An integrated system for safety analysis and management in LPG industry

ISPESL - National Institute for Prevention & Safety at Work in Italy

Paolo A. Bragatto,
Patrizia Agnello,
Silvia Ansaldi,
Paolo Pittiglio.

Centro Ricerche ISPESL
Monteporzio Catone (ROMA)
LPG industry

- Liquefied petroleum gas (LPG) industry is important in Italy and worldwide
- LPG depots and bottling facilities are the most simple and common, among hazardous industrial facilities
- This industry is ruled worldwide by standard codes and regulations.
- In many countries the facilities are small sized and operated by persons with high skill but low education level.
- A suitable benchmark to study the limits of present safety management systems and to experiment new solutions

A new method, aimed to fill the gap between safety documents and operational experience.
Deductive or inductive?

- In a small sized haz. facilities the first concern of operators is complying with the regulations.
- Due to the poor expertise, the safety documents are usually outsourced to consulting firms.
- The inspiration of the present work is to reverse the reasoning way of duty operators.
- Operators may learn a lot of things from experience and may improve definitely the safety system.
Safety digital representation

- Equipment digital representation used for supporting hazard analysis. In previous papers* it has been derived from a CAD model, here a new solution will be presented.

- Safety Digital Representation = Equipment digital representation + digital safety documents + link

- Safety digital representation to assist duty holders in preparing and updating the safety documents (safety report & safety management system)

- Safety digital representation to analyze near misses

The pillars of the Safety System

- Safety Assessment (Annex II Eu. Legislation)
  Hazard identification and ranking
  Analysis of historical accidents
  List of top events (with likelihood)

- Safety Management (Annex III in Eu. Legislation)
  Operating Manual
  Inspection Plan
  Emergency Management
Mond index customized for LPG industry

• A tailored method version of Mond Index for LPG depots and bottling facilities (enforced in all LPG establishments since 1996). It is based on check list, penalties and credits.
• An accurate scrutiny, according to a check list, of each unit.
• At the end of the scrutiny for each unit the risks are weighted, discriminating explosion, fire and general risk.
Mond index for digital representation

Exploit scrutiny phase to build step by step a digital representation of the plant. By the scrutiny of the plant, two side effects may be derived:

- Verify for each single component the compliance with regulation and standard
- Build step by step a simple but efficient representation of the plant
An integrated system for equipment digital representation

indexes for fire, confined explosion, unconfined explosion, general risk penalties+
credits

The hierarchy unit-component-accessory. Standard accessories and components are represented by icons.

<table>
<thead>
<tr>
<th>Indice Equivalent Dow</th>
<th>145.04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indice d'Incendio</td>
<td>59.4</td>
</tr>
<tr>
<td>Indice di Esplosione Confinita</td>
<td>3.57</td>
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<td>Indice di Esplosione in Aria</td>
<td>4364.29</td>
</tr>
<tr>
<td>Indice di Ricchi Generale</td>
<td>37240.13</td>
</tr>
</tbody>
</table>
Link equipment – safety documents (examples)

- **Example 1** A technical safety system, (e.g. fire-fighting component) is taken into account for computing the risk credit in the Mond/LPG index check lists. A link between the individual component and the credit factor in the Mond/LPG index may be established.

- **Example 2** An accessory is critical as may have a failure, which is in the event chain that leads to an accident with major consequences. It may be tagged and linked to the single event, which is present in the list of top events, as handled in the Safety Report.
Link equipment – safety documents (examples)

• Example 3 An action of a procedure. It requires an operation to be done on an individual accessory (e.g.- a valve), which is, of course, included in the equipment digital representation.

• Example 4 The inspection plan, which has a list of individual piece of equipment, which may be found in the plant digital representation.
An integrated system for risk assessment.

- Facility
- Accident Sequence
- List of top events
- Accident sequence
- Event
- Component
- Accessory
- Credit
- Penalty
- Mond Index
- Inspection Plan
- Operating Manual
- Operating Procedure
- Inspection
- Action
- Emergency Plan
- Emergency Action

Risk Management

Risk assessment
Benefits from safety digital representation

- A definite consistency between Safety documents and actual equipment may be assured in this way.
- Any change in installation may be reflected in the Safety documents.
- For any piece of safety document the piece of equipment may be found, which may be affected.
- Revision /reviewing of Safety Assessment every 5 years or following plant or process changes
- Revision /reviewing of Safety Management every 2 years
As easier as possible ..

- The need of recording and analyzing non-conformances, near-misses and failures, which are much more frequent than accidents.
- The usual formal approach for accident analysis is too difficult

Our approach: **navigate the documents, which are the pillars of the safety system.** The chart for the navigation is the SAFETY DIGITAL REPRESENTATION

The information coming from near misses may be used basically for:
- Safety Management System (operating manual and inspections plan)
- Safety Report (hazard identification and list of the top events)
Risk assessment

- Facility
- Mond Index
- Credit
- List of top events
- Event
- Accidental sequence
- Component
- Accessory
- Unit

- Inspection Plan
- Operating Manual
- Operating Procedure
- Inspection
- Action
- Emergency Plan
- Emergency Action
Non Conf. Event (Safety Assessment Top Events)

Unit - Mond/GPL index
D-Dow; F-Fire; Confined Expl;

From the list of top events in the Safety Report: the failure; the top event, which could happen; The events sequence
In the safety management system procedures, the inspection plan has been improved, in order to prevent accidents.
Exporting Results

- It is possible to build a “safety digital representation”, which may be used for reporting and analyzing near misses, as well as for updating safety report and related documents. For building the digital representation, no extra duties are required; but exploiting in a smarter way documents which are already present.

- The high standardization level of LPG industry has been exploited to build the equipment representation during the plant scrutiny. If the standardization was lower this step could be more difficult.
thank you for your attention

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