TOTAL PETROCHEMICALS

The Need for Excellence in Safe Operations to Manage High Risk Plants

Human Reliability : learning from Aviation Industry

Herman Van Roost

MarcusEvans 2nd Annual Health & Safety Management Convention in EMEA Region
Prague, September 14th and 15th, 2009

TOTAL

Acknowledgement

Contributions from external sources (publications) :

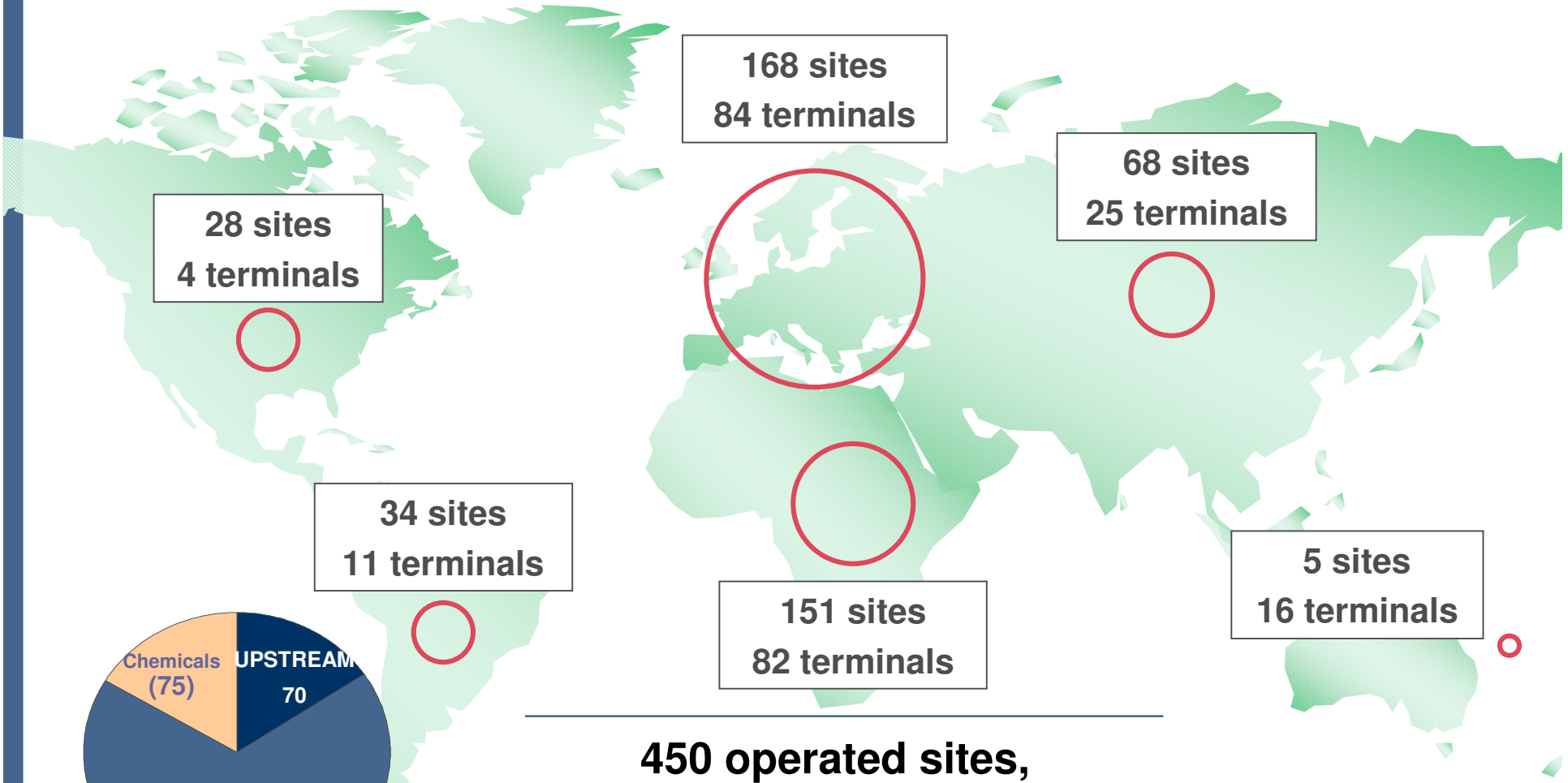
- **CCPS**
  - 2005 – 2009 Convention papers
  - Library of handbooks "Guidelines ….."
- **ASM Consortium**
  - Incl. Honeywell
- **Air France Flight Operations**
  - Etienne Lichtenberger, VP Flight Safety and Quality
- **ICSI**
- **Senior authors on process safety**
  - Trevor Kletz
  - Andrew Hopkins
  - …

« Total considers safety in regard to operations, human health, respect for the environment and customer satisfaction as paramount priorities. »

Article 1 of Health, Safety, Environment, Quality Charter

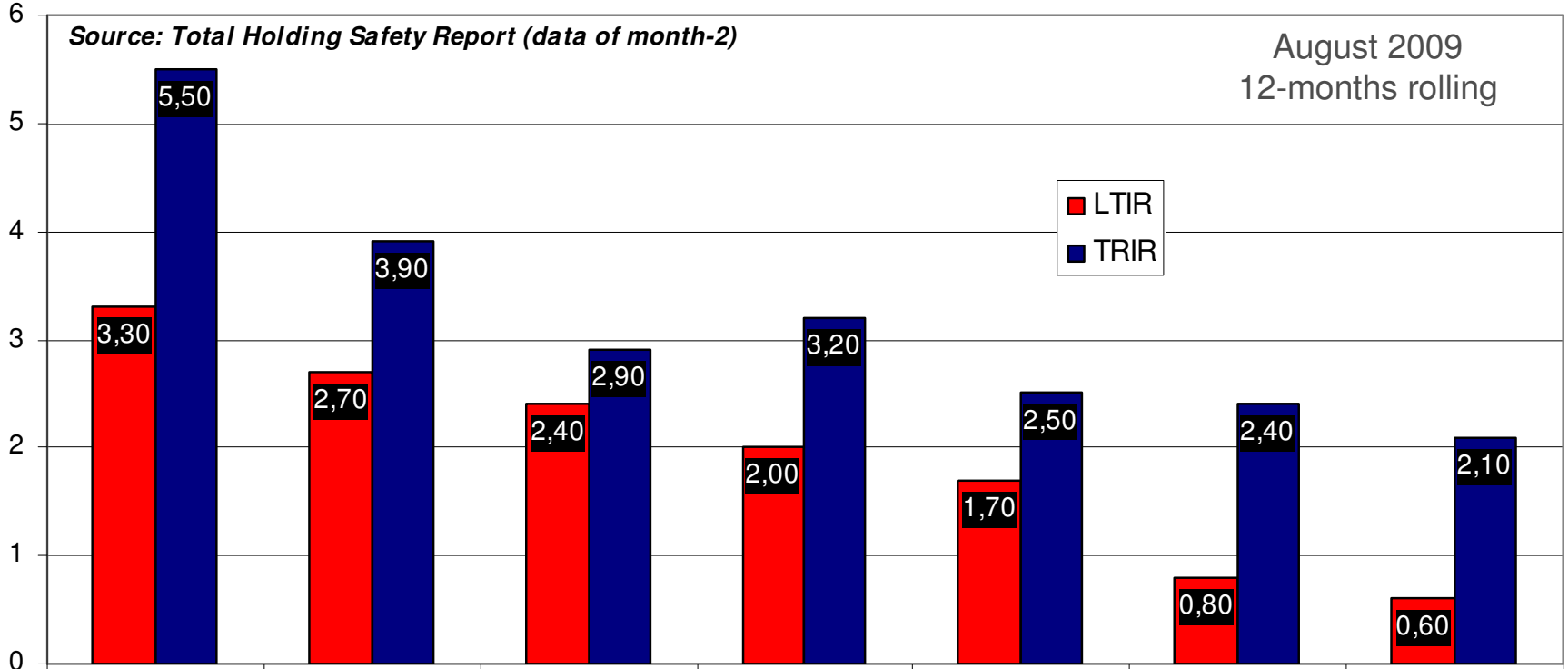
January 2001

TOTAL : hundreds of high risk installations worldwide



450 operated sites,
222 terminals,
23 000 km pipelines

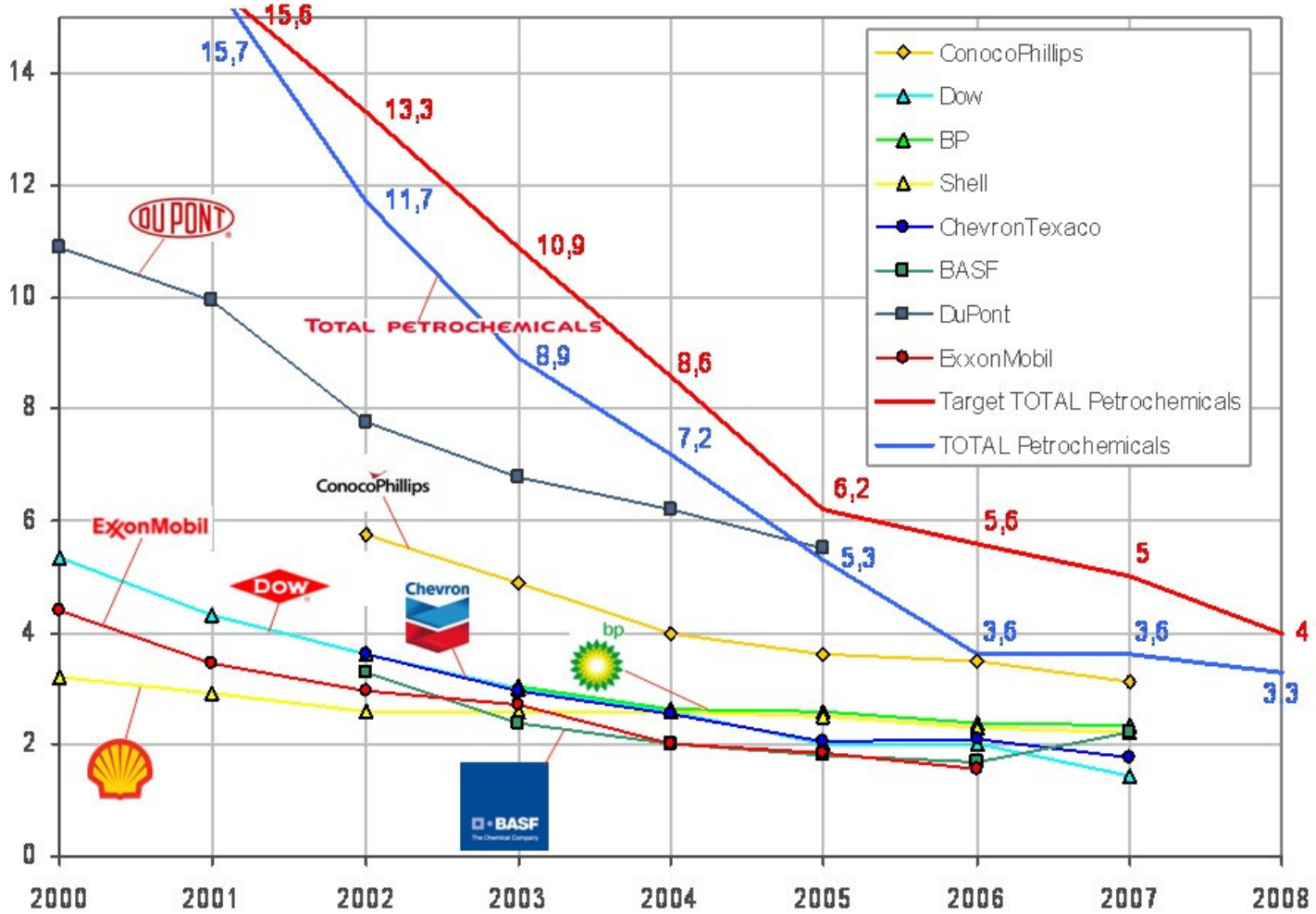
Total historical safety indicators : LTIR, TRIR (°)



	Chemical Branch	Refining	Refining - Marketing	TOTAL	Gaz & Power	Petrochemicals	Exploration - Production
LTIR	3,30	2,70	2,40	2,00	1,70	0,80	0,60
TRIR	5,50	3,90	2,90	3,20	2,50	2,40	2,10

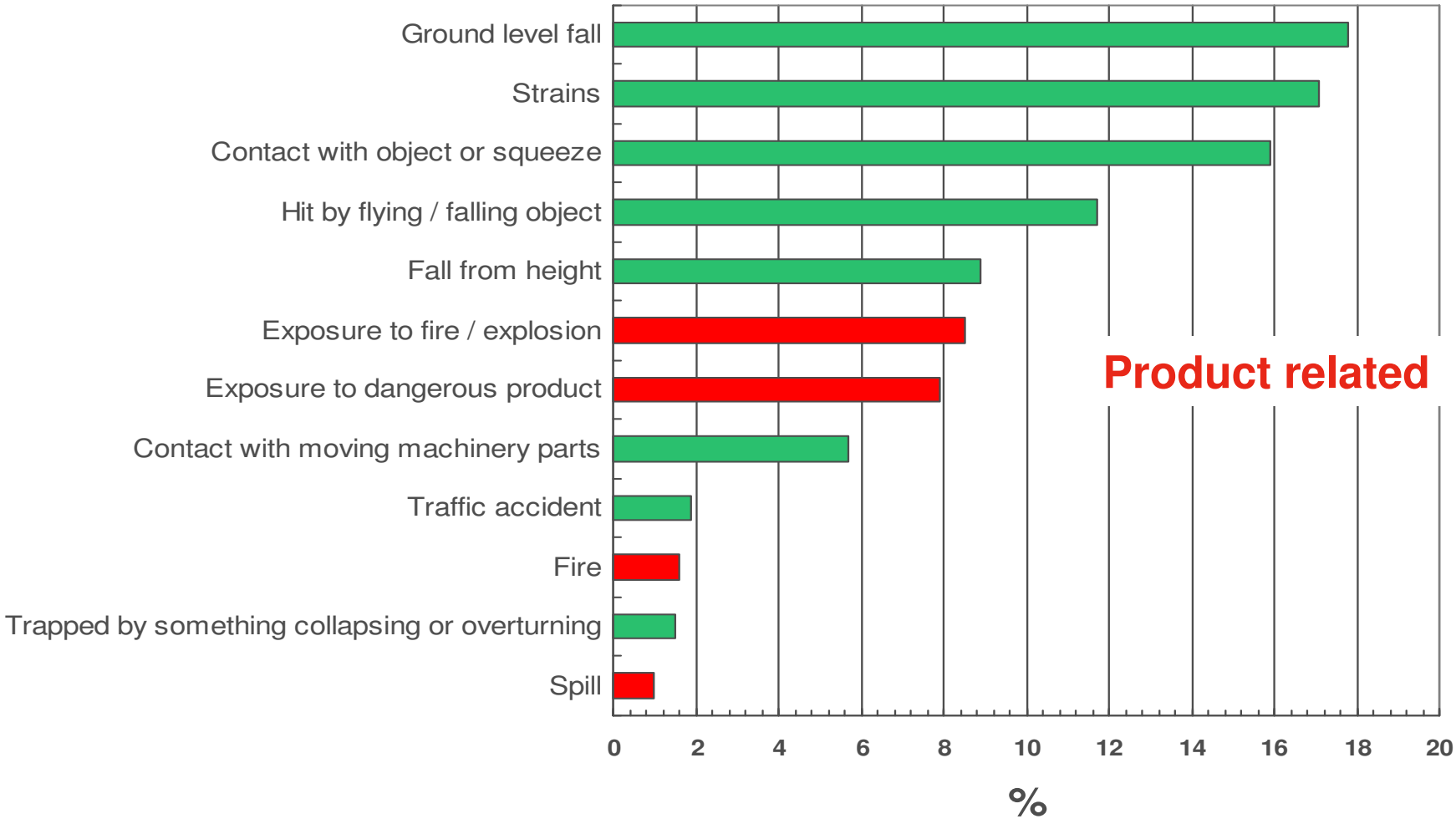
(°) LTIR = number of Lost Time Injuries per million working hours
TRIR = number of Recordable Incidents per million working hours

Total Petrochemicals : external positioning



Total Recordable Injury Rate (own + contractors) per million worked hours

Accident typology



~700 accidents in Total Petrochemicals in the period 1998 - 2008

Petrochemical industry in the ’60 – ’80 period

- Steady growth of chemistry and petrochemistry
- « New » type of accidents, not covered by legislation
- Physical phenomena (BLEVE, VCE) are not well understood

UK (1974)
VCE chemical site
28 fatalities
104 injuries

Belgium (1967)
BLEVE road tanker
22 fatalities
47 injuries

France (1973)
BLEVE road tanker
13 fatalities
37 injuries

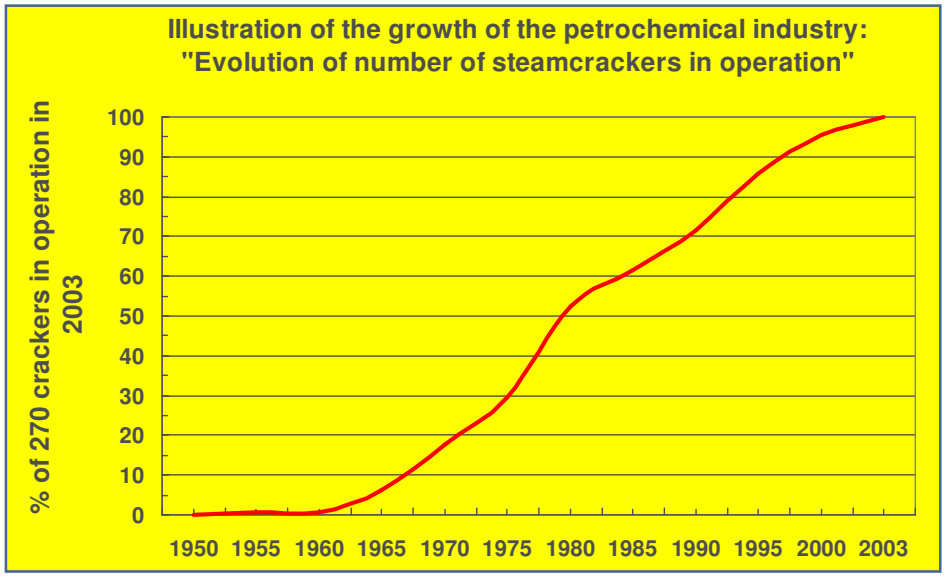
Netherlands (1975)
VCE steamcracker
14 fatalities
107 injuries

France (1966)
BLEVE Spheres
18 fatalities
81 injuries

Netherlands (1971)
Butadiene explosion
8 fatalities
21 injuries

Spain (1978)
BLEVE road tanker
216 fatalities
200 injuries

Italy (1977)
VCE steamcracker
3 fatalities
107 injuries

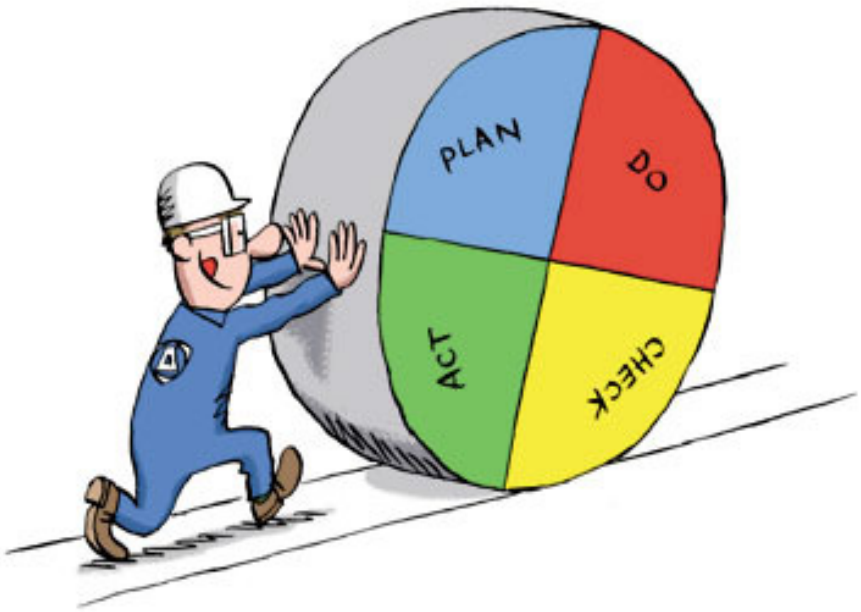


Mexico (1984)
BLEVE LPG depot
500 fatalities
7,000 injuries

Bhopal (1984)
Toxic release
20,000 fatalities
200,000 injuries

Science, industry and authorities have steadily moved forward together

- **Distinction of « Seveso » class installation**
- **Deep understanding and modelling of explosion physics and chemistry**
  - VCE : deflagration – detonation – … + influencing factors
  - Overpressure damage and resistance of buildings
  - Quantitative modelling + extensive testing
- **Risk evaluation techniques and modelling**
  - Risk matrix
  - QRA
  - FMEA, Fault Tree, Bow-Tie, …
- **Technical prevention concepts and norms**
  - LOPA, SIS, …
  - Asset integrity
  - Management of Change
  - Best Industry Practices
  - APEX, …
- **Management systems**
  - ISRS, AIMS, ISO14000, …



Since 2000, a new series of spectacular accidents hit the process industry ….

Toulouse, 2001

The accidents happen now in an environment that was thought « under control » :

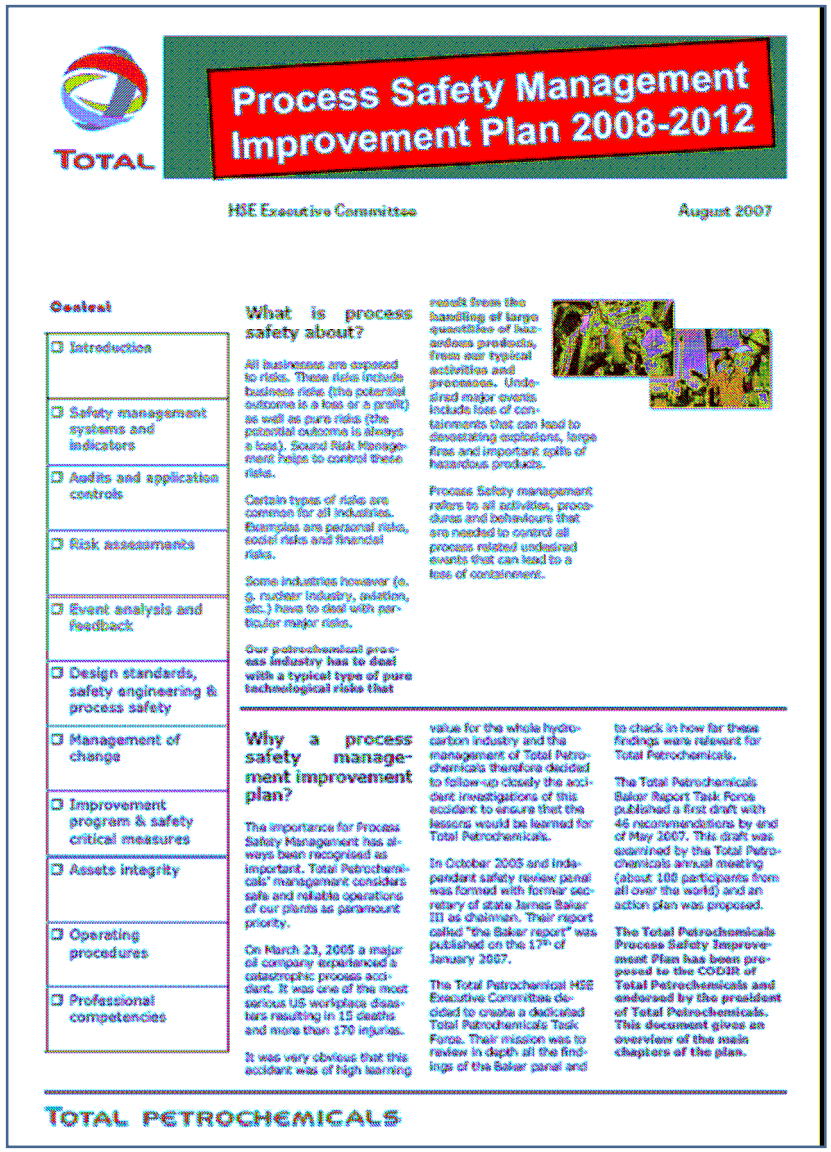
- Adapted legislation (Seveso)
- High standard of design
- Well established companies
- Good safety track record (LTI)

Buncefield, 2005

Skikda, 2004

Texas City, 2005

Corporate Action :
Process Safety Management Improvement Plan



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Process Safety Management Improvement Plan 2008-2012

HSE Executive Committee — August 2007

Content

- Introduction
- Safety management systems and indicators
- Audits and application controls
- Risk assessments
- Event analysis and feedback
- Design standards, safety engineering & process safety
- Management of change
- Improvement program & safety critical measures
- Assets integrity
- Operating procedures
- Professional competencies

What is process safety about?

All businesses are exposed to risks. These risks include business risks (the potential outcome is a loss or a profit) as well as pure risks (the potential outcome is always a loss). Sound Risk Management helps to control these risks.

Certain types of risks are common for all industries. Examples are personal risks, social risks and financial risks.

Some industries however (e. g. nuclear industry, aviation, etc.) have to deal with particular major risks.

Our petrochemical process industry has to deal with a typical type of pure technological risks that result from the handling of large quantities of hazardous products, from our typical activities and processes. Undesired major events include loss of containments that can lead to devastating explosions, large fires and important spills of hazardous products.

Process Safety management refers to all activities, procedures and behaviours that are needed to control all process related undesired events that can lead to a loss of containment.

Why a process safety management improvement plan?

The importance for Process Safety Management has always been recognised as important. Total Petrochemicals' management considers safe and reliable operations of our plants as paramount priority.

On March 23, 2005 a major oil company experienced a catastrophic process accident. It was one of the most serious US workplace disasters resulting in 15 deaths and more than 170 injuries.

It was very obvious that this accident was of high learning value for the whole hydrocarbon industry and the management of Total Petrochemicals therefore decided to follow-up closely the accident investigations of this accident to ensure that the lessons would be learned for Total Petrochemicals.

In October 2005 and independent safety review panel was formed with former secretary of state James Baker III as chairman. Their report called "the Baker report" was published on the 17th of January 2007.

The Total Petrochemical HSE Executive Committee decided to create a dedicated Total Petrochemicals Task Force. Their mission was to review in depth all the findings of the Baker panel and to check in how far these findings were relevant for Total Petrochemicals.

The Total Petrochemicals Baker Report Task Force published a first draft with 46 recommendations by end of May 2007. This draft was examined by the Total Petrochemicals annual meeting (about 100 participants from all over the world) and an action plan was proposed.

The Total Petrochemicals Process Safety Improvement Plan has been proposed to the COMEX of Total Petrochemicals and endorsed by the president of Total Petrochemicals. This document gives an overview of the main chapters of the plan.

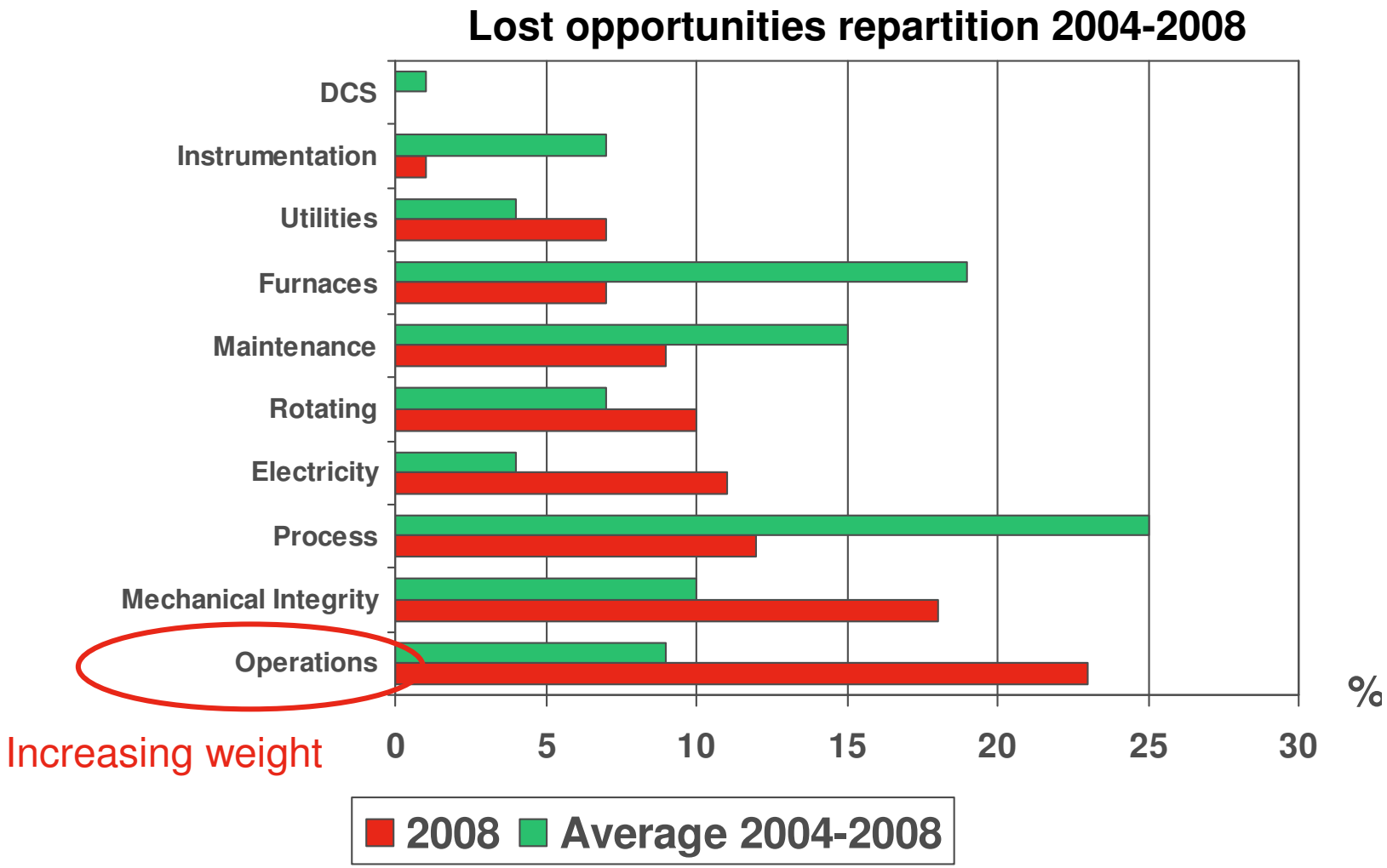
TOTAL PETROCHEMICALS

- Hazards and risks are identified
- Safety management systems are in place
- Expertise and methods are available
- Technical resources are in place
- Incidents and near-misses are analyzed and the learning process is stimulated
- …. BUT the main vulnerability appears to be

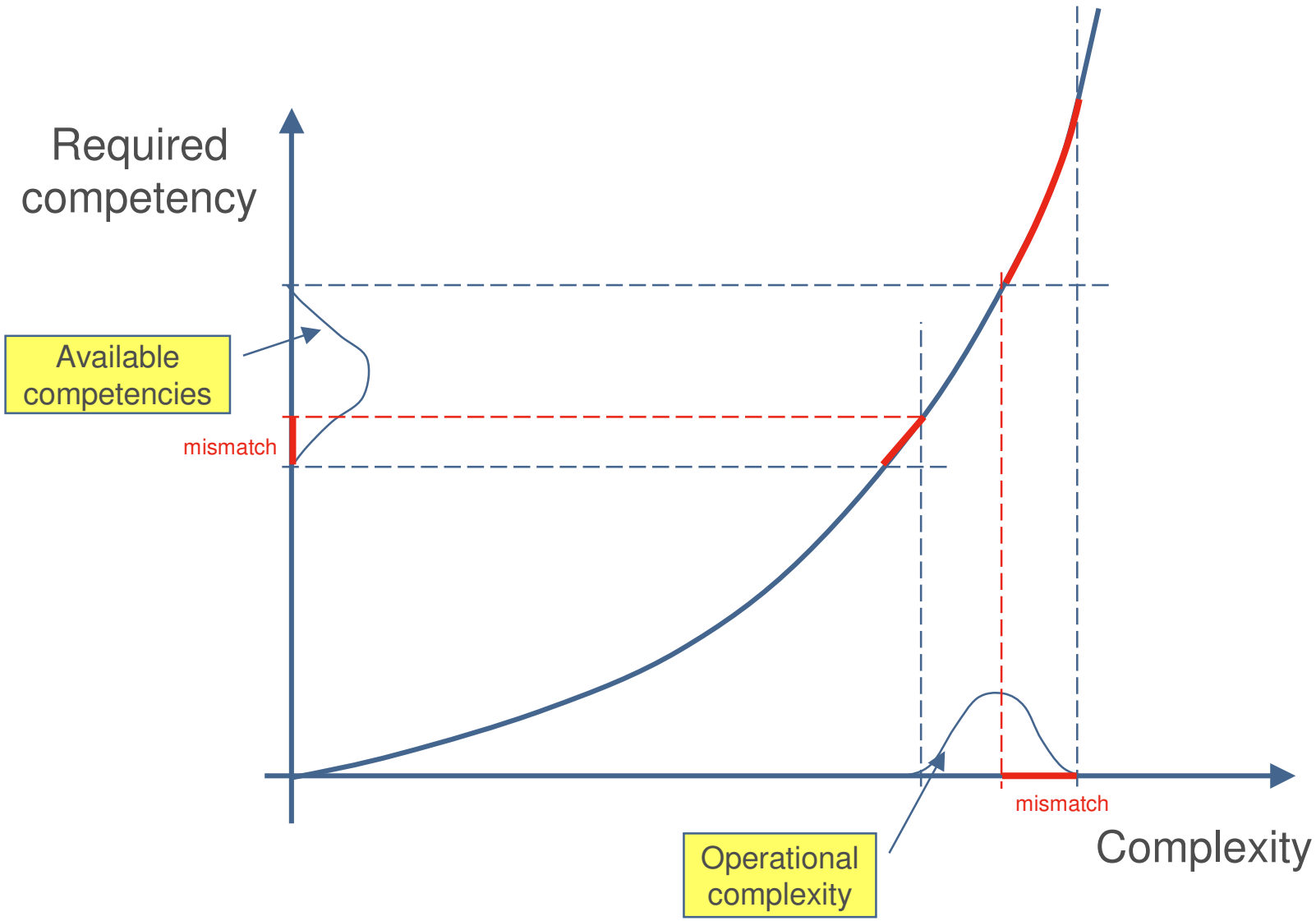
Human and Organizational Factors

Reliability Management perspective :

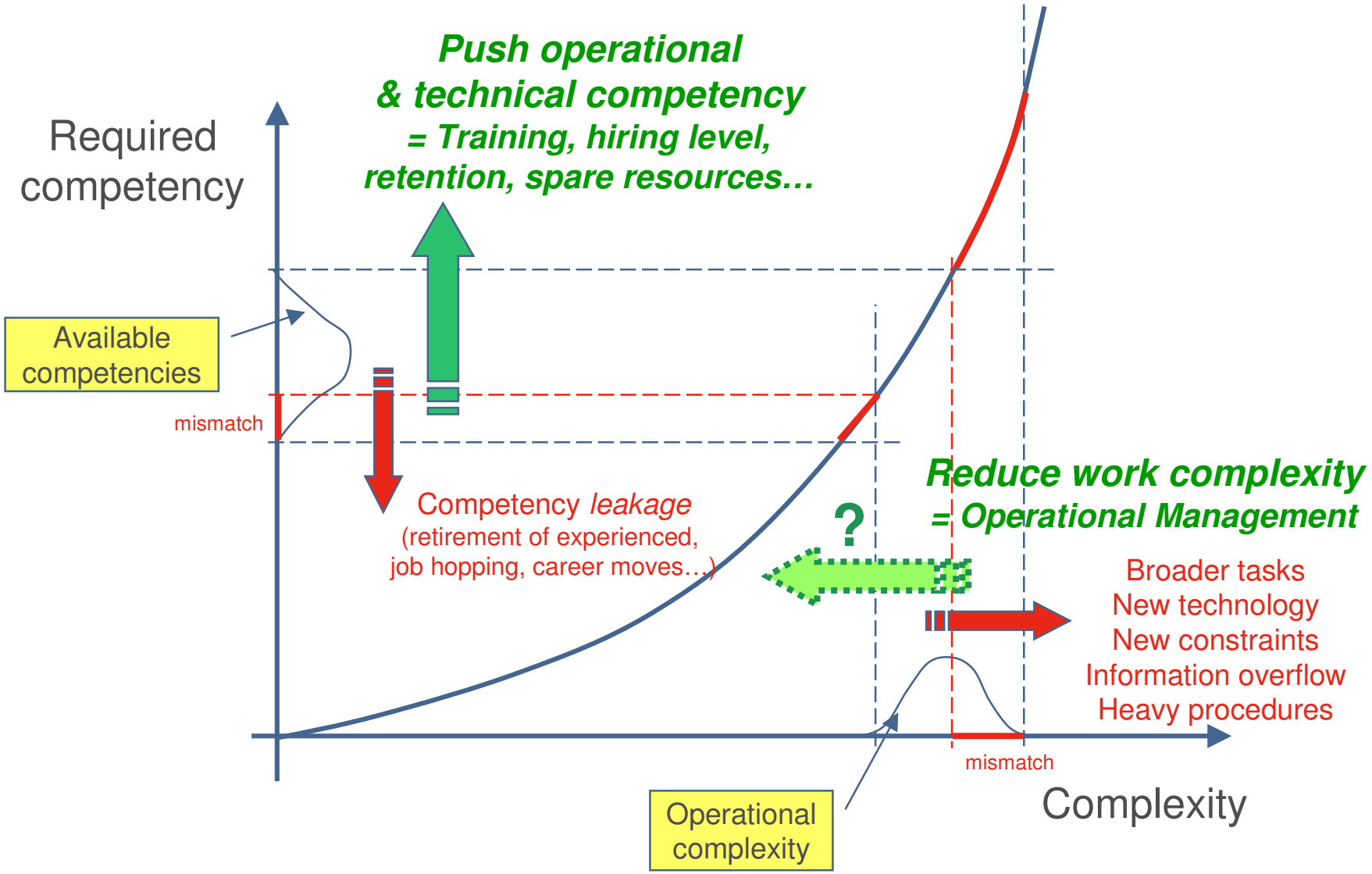
same observation



Competency – complexity gap



Why the problem gets worse



Operations & Maintenance functions : KEY actors in Process Safety

- Unique position : monopoly on field *reality*
- Population exposed to accidents
- Last line of defence for MOC, engineering / construction errors, technical failures
- Centre of the petrochemical profession : needing SUPPORT from all others
- *Concentration of observed Human Performance Error and Accountability issues*

Human Performance Error in Operations and Maintenance functions = major risk contributor

Selection of reported accidents and near misses, 2007 - 2009

2007-065	2008-026	2008-028	2008-059	2008-061
Burns by caustic soda during operator intervention at a pump	Worker spread with sulphuric acid	Working on a blind while system still in service	Worker spread with sulphuric acid	Ethylene ship connected to propylene loading arm

2008-065	2008-070	2008-072	2009-014	2009-020
Isobutane cloud after rupure of nitrogen hose during startup	Large benzene spill in pipeway	Hot quench oil spread on operator after manometer removal	Large fuel oil spill after contractor opened purge	Fire during furnace startup

Case study

Operational Reliability / Process Safety Case Study

2008 Near Miss :

Isobutane cloud after rupture of nitrogen hose

during startup after Turnaround

Typical use of flexible hoses for N_2 (10 bar) purging, to prepare for start-up after « turn-around »

Sequence of events (1)

Proceeding of startup procedure of polymerization unit E after 3w Turnaround

- 18/10 Recycle isobutane system : isolation blinds removed, pressure tested
- 20/10 Startup log : comment about remaining N2 flexible hose connected to the process
- 23/10 Preparation for filling and startup :
  - New nitrogen purge
  - Operator tour : flexible hoses removed
- 25/10 (saturday night)
  - 1h56 Isobutane pump started (45 bar)
    while a flexible hose was still connected
- 1h57 Flexible hose bursts ; spill of liquid isoC4 ;
  35 gas alarms light up

Detection by gasdetectors

- Location leak

75-100% LEL

25-50% LEL

10-25% LEL

Sequence of events (2)

- **Emergency response by Operations**
  - 1h58 Pump stopped from MCR
  - 2h01-05 : feed to reactor stopped and reactor dumped (to the flare)

No wind, C4 vapour cloud hanging in the plant

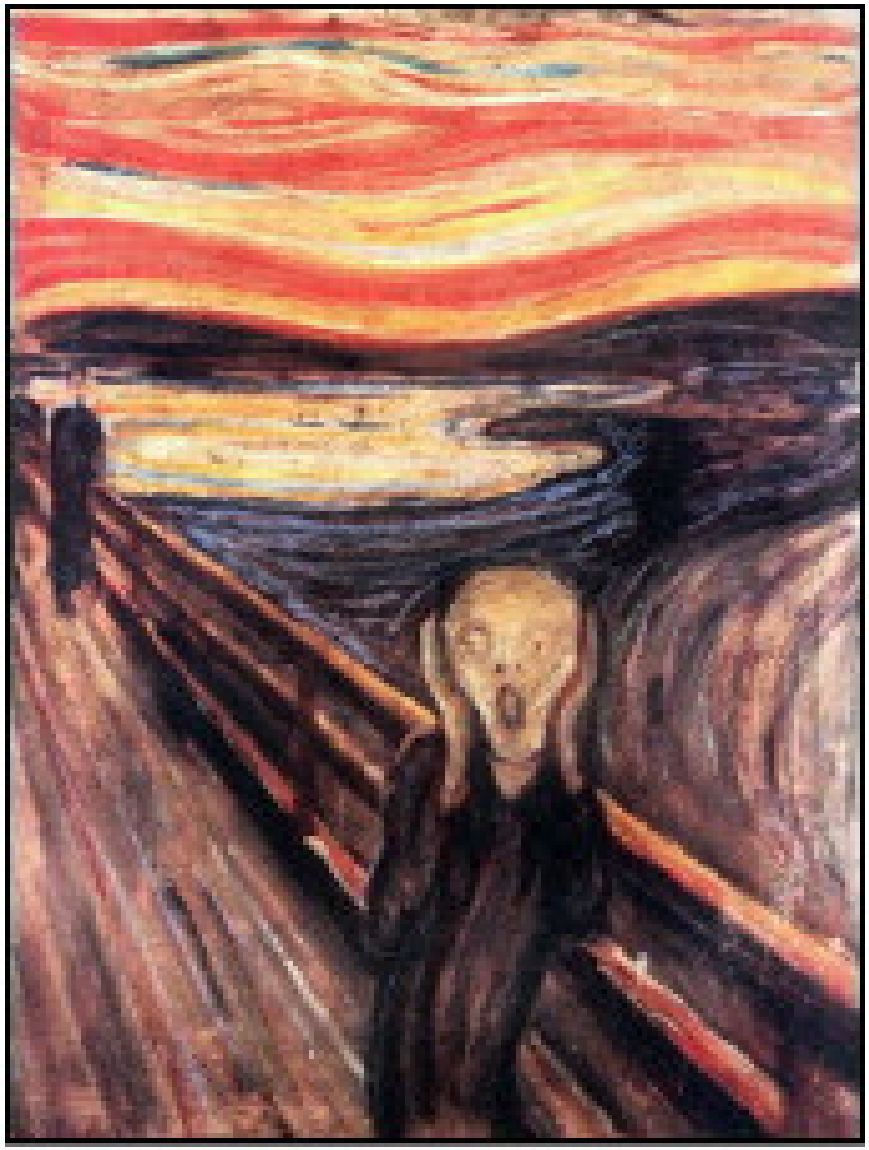
  - 2h07 Fire brigade starts diluting the C4 cloud with sprinklers & fire guns
  - 2h24 No more gas alarms
  - 2h36 Formal end of alarm phase

Post-calculation by corporate Process Safety experts :

- Estimated spill 2500 kg i-C4
- Calculated vapour cloud of 2000 m3
- **Potential effect : Vapour Cloud Explosion**

700 mbar @ 30m ; 130 mbar @ 100m

Sequence of ev



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No wind, C4

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  - 2h24 No mo
  - 2h36 Forma

rs & fire guns

Post-calculation by

:

- Estimated spill 250
- Calculated vapour
- **Potential effect : Vapour Cloud Explosion**

700 mbar @ 30m ; 130 mbar @ 100m

Physical evidence

- **Coupling still on the purge, the flexible teared apart**

- **The purge valve was open** (and closed during the emergency intervention)

- **The valve at the other side of the flexible (N2 collector) was closed**

Initial summary of conclusions :

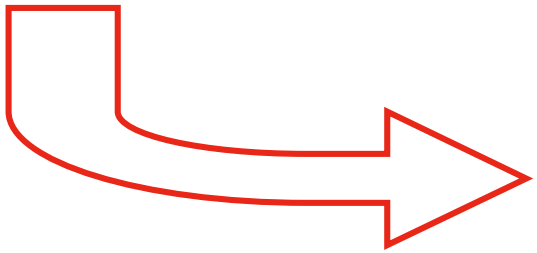
- Direct cause :
  - N2 flexible hose in connection with the process during startup

(Exact information about reason and timing of the last operation of this flexible could not be provided)

- Main cause = “Human Performance Error” :
  1. Procedure not followed : flexible hoses must be taken away before startup
  2. The flexible hose was not seen during control before startup

Human Performance Error : now what ?

- Sanction ?
- Training ?
- Better procedure ?
- Telling people to take more care ?
- People behaviour program ?
- Safety Culture improvement ?



Which of these would effectively avoid my human errors ?

Comparison : car driver safety

I had initial driving training
I know the traffic regulation
I became very experienced on the road
I feel responsible for my family
I follow training on defensive driving
I am physically and mentally OK
My car is comfortable + techn. OK
I know the road very well

Still I make "human errors" !
- many minor
- sometimes "near miss"
- exceptionally an accident

About Human Performance Error

Human Error = unavoidable, linked to the specific nature of people !

Required strategy =
- Understand human error
- Reduce error-likeliness by adapting work to people
- Strengthen the defence barriers preventing evolution into major accidents
- Continuous learning : active tracking of minor work errors and near misses

Cfr. The success we booked with personal safety (LTI) !

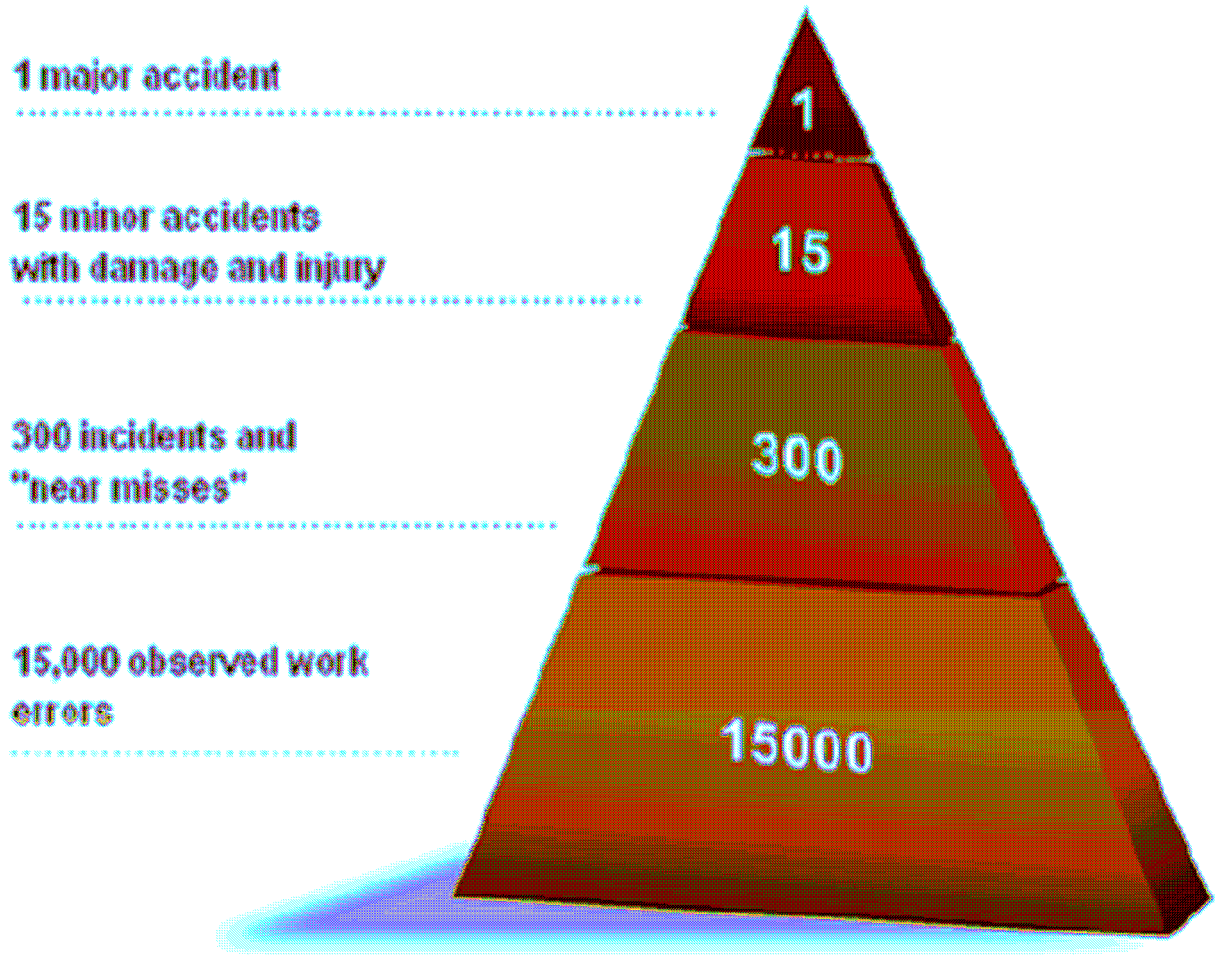


Figure from Honeywell & ASM Consortium

Human Performance Error in Process Operations :

Classification according to CCPS

Operator perspective :
Allows management to understand and to define remedies for help

Active failures

- Slip — Correct Intent but failure in execution
- Mistake — Action as intended but intention was wrong
  - Expertise failure
  - Lack of expertise
- Laps — Error in memory recall
- Violation — Intended action that deliberately ignores a known rule, restriction or procedure
  - Shortcut
  - Necessary
  - Optimising
  - Exceptional
- Socio-technical — Based on team behaviour
- *Mgt / org. failure* — E.g. unclear goal setting, poorly defined roles and responsibilities, allowing deviance, …

Latent conditions

In combination with active failure, will result in incident

Includes management / organisational error

The Aviation industry as external benchmark : *they survived* by becoming successfull in Human Reliability

1) *Organisational FUNDAMENTALS* were imposed to all actors

- Common but specific for the industry, centralised and audited by a regulatory body (IATA)
- Covering all industrial activities
  - airlines, airports, air traffic control, airplane construction, …
  - independant of the type of airplane, technology, use, size, …
- Focused on human reliability, by integrating the *science* of "Human Factors" (HF)

Respecting these rules has become part of the professionalism and image of every individual in the industry (= safety culture).

2) Many top companies have developed HF as "core competence"

… and became "High Reliability Organisations" (HRO)

Aviation industry :
relevant as benchmark for process industry ?

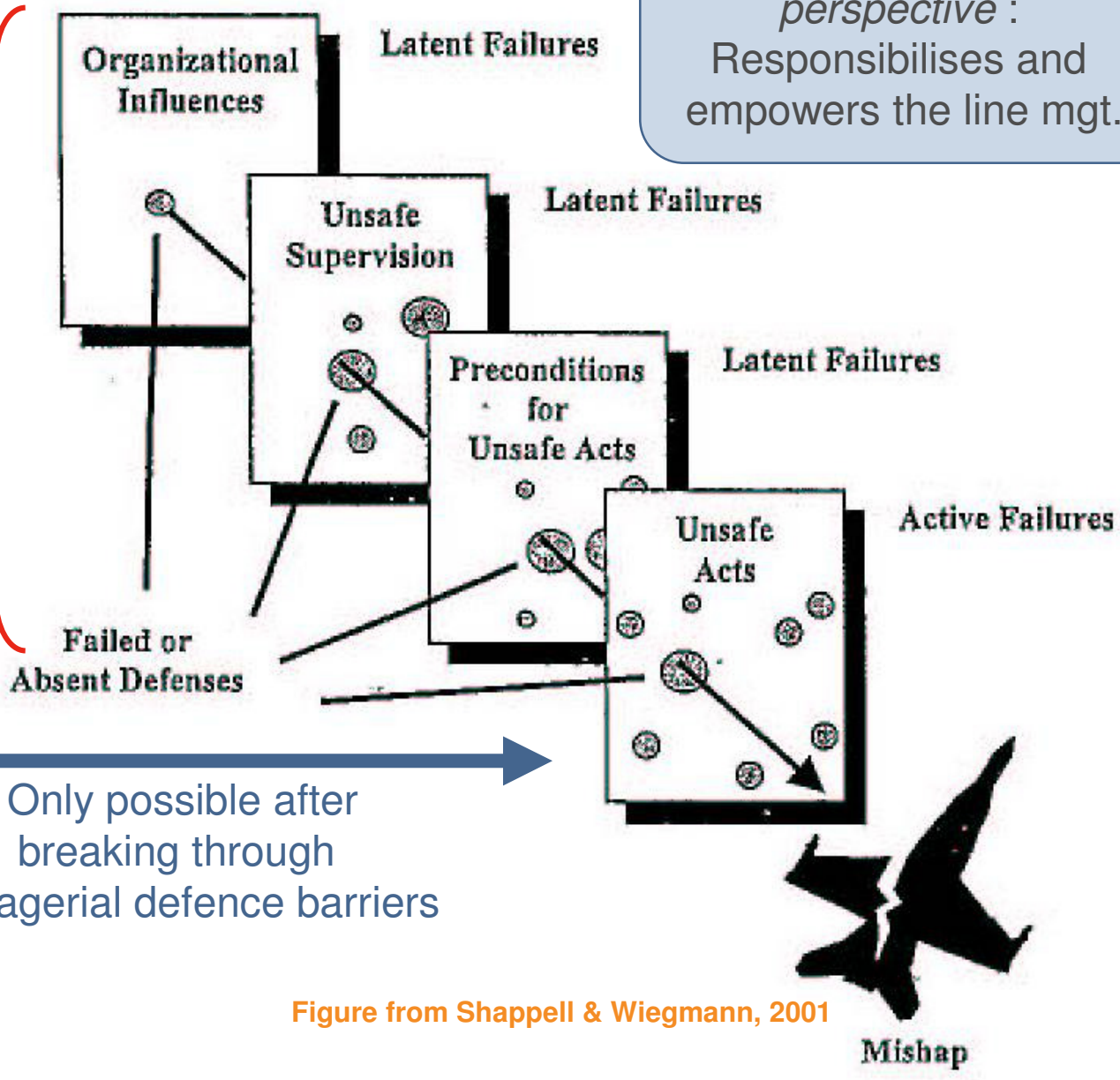
- **Absolute safety priority ?** **YES**
- **Dependant on technical reliability ?** **YES**
- **Dependant on human reliability ?** **YES**
- **Efficiency concern ?** **YES**
- **Complex operational reality ?** **YES !**
  - Thousands of aircrafts
  - Hundreds of airports
  - Hundreds of airline companies
  - Different aircraft types and technologies
  - Hundreds of nations
  - Military and civil
  - Hundreds of languages
  - Flight teams, maintenance teams, air control teams, ground support teams, …
  - Evolving challenges : terrorism, …

And only one sky

Human Error approach in the Aviation Industry

Operational management perspective : Responsibilises and empowers the line mgt.

Managerial defence barriers



Cockpit failures

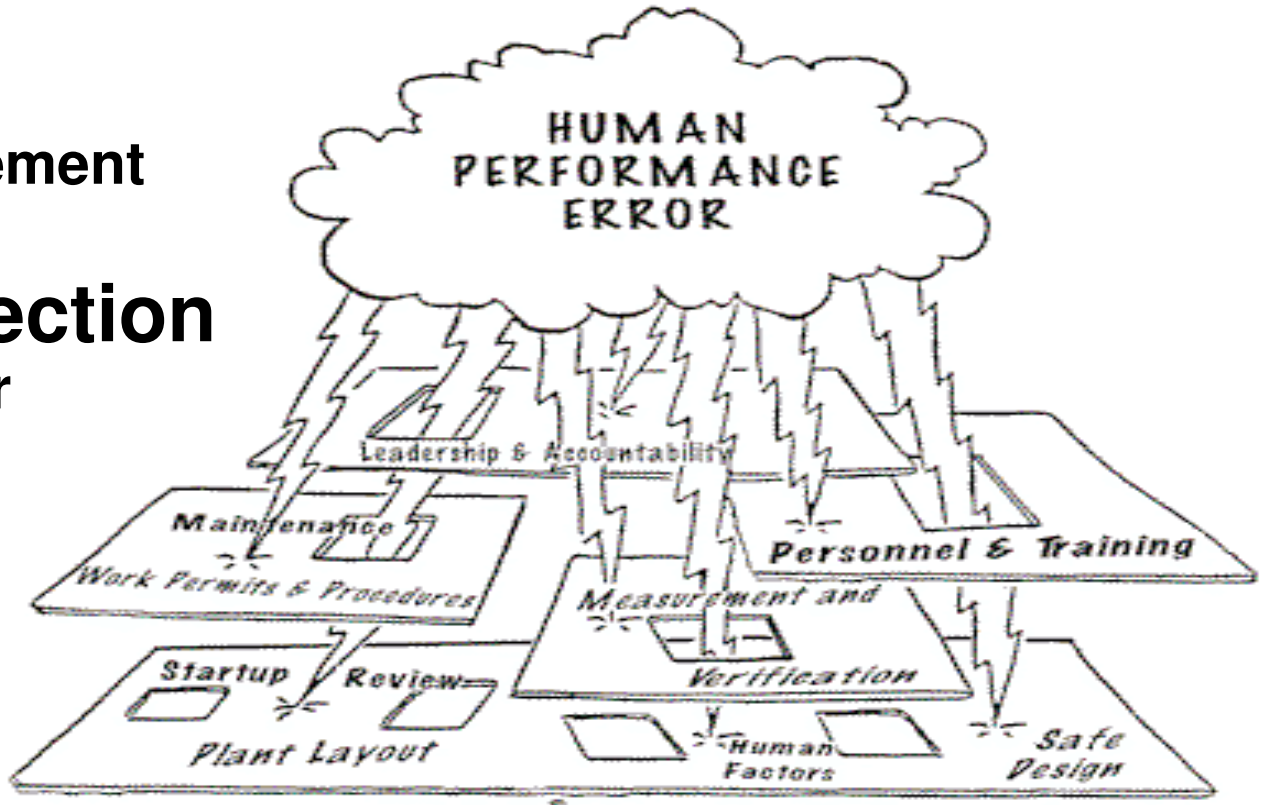
Only possible after breaking through managerial defence barriers

Figure from Shappell & Wiegmann, 2001

The role of Operational Management = installing

Layers of Protection

against human error



In order to be effective against human error, ***organisations*** have to take into account the science of *Human Factors*

…

Human & Organisational Factors (H&OF)

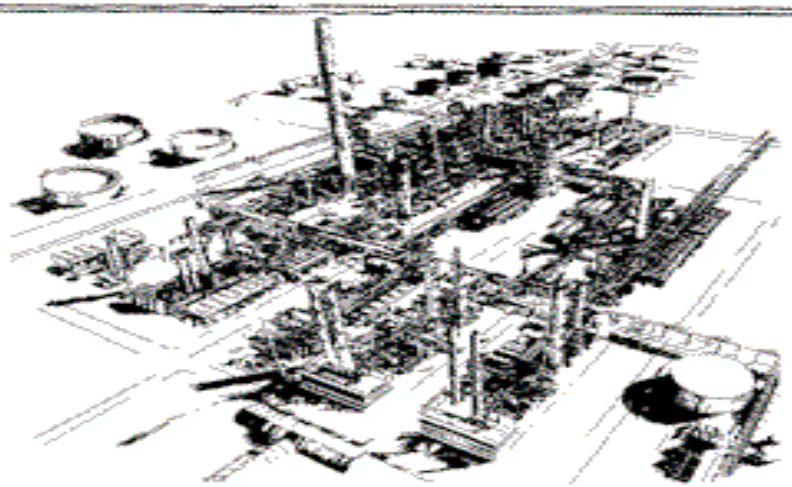


Figure from CCPS website

Case study : Human & Organisational Factors (1)

- **Startup preparation : STOP & GO during 7 days** while other parts of the plant had a difficult startup
  - Sufficient formalism support tools to ensure coherence over 21 shift changes ?
  - Rely on checks made several days ago ?
- **Unexplained role of flexible hose, last use and by whom**
  - Sufficient preparation and oversight on the startup operations ?
  - Sufficient formalism to track status of complex procedural operation ?
- **Effective startup by Friday night shift**
  - Sufficient supervision, coordination and support resources ?
  - Operator's concentration, physical and mental fitness ?

Would you feel safe flying with a pilot who
- did part of his pre-flight checklist several days ago
- keeps little oversight on his crew's initiatives
- takes off after closure of the control tower

?

Case study : Operational Management aspects (2)

- **New « Pre-Startup Safety Review » procedure : was in test but *not officially in service …?***
  - Identified correctly an action point about remaining flexible hose,
  - …BUT this was not signed off : « because procedure not mandatory, only for test » !

Would you feel safer to cross a road-crossing

- without any traffic lights, OR

- with traffic lights « in test but not mandatory to stop for the red light »…

?

Case study : Human & Organisational factors (3)

Flexible hoses = for operations what scaffolds are for maintenance

= a flexible tool, allowing interventions beyond the capabilities of the fixed installation

Management of scaffolds		**Management** of flexible hoses
Technical material spec Yearly inspection of materials Construction quality norms		Technical material spec Yearly inspection of materials Application quality norms
Formal initiation for specific use Identification, field label, Technical field approval (ID, signature) "Fit for use" field approval (ID, signature) Max. validation date Frequent inspection tours Strict procedures for users Toolbox training for users Central register Mgt. system audit	In-service management	?

Revised summary of conclusions :

- Direct cause :
  - N2 flexible hose in connection with the process during startup :
- Main cause :
  - The flexible hose was not seen during control before start-up
- *Underlying cause : insufficient organisational defence measures to exclude a remaining flexible hose during start-up*
  - No management system for flexible hoses in service
  - **Lack of adapted formalism and coherent supervision / coordination for complex operations like unit start-up** (Group Directive n°12)

Operational Management = KEY : now what ?

- Sanction ?
- Adapt bonus scheme ?
- Training ?
- Telling Operational Management to take more care ?
- Safety Culture program for Operational Managers ?

Can the process industry, like aviation (IATA), define for their Operational Management a set of organisational «FUNDAMENTALS» which

- is specific for our industry

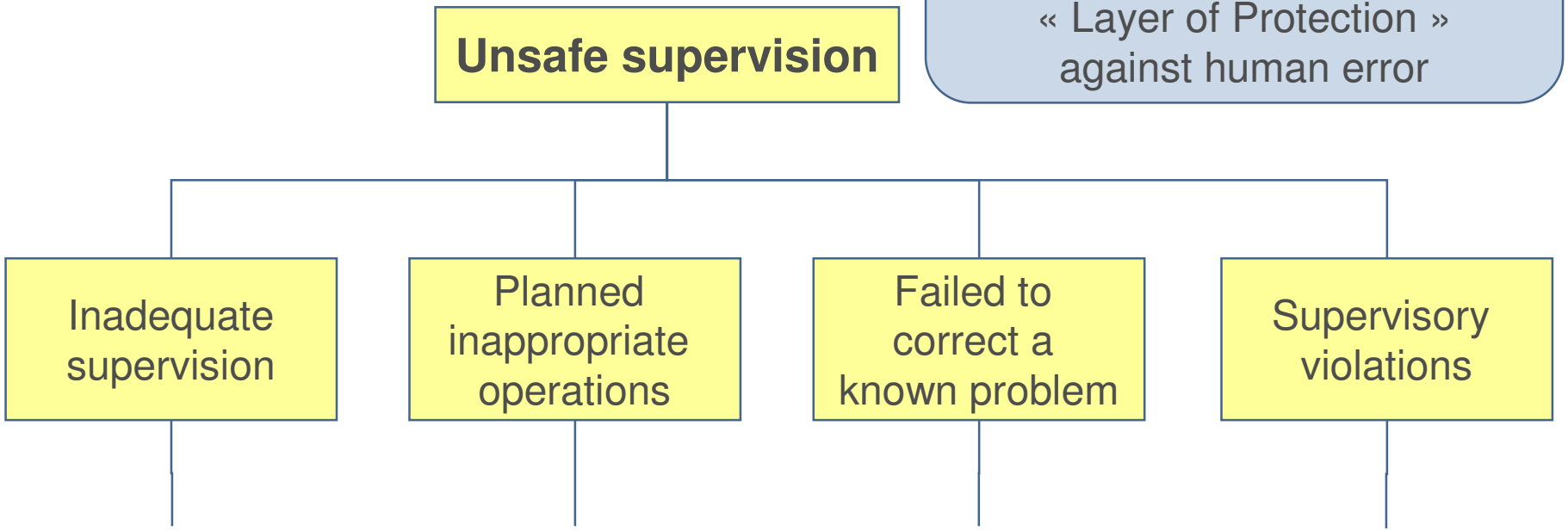
- is overall applicable

- is effective in avoiding accidents caused by human error

- can be given priority over any other consideration ?

Aviation Industry example :
Unsafe Supervision failure modes

Starting from the **professional expectations** towards the function as a « Layer of Protection » against human error



from Shappell & Wiegmann, 2001

Organisational « Layers of Protection »

based on the professional expectations towards the Operational Management function in the process industry

1. Leadership, organisation and accountability
2. Safe work procedures and work permits
3. Safe work practices
4. Proper plant and equipment status
5. Proper communications within operations
6. Operational discipline and team capability

Organisational « Layer
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MarcusEvans 2nd Annual Health & Safety Management Con
Prague, September 14th and 15th, 2009

1. Leadership, organisation and accountability

- Strict role separation : Operations vs. Maintenance / Construction

2. Safe work procedures and work permits

3. Safe work practices

- All non-routine work (°) is formally initiated, approved and registered

4. Proper plant and equipment status

5. Proper communications within operations

6. Operations discipline and team capability

- **Operations are conducted within formally defined safe operating limits**
  - Defined Process Operating Window : for all critical parameters
  - Process position is tracked and information is known
- **Complex operations are conducted with adapted formalism and preparation**
  - Formal initiation, operator assignment, status tracking, singing-off checklists
  - Verify initial "stable status" before start of procedural operation
- **Operations support tools are effectively used**
  - E.g. critical procedures are "at hand" during operation
  - Critical checklists are signed off after each step
- **Operators are aware of the field / process situation**
  - Information is correct, complete, "smart", readily available and effectively used
  - Diagnoses are correct
  - Any recent changes are known, trained, documented
- **Operations are within the operation team's capability**
  - Adequate resources are available
  - People are trained, concentrated, prepared, fit for duty ("permit to operate")
  - Tools and environment are 100% adapted to the task, functioning and in good shape
  - Plant design and layout allows proper operability
- **Teams are managed as sensitive processes (Crew Resource Management)**

Full slides in attachment

TOTAL

Organisational FUNDAMENTALS !

for the process industry

- **Valid for all process operations, all sites : corporate directives**
- **Effective *Layers of Protection* against the developement of human error into major accidents**
- **Key focus areas for OPERATIONAL MANAGEMENT**
- **Can easily be detailed over many levels further, while still remaining generic.**
- **Absence of any part = an organisational failure**
  - Heading for trouble
  - Main criteria for incident investigation

1. Leadership, organisation and accountability

- **Strict role separation : Operations vs. Maintenance / Construction**

2. Safe work procedures and work permits

3. Safe work practices

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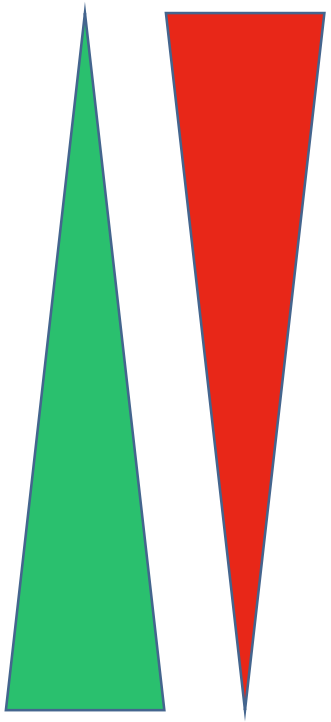
Hierarchy of Rules

Completeness, Coverage

Daily life

1. **Human rights**
2. **CONSTITUTION**
3. **Laws**
   - **Penal**
   - **Civil**
4. **Ministerial memos**



Level of detail

- ***Lower level rules must comply with higher levels***
- ***A problem at higher level cannot be corrected by a rule at lower level***

Hierarchy of Rules

Completeness, Coverage

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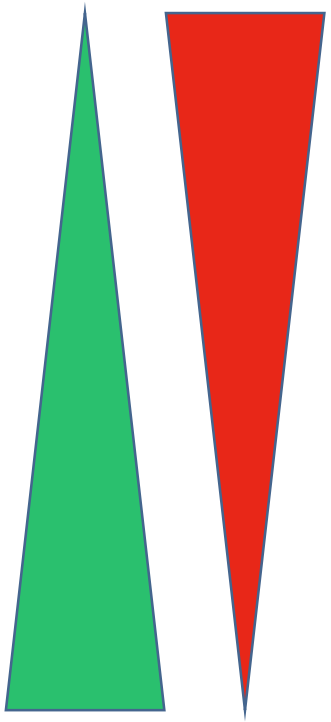
   - **Civil**
4. **Ministerial memos**



Process Industry

1. Company values
2. ***Organisational FUNDAMENTALS***
3. Procedures
   - Critical
   - Reference
4. Daily instructions

Level of detail

- ***Lower level rules must comply with higher levels***
- ***A problem at higher level cannot be corrected by a rule at lower level***

Are these Organisational FUNDAMENTALS *generally applicable* to prevent accidents by Human Error ?

2007-065	2008-026	2008-028	2008-059	2008-061	2008-065	2008-070	2008-072	2009-014	2009-020
Burns by caustic soda during operator intervention at a pump	Worker spread with sulphuric acid	Working on a blind while system still in service	Worker spread with sulphuric acid	Ethylene ship connected to propylene loading arm	Isobutane cloud after rupure of nitrogen hose during startup	Large benzene spill in pipeway	Hot quench oil spread on operator after manometer removal	Large fuel oil spill after contractor opened purge	Fire during furnace startup

Case study

Apparent absence of « organisational Layers of Protection » (°)

Organisational Layers of Protection		2007-065 Burns by caustic soda during operator intervention at a pump	2008-026 Worker spread with sulphuric acid	2008-028 Working on a blind while system still in service	2008-059 Worker spread with sulphuric acid	2008-061 Ethylene ship connected to propylene loading arm	2008-065 Isobutane cloud after rupure of nitrogen hose during startup	2008-070 Large benzene spill in pipeway	2008-072 Hot quench oil spread on operator after manometer removal	2009-014 Large fuel oil spill after contractor opened purge	2009-020 Fire during furnace startup
Leadership, Organisation and Accountability	Strict distinction Operations vs. Maintenance / Construction	X	X					X	X		
	Operations = overall coordinator							X			
	Single set of coherent procedures and instructions						X				
	Clear and single line of command			X			X				
Safe Work Procedures, practices and work permits	All non-routine work is based on SWP and permit	X	X						X		
	Special permit required for special works	X	X						X		
	Standard process to authorise deviation	X							X		
Safe work practices	All non-routine work is formally initiated, authorised and registered	X									
	Golden rule of first choice : installation de-energised	X	X		X				X		
	Special works require special coordination (operations - maintenance)				X						
	Changes to the work plan require new autorisation										X
	Individual signature = personal commitment			X							
	Paperwork is complete before the work execution					X					X
	Work execution follows stricty the permit prescriptions		X							X	X
Proper plant & equipment status	Each equipment is in a well defined accountability perimeter	X	X					X			
	Accountability perimeters in the field are indicated and respected							X		X	
	Field equipment is properly TAGged										
	Good housekeeping and cleanness										
	Proper lighting										
Proper communications within operations	Effectife shift transfer : structured and formalised		X	X			X				
	Proper coordination with the day organisation			X							
	Effective communications between operations		X				X				
	Permanent coherence between field and control room						X				
Operational discipline and capability	Operations are conducted within formally defined safe limits										
	Complex operations are conducted with adapted formalism and supervision						X				X
	Operations support tools are effectively used										X
	Operators are aware of the field / process situation			X			X	X			
	Operations are within the operation team's capability										
	Procedural formalism and planning of operations						X				X
	Operator training and performance measurement										

(°) as observed through information in initial incident reports

X = identified failure X = not identified failure

Observations of this analysis

1. As obvious as they seem, …

   Organisational FUNDAMENTALS are extremely powerful : they could have prevented 100% of the described incidents if they had been effectively in place !

2. The absence of such Organisational FUNDAMENTALS as defence barrier is mostly not identified by the sites as causes of incidents – *so there is little chance that they will develop "spontaneously".*

   - **Frequently identified causes are incomplete procedures, poor installations, operator competency.**

A role for corporate management

- For every profession considered « core competency », corporate management not only specifies WHAT to achieve, but also HOW :
  - Inspection
  - Safety studies
  - Rotating equipment
  - Furnaces
  - Process automation
  - ….
- For these professions, corporate experts lead professional networks with site professionals, to define Best Practices and directives for Minimum Required Practices, and define plans to close the gap for each site
- **“Conduct of Operations” requires the same approach from corporate level, *in order to develop this profession as “corporate core competency” on a cross-site basis.* Organisational FUNDAMENTALS are the starting point and common reference.**

Case study : safety KPI's (1)

- **The site had an excellent historical track record of LTIR and TRIR**
  - 100% in line with the corporate targets

Also Aviation industry keeps track of Lost Time Injury Rate (LTIR) as KPI
… mostly reflecting safe practices in the baggage handling !

*This has however NO RELATION with **flight safety**, which is monitored by totally different KPI's.*

*What both categories have in common is the **approach** of the **BIRD pyramid**.*

Case study : safety KPI's (2)

- **The site had successfully passed an ISRS audit, reaching level 8**
  - 100% in line with the corporate target

The role of audit =

- Avoid the « failure of success » : (re)activate the improvement process
- **Find the real weaknesses in the field … *before Murphy does !***

- By auditing just the management system ? …

… Or by inspecting the operational reality !

(ref : "tiger team" in ICT industry as only valid defence against hackers)

Case study : aspect of safety culture

- **Difficulty to obtain correct information :**
  - Local site management was informed only after the weekend …by the fire brigade activity report
  - Internal group incident declaration : only 4 days after (procedure = 24h)
  - Operational team activated a “collective defense mechanism”
    - Operators were in shock : they experienced a 20 minutes death risk
    - Practices leading to the near miss were defended as “normal standard, has never created any problem”
  - Operator error = apparently a “taboo”
    - lack of understanding of Human Error phenomenon

Do we (corporate management) encourage sufficiently enough
*an **open, blame-free information flow ?***

to compensate for the people’s (and operational management’s)
- fear of sanction
- fear to be questioned on their competency

Aviation industry example :
enforcing the information flow needed for the learning process

VISION 2010 Air France, vers l'excellence

COMMITMENT OF OUR CEO

- ✓ Safety of our flights must be our first concern
- ✓ An airline must be trustworthy towards its passengers
- ✓ An airline must draw lessons from day to day events and enforce corrective actions when necessary
- ✓ Therefore it is the responsibility of every AF agent to report spontaneously and without delay any information regarding any safety event
- ✓ In order to facilitate voluntary reporting, I guarantee to all staff members not to use such spontaneous and immediate reports for prosecution or disciplinary action
- ✓ This guarantee will not apply to deliberate and repetitive violations
- ✓ Every staff member must contribute, from top to bottom

AIR FRANCE

TOTAL

To conclude,

some good old MANAGEMENT advise

The engineer's trap

« Humans are not machines… »

… so we cannot do anything

How about doing AT LEAST what we do for machinery :

- understand their functioning in all details, develop expertise
- ensure utilisation in their optimum operating range
- install alarming and overload protection
- ensure long lifetime by effective maintenance
- use our expertise to constantly enhance their performance

= Human Factors science

Management Principle n° 1

Management always receives

what it encourages !

If you observe a behaviour you don't like, ask yourself :

- ***How am I encouraging this non-desired behaviour ?***
- ***Am I sufficiently encouraging the desired behaviour ?***

Organisational FUNDAMENTALS

reduce the work complexity

« Management is :

making complex realities more simple »

1) We are ready to spend a lot of money for complex things …

Are we ready to spend some money for ***complexity reduction*** *?*

2) We tend to encourage (promote) managers who make good management presentations, *because they reduce complexity* ***for us*** *(decision making).*

Do we sufficiently encourage managers who are capable to reduce complexity ***for their operational teams ?***

The hidden value of Process Safety

Process Safety **is why you do it, …**

Reliability **is how you pay it !**

Attachments

1. Leadership, organisation and accountability

- **Strict role separation : Operations vs. Maintenance / Construction**
  - Each has it's own accountability perimeter and demonstrates "ownership behaviour"
  - Formal interaction and hand-over between all perimeters
  - Each equipment is, at any moment, either in Operations or in Maintenance / Construction perimeter

- **Operations = overall coordinator**
  - Strong « ownership » behaviour required, both day and shift organisation
  - Keeps overall view on perimeters (which equipment or zone is « owned » by whom), their coherence and compatibility with evolving process or operations status
  - Access and occupancy control on operations perimeter
  - Requires to be informed of any event with potential impact on the process even without being the initiator (e.g. electrical operations or tests, …)

- **Clear line of command within each accountability perimeter**
  - No confusion who gives which orders
  - No contradictions
  - Domino system towards plant / site manager
  - Contractors : report / belong to 1 single functional accountability perimeter

2. Safe work procedures and work permits

- **Single set of coherent procedures and instructions**

- **All non-routine work (°) is based on safe work procedure and permit**
  - "Permit" = second person implication + analysis + prevention + personal authorisation
    - Signed paper = 1) necessary "gate to work" and 2) for traceability, to support process quality
  - Single scope and planning definition ; change requires new permit
  - Authorisation : independent from work execution ; proper level

- **"Special Works" requiring special permit**
  - Installation not de-energised
  - Hot work – confined space entry – roof access – elevated work – line opening
  - Hot tapping – excavations – vehicles in process areas – use of heavy construction equipment
  - Fire system impairment – relief valve isolation – interlock bypassing – electrical test / switch / maintenance potentially causing interruption
  - Use of ionizing radiation (effect on instruments)

- **Standard process in place to authorize any deviation from existing procedure**
  - Objective to realise equivalent safety level
  - Incl. procedure review and start of change process, *prior to deviation*

(°) including « 1st line maintenance » (small works by operators)

3. Safe work practices

- **All non-routine work (°) is formally initiated, approved and registered**
  - Mentioning equipment TAG nr.
  - Proper description of required work

- **Golden rule of first choice : installation de-energised**
  - "Visual physical separation" criterion
  - Complementary protective measures : first common, then personal
  - Written justification if "Golden Rule" not applied

- **"Special Works" require special coordination (operations - maintenance)**
  - Could be common supervision, standby, open communication line, hierarchy attention, …
  - See list on previous page

- **Changes to the work plan require new authorisation**
  - Any relevant deviation from defined work description
    - equipment TAG – area – timing – method – resources …

- **Individual signature = personal commitment**
  - In interaction between operations – electrical – maintenance – construction
  - Within each function's accountability perimeter

- **Paperwork is complete before work execution**

- **Work execution follows strictly the permit prescriptions**
  - Both common and personal protection measures

(°) including « 1st line maintenance » (small works by operators)

4. Proper plant and equipment status

- **Each equipment is in a well defined accountability perimeter**
  - Operations – Maintenance / Construction
  - Coherent with available paperwork
- **Accountability perimeters in the field are indicated and respected**
  - Working area indication
  - Energy status of equipment
- **Field equipment is properly TAG numbered**
  - Coherent with up-to-date plans and registers ; no confusion possible
- **Good housekeeping**
  - Clean and organised working areas
  - People and materials logistics
- **Proper lighting**

5. Proper communications within operations

- **Proper shift transfer**
  - Each new shift is fully aware of the actual situation before it becomes “in charge” (and writes permits, initiates operations, …)
  - Function per function
- **Proper coordination with operational day organisation**
  - Daily instructions are clear, followed and result reported back
  - Written instructions, written feedback
  - No confusion between orders and information
- **Effective communication between operators**
  - Oral : two-way communication
  - Briefing – debriefing
- **Permanent coherence between field and control room**
  - Registers, logbooks, …
  - Proper and frequent operator tours
  - Effective inter-team (and inter-unit) communication
    - Two-way communication

6. Operations discipline and capability

- **Operations are conducted within formally defined safe operating limits**
  - Defined Process Operating Window : for all critical parameters
  - Process position is tracked and information is known
- **Complex operations are conducted with adapted formalism and preparation**
  - Formal initiation, operator assignment, status tracking, singing-off checklists
  - Verify initial “stable status” before start of procedural operation
- **Operations support tools are effectively used**
  - E.g. critical procedures are “at hand” during operation
  - Critical checklists are signed off after each step
- **Operators are aware of the field / process situation**
  - Information is correct, complete, “smart”, readily available and effectively used
  - Diagnoses are correct
  - Any recent changes are known, trained, documented
- **Operations are within the operation team’s capability**
  - Adequate resources are available
  - People are trained, concentrated, prepared, fit for duty (“permit to operate”)
  - Tools and environment are 100% adapted to the task, functioning and in good shape
  - Plant design and layout allows proper operability
- **Operator performance assurance**