



An integrated system for safety analysis and management in LPG industry

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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

* Bragatto & al. (2007) *J. of Loss Prevention in the Process Industry* 20 pp. 69-78



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)
Safety Policy – Safety Management Manual
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

IRIS_GPL - Identificazione dei RISchi negli impianti industriali per GPL

File Visualizza Documenti Strumenti Finestra Guida

Rischi Particolari di Processo - STOCCAGGIO

D.M. 13 ottobre 1994

4. Serbatoi interrati o ricoperti
5.4.1. I serbatoi possono essere installati completamente sotto il livello del suolo (vd. tav. 1 A) oppure parzialmente o totalmente al di sopra del livello del suolo (vd. stessa tavola, punti B, C, D ed E). In

TOTALE RISCHI PARTICOLARI DI PROCESSO 214

LEGENDA
A: diametro minimo: 0,5 m
B: materiale di ricoprimento
C: diametro esterno compatibile per l'appoggio del serbatoio
D: angolo di inclinazione

Tav. 1b: SERBATOIO TOTALMENTE RICOPERTO



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

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

...ment digital representation

Proprietà

ROCKERDUCK GAS

IMPIANTO DOMESTICO

Unità 3

FO 13994/81

- SG 191
- SG 295
- SG291
- H285-A
- H285-B
- H285-C
- H285-D
- H285-E
- H285-F
- H285-G
- H285-H
- acc-52
- acc-53
- acc-54
- acc-55
- acc-56
- acc-57

Sfera da 1000m3 coibentata

Diagram dimensions: H=150 mm, H=80 mm, L=4633 mm

Indice Equivalente Dow	D	145,04	
Indice d'Incendio	F	29,4	
Indice di Esplosione Confinata	C	3,57	
Indice di Esplosione in Aria	A	4364,29	
Indice di Rischio Generale	G	37240,13	D

F'	1,87
C'	0,49
A'	240,56
G'	295,59
	B

serbatoio sferico
acciaio al carboni
Propano

Tipo di entità	serbatoio sferico
Materiale	acciaio al carboni
Fluido	Propano
pressione d'esercizio	9,3 bar
pressione esercizio me	8,5 bar
pressione di progetto	13,5 bar
pressione di collaudo	23 bar
pressione di scatto	18 bar
pressione di bollo	17,5 bar
temperatura di eserciz	30 °C
temperatura min di pro	-10 °C
temperatura max di pro	40 °C
Volume	1000000 lt

Avvia Calcolo degli Indici -->

Importa Calcolo degli Indici

- Rischi Generali di Processo
- Rischi Particolari di Processo
- Rischi Dovuti alle Quantità
- Rischi Connessi al Layout

Generale (DPCM 27/89)

GPL (DM 113/96)

Depositi (DM188/98)



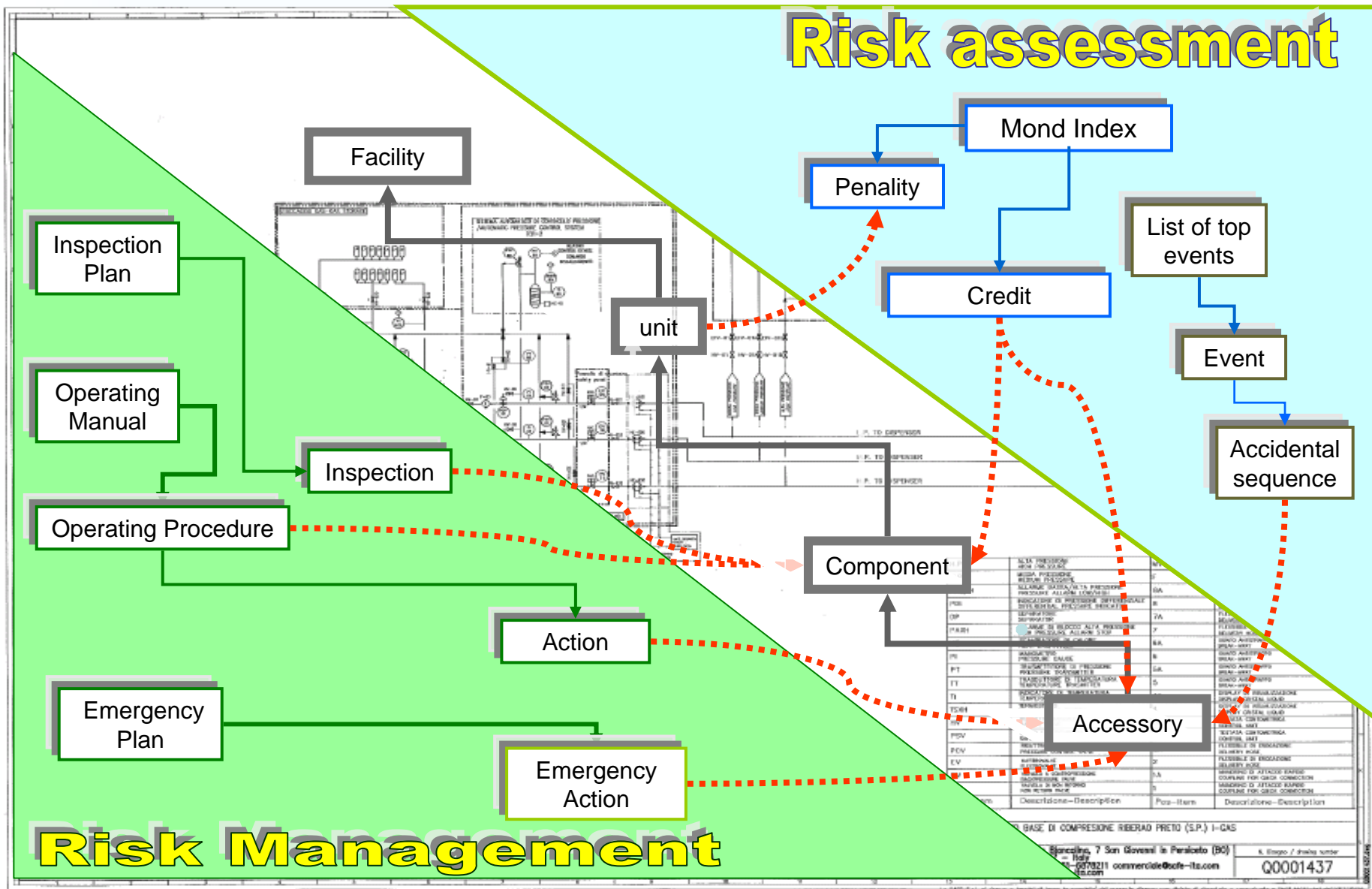
Link equipment – safety documents (examples)

- 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.





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





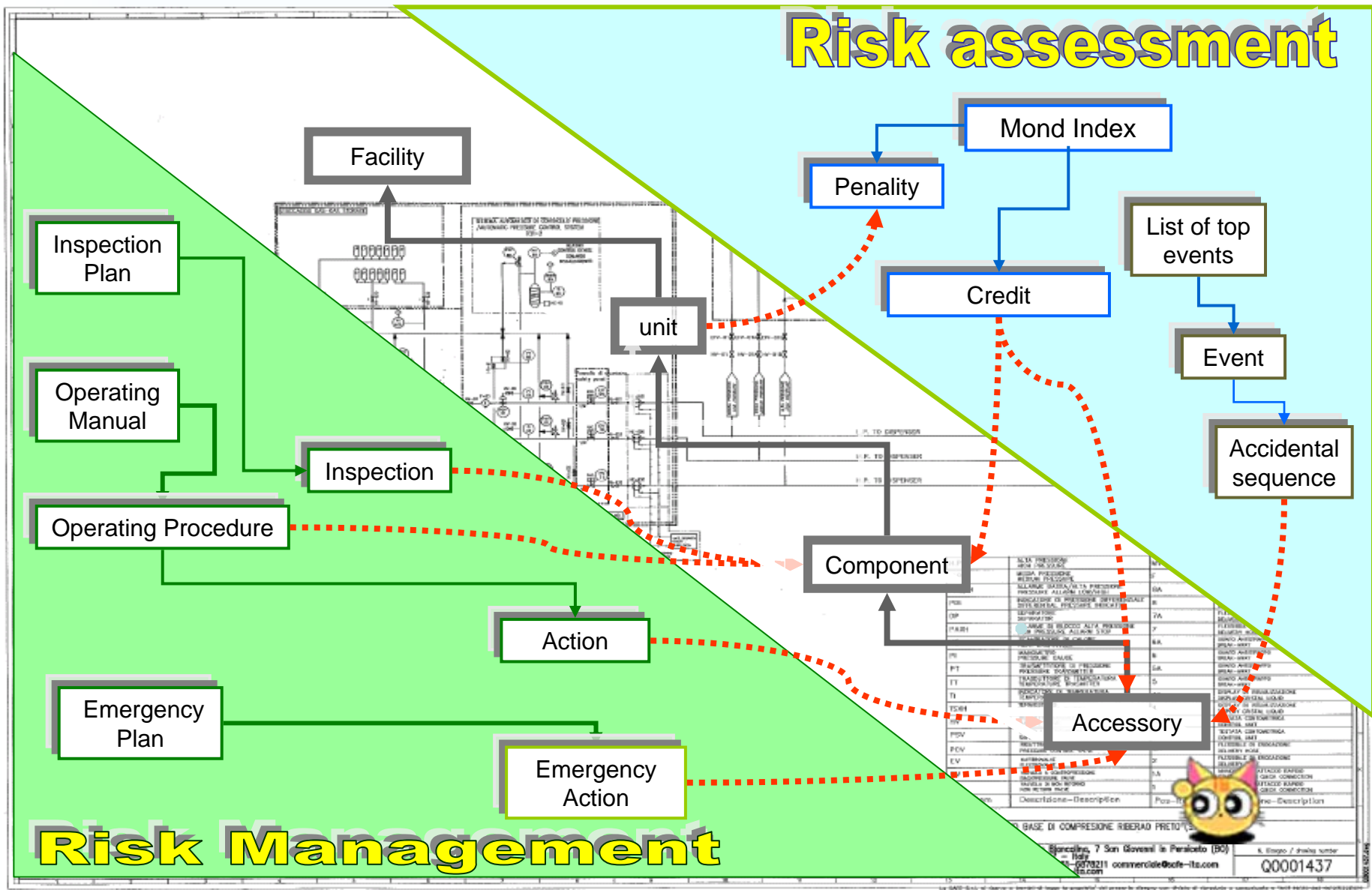
As easier as possible ..

- 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 :

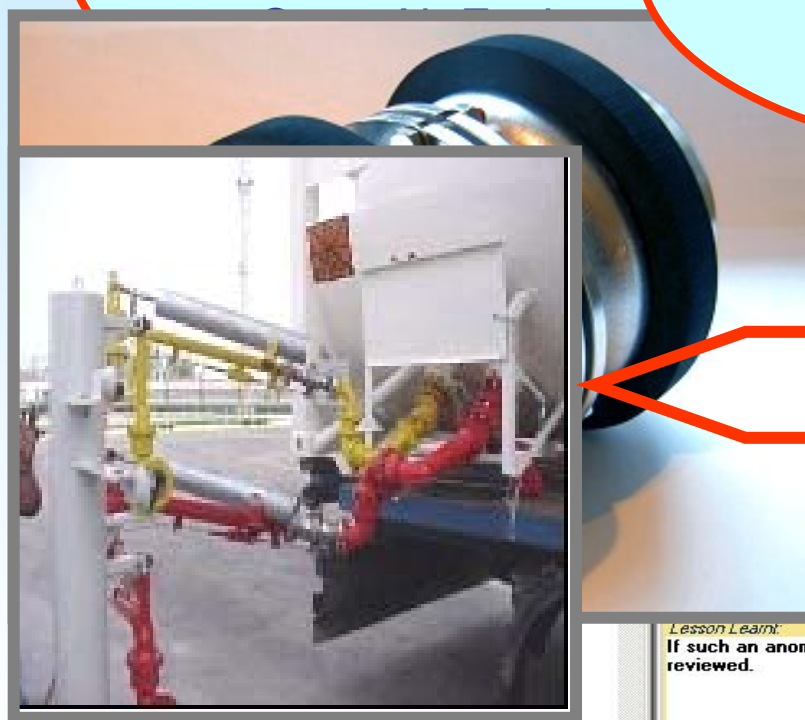
- ✓ Safety Management System (operating manual and inspections plan)
- ✓ Safety Report (hazard identification and list of the top events)



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



ices	D-Dow	F-Fire	ol	A-AirExpl	G-Global
/UNLOAD]	13,3	2,83	4,48		219,9

Top Events:

- Liquid leak from failure of loading pipe
- Vapour leak from failure of unload arm
- Leak from load/unload arm failure
- Blowby from failure of PSM on unloading
- Build-up of product in the imp top system
- Detection and leak stop
- Refrigerate system for road tanker
- Ingress of air

Lesson Learnt:
If such an anomaly occurs again, the reliability assigned to the component (loading arm) should be reviewed.



Non Conf. Event (Safety Mgmt - Inspection Plan)

In the safety management system procedures, the inspection plan has been improved, in order to prevent accidents

New Events List

Rottura sistema di fissaggio braccio di carico Date: 14/02/2005 - 15:58:54
 Worker/Supervisor: Mario Rossi

Description:
 Le viti utilizzate per fissare al braccio meccanico del punto travaso n.2 la valvola flip-flap risultano allentate

Actions done:
 1. Effettuata sostituzione
 2. Controllo sugli altri bracci di carico

Recommendation:
 nessuna

Event Ref.: 6 Cause type: Meccanica Consequence: Produzione

Safet Management System Manual

SMS Manual Indexes:
 3.4 - Attività ed operazioni di manutenzione

Procedures:
 14. Verifica periodica e manutenzione preventiva dell'impianto

proc14 VERIFICA PERIODICA E MANUTENZIONE PREVENTIVA ELEMENTI CRITICI DELL'IM.

Giunti antivibranti compressori	GPL	Manichette punti di carico	Manichette carico bombole 1.
Verifica Visiva	Giornaliera	-addetti	
	2.Pressatura 30 bar	Annuale	-Contratto
	3. Sostituzione entro 2009		Ogni 5 anni
alla costruzione	-Contratto		
bracci di carico	1. Verifica Visiva		
	2		
	3. Verifica generale		
Contratto	Scadenza 2006-		

Label or Notes
 Rif.N°:6 - Viti allentate: segnalato il 16/02/2008

... riguarda un elemento critico ed è presumibile che si possa presentare su
 effettuare un controllo straordinario su tutti.



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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