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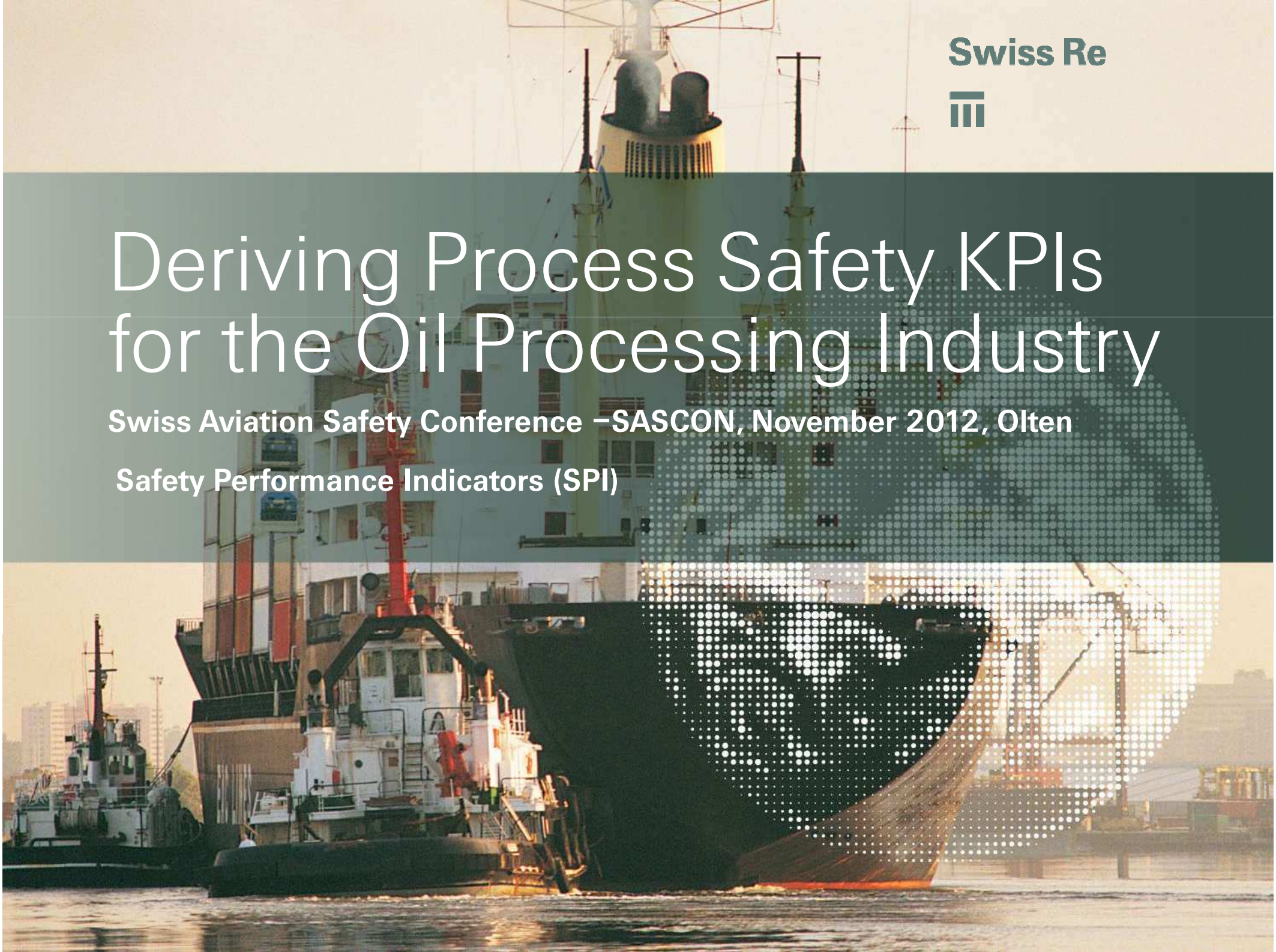
Deriving Process Safety KPIs for the Oil Processing Industry

Swiss Aviation Safety Conference –SASCON, November 2012, Olten

Safety Performance Indicators (SPI)



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Agenda

- High Loss Burden in US Refining
- Personal Safety vs Process Safety
- SwissRe Process Safety KPI Suggestions
- American Petroleum Institute API 754 on Process Safety KPI
- Chemical Safety Board CSB on Process Safety KPI
- Occupational Health and Safety Admin OSHA on Process Safety KPI
- Analogy between Processing Industry and Aviation

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Initiative for Process Safety KPI's, because of high normalized loss burden in the USA

Personal safety key performance indicators KPIs ("OSHA recordables") are monitored closely and made public, however **process safety** KPI are not controlled in the same way and still unknown to the public.

Defining and measuring process safety KPIs would be beneficial to identify the good performers, additionally it would create a level playing field for all operators.

Process Safety KPI acc. to SwissRe Observation after Large Losses

Backlog Cluster

- backlog of work orders WO (Macondo Platform, Avon Refinery el al)
- Accumulated overtime
- backlog of inspection
- Backlog of safety critical equipment maintenance, audit, testing etc
- number of clamps per line

Operational Cluster

- Bypassed trips (Macondo, Texas City Refinery)
- Loss of primary containment LOPC, including lifted pressure safety valves PSV
- excursion form the operating envelope
- Unplanned shutdown, plant wide and partial (Macondo, Pembroke, Puerto Llano)
- Startup without applying Prestart up safety reviews PSSR (Lysekil)
- Observed failure on demand on a safety instrumented system SIS,

Process Safety KPI acc. to SwissRe Observation after Large Losses

Engineering Cluster

- Status of recommendations from HAZOP , Safety Management System Audit, MOC and external audits (Texas City, Macondo)
- Postponed turnaround without formal risk assessment, (Humberside)
- not updated P&IDs and operating procedures SOP, EOP, (Kuwait)
- Loss mitigation system fails on demand, (Mexico)
- Incident investigation and near miss reporting system low priority

Process Safety Performance Indicators for the Refining and Petrochemical Industries

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ANSI/API RECOMMENDED PRACTICE 754
FIRST EDITION, APRIL 2010

energy API

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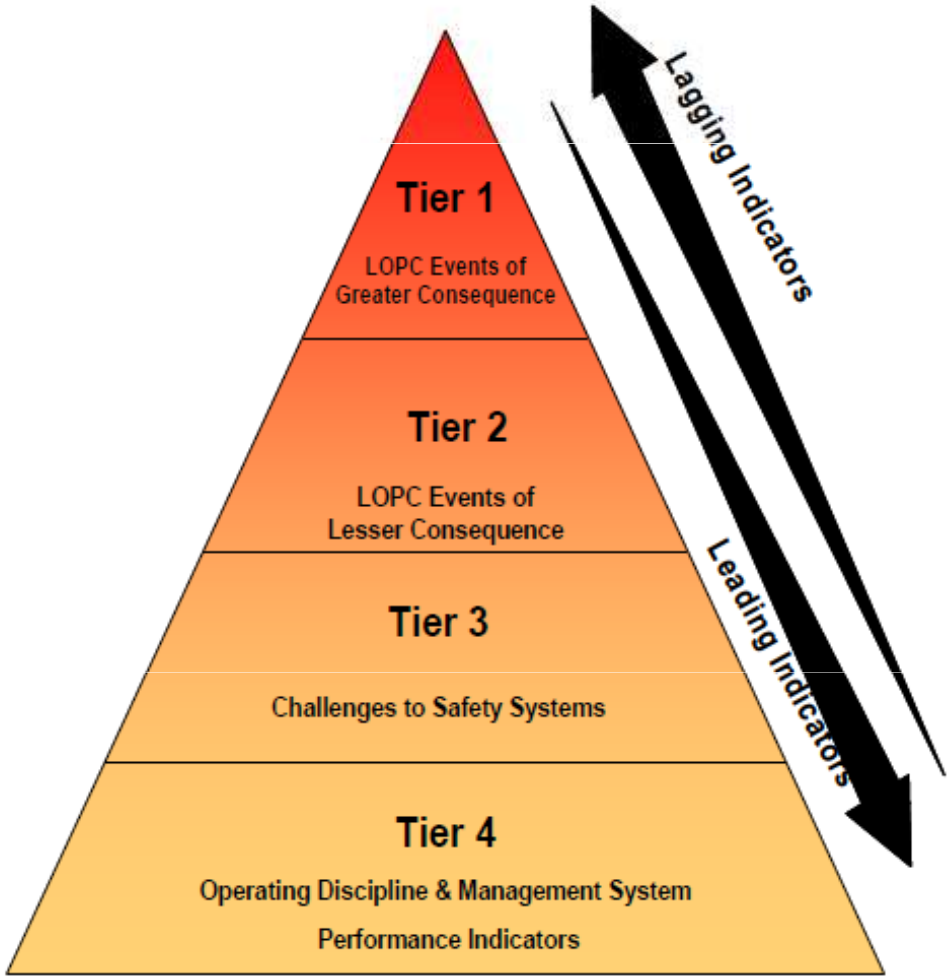
API 754, Process Safety Performance Indicators for the Refining and Petrochem. Industry
4 Tier reporting system



- The count of **Tier 1** process safety events is the most lagging performance indicator and represents incidents with greater consequence resulting from actual losses of containment.
- The count of **Tier 2** process safety events represents loss of primary containment events with a lesser consequence, but may be predictive of future, more significant incidents.
- **Tier 3** events represent challenges to the safety systems. Indicators at this level provide an opportunity to identify and correct weaknesses within the safety system.
- **Tier 4** indicators represent operating discipline and management system performance.

API 754, Performance Indicator
Tier 1 Process Safety Events PSE

Tier 1 PSE Rate = Total Tier 1PSE counts/total work hours * 200,000h

- Property damage of more than 25,000 USD
- Spills of more than 500 kg of flashable material eg propane within one hour, LOPC loss of primary containment
- Pressure release to flare or vent of more than 500 kg of flashable material

  Resulting in:

  - Fatality
  - Injury resulting in days away from work
  - on site "shelter in place"
  - road closure
  - community evacuation or "shelter in place"

API 754, Performance Indicator
Tier 2 Process Safety Events PSE

Tier 2 PSE Rate = Total Tier 2PSE counts/total work hours * 200,000h

- Property damage of more than 2,500 USD
- Spills of more than 50 kg of flashable material eg propane within one hour
- Pressure release to flare or vent of more than 50kg of flashable material

  Resulting in:

  - Injury resulting in a OSHA recordable
  - on site "shelter in place"
  - road closure
  - community evacuation or "shelter in place"

API 754, Performance Indicator
Tier 3 Challenges to Safety Systems

Tier 3 some use a rate, others prefer a count of PSE, **not uniform presently**

- Safe operating limit SOL excursions, eg working beyond alarms, power failures
- Metals inspection or testing results outside acceptable limits eg below min. wall thickness, test release pressure PSV too high or low
- Demands on safety systems
  - activation of safety instrumented system SIS, eg trip,
  - activation of a mechanical shutdown system, eg overspeed trip
  - activation of pressure safety valve PSV

API 754, Performance Indicator
Tier 4 Operating Discipline & Mgmt Systems

Tier 4 some use a rate, percentage , others prefer a count of PSE, **not uniform presently**

- Process Hazard Evaluations done on time
- Process safety action items done on time, coming from:
  - Process hazard evaluations (and MoCs??)
  - incident and near miss investigations
  - Safety audits
- Training completed on schedule
- Updated procedures and drawings
- Permit to work, Lock-out Tag-out procedures compliance
- Safety critical equipment inspection done on time

API 754, Performance Indicator
Tier 4 Operating Discipline & Mgmt Systems

cont'd

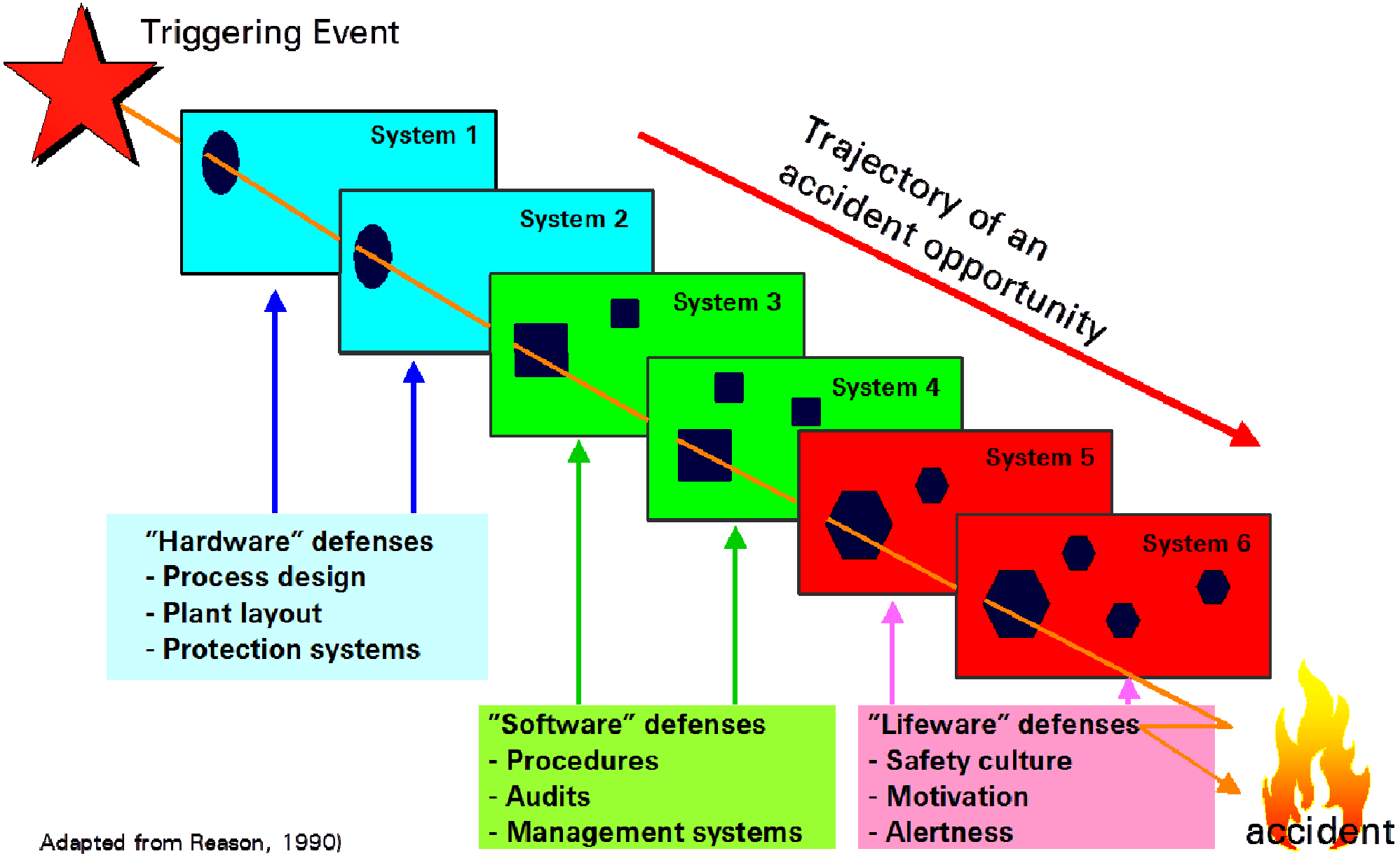
- Action items after Failure on demand of Safety critical equipment
- MoC and PreStartup Safety Review PSSR procedure compliance
- Completion of emergency response drills
- Fatigue risk management
  - overtime percentage
  - number of open shift positions
  - number of extended shifts
  - number of consecutive shifts worked
  - number of exceptions

Priority Process safety KPIs per CSB Chemical Safety Board, Washington DC

General on lessons learnt from losses:

- Process Safety KPIs must be part of the **incentive program** at all hierarchies, because completion rate 90% when rewarded but else less than 70%
- Note that all KPIs are subject to **manipulation**
- **3 to 8 Layers of protection** have been penetrated per large loss, on avg 5, (Swiss Cheese model)
- all contributing causes can be attributed to the 14 PSM (OSHA's PSM regulations at 29CFR1910.119) elements (mainly mech integrity, MoC, HAZOP, Process Safety Info)
- management **oversight** (safety culture, "production first")
- Product stewardship (**understanding** eg Material Data Sheet MDS, blaming supplier)

Layers of Protection, Swiss Cheese Mod



Adapted from Reason, 1990)

Priority Process safety KPIs per CSB Chemical Safety Board, Washington DC

Suggested 6 process safety KPIs :

1. Maintenance of safety critical equipment
2. Unplanned shutdowns occurred per unit / site per year
3. Share of breakdown maintenance
4. Pressure safety valve PSV lifting
5. Excursion of the operating envelope
6. Work order backlog and /or leak clamps per line

Priority Process safety KPIs per OSHA, Occupational Safety and Health Admin, Washington DC

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Suggested 6 process safety KPIs :

These were mentioned to SwissRe after the National Emphasis Program NEP, a nation wide refinery audit program, after TX City explosion. Repeat findings at same site were main frustration for auditors (fines ineffective)

1. Near miss reporting system with a degree of confidence
2. Implementation of Process Hazard Analysis PHA findings
3. Past due inspections, eg PSVs, vessels, piping, ESD etc
4. increasing work order WO backlog with increasing overtime
5. Loss of primary containment LOPC and PSV lifting
6. Incident investigation and recommendations

Analogies between Processing Industry and Aviation

- Low probability - high consequence losses are of concern
- Personal safety indicators (slips, trips, and falls) are useless for process safety indication
- Need to learn from near misses rather than from seldom losses
- Main issue: Oil processing — Leak; Aviation — Spacing

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Tier 1 of API 754 analogy ??

- Spiral dive (Nassenwil)
- TCAS off or unclear priority with controller´s instruction (Ueberlingen)
- Min. separation (Ueberlingen)
- Uncalibrated altimeter – ILS (Stadlerberg)
- Decent below MSA without "in sight" (Bassersdorf ?)
- Changes to aircraft with weak approval process (Halifax), MoC
- Little "pitch and power" training hours (AF447) or little no autopilot / autothrottle flight experience (fear blame from Flight Data Monitoring??)

LEGISLATION **DAVID LEARMOUNT** LONDON

EASA plans radical training shake-up

Safety agency proposes wide-ranging changes to pilot instruction in the light of investigation into crash of flight AF447

Recommendations arising from the investigation into the fatal June 2009 Air France flight 447 loss-of-control accident have prompted the European Aviation Safety Agency to prepare a radical rulemaking programme.

Confirming its plans, EASA says that when drafted, the proposed regulations – mostly on pilot training – will be subject to the statutory consultation process. Therefore, it may be a year or more before any resulting regulatory change sees the light of day.

EASA confirms that a mandate for "loss-of-control avoidance and recovery training" is already included in its rulemaking programme. The specific recommendation by French accident investigation agency BEA is that EASA should: "Review the content of check and training programmes and make mandatory, in particular, the setting up of specific and regular exercises dedicated to manual aircraft handling of approach to stall and stall recovery, including at high altitude."

BEA

The Air France A330 came down in the South Atlantic

EASA says it is also working within the international "Loss of Control Avoidance and Recovery Training" initiative, established by the International Civil Aviation Organisation in co-operation with the US Federal Aviation Administration. The effect of cockpit automation on pilot skills is another issue EASA is preparing to tackle. It has set up an internal group on the topic which recently conducted a survey. This concludes: "Basic manual and cognitive flying skills tend to decline because of lack of practice, and feel for the aircraft can deteriorate."

EASA notes this fundamentally affects the assumptions about pilot competency and expected flightcrew reactions upon which aircraft certification decisions are made. Either those assumptions have to change – affecting aircraft design – or training has to counter the effects of automation successfully, it says. It is also working on rules that will require flight simulators to provide greater handling and aircraft behavioural fidelity at the edges of the flight envelope. This would improve the value of simulator training for stall recovery and recovery from extreme attitudes. ■

A special feature in the 20 November issue of *Flight International* will examine all potential future consequences of the AF447 accident

David Learmount comments on operational and safety issues at flightglobal.com/learmount

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Tier 2 of API 754 analogy ??

- Conflict of interest. Training (ADI) and certification not separated from operational / business needs (Nassenwil ?)
- Near Miss, below required separation (Kloten ?), 16 similar stall cases AF447
- TCAS action required
- Prolonged or repeated stall warning (AF447)

SAFETY **DAVID KAMINSKI-MORROW** LONDON

Final AF447 report set to re-ignite row

Source says Airbus may propose a pan-European accident investigation agency if it finds BEA's conclusions unsatisfactory

French investigation authority BEA appears likely to rekindle the smouldering conflict over the loss of Air France flight AF447 when it releases the final report into the accident on 5 July.

Air France and the main French pilots' union, SNPL, have previously clashed with Airbus over the circumstances of the crash and whether the fundamental reason for the loss centred on pilot competence or the design of the Airbus A330's flight-control and warning systems.

Airbus submitted 80 pages of comment to the inquiry after the airframer received the draft version of the report. The draft did not include recommendations but did feature analysis by the human factors panel established to look into the crew's response to the stall which downed the jet.

SNPL has already reiterated its concerns over aircraft functions and the alerts given to the crew, in a document published in February. While Airbus declines to comment on the AF447 report ahead of publication, a source familiar with the situation states that the airframer is concerned whether the conclusions will focus too narrowly on the human-machine interface.

"If there are things to improve on the aircraft, [Airbus] won't try to escape in any way"
INDUSTRY SOURCE

"If there are things to improve on the aircraft, [Airbus] won't try to escape in any way," says the source, but adds: "We'd like to see a report in which all the issues are being dealt with."

He also indicates that Airbus is likely to "become vocal" if it finds the BEA's conclusions unsatisfactory – even potentially proposing a pan-European accident investigation agency.

Former BEA deputy chief Jean Pariès – who heads human factors consultancy Dédale and took part in an Air France safety review – told an operations forum in Oslo in April that current safety models assume pilots will recognise and identify abnormal situations, then implement relevant procedures.

However in reality, he said, emergency situations generate surprise, causing momentary loss of cognitive control as well as resistance to recognising a loss of comprehension.

Pariès cited 16 events similar to AF447, all of which showed poor understanding, rare implementation of unreliable airspeed procedures and stall warnings which were "perceived but mostly not believed".

He suggests the problem cannot simply be reduced to "automation complacency" or loss of basic skills. Pariès claims crew training aims to prepare pilots for anticipated emergencies, not the unexpected, and highlights the irony that the competencies needed to cope with the unexpected "are those that are lost in a continuous effort to anticipate and respond to all potential threats".

Investigations into a strikingly similar event to AF447, involving an Air France A340 in July 2011, recommended that pilot training include shock and surprise elements. ■

Source: Flight International 3.-9 July12

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Tier 3 of API 754 analogy ??
Challenges to Safety Systems

- Selected safe operating limit SOL excursions, eg working beyond alarms, power failures
- Airplane inspection show unacceptable conditions (lube oil connections A380, damaged blades at GT, worn out breaks et al)
- Near Miss, on trajectory towards below min. separation
- TCAS alarm only
- Stall warning

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Tier 4 of API 754 analogy ??
Operating Discipline & Mgmt Systems

- Flight safety action items done on time, coming from:
  - incident and near miss investigations, own and others
  - Safety audits
  - Safety meetings
  - Airplane manufacturer (Thales Pitot, Concorde wheel bar)
- Training completed on schedule
- Updated procedures
- Safety critical procedures compliance
- Safety critical equipment inspection done on time
- Action items after failure on demand of Safety critical equipment
- Completion of emergency response drills
- Fatigue risk management

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Be pragmatic –
use lessons learnt from losses

Phase 1

Phase 2

Phase 3

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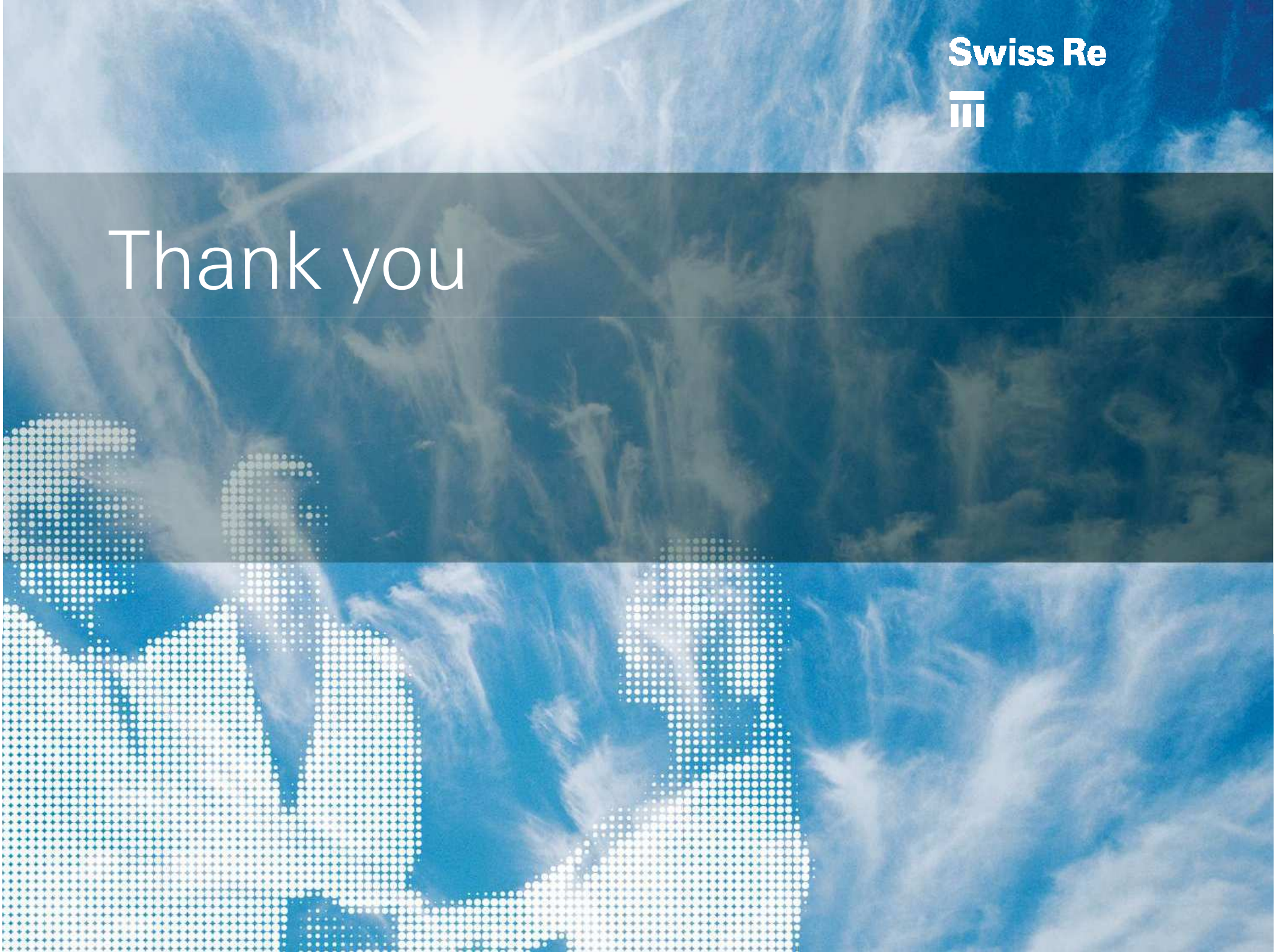
Can Safety KPIs replace audits?

No! Audits make a difference.

- → Large number of losses observed prior to first engineering visit.
- → Loss frequency decreases after the first field visit and again after the second.
- → After the fourth visit, the frequency levels off.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