TOTAL PETROCHEMICALS

Process Safety through Operational Management

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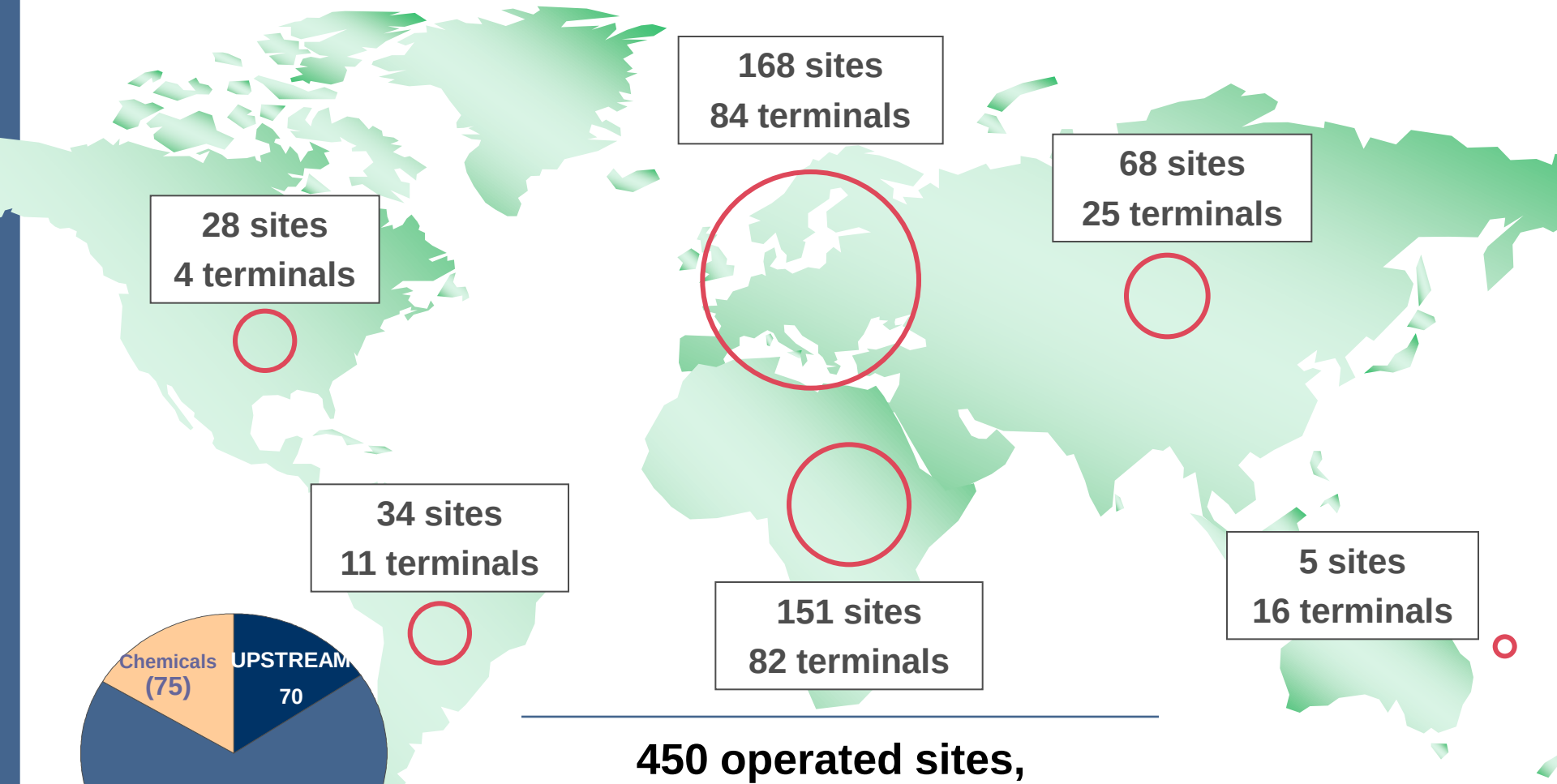
TOTAL

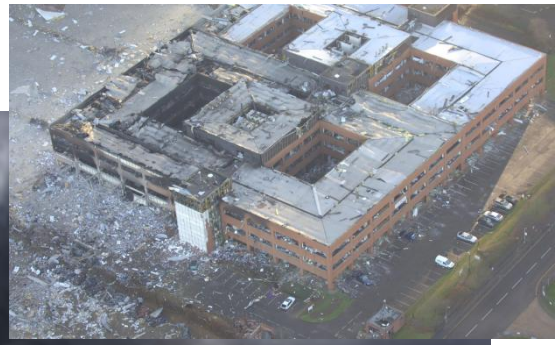
TOTAL : hundreds of high risk installations worldwide



450 operated sites,
222 terminals,
23 000 km pipelines

For all : “Safety first” = also “survival first” …

(the duty of every business)



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Incident Investigation : huge effort at Total

- All new incidents have already happened before…
- Central effort to extract the full learning potential of every incident : “REX” = “Return of EXperience” from sites are challenged, translated and distributed to all sites.
- Opportunity for the involved site to transform their problem into something positive for Total Petrochemicals.
- Strong focus on High Potential (HIPO’s) : often Process Safety

But how effective are we ?

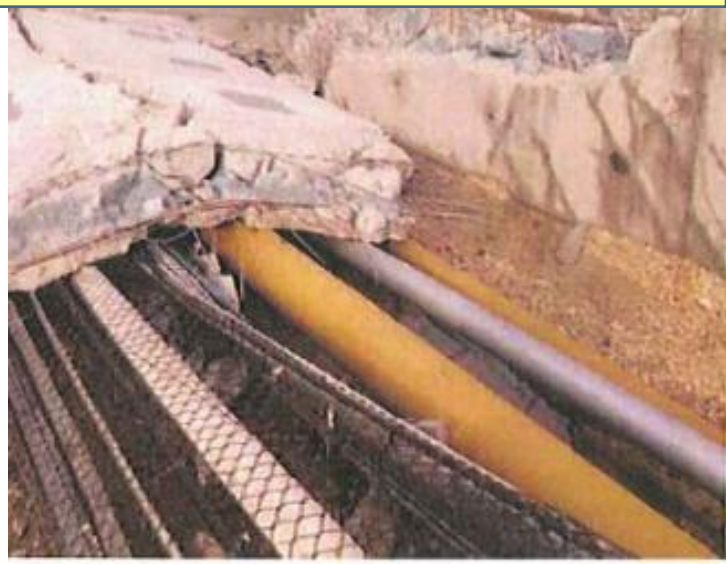
TOTAL

Why didn’t we see these coming ?

LPG derailment by push & pull without break connection between 2 locomotives

Unadapted tractor for heavy load on unbreaked wagon, almost damage to hydrocarbon pipes

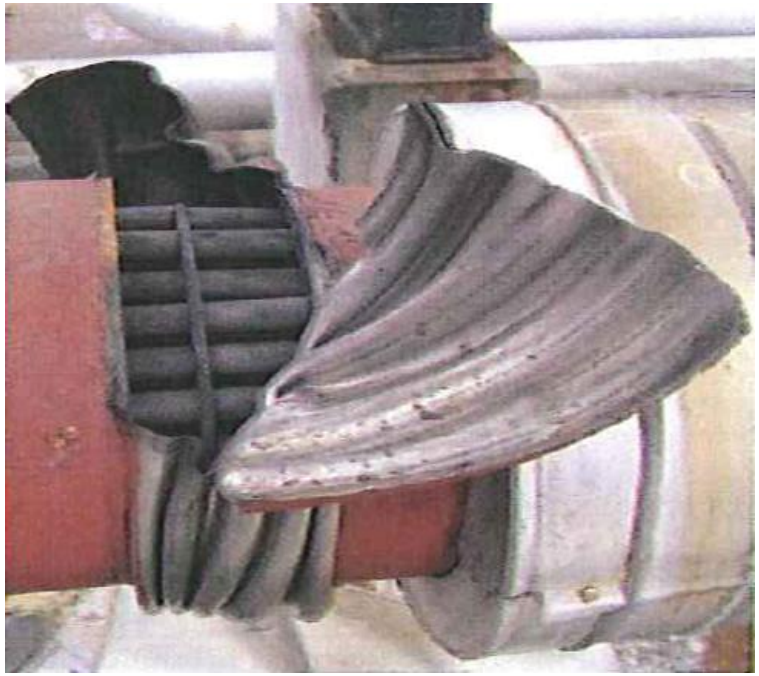
Collapse of new storm basin during first test, damage to hydrogen line with leak

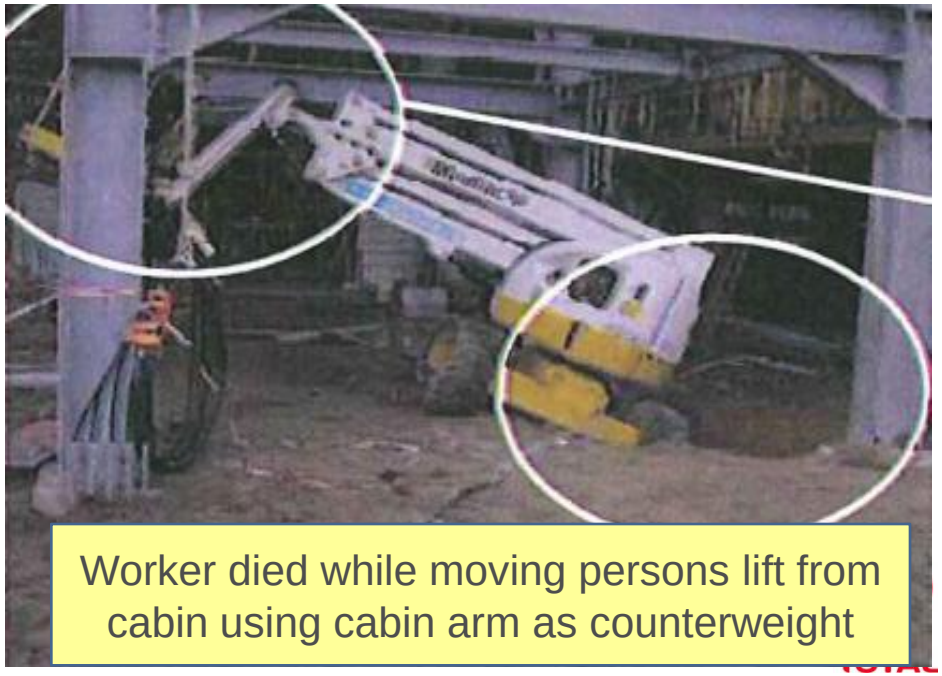


Why wasn't this prevented ?

Crane without support shoe on unstable ground : disaster just avoided

5 ton benzene spill by rupture of bellow after visual misalignment (15mm)





Worker died while moving persons lift from cabin using cabin arm as counterweight

Do we continue mastering the basics of our profession ?

500 kg propylene cloud during 1 hour after contractor removed valve on reactor body under pressure

2 operators died and 6 got burnt by explosion of superheater during startup

2 workers wounded by explosion of sulphuric acid tank in which hydrogen had formed by adding water

Common findings

as produced by actual Incident Investigation system

Root causes for human error :

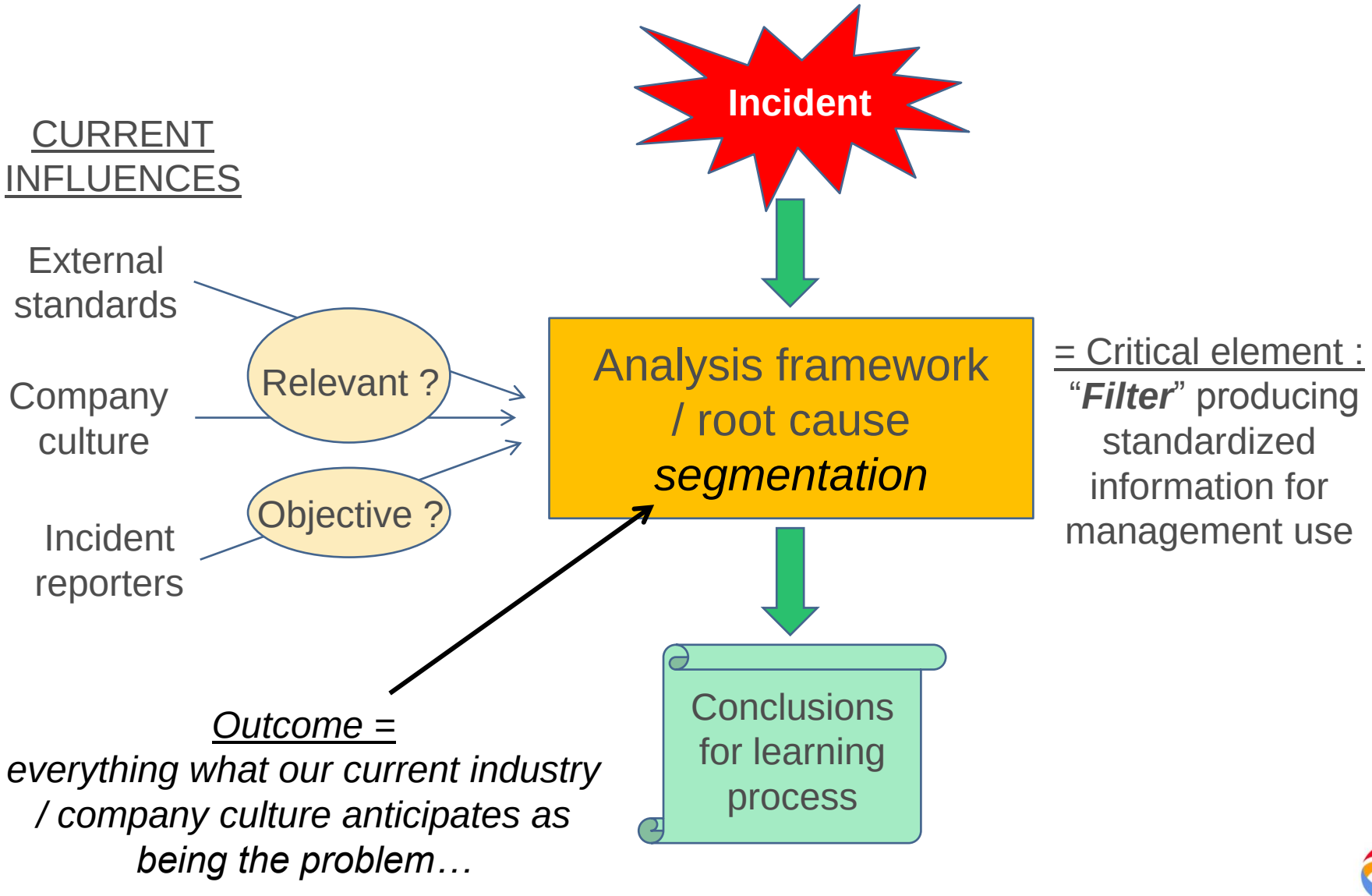
- Lack of Competency
- Procedure not followed
- Procedure incomplete

Which people ?

- Contractors
- Maintenance technicians
- Operators
- …

TOTAL

Could we be mislead by our Incident Investigation?



Abnormal situation Management Consortium's **detailed 2008 survey on public and shared member incidents revealed a key insight :**

- Current incident reporting approaches **do NOT effectively capture the influence of human reliability** on process safety or abnormal situation management performance

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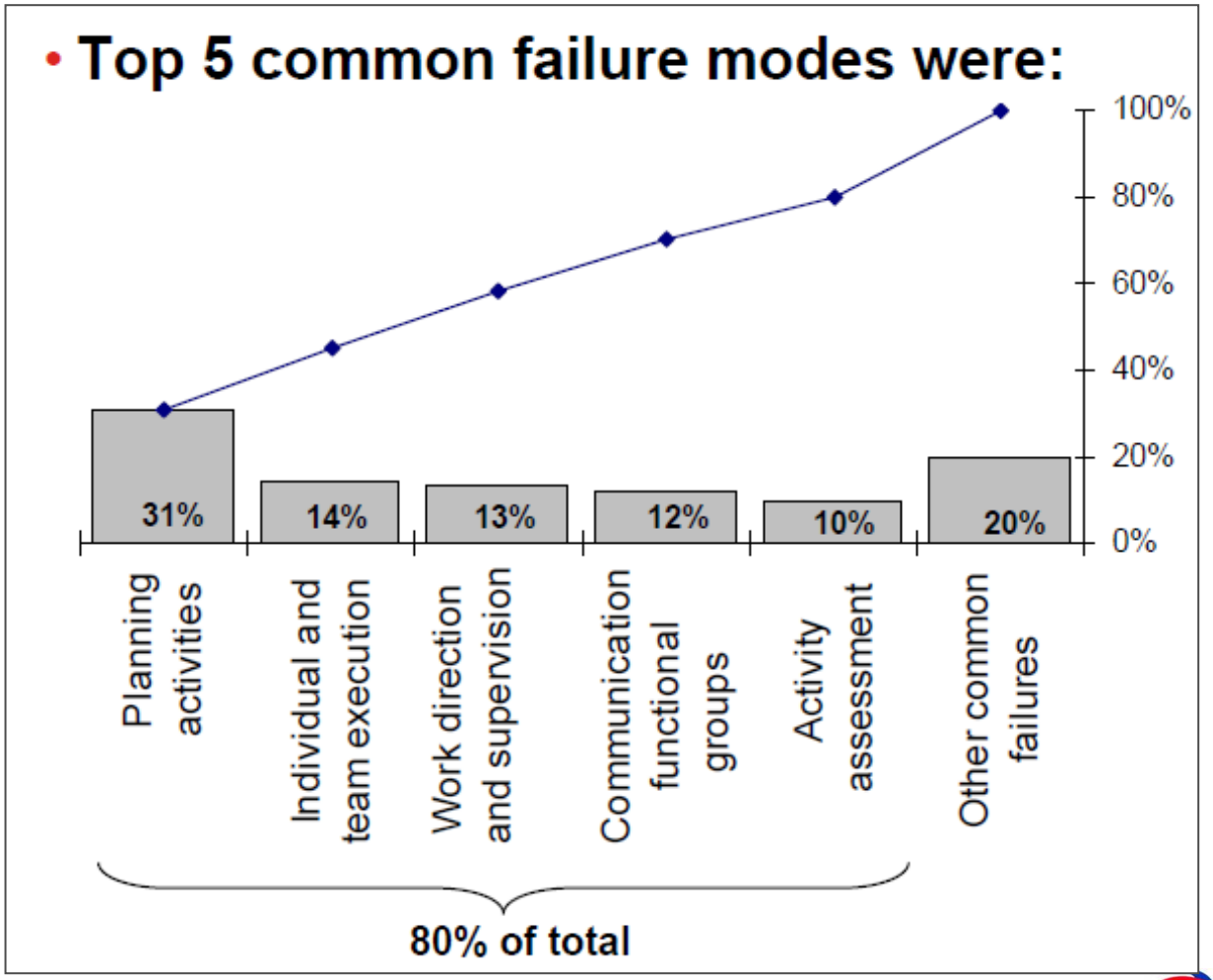
ASM Consortium “deep dive” on communication and coordination failures

14 selected incidents

207 failures

80% = 5 failure modes



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“Deep dive” insight

- **Common root causes show why failures occurred across incidents**

Significant contributor (>15%)

Substantial contributor (>10%)

Moderate contributor (>5%)

Not a contributor (0%)

Root Cause	Combined for Top 5 %	Planning activities %	Individual and team execution %	Work direction and supervision %	Communication between functional groups %	Activity assessment %
No SPAC	12.2%	20.4%	8.6%	7.8%		15.2%
Crew teamwork needs improvement	11.1%	7.4%	15.5%	17.6%	6.5%	12.1%
SPAC not followed	8.8%	7.4%	19.0%	7.8%		9.1%
No communication	8.4%	6.5%		5.9%	32.6%	
No supervision	7.4%		12.1%	19.6%		15.2%

SPAC – Standards, Policies, Administrative Controls

Who is in charge of this ?

Incident Investigation Paradox

1.

- Up to 80% of all incidents are related to human error
- Up to 80% of all human error is related to organizational matters

2.

- Up to 80% of all incidents are related to worker's behavior
- Worker's behavior is overwhelmingly influenced by their management

- **So :**
  - ***Why are organizational / managerial matters not the primary criterion of the incident investigation ?***

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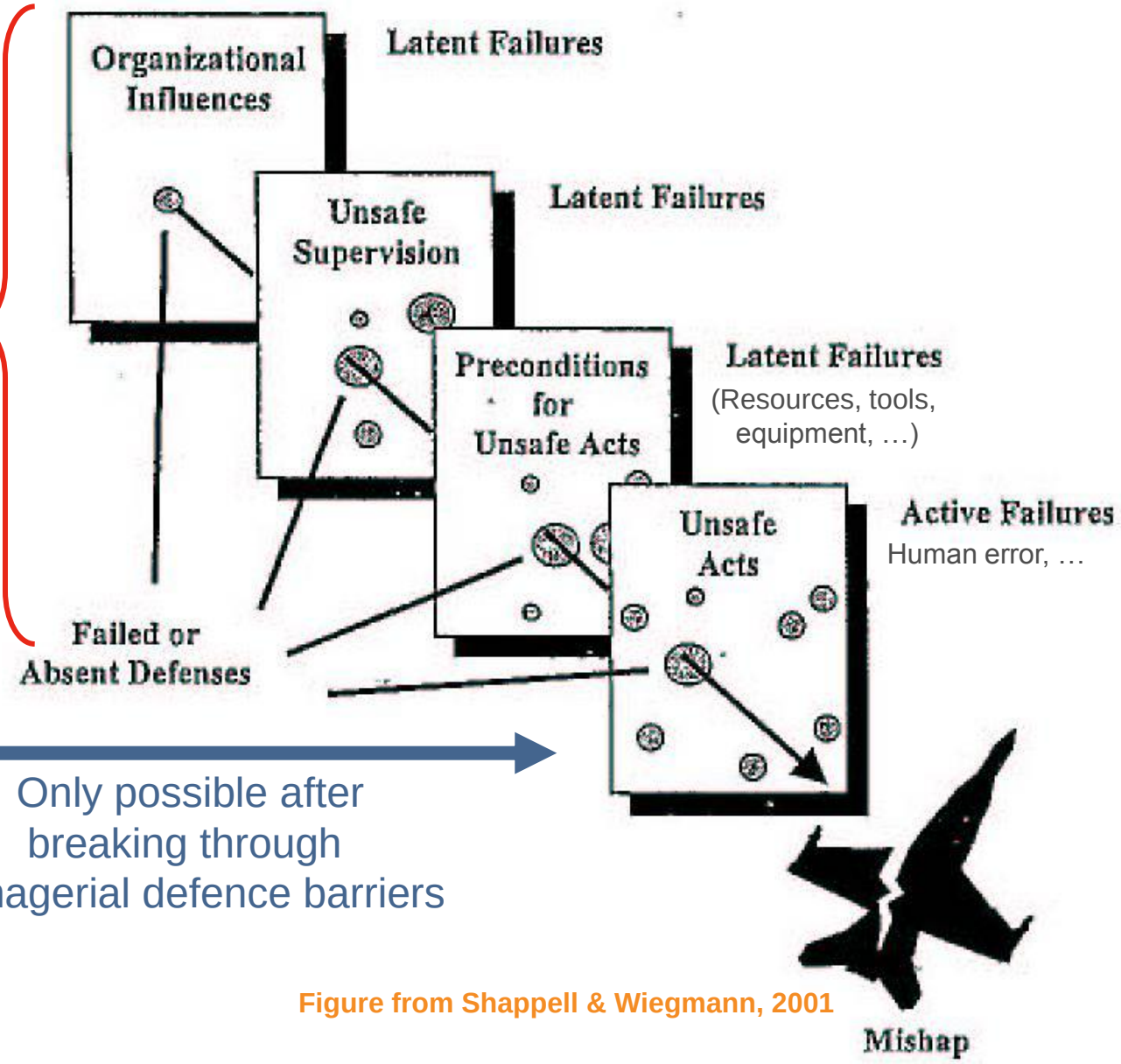
Management emphasis on Human Error approach in the Aviation Industry

Managerial defense barriers



Cockpit failures

Only possible after breaking through managerial defence barriers

Figure from Shappell & Wiegmann, 2001

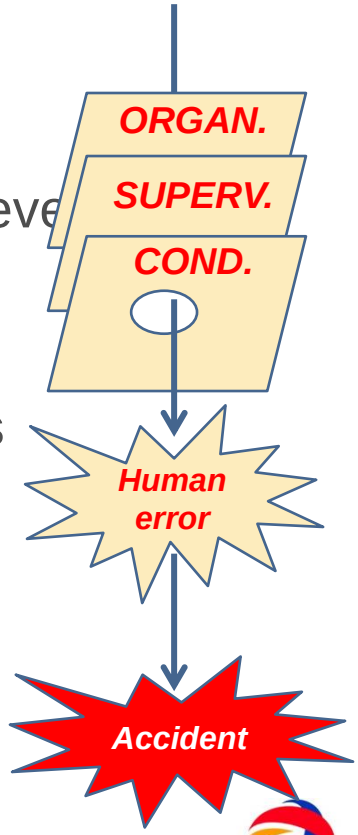
The Operational Management as Defense Barrier

- **High level mission :**
  - *Conduct the operations at a high standard of excellence (total safety and effectiveness)*

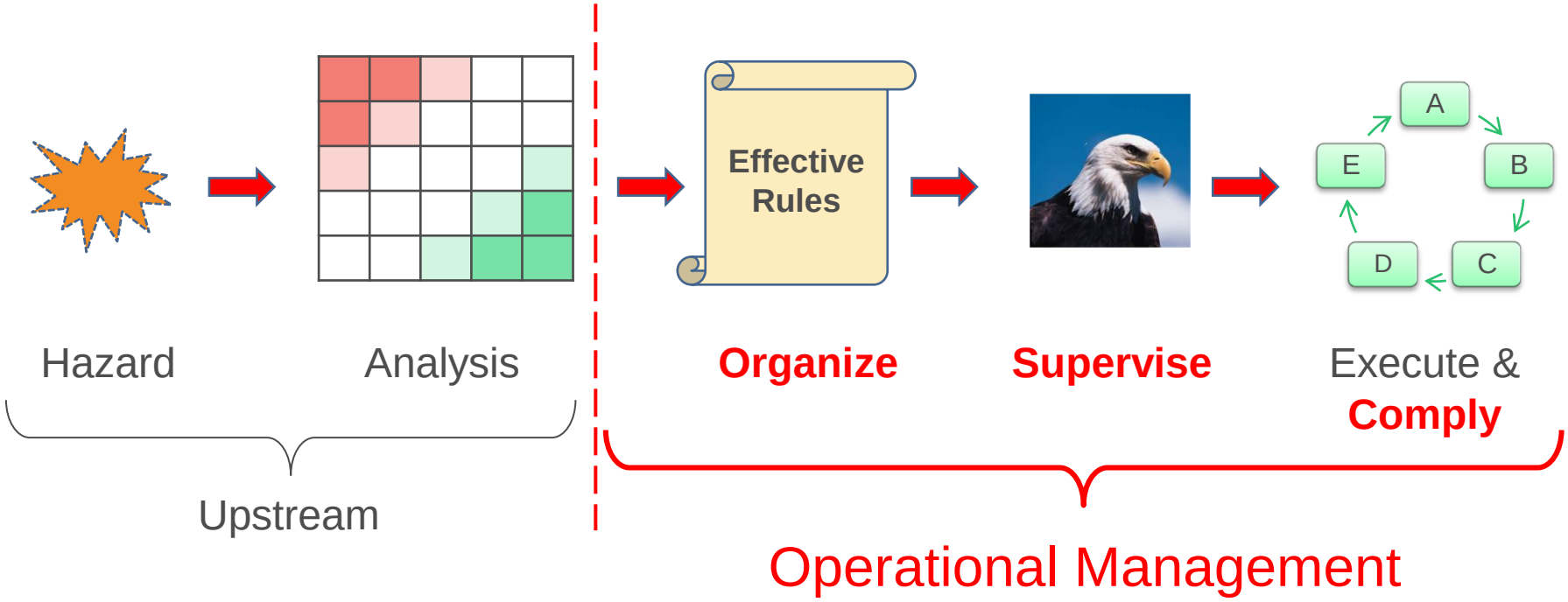
- **<u>All</u> accidents can be prevented by ensuring**
  - That every hazard is identified
  - That effective organizations (rules) are in place against eve hazard
  - That the rules are effectively implemented
  - That all conditions are adapted to the work requirements

- **Also human error …? YES**

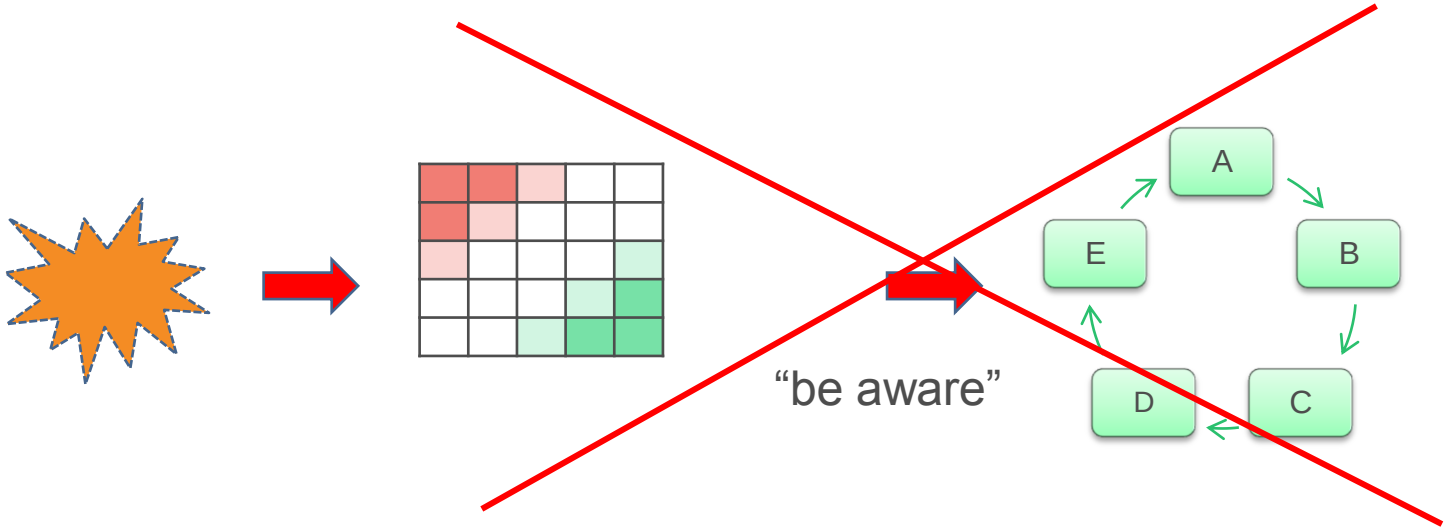
- **How about risk and probability considerations ?**



Message : Operational Management = *Rule* Based !



Without good rules and compliance : *“stuck in the matrix”*

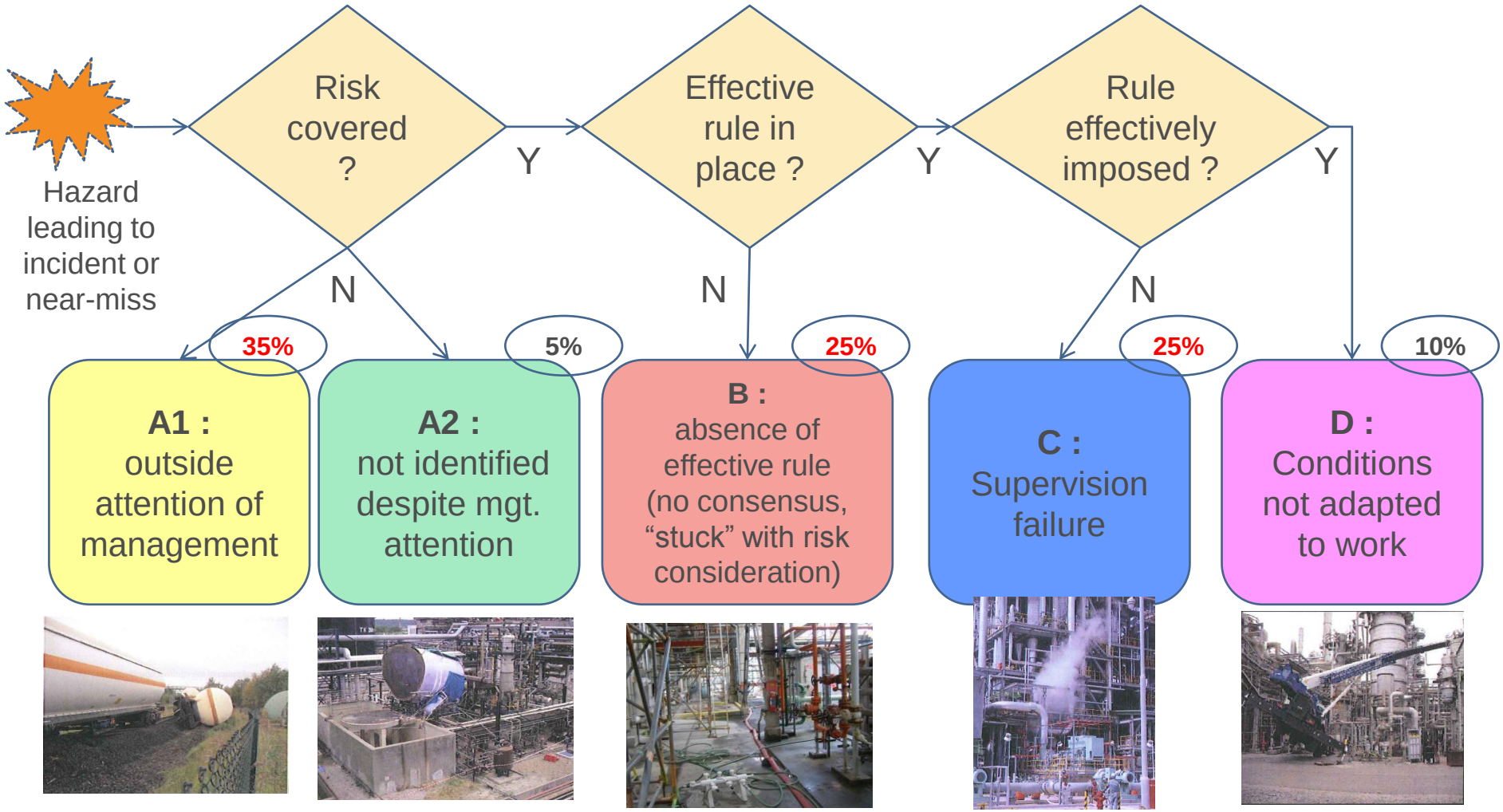


Operational decisions require guidance with <u>rules</u>, not just *risk considerations and awareness*

- *Should I wear a hard hat on a production site, to reduce the risk of being injured by falling objects, or not?*
- *Is it too hot to work in the normal way, or not?*
- *Am I too fatigued to fly this aircraft, or not?*
- *Should I stop a process now because of the risks involved, or not?*

TOTAL

Effectiveness of Managerial Defense Barriers as *relevant segmentation* for incident investigation



- **Advantage : categories identify clearly the corrective action to be taken, by the resource which has the single most direct impact : the operational management**

TOTAL

Observed recent tendencies undermining the excellence of the *human manager*

- **Effect of outsourcing and lump sum contracting**
  - Considered “not core” for the company : human (managerial) reaction = focus on other aspects which have hierarchy attention
  - Contractual result = prescribed : human reaction “not my problem any more” (mgt. failure cat. A1)
  - After a while : “we are not competent for this, we have no professional experience”

- **Risk and probability considerations in operations :**
  - Message to the young manager = whatever you do, these (the matrix) are the probabilities that incidents happen in your area … and everyone knows it and agrees
  - Degradation of good rules by “add-on” in order to move at lower risk position in matrix
  - Human reaction : “ despite the 10^{-4} it happened in my duty : just bad luck”

- **Audits focused on administrative ‘management *systems*’**
  - Instead of detecting field weakness to trace underlying management problem
  - General score system leading to “congratulations” may stop the learning and reduce the essential “sense of vulnerability”

Organisation's competency evolution

1950… 1980

hired

Training :
Fundamental Organizational Principles for Process Industry
+
"Murphy !"

Mtce vs. prod. perimeter
Permit vs. execution
Signature commitment
Single line of command
Written instructions
TAG numbering
Nothing w/o work order
Supervision
Perimeter of accountability
…

New concept

New concept

New concept

New concept

New concept

New concept

Detailed procedures
Continuous learning
Contractors
Risk matrix
SMS
Bow-tie
BBS
Safety culture
Human Factors
…

retired

retired

2000… 2010

Fundamental organizational principles ? Never heard about them

TOTAL

What are “good rules” for the Process Industy ?

- **Simple to understand**
- **Universally applicable**
- **Focused on avoiding human error : *Organizational Layers of Protection***
- **Not necessarily the most efficient way to do things, but their universal application generates *overall predictability of the complex reality and overall efficiency***
  - Cfr. Airplane landing
- **Specifically reinforcing Process Safety (the heart of our profession)**

- **“Organizational layers of protection” : not just any rule, but part of a “constitution for the process industry” to which all procedures, organizations and work methods should comply**

TOTAL

Conclusions

- **Operational managers are HUMANS too !**
  - Not immune to human errors
  - Subject to Human Factors
  - Needing guidance and clear expectations framework to perform well
- **Their impact is huge : probably most important improvement tool**
  - Much more direct than “show commitment”
  - Should not be placed in the role of “observers of their department”
- **Operational Management performance vs. high expectation standard should be part of any Incident Investigation**
- **Modern concepts like BBS, risk matrix etc.**
  do NOT replace good organization and RULES
  but come on top of it…

TOTAL

Attachment

Organizational FUNDAMENTALS
For the Process Industry

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)

TOTAL

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)

TOTAL

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**

TOTAL

5. Proper operational communications

- **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**

TOTAL