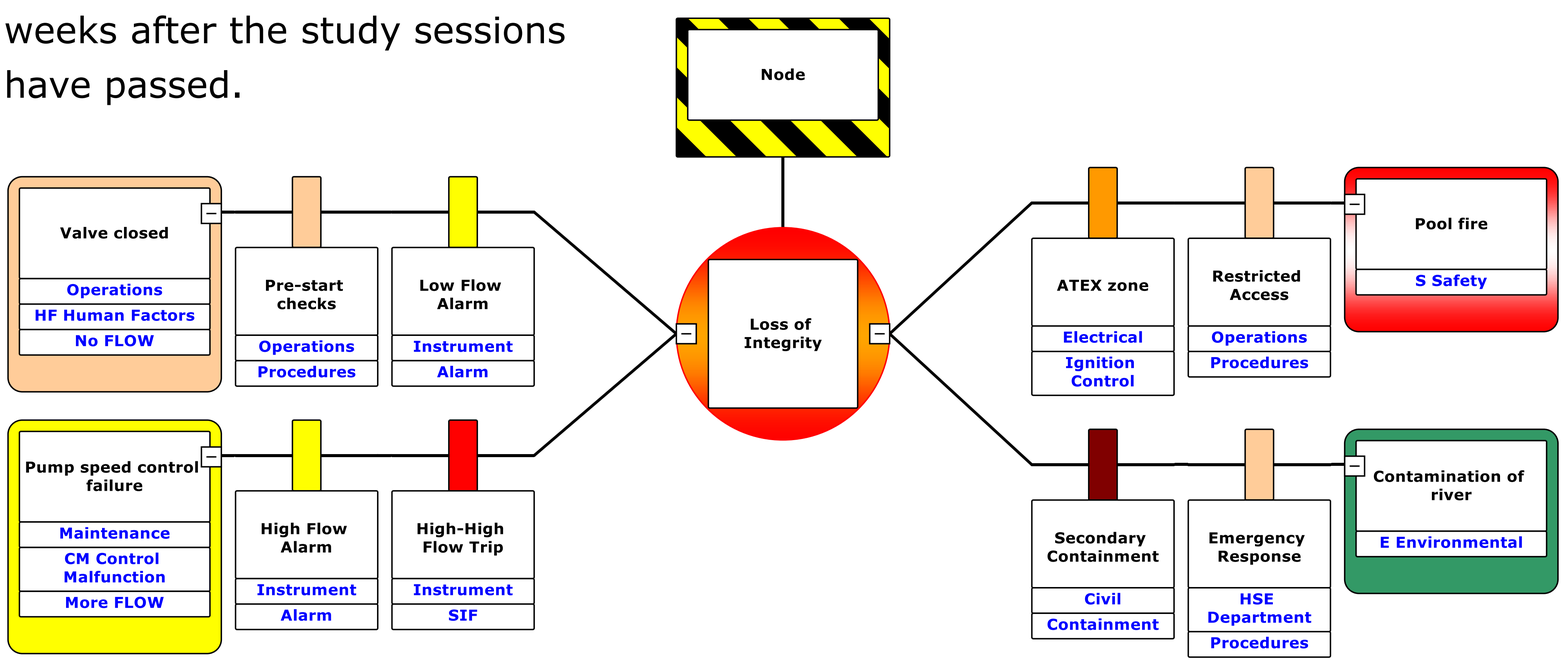
Although integrated HAZOP & LOPA applications exist, they are however limited by the quality and quantity of information or knowledge they can impart to those who were not present during the studies.

It is also often the case that **participants may become disengaged from a method that is wholly textual (particularly those unfamiliar with the technique)**.

The **visual** & intuitive nature of **bowties** allows the risks associated with the Threat-Consequence **scenarios** to be universally **understood**, promptly addressed, and successfully **managed**.



This clarity helps study participants quickly develop hazard scenarios in a **collaborative** environment and also assists in recalling discussions several days or weeks after the study sessions have passed.



An **enhanced HAZOP** methodology approach is therefore proposed which exploits the **immediate efficiency** of scenario development plus the long term **knowledge retention** that a simple but effective graphical representation offers.

Bowties and worksheets can be easily **interchanged** to assist in the transition between primitive worksheets and a more advanced representation.

A picture tells a thousand Guidewords - read the Visual HAZOP article in **The Chemical Engineer** magazine (**Nov 2017**) IChemE Hazards 28 (**HAZ28-079**)

For more information, please contact **dhatch@psintegrity.com** or visit **www.VisualHAZOP.com**