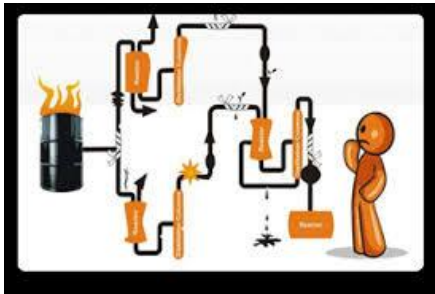
PROCESS HAZARDS ANALYSIS

PHA

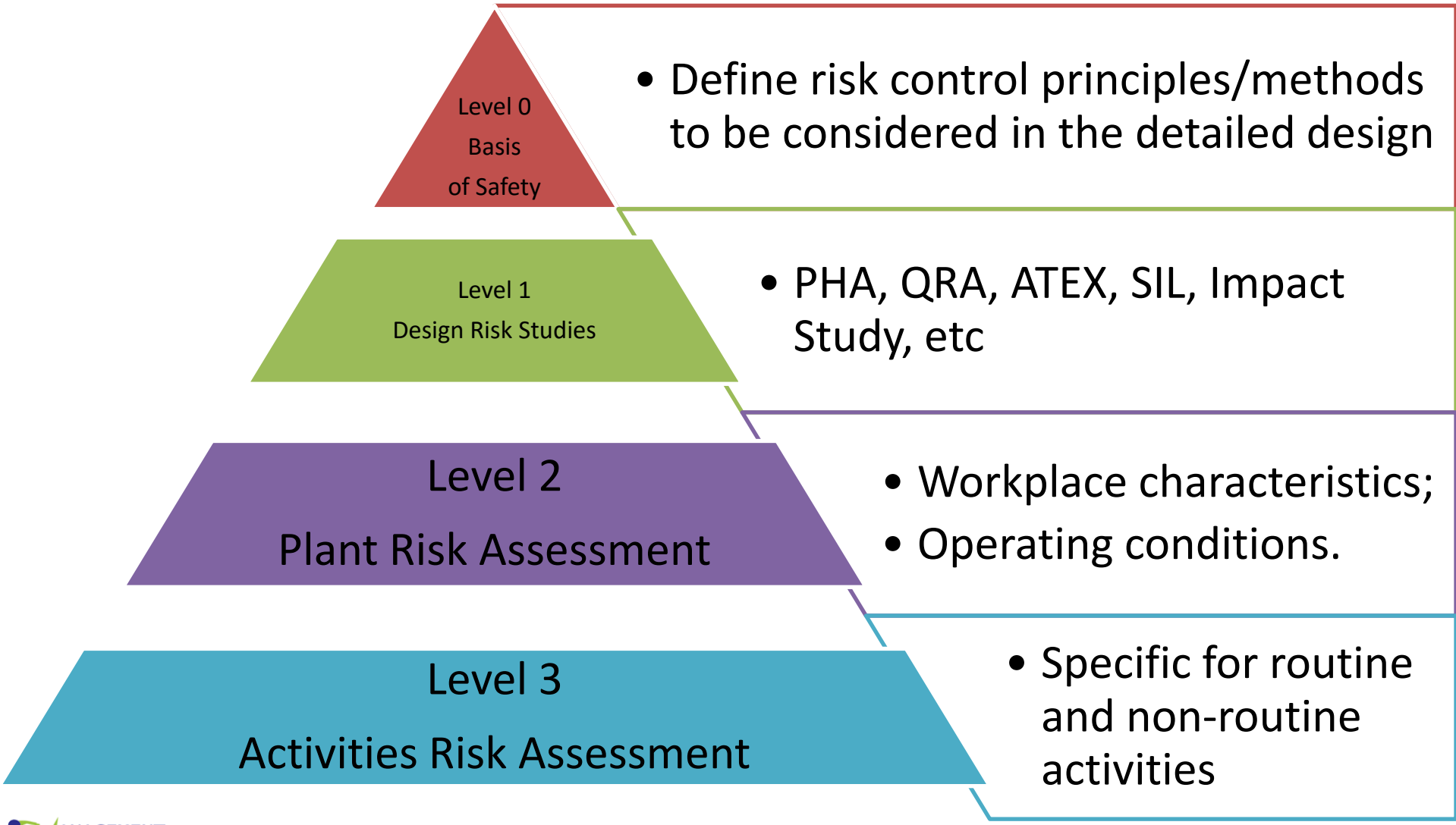
THEODOROS KRANIDIOTIS
MANAGEMENT FORCE GROUP

What is PHA?

- Proactive and systematic identification and evaluation of “incidents” that could occur as a result of failures in process, procedures or equipment;
- It provides the structure upon which an effective Process Safety Management program is designed and built;
- It is applied during the detailed design of a Project and before applying a “design change” during normal operation.



Risk Control Pyramid



Why PHA?

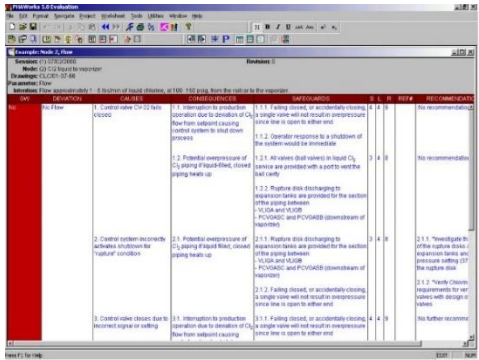
- Legal compliance:
  - Prevent incidents;
  - SEVESO regulated facilities; HP NG systems;
- Business optimization:
  - Less interruption, no loss of production, increased productivity, higher turnover/profit.
- Costs saving:
  - Insurance;
  - Cheaper/sometimes only possible to intervene during design than later.
- Corporate image:
  - Less problems with authorities, no incidents;
  - Easier permitting;
  - Easier investment, market more accessible to good performers.

PHA Objective

- Identify hazards as early as possible, in order to determine the most appropriate "solution" for managing their risk;
- Modifications made early in the design stage of project have minimal effect on cost and schedule;
- PHA methodology shall be appropriate to the complexity of the process.

The PHA Must Address

- Facilities description/sitting.
- Components/Equipment in the process;
- Hazards of the process;
- Consequences of deviations or failures;
- Engineering and administrative controls;
- Human factors;
- Evaluation of consequences and effects; Qualitative/Semi-Quantitative;
- Steps required to correct or avoid failures/deviations.



PHA Methodologies

- Hazard and Operability – HAZOP;
- Hazard Identification – HAZID;
- What-If analysis;
- Checklists;
- Failure Mode and Effects Analysis –FMEA;
- Fault Tree Analysis;
- Combination of the above.

HAZID/HAZOP

- PHA methodology presented includes:
  - **Hazard Identification (HAZID):** A structured approach for the identification of undesirable consequences (human, environment, business). Usually a register of all possible hazards is considered.
  - **Hazard and Operability study (HAZOP):** A systematic approach to identify hazards and operability problems occurring a result of deviations from the intended range of process conditions;

HAZID

- Team work:
  - Chairman, Safety, Operation, Maintenance, Designer, Other.
- Review of physical hazards and operability issues associated with the facilities;
- Process and human interaction is considered;
- Project is divided into manageable, logical sections (systems or units);
- Team analyzes each section using a proposed register of hazards and consequences and identifies which hazards can be realized and what are their consequences.

HAZID Register (ISO 17776)

- Natural Hazards:
  - Temperature extremes, Waves, Wind, Dust, etc.
- External & 3rd Party Hazards:
  - Sabotage, Third Party Activities, etc.
- Facility Systems:
  - Hydrocarbons under pressure, Toxics, Liquids and gases under high pressure, Hot or cryogenic fluids, Blastic agents, Explosives, Dangerous equipment, Ignition sources, Lifting facilities, Health Hazards, Working Environment, etc.

HAZID

- Once the hazards applicable are identified, an assessment for each hazard is made:
  - **Raw Risk:** is the risk introduced in a system without considering the safeguards according to the design.;
  - **Residual Risk:** is the residual risk estimated considering the safeguards defined in the design. If residual risk is still intolerable then recommendations shall be considered;
  - **Final Risk:** is the risk estimated considering the proposed recommendation(s).

Risk Ranking

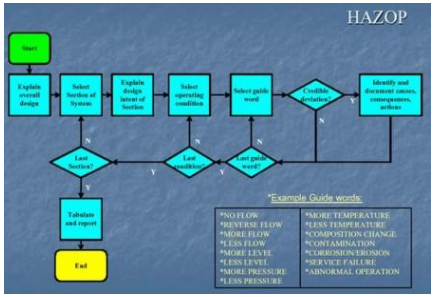
Severity		Likelihood				
		1-Very Unlikely ($<10^{-6}$)	2- Unlikely (10^{-6} to 10^{-4})	3- Likely (10^{-4} to 10^{-2})	4- Very likely (10^{-2} to 10^{-1})	5- Certain (10^{-1} to 1)
	5-Catastrophic Internal: many fatalities External: irreversible effects, multiple fatalities	5	10	15	20	25
	4-Very Extensive Internal: Fatality. External: irreversible effects, fatality, public evacuation	4	8	12	20	
	3-Critical Internal: major injuries. External: irreversible effects, public shelter in place		6	9	12	15
	2-Marginal Internal: small injury. External: reversible effects		4		8	10
	1-Negligible Internal: First aid, keep working. External: no effects	1		3	4	5

UNACCEPTABLE

ALARP

ACCEPTABLE

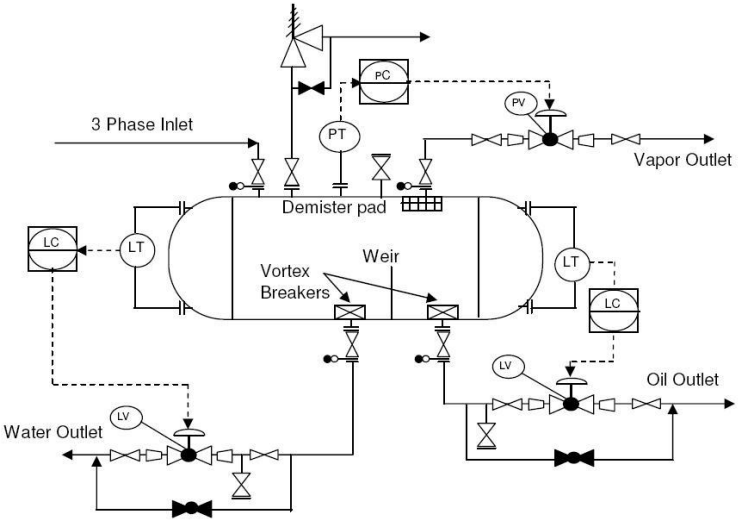
HAZOP



- Team Work:
  - Chairman, Process, Safety, Operation, Maintenance, Instrument, Other.
- Systems/processes are divided into nodes;
- Each node systems/components is systematically questioning in order to establish how deviations from the design intent can arise;
- Appropriate guidewords and deviations are used to focus the attention of the team upon deviations and their possible causes.

HAZOP Guide Words

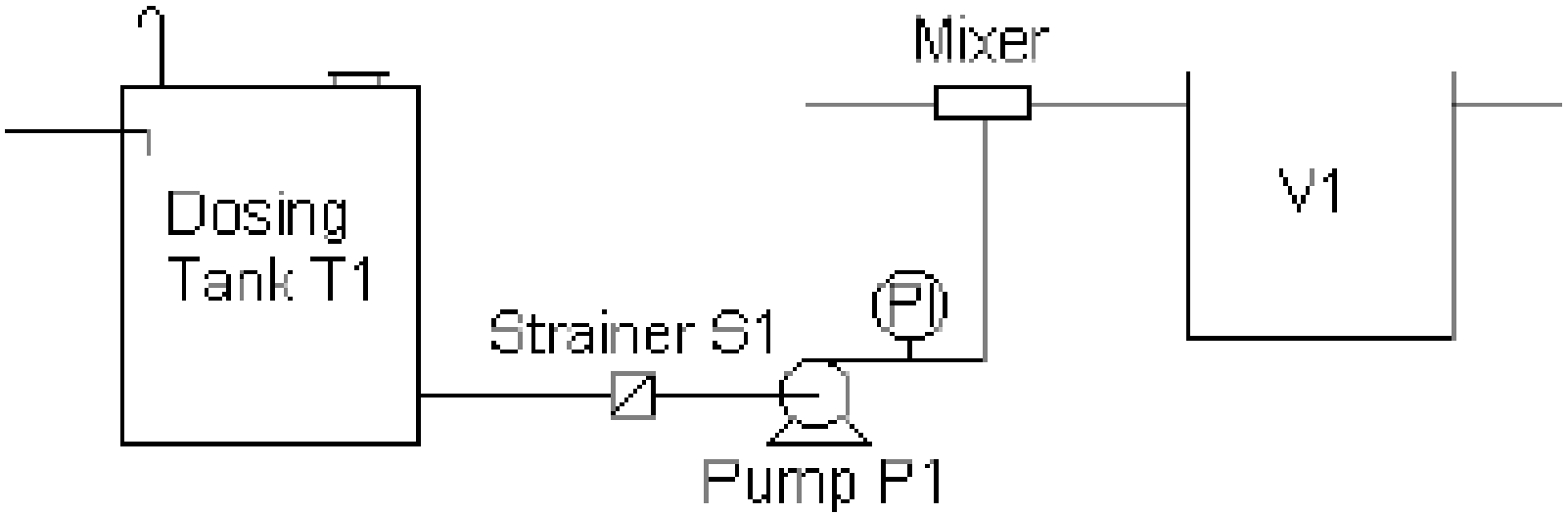
- Flow
  - Low/No/High/ Reverse
- Pressure
  - Low/High
- Level
  - Low/High
- Temperature
  - Low/High
- Different Composition / Contamination
- Corrosion/Erosion/Deposition
- Loss of power / utilities / instrumentation
- Isolation / Drain / Vent
- Start-up / Shut down
- Other



HAZOP

- Once a deviation is considered valid, consequences are identified and an assessment is made according to the risk assessment approach (Raw Risk, Residual Risk, Final Risk);
- If “Residual Risk” is still “Intolerable” recommendations are raised for further actions;
- Typical assumptions:
  - No catastrophic loss, No double jeopardy, Good faith

Analysis Example

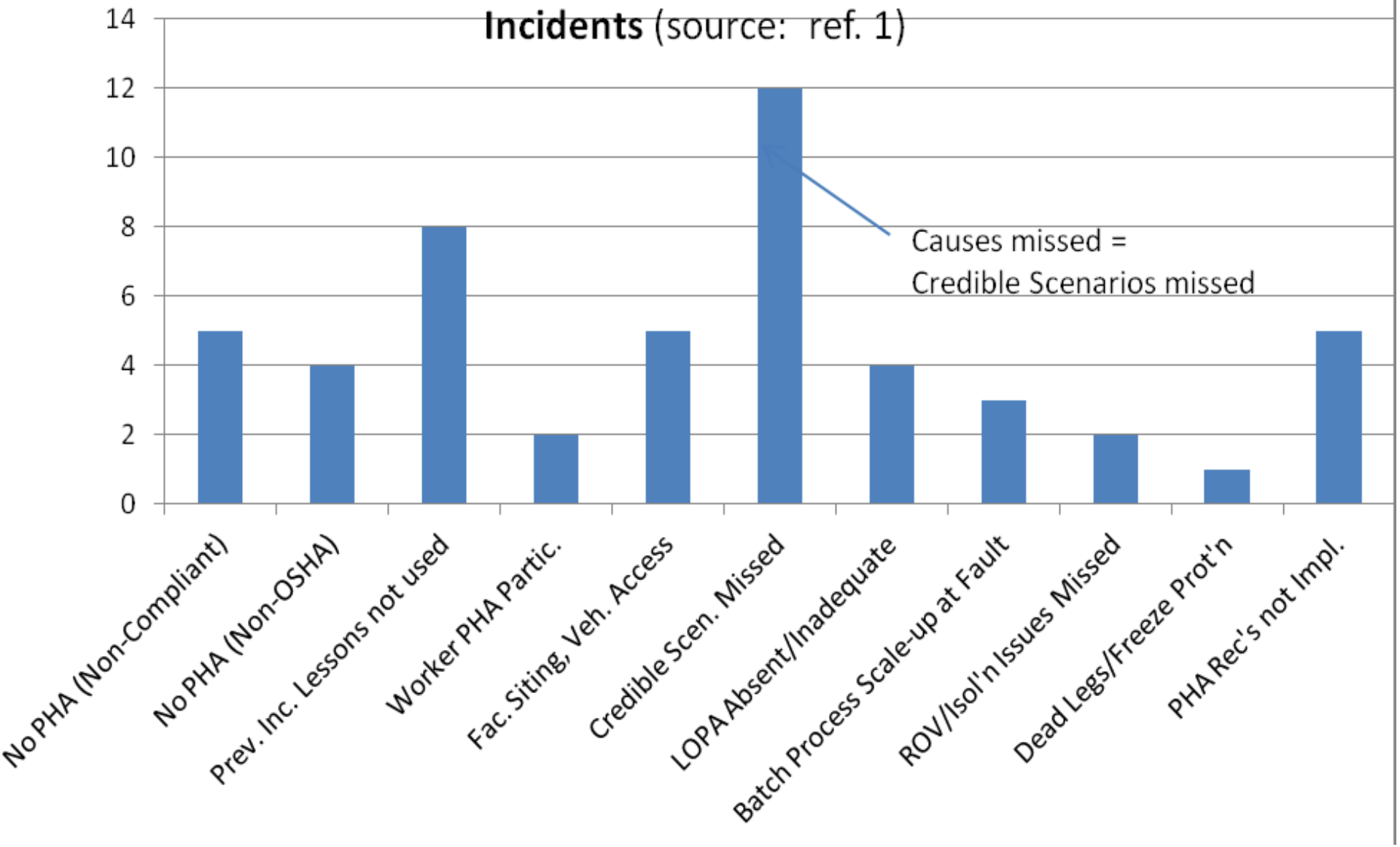


Deviation	Cause	Consequences
No Flow	Strainer S1 blockage due to impurities in Dosing Tank T1	• Tank T1 High level, overflow, injury, fire/toxic • Cavitation in Pump P1, pump damage • Loss of process

Always be Alert

- PHA may not identify all incidents that could occur in a process if:
  - A scenario may be excluded from the scope of the analysis;
  - The team may be unaware of a scenario;
  - The team consider the scenario but judge it not credible or significant;
  - The team may overlook the scenario.
- No shortcuts; systematic consideration;
- PHA team experience and expertise.

Figure 1. Pareto Analysis: Contributing Factors to Serious Incidents (source: ref. 1)



Mark Kaszniak, —Oversights and Omissions in Process Hazard Analyses: Lessons Learned from CSB Investigations‖, presented at the AIChE 2009 Spring National Meeting, 5th Global Congress on Process Safety, 43rd Annual Loss Prevention Symposium, Tampa, Florida (April 26–30, 2009)

Summary

- The Process Hazard Analysis is the backbone of the Process Safety Management program;
- PHA is the tool to achieve:
  - Risk reduction;
  - Business optimization.

- Questions?

- Contact Details: Theodoros Kranidiotis, tkranidiotis@mforsafety.com, +30 6947709950