

## Process Safety Cards – A Good Deal Safer

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To improve the awareness of less technical personnel to potential Loss of Containment (LoC) scenarios and increase their vigilance to such events & their potential causes so they can be promptly addressed; memorable images are shown on familiar playing cards representing typical LoC events.

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### Introduction

Process Safety Cards have a simple goal – to improve the awareness of a broad range of personnel to potential major accident scenarios and increase their vigilance to such events & their potential causes so they can be promptly addressed.

These memorable images represent typical LoC events to deliver knowledge literally into the hands of those who might contribute to and/or be affected by unplanned events or Process Safety Incidents.

With an ageing workforce and increased outsourcing of maintenance and operations activities, it is vital that time and knowledge-poor stakeholders (who typically fall outside corporate process safety training strategies) are engaged and equipped to ensure they play their part in sustaining the integrity of assets.

### Challenge

Process Safety Incidents, Major Accidents or Loss of Primary Containment Events continue to occur in the 21st Century despite better technology and bigger data. For example, on 27th July 2021, a significant release of acetic acid at the LyondellBasell facility in La Porte, Texas resulted in 2 contractor fatalities and 30 other personnel receiving medical treatment.

A review (by the author) of the 100+ CSB Investigations [6] indicates 200+ fatalities occurred of which approximately 40% were Contractors. This does **not** suggest or imply that the Contractors were at fault, however it does highlight that 3rd parties are often involved in major accidents.

Although Process Safety initiatives, typically referencing Process Safety Management frameworks including OSHA [7], CCPS [1] or the Energy Institute [3], are now commonplace, these may exclude external resources including outsourced Operations & Maintenance personnel who are therefore not as equipped as their internal counterparts to recognize and address potential Process Safety incidents.

We must also acknowledge that wisdom is being lost with the ageing workforce and that assets are getting older whilst those responsible for them are getting younger.

Are we possibly focusing on the wrong people and/or protection measures?

How do we put knowledge into the right hands?

### Workforce Engagement

In order to gain **and** sustain the attention and participation of the workforce, which may range from novices (who need to be informed) to veterans (who need to be reminded), it is becoming more common to use Gamification methods. These employ game design elements e.g., point scoring, competition with others, rules of play to improve user engagement, learning and knowledge retention.

However, many games require considerable time to setup and play or often cannot be played in the workplace due to the cost and complexity of deploying electronic devices e.g., laptops or tablets to host the games safely (flammable atmosphere ignition potential).

Process Safety Cards offer an alternative (analogue) approach which offers the benefits of gamification without the time and cost burdens and is based on Microlearning e.g., small learning units absorbed in small time units.

Players are encouraged and helped to learn and apply simple principles:

- REMEMBER Events,
- RECOGNISE Causes (Threats) of Events,
- RESPECT Controls (Barriers) which prevent or mitigate Events.
- REPORT Concerns about the presence or performance of the Controls/Barriers,

Thereafter there is an obligation on the duty-holder or owner/operator to:

- RESPOND           to Feedback (concerns, questions, or suggestions).
- RECOVER           Protection to its original state.

Using this simple & memorable 'R' model aims to embed these principles into the minds & memories of frontline personnel.

It is critical that the RESPOND & RECOVER steps are performed otherwise there can be no faith that contributions are valued and that improvements are being made.

## Deployment

Process Safety Cards represent 52 different LoC events that occur in the Process industries which are presented as familiar playing cards split into 4 separate suits.

- DEGRADATION   Failure within design conditions or "under-strength"
- DISCHARGE       Open route to atmosphere
- DAMAGE           External impact
- DEVIATION       Failure beyond design conditions or "over-stress"

These events are drawn from industry publications including the HSE [5] and CCPS [2] and whilst they are not claimed to be an exhaustive list, they can be attributed to familiar major accidents across a variety of industries.

Cards make it easier to communicate in all directions within, top-bottom, side-to-side and inside-outside the organization by providing a common visual language. This gets and keeps the workforce onboard with the Process Safety or Asset Integrity mission.

Sample cards are shown in **Figure 1** below.

One of the core concepts of this approach is to "Know your Enemy" [4] where hazards are not the enemy (these are part of doing business) – it is Loss of Containment that is everyone's opponent.

There are several different opportunities to deploy the cards in operational arenas, because they are easy to carry & exchange:

- Simple passive learning (by osmosis) via familiar, informal card games.
- Toolbox talks, e.g., explain your experience of the card you've been dealt.
- Quick quiz e.g., name the event on the card (without title)
- Hazard spotting or surveys e.g., punch hole in cards and tag/tie them onto the plant at vulnerable locations
- Hazard reminder e.g., attach relevant cards to Permit to Work.
- Inductions e.g., visitors, suppliers or short-term contractors during outage, turnaround etc.

The cards are not limited to frontline personnel as they can also be used to engage engineering or management personnel.

- Safety moments e.g., discuss your role related to the card you've been dealt.
- HAZOP validation e.g., ensure all deviations (cards) have been discussed.
- Performance dashboards e.g., incidents categorized according to LoC type (or card)
- Hazard potential e.g., sum (add) the values of each card i.e., Ace = 11, King/Queen/Jack = 10 & other cards numbered
- Campaigns e.g., each week showcase specific events or cards.
- Relate cards to client or industry incidents e.g., CSB investigations [6].

Just as a pack of cards can create a variety of different games e.g., poker, blackjack, bridge etc. Process Safety Cards utilize the same playing cards elements (or 'pips') which offers an organic approach to gamification that can grow with peer or community feedback i.e., facilities, organizations or industries can develop their own games based on their technology and culture.

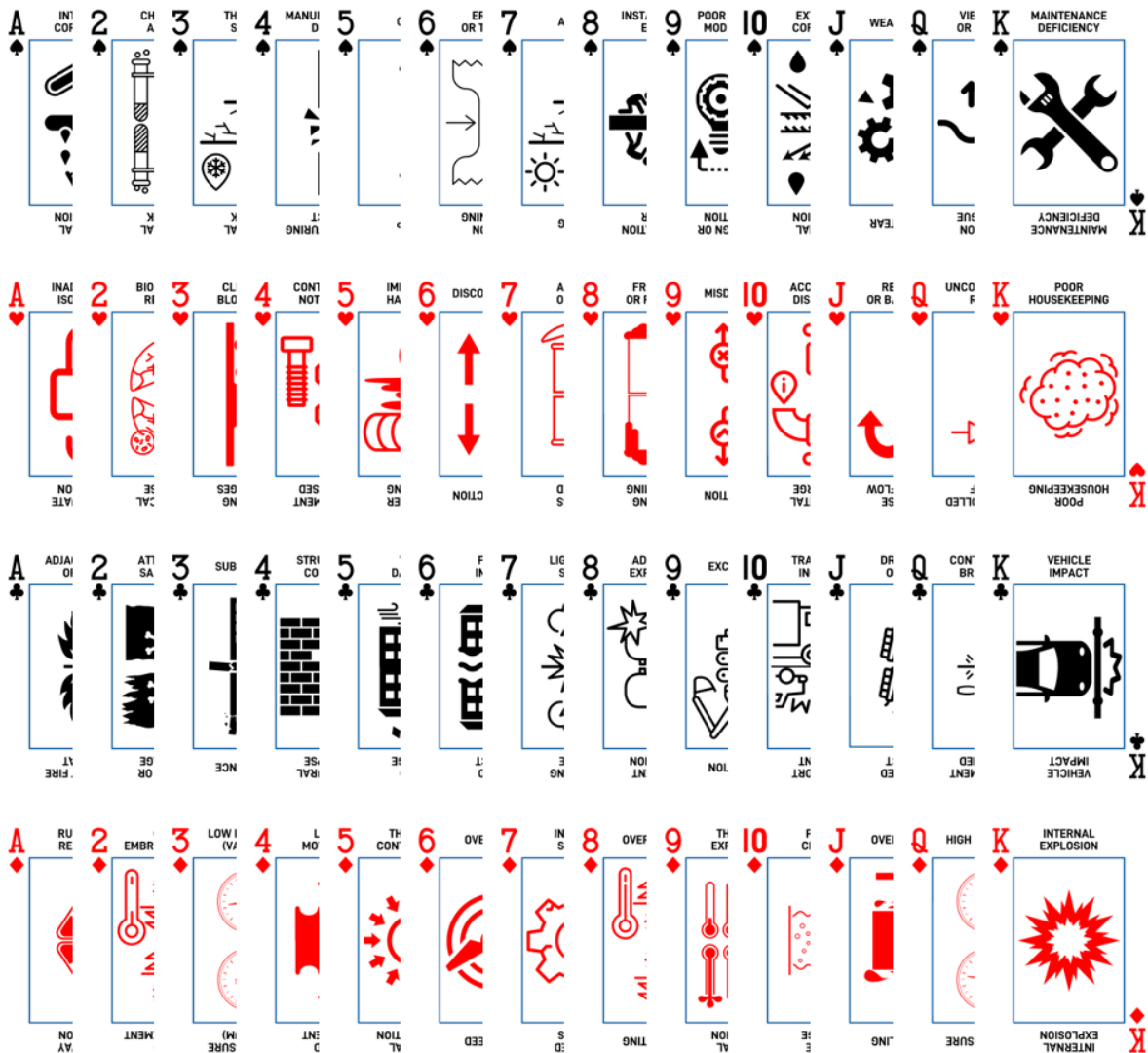


Figure 1 Sample Playing Cards

**Scenario Summaries**

Playing cards increase awareness of the potential LoC events, however in order to address these, an appropriate level of insight is necessary. Visualizing the LoC scenarios in bowtie format provides a clear, concise summary which is more easily understood and retained than textual or numeric data.

A one-page representation of each type of LoC event i.e., playing card, provides typical:

- Cause (Threat)
- Controls (Barrier)
- Effectiveness or Vulnerabilities (by barrier type)
- Degradation factors (by barrier type)

These are not intended to replace existing analyses and should not be considered sufficient to properly monitor & manage barriers, however they do provide memorable context with a particular focus on the Degradation Factors which create and/or enlarge the holes in the Swiss Cheese model and are controlled via asset and/or safety management systems e.g., competence, information, maintenance, change etc.

A sample scenario is provided in Figure 2 below:



# INTERNAL CORROSION



## Typical CAUSES (Threats)

- ◇ Contamination
  - Process e.g. carbon dioxide, water, acids & other chemicals.
  - Microbiologically Influenced Corrosion (MIC)
- ◇ Stress corrosion cracking
  - Chlorides, sulphides, alkali & nitrates
- ◇ Chemical embrittlement
  - Hydrogen assisted/induced or Liquid metal (mercury)

## Typical CONTROLS (Barriers) & VULNERABILITIES (Degradation Factors)

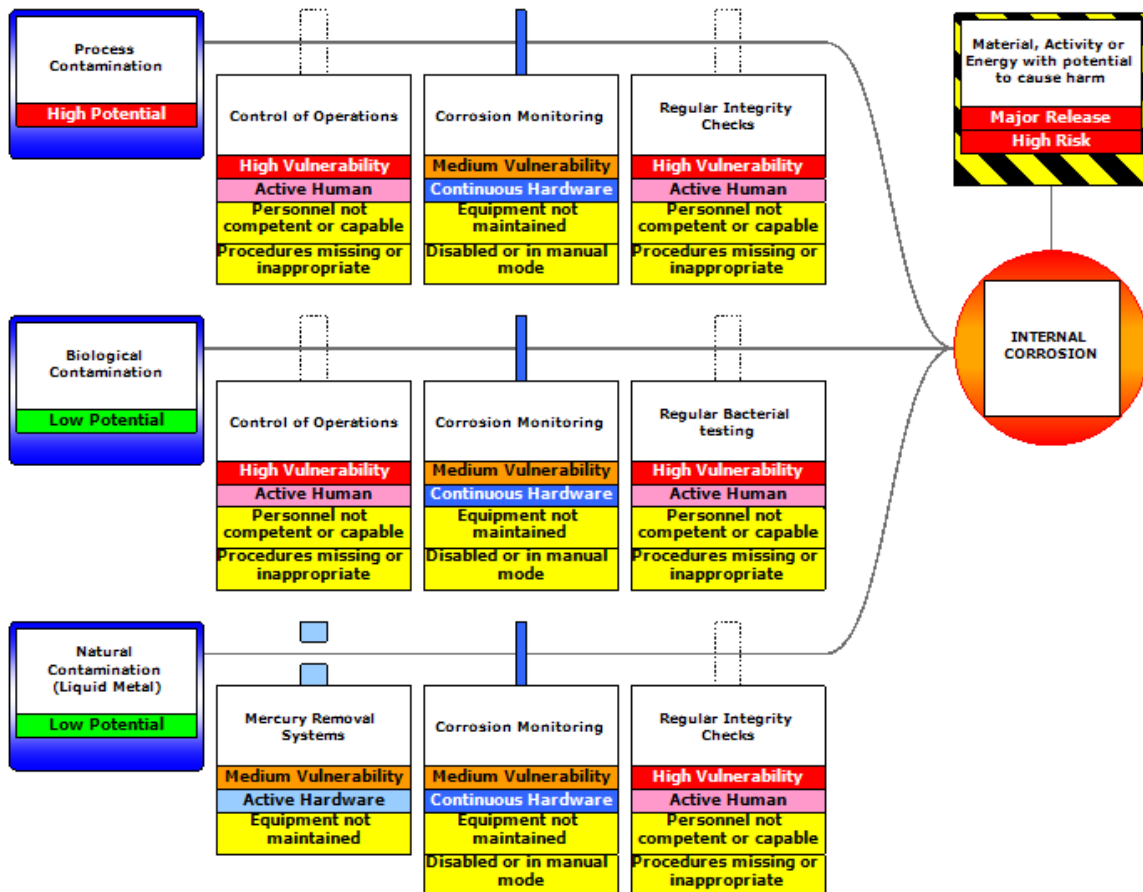


Figure 2 Sample Scenario Summary

Scenario summaries can be posted inside or outside populated or high traffic areas such as control rooms, canteens, workshops, or meeting rooms and rotated on a campaign basis e.g., a different LoC per week. They can also be published online e.g., intranet, SharePoint, or newsletter.

### Online Collaboration

Although Process Safety Cards are designed to be physically handled, the current COVID-19 pandemic prevents or discourages such personal interaction, therefore digital solutions can be used to use or play the cards via collaborative platforms e.g., virtual whiteboards to connect remote or isolated team members.

Using familiar Office® platforms, informal quizzes and structured surveys can be created to gauge the awareness and adoption of the events and associated cards. These use the same images as the cards to provide continuity and familiarity and the results can be used to identify areas of potential weakness and therefore improvement opportunities.

### Knowledge Access

The increase in adoption of digital equipment in the field (where safe to do so) presents an opportunity for 'players' i.e., safety card users, to use their devices to directly access relevant process safety knowledge via QR codes on the cards as per **Figure 3** below:

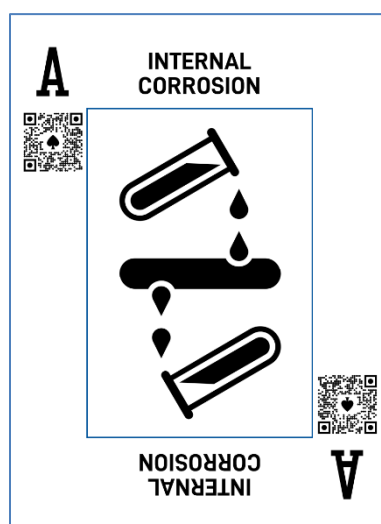


Figure 3 Sample Card with QR Codes

The code can direct or link to an intranet or portal page or other external resource. These may be corporate or industry guidance, more detailed bowties, relevant incidents or any other documents or media that will help the card holder better understand the control of each event (card).

### Frontline Feedback

Although the cards have been provided to operations personnel in a variety of industries (including Onshore & Offshore Oil & Gas, Petrochemicals, Mining, Chemicals & Water) and jurisdictions (including UK, EU, Australia, North America & South America) current COVID-19 restrictions have limited the opportunities for substantial knowledge exchange, however initial feedback from prototype sites has been positive and it is hoped that measurable results (based on significant reductions in unplanned events) will be forthcoming as wider adoption encourages and facilitates conversations about complex & critical issues in an intuitive and engaging way.

Cards have been customised to suit specific operations, including mining & drilling as well as common themes including control of ignition sources, human & organisational factors, process safety fundamentals & process safety stewardship (management).

### Conclusion

Although based on gamification principles, the Process Safety Cards are not a game in themselves i.e., there are no rigid rules to follow. They simply provide a knowledge exchange toolkit to facilitate communications (in both directions) between management and frontline personnel to share learning using universal images and local languages.

These are not a new strategy (although they are a novel idea), they simply help deliver or reinforce established Process Safety (Asset Integrity) initiatives which are designed to ‘Protect the Protection’ i.e., look after the systems (hardware & humans) that look after you.

The cards increase awareness, the bowties enhance understanding, knowing your enemy improves vigilance which drives better protection and more robust asset integrity.

## References

- [1] American Institute of Chemical Engineers (AIChE), Center for Chemical Process Safety (CCPS) Risk Based Process Safety (RBPS) Framework (<https://www.aiche.org/ccps/resources/publications/summaries/summary-guidelines-risk-based-process-safety>).
- [2] American Institute of Chemical Engineers (AIChE), Center for Chemical Process Safety (CCPS) “Guidelines for Chemical Process Quantitative Risk Analysis”.
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- [4] Tze, Sun “The Art of War”.
- [5] UK Health & Safety Laboratory “Loss of Containment Incident Analysis” HSL/2003/07.
- [6] U.S. Chemical Safety Board (CSB) Investigations (<https://www.csb.gov/investigations/>).
- [7] U.S. Department of Labor, Occupational Safety & Health Administration (OSHA) Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) (<https://www.osha.gov/process-safety-management>).