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AUTOMATION

Automation in Safety
Safer Workplaces Through Automation

Growth through Integrity, Understanding and Innovation

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  - 30+ years experience in Automation and Process/Functional Safety
- Member of a number of committees
  - IEC 61508 International
  - SCC – TFFS, IEC61511 mirror committee, others
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Featured in Control magazine September cover story

The Argument for Proactive Process Safety

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The argument for proactive process safety - Part 1

You can't wait for legislators and business owners to care enough to help.

If you want something done right, you have to do it yourself. This old aphorism was never more true than when applied to process safety—at least in the U.S. and other backward regions.Lip service about valuing employees' lives and health masks often insufficient safety mechanisms and scant training in many process applications, facilities and industries. Intractable corporate cultures still view safety as a drag on productivity. Toothless federal, state and local regulations provide little if any prescriptive requirements, grandfather in potentially dangerous processes and facilities, and enforce after the fact with slaps on the wrist. And, despite an unending series…

FULL STORY

Top Stories

Mobile process automation monitoring and control evolves
Mobile monitoring, automation and control means freedom and flexibility, but it also unlocks imagination and innovation.

Control's 2018 salary survey
Average age and pay edge down, while benefits, most other indicators hold steady in 2018 salary survey

How process control can get the most out of IIoT
IIoT's teeth marks are everywhere, but what do all it's new players have to say?

Knowledge on demand - Part 1

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Agenda

Introduction – Automation in Safety

Hazard Identification

Safety Automation

Functional Safety in Western Canada

Project Execution With Functional Safety

Benefits of Automation

Discussion/Questions

Introduction – Automation in Safety

This presentation draws parallels between three separate fields of safety.

- Traditional HSE Safety
  - Slips, Trips and Falls
- Machine Safety
  - Life and Limb Safety
- Process Safety

- All have the same purpose but are applied differently

Introduction – Automation in Safety

- **Slip, Trip, Fall**
- Lifting drywall/shingles
- Ladder/stairs
- Cherry picker

- **Machine Safety**
- Material Handling
- Trucking
- Conveyor

- **Process Safety**
- Monitor/Operate
- Operator Rounds
- Remote control

Introduction – Automation in Safety

Definition – Automation

The completion of one or more tasks through the use of computers/machines – often without human interaction.

Examples:

- Ingredients are added according to a recipe.
- A gear is milled in a CNC machine.
- The flow to a tank is controlled by a level transmitter.

Introduction – Automation in Safety

Why do we automate?

- Improved/consistent quality
- Higher productivity
- Lower training costs
- Lower costs
- Flexibility (change on the fly)

How do we automate?

- Semi-auto (some human interaction)
- Fully automated (one touch start)
- Remote monitoring and control

Hazard Identification

Automation may introduce hazards not inherently obvious.

- Semi-auto (some human interaction)
  - Human interaction with partially automated process.
- Remote monitoring and control
  - Communication path becomes critical.
- Fully automated processing units
  - A valve failure may cause a high pressure condition.

Hazard Identification

- OH&S Requirement
  - All hazards shall be identified.
    - Eliminate or control
  - Hazards within the processing or manufacturing facility may not be easily identified through a Job Hazard Analysis.

Hazard Identification

- Process Industry
  - A systematic walk down of the process by failing one device at a time to evaluate potential outcomes
  - Identifying and evaluating safeguards to prevent the consequence

Assessing for Required Safety

Assessing process/machine safety is similar to a JHA.

- Two primary questions are asked:
  - What is the most logical outcome of the risk?
  - How often can the initiating event occur?
- Risk Gap identified
  - Close with Independent Protection Layers – as many as required.
  - Alarms, executive actions, operating procedures.

Hazard Identification

- Process Hazard Assessment
  - Guide-word **HAZ**ard and **OP**erability Study
  - What-If, Bow Tie, Checklists, etc.

- Systematic process fails a design to determine consequences.
  - Conducted before construction drawings issued
  - Ranks consequences
  - Estimates cause frequencies
  - Safeguards identified
  - Recommendations

Hazard Identification

SEVERITY	a 1E-05	b 1E-04	c 1E-03	d 1E-02	e 1E-01
5	H	H	E	E	E
4	M	M	H	E	E
3	L	M	M	H	E
2	L	L	M	M	H
1	L	L	L	M	M

LIKELIHOOD (yrs)

People	Environment	Assets
Multiple Fatalities	Catastrophic release - Long term effects - Remediation > 1yr	Greater than $100M
Permanent Injury or Fatality	Major release - remediation <= 1yr	$10M to $100M
Lost Time Injury	Offsite release - localized effects - Remediation > 1mth	$1M to $10M
Medical Aid / Restricted work	Reportable on-site release.	$100K to $1M
First Aid	Insignificant. Not reportable.	Less than $100K

E	The risk is unacceptable. Additional risk reduction is required. Further analysis necessary.
H	Risk is normally unacceptable and should be reduced with additional safeguards. Risk can be accepted with Operations VP approval.
M	Evaluate risk reduction measures. Risk is tolerable if reduced ALARP. Documented justification of ALARP required.
L	The risk is tolerable with the existing safeguards.

Hazard Identification

CAUSE **CONSEQUENCE** **IPLs/SAFEGUARDS** **RESULTS**

Node: 1. HP Gas Inlet
Deviation: 8. High Flow

Cause	Consequence	CAT	W/o Safeguards			Safeguards	Safeguards			Recommendations	Recommendations			Responsibility
			L	S	RR		L	S	RR		L	S	RR	
1. PV-1450 (PIC) fails or mal open	1. Overpressure V-1400; leading to potential loss of containment of toxic gas, fire & explosion; off-site release; loss of production		E	4	E	1. PSV-1402	B	4	M	1. Install mechanical stop on PV-1450 to limit flow to 250 e3m3/d	B	2	L	J. Dough
						2. PAHH-1451 trips XV-1262 (Inlet gas feed)				2. Confirm PSV-1402 sizing for blocked flow case				D. Downer

Hazard Identification

A quick note on safeguards

- Prevention/Mitigation includes:
  - Administrative controls
    - Procedures
  - Engineered Safeguards
    - Physical guards/Shrouds/Secondary Containment
  - Mechanical Devices
    - Pressure/Thermal Relief Valves
  - Alarms
    - Process/Evacuation
  - Automated/Executive Actions
    - Shutdown/Idle

Risk Assessment

Likelihood Analysis

- Typically Layers Of Protection Analysis (LOPA).
  - Can also be Hazard Matrix, Risk Graph
- Defines Initiating Event Likelihood.
- Evaluates Safeguards (from PHA) as Independent Protection Layers (IPLs).
  - Independent
  - Specific
  - Auditable
  - Dependable
- Not all safeguards are IPLs.

Hazard Evaluation

CONSEQUENCE

CAUSE

IPLs/SAFEGUARDS

RESULTS

LOPA Worksheet

Last LOPA/SIL Analysis Session Date: | No. of LOPA/SIL Analysis Sessions: 0 | Scenarios: 79 | Scenarios with Unacceptable Risk: 24

LOPA/SIL Analysis Hazardous Event Description					Event Frequency Analysis							Independent Protection Layers				LOPA						LOPA/SIL Analysis Actions Required								LOPA /SIL Analysis Actions Required
					Initiating Event		Enabling Events																Recommendation/Action Details							
Hazard Scenario Title	Haz Type	Haz Cat.	TRC/y	Safeguards	Initiating Event	Events/yr	Enabling Event	Prob.	Unmit. Event Freq (Events/yr)	Min Reqd RRF	Min Reqd IPL SIL	Independent Protection Layer Description	IPL Type	IPL RRF	IPL Total RRF	Mitigat. Event Freq (Events/yr)	RRF Gap	RC-330 Cat.	Min Reqd Add IPL SIL	Is remaining risk acceptable?	Notes	Recommendation /Action Required	By	Rec Date	Status	Res Date	Resolution	Implementation Date	SIL Selection Ind Ver By
1. Flow of HC to atmosphere, ignition, fire and worker injury HAZOP - Consequence: 4.1.1.5.1.2	A	S	1E-04	1. Reactor Purge 81-XV-110 designed as Fail Closed on loss of power and loss of instrument air. 2. 81-XV-110 not closed position alarm	Atmospheric Vent 81-XV-110 inadvertently opened NOTE: Reactor Purge 81-XV-105, 81-XV-109 and 81-XV-110 valves are spring return valves. P&ID currently shows the valve as a dual-acting valve.	2.5E-01	1. Pr. of ignition 2. Pr. of worker present	0.1 1	2.5E-02	250	2	1. None		1	1	2.5E-02	250	A	2	No		12. Develop an IPL to provide an RRF= 250. Consider the following options: 1. Provide an alarm on opening of the 81-XV-110.	John Doe, Joe Somebody						
2. Release of HC to environment HAZOP - Consequence: 4.1.1.5.1.1	A	S	1E-02	1. Reactor Purge 81-XV-110 designed as Fail Closed on loss of power and loss of instrument air. 2. 81-XV-110 not closed position alarm	Atmospheric Vent 81-XV-110 inadvertently opened NOTE: Reactor Purge 81-XV-105, 81-XV-109 and 81-XV-110 valves are spring return valves. P&ID currently shows the valve as a dual-acting valve.	5.E-01	1 None 2. pressure over 3X MAWP of pipe/hose resulting in catostraphic failure 3. Pr. of sufficient exposure	1 1 1	5.E-01	50	1	1. None		1	1	5.E-01	50	A	1	No		12. Develop an IPL to provide an RRF= 250. Consider the following options:	John Doe, Joe Somebody						

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Hazard Evaluation

LOPA (Layers of Protection Analysis)

- Analyze Cause/Consequence pairs to identify Event Frequency (F_{EVT})

- $F_{EVT} = I.E. \times IPL_1 \times IPL_2 \times IPL_n$
  - I.E. = Initiating Event (events/year)
  - IPLn = Independent Protection Layer (PFD, Probability of Failure on Demand)

- Example
  - F_{EVT}= 0.1/yr x 0.1 x 0.1 x 0.01
  - F_{EVT}= 0.0001/yr (or 1/10,000 yrs)

Hazard Evaluation

LOPA

- Compares Event Frequency (F_{EVT}) to Ranked Consequence Tolerable Frequency (F_{TOL})

Equation:

- $RRF = \frac{F_{EVT}}{F_{TOL}}$

Example:

- F_{TOL} = 0.0001(1/10,000yrs)

- $RRF = \frac{0.0001}{0.0001}$
- LOPA Gap = 1.0

Evaluating LOPA Results

- LOPA Gap greater than 1 ($F_{EVT} > F_{TOL}$)
  - Look for Additional IPLs.
  - Accept the Risk Gap (typically requires sign-off).
  - Install a Safety Control System (more later).

- LOPA Gap less than 1 ($F_{EVT} < F_{TOL}$)
  - Tolerable risk is met (or exceeded).
  - A Safety Control System is not required.

Critical Devices

- The IPLs from the LOPA now become Critical Devices.

- IPLs are **Dependable** and **Auditable.**
  - Critical devices require testing
  - Test Records required for auditing
  - Verify IPL PFD credit assumptions

Safety Automation

The automatic action taken to reduce and/or eliminate identified hazards associated with the materials (raw and manufactured), automated procedures and tasks and the machines themselves

Examples:

- Relays (ideal for small systems)
- Specialized industrial computers (larger systems)

High Integrity, High diagnostics

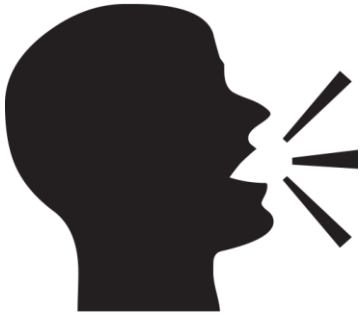
Interpreted Path:

- IEC 61508 & 61511 are included in Appendix A of the 2018 version of the Canadian Electrical Code.
- Appendix A is "Normative"
- Provincial Authorities are expected to adopt CEC-2018 including Appendix A.
  - Alberta – February 1, 2019
  - Saskatchewan – January 1, 2019
  - BC – Still considering (public review closed)

The IEC 61511 standard can be broken down into three components:

Execution

Long Term Requirements



- **Say What You Will Do**
- **Do What You Said**
- **Prove It**

Through the following:

Proof Testing
Management of Change
Re-validation (including HAZOP and LOPA)
Audits and Assessments

Benefits to Safety Automation

Automation will:

- Enforce Administrative procedures.
- Remove workers from the hazard in most cases.
- Reduce travel to remote locations.
- Consistent product quality.
- Moves brain power to more skilled tasks.

Examples

- Robotic assembly lines.
- Remote Operation.
- One touch start sequences.

The Benefits of Automation in Safety

Other Benefits to Automation:

- Efficiency
  - Computers & Robots don’t tire or lose focus.
  - Individual tasks can be completed faster.
- Quality
  - Typically higher/consistent quality for repetitive tasks.
- Early warning
  - Air monitoring (vapors, toxic gases) for evacuation.
  - Detects and prevents entry into hazardous areas.

The Benefits of Automation in Safety

Disadvantages to Automation

- Increased capital costs
  - Sensors
  - Safety Control System
  - Shutdowns (valves, contactors, etc.)
- Increased maintenance costs
  - Calibration
  - Testing
  - Repair

The Benefits of Automation in Safety

Examples

- Packaging line uses a pallet wrap machine for shipping
  - High speed machine – risk of injury to operator.
  - Hazard prevention – physical barrier – fence.
  - Ensure operator is out of harms way – light curtain, safety mat, two handed controller.

The Benefits of Automation in Safety

Examples

-Pipeline feeding Natural Gas to a processing facility.

- Pressure reduced through an automated valve.
- Process monitored by safety system for high pressure conditions.
- Remote operations removed operator from area.

Questions or Comments?

Thank You!

www.autopro.ca

References

- OHS Answers Fact Sheet, CCOHS website (https://www.ccohs.ca/oshanswers/hsprograms/hazard_control.html)