DRIVING PSM PERFORMANCE BEYOND KPI METRICS

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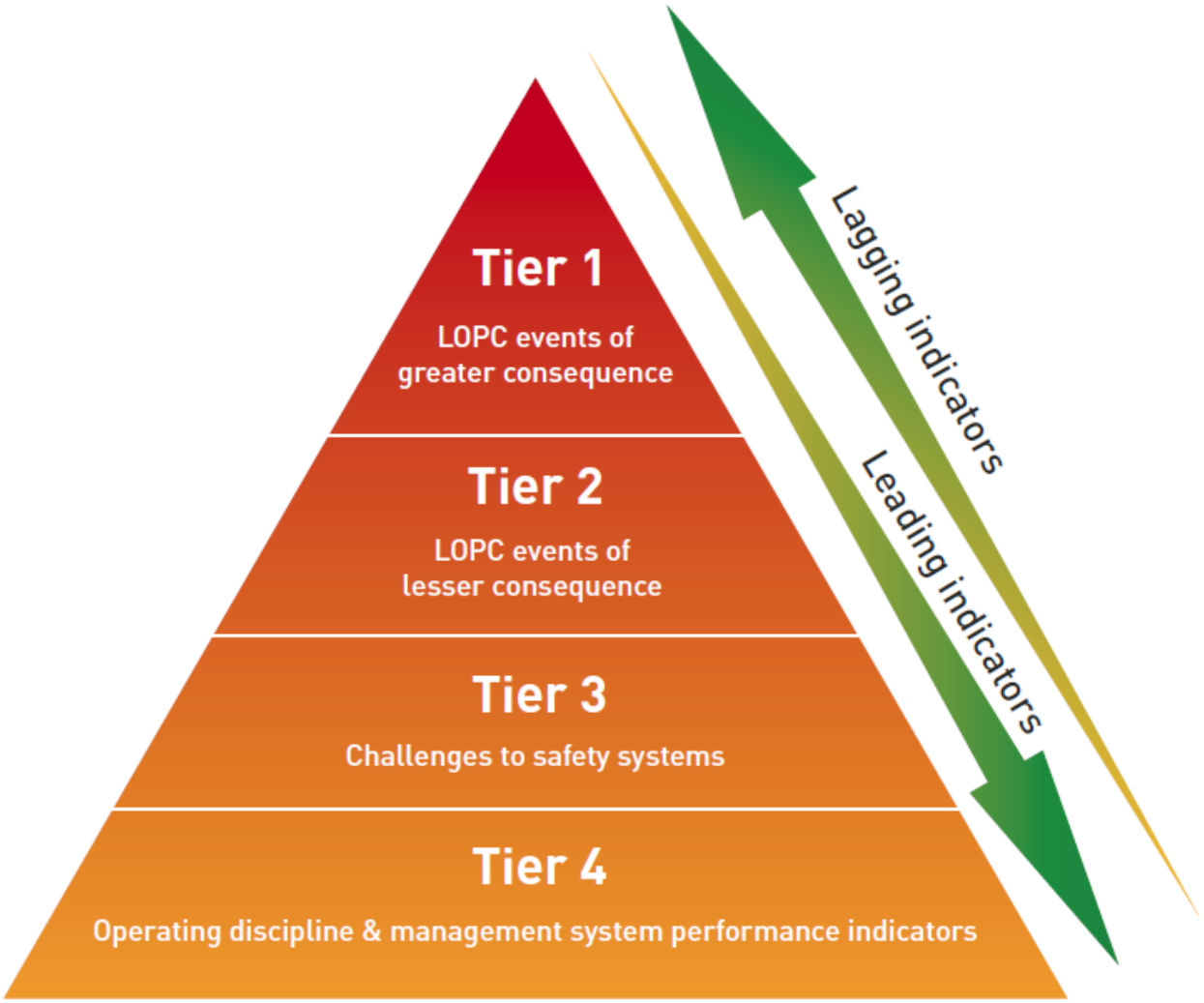
Remembering the world's Process Safety Guru

Discussion Outline

- Review of Process Safety Management (PSM) metrics & past performance
- The relationship between the non-fatal incident rate and fatal and serious incidents rates
- Barrier health management as a key to reducing the number of operating plant incidents
- A different approach to safety to reduce fatal accident rates

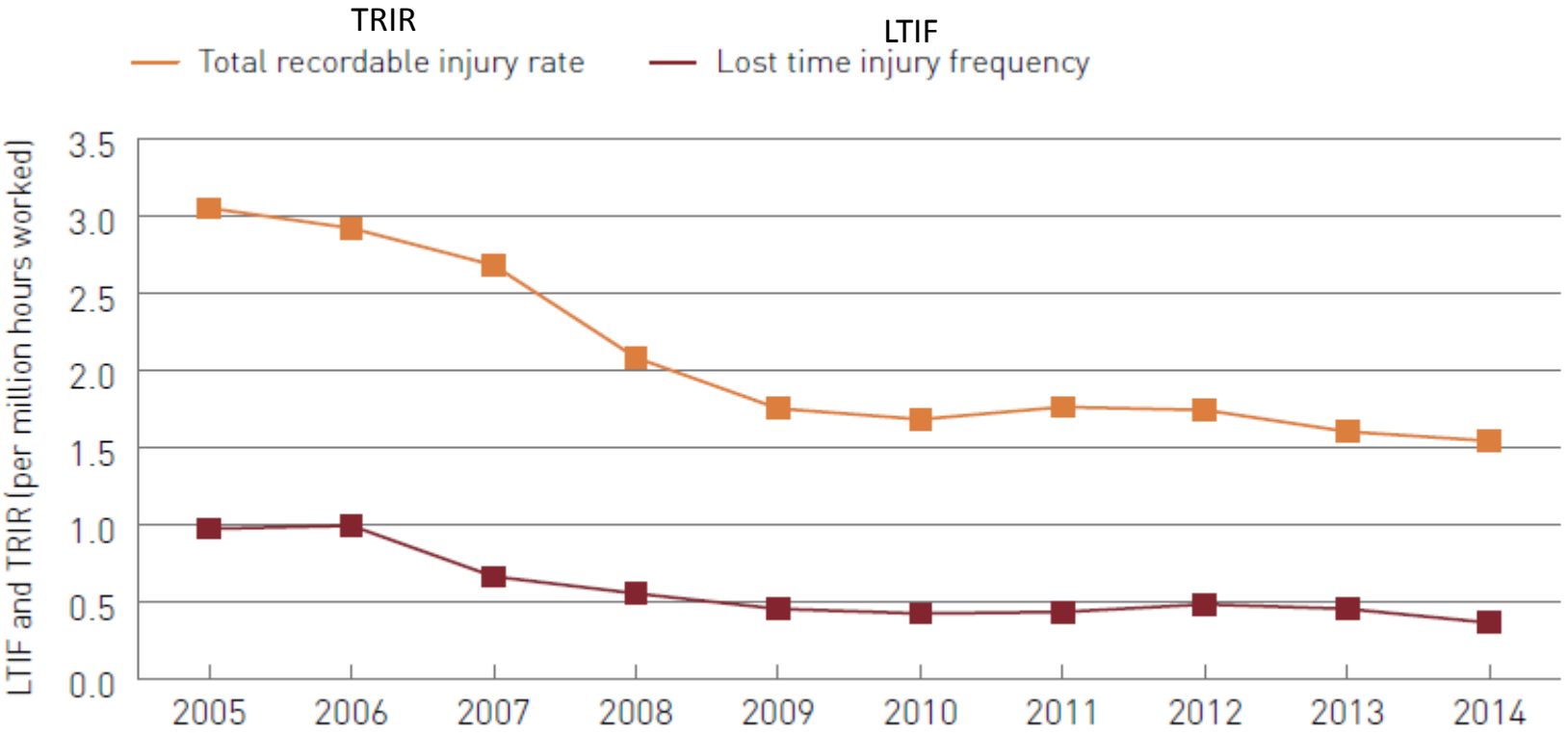
Process Safety Indicators Pyramid
(IOGP, Report 456, November 2018; API 754, April 2016)



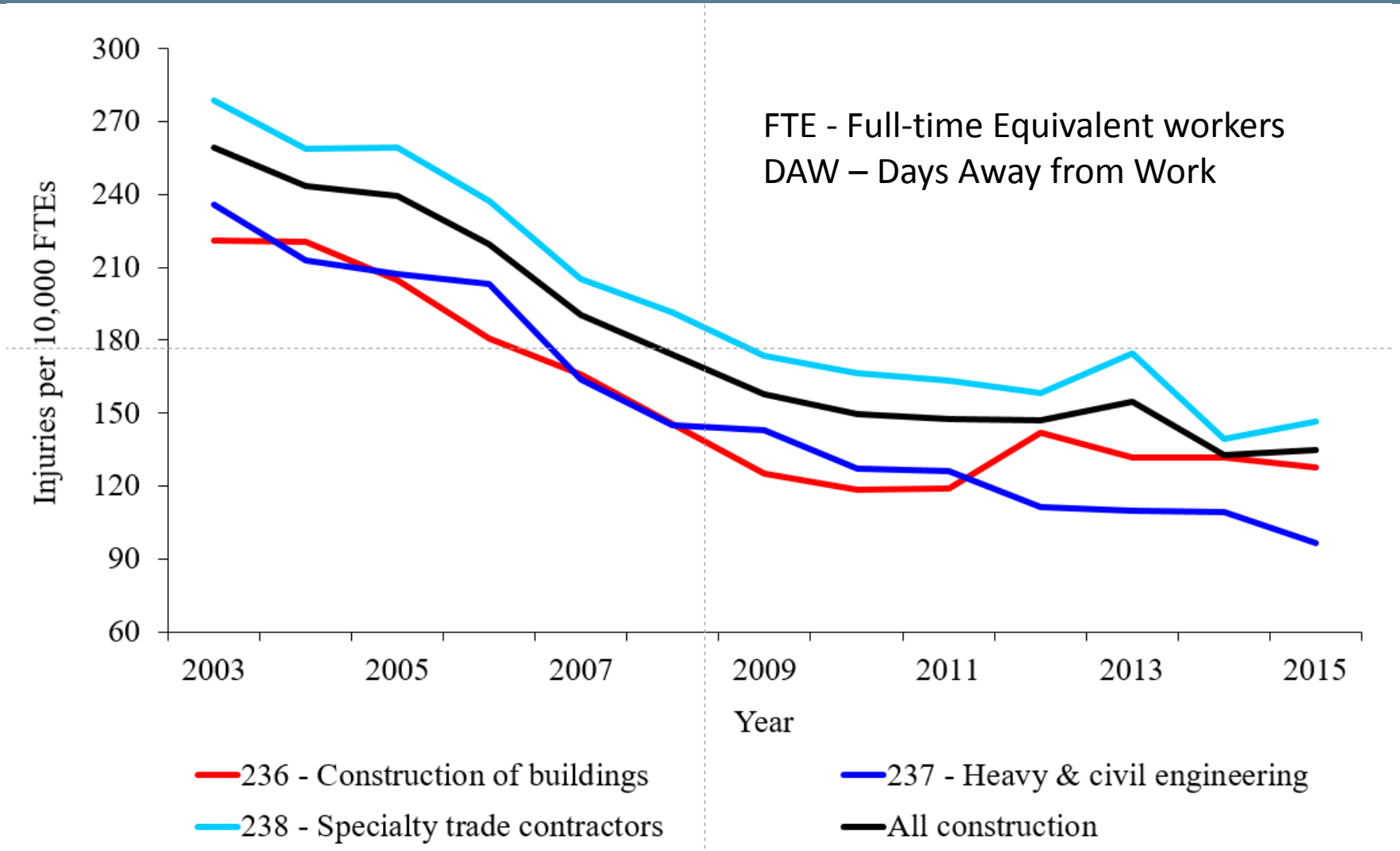
Example of PSM KPI Metrics

- **Tier 1 PSE**: an unplanned or uncontrolled release of any specified material from a process that results in one or more of the seven specified consequences.
- **Tier 2 PSE**: an unplanned or uncontrolled release of any specified material from a process that results in one or more of the five specified consequences not a Tier 1 release.
- **Tier 3 PSE**:
  - Safe Operating envelop excursion
  - Pressure relief device or Emergency blowdown system activation
  - Fixed gas detection system activation
  - Safety system or device failure to function on demand or test
  - Disabled / non-functional safety systems and devices
- **Tier 4 PSE:**
  - Process Hazard Analysis (PHA) Completion
  - Process Safety Action Item Closure
  - Procedure review
  - Work order compliance
  - Emergency Response drills
  - MOC / PSSR
  - Alarm management
  - Fatigue risk management

Safety Performance - LTIF and TRIR
(OGP Safety Performance Indicators 2014)



Rate of nonfatal injuries resulting in DAW
(Center for Construction Research and Training - CPWR 2016)



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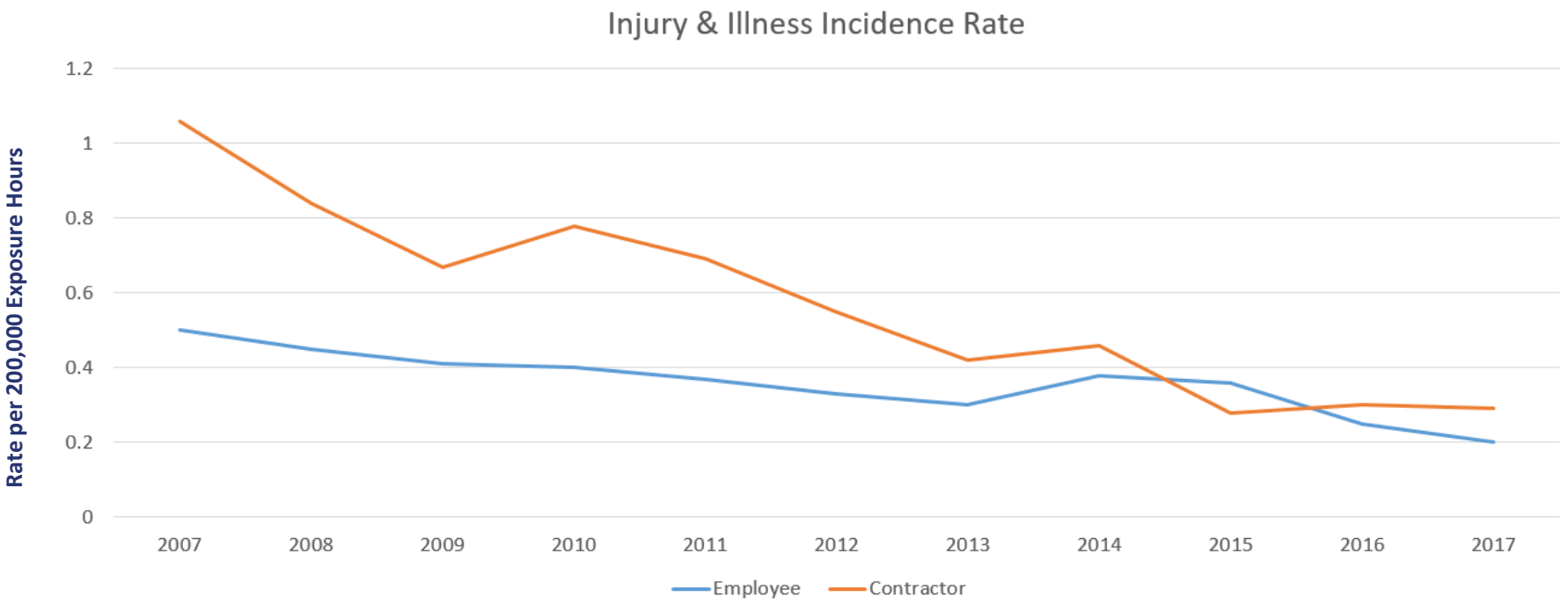
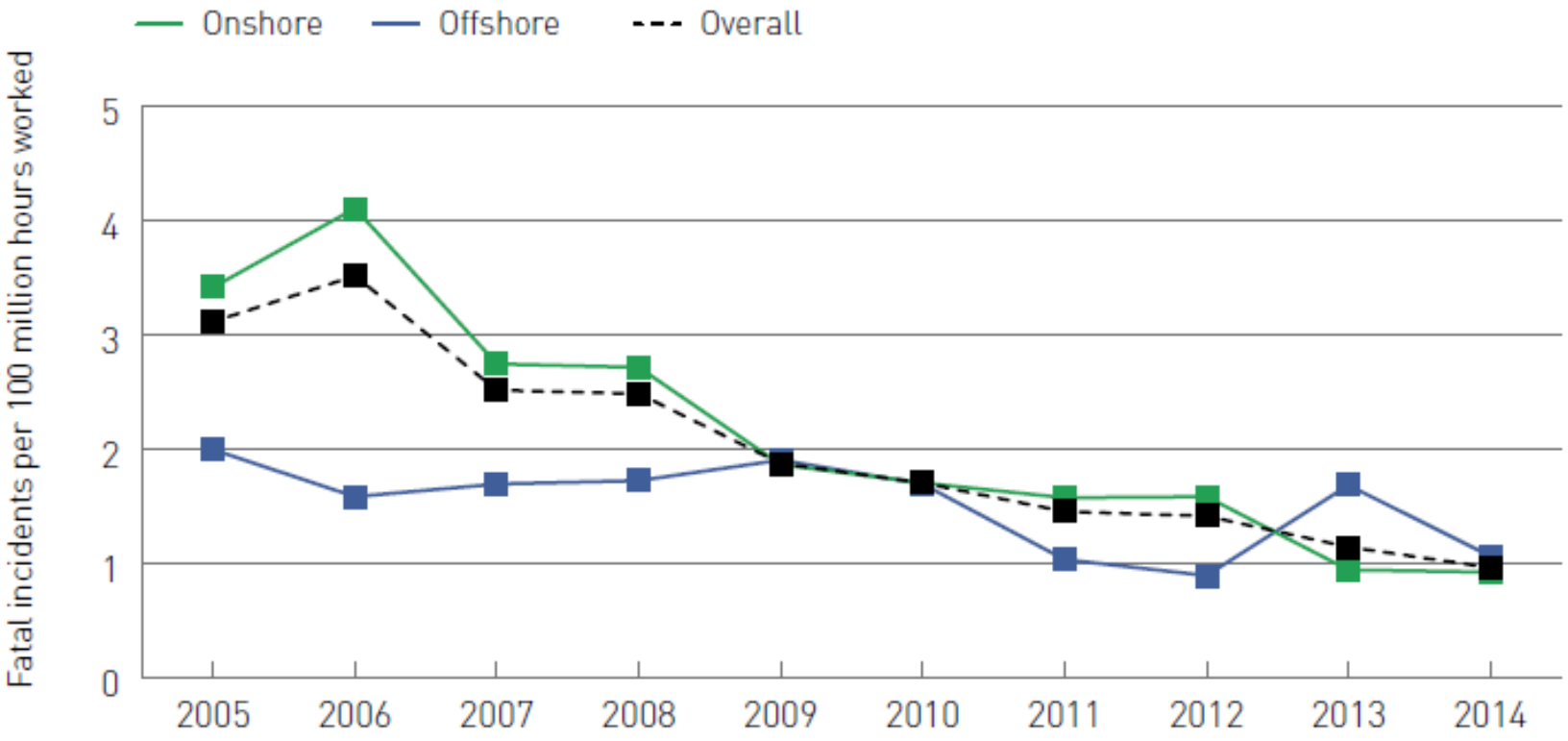
Injury & Illness Incidence Rate (IIR)

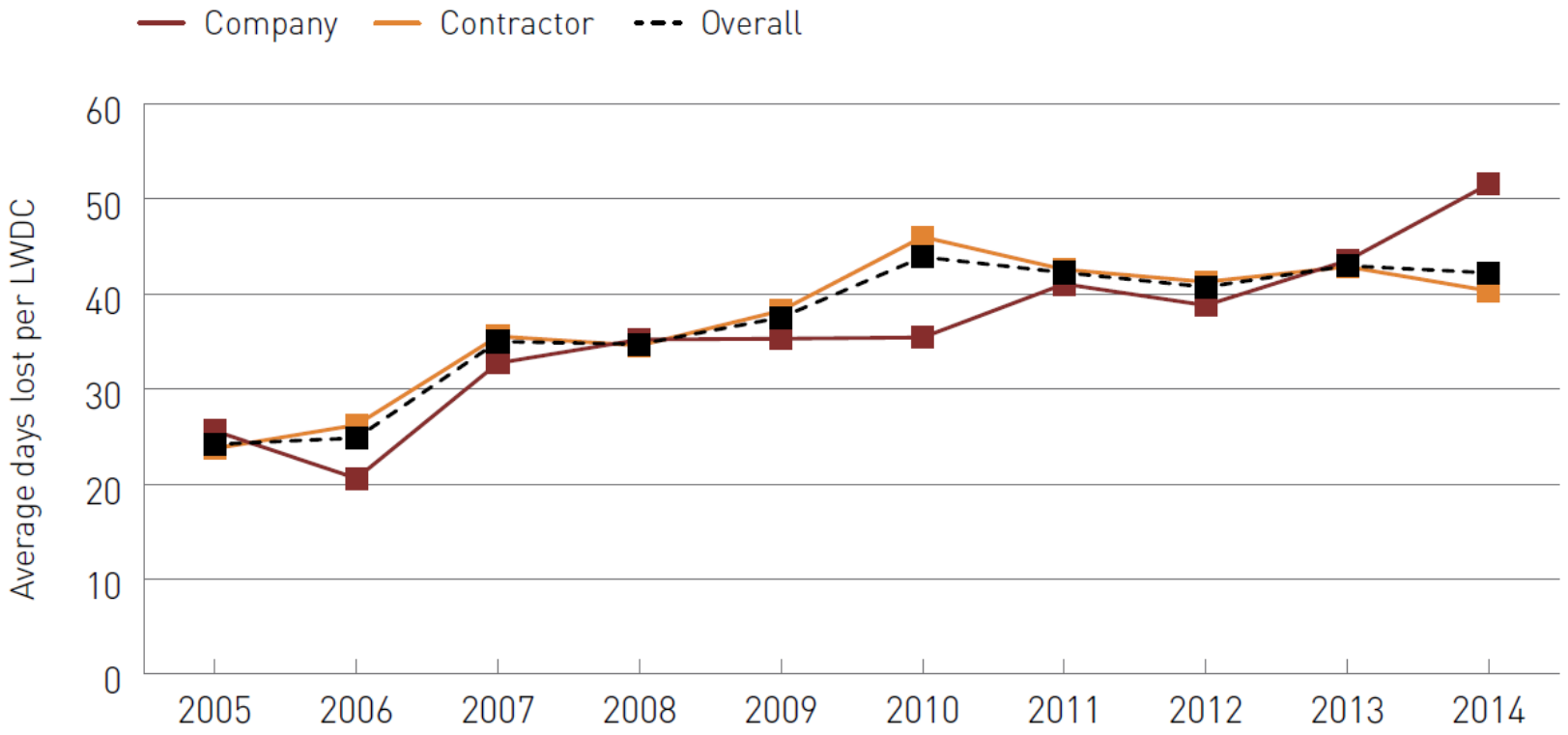


Fatal Accidents
(OGP Safety Performance Indicators 2014)



Fatal incident rate is decreasing but leveling off

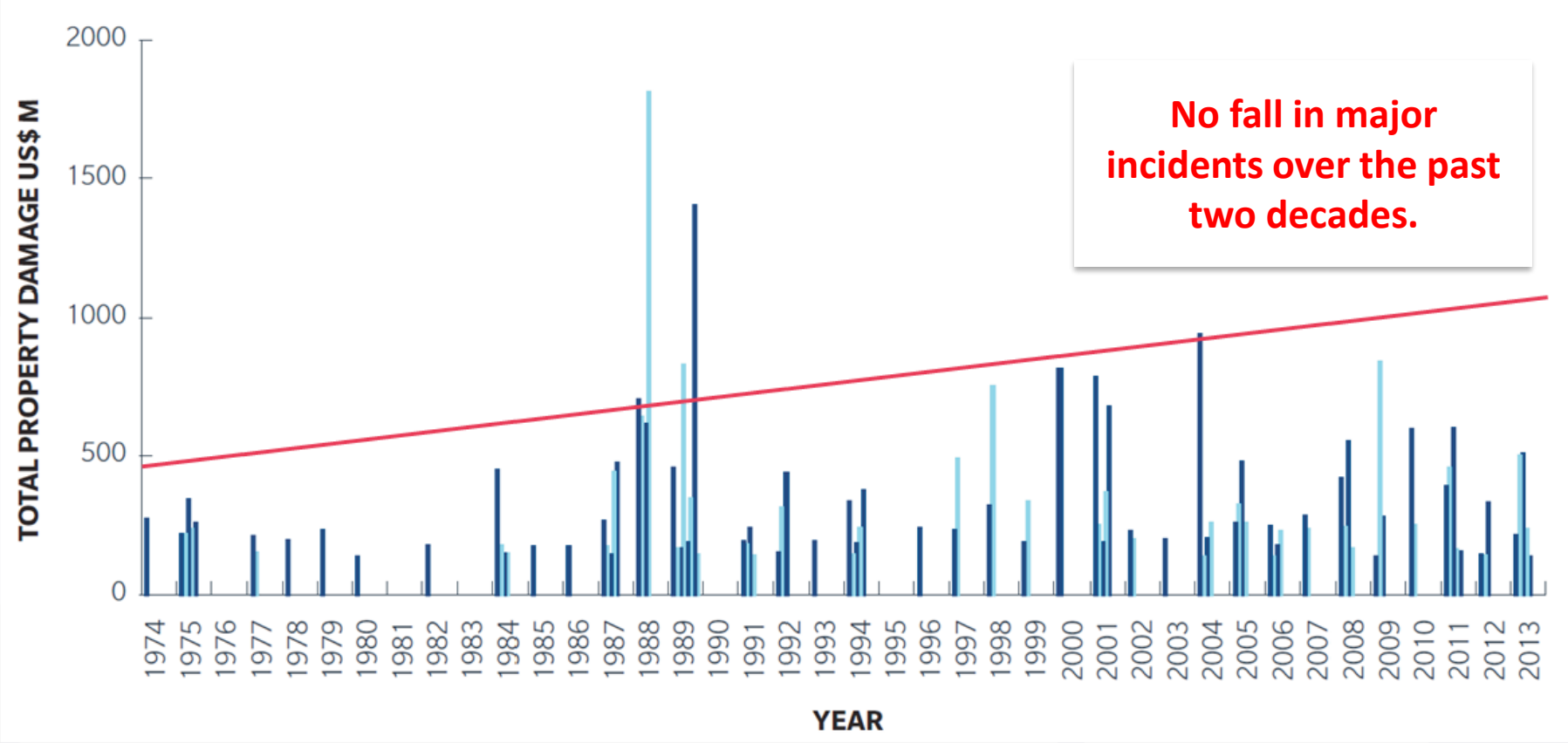
Lost Work Day Cases – Severity
(OGP Safety Performance Indicators, July 2014, OGP Data Series)



The number of serious incidents have decreased but the severity of those occurring has increased over past 10 years.

Trend in Total Losses by Year (all industry sectors)
(Refineries, Petrochemicals, Gas processing, Terminals and distribution, Upstream)

Distribution of the 100 Largest Losses by Year (in 2013 values)



Trend line = the trend of the total losses by year 1974-2013

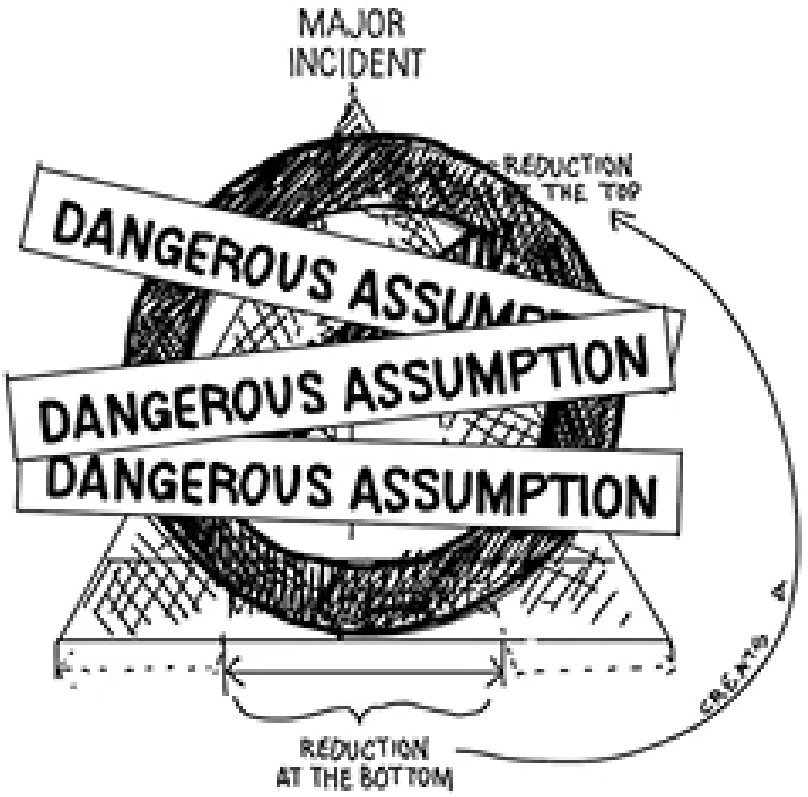
Source: Marsh & McLennan: The 100 Largest Losses 1974-2013 - Large Property Damage Losses in the Hydrocarbon Industry

The Safety Triangle of Accident Prevention

- Inherent assumption: Correlation between the bottom and the top of the pyramid
- A reduction of low consequence incidents will reduce the number of high consequence incidents

Is this a Dangerous Assumption?

THERE IS NO CORRELATION BETWEEN NUMBER OF INCIDENTS BEING ABLE TO PREDICT A MAJOR INCIDENT



Are the root causes of low and high consequence incidents very different?

Safe Operations?

Low incidents rates are not an indication of safe operations

Deep Water Horizon operator Transocean had a great safety record in the years leading up to the 2010 incident that killed 11 people

The Nature of Fatal Accidents

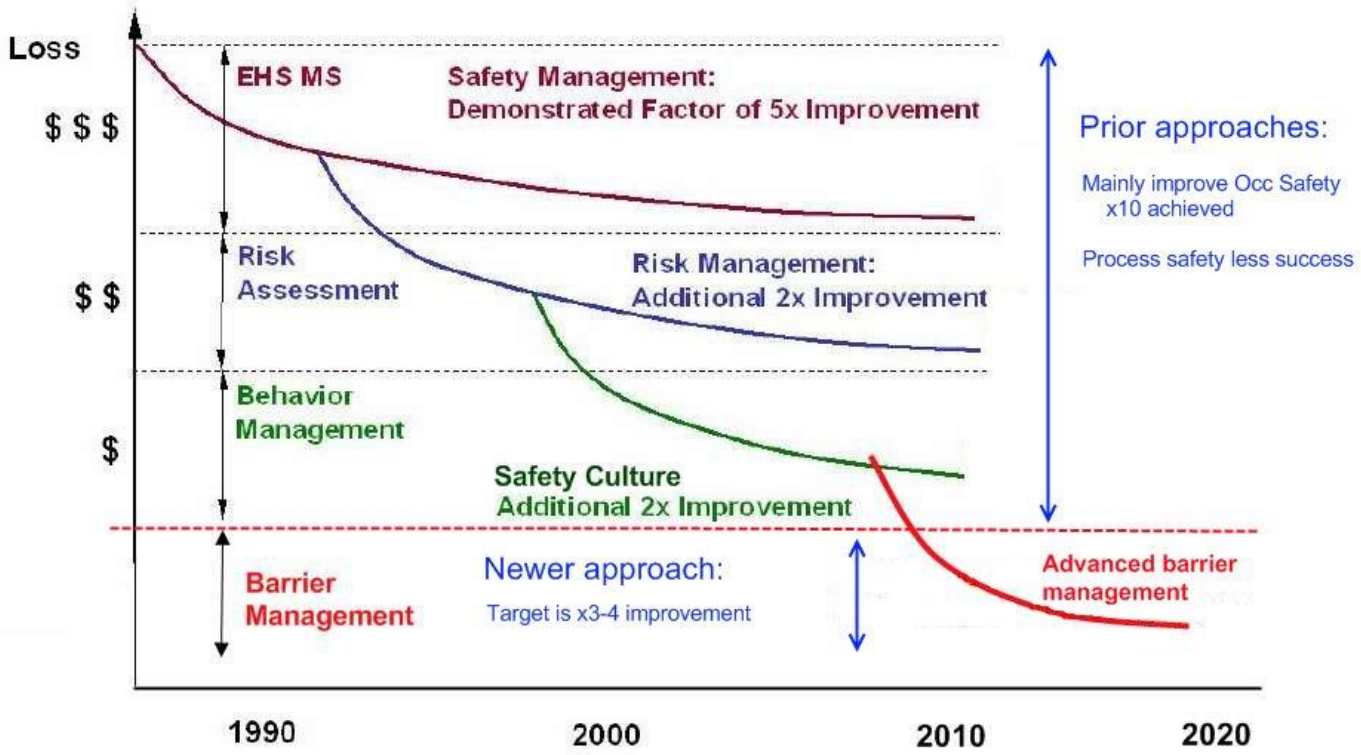
- Anomalies / outliers
  - Do not follow a pattern that can be identified, predicted & prevented
  - Cannot be prevented by reducing non-fatal incidents
- Not a failure of prevention systems
- Are a failure of preparation and recovery mechanisms
- Reduction requires a different focus to overall safety management

Reducing the Number of Fatal Incidents

- PSM KPI metrics are necessary but not sufficient to drive overall safety performance further
  - Tier 3 and 4 metrics are driving these improvements
  - Fewer incidents are occurring but severity is increasing

- Approach: Implement a tool that operators better understand and relate to
  - Based on equipment performance
  - Based on positive outcome measure (presence of controls)

Trends in Process Safety Enhancement



Existing PSM programs are insufficient to promote step-change improvements.
A new approach is needed to achieve and maintain the health of critical plant component barrier systems

Barriers Types – OGP

- Active barriers
  - Hardware
  - Human performance

- Inactive / Support System barriers
    - Management System components

Reference: “Standardization of barrier definitions”, International Association of Oil and Gas Producers (OGP), Report 544, Supplement to Report No. 415, April 2016

Hardware Barriers – OGP Definitions

Category 1: **Structural Integrity**

Category 2: **Process Containment**

Category 3: **Ignition Control**

Category 4: **Detection Systems**

Category 5: **Protection Systems – including deluge and firewater systems**

Category 6: **Shutdown Systems – including operational well isolation and drilling well control equipment**

Category 7: **Emergency Response**

Category 8: **Life-Saving Equipment – including evacuation systems.**

Reference: “Standardization of barrier definitions”, International Association of Oil and Gas Producers (OGP), Report 544, Supplement to Report No. 415, April 2016

Human Barriers

Category 1: **Operating in accordance with procedures**

- Permit to Work
- Isolation of equipment
- Overrides and inhibits of safety systems
- Shift handover, etc.

Category 2: **Surveillance, operator rounds and routine inspection**

Category 3: **Authorization of temporary and mobile equipment**

Category 4: **Acceptance of handover or restart of facilities or equipment**

Category 5: **Response to process alarm and upset conditions (e.g. outside safe envelope)**

Category 6: **Response to emergencies.**

Reference: “Standardization of barrier definitions”, International Association of Oil and Gas Producers (OGP), Report 544, Supplement to Report No. 415, April 2016

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Management System Barriers

- Permit to work (Element 8)
- Management of Change (Element 5)
- Emergency Response Procedure (Element 7)
- Competency Management (Element 3)
- Contractor Management (Element 3)
- Technical Integrity (Element 6)
- Corrosion Management (Element 6)
- Equipment Isolation (Element 8).

Reference: “Standardization of barrier definitions”, International Association of Oil and Gas Producers (OGP), Report 544, Supplement to Report No. 415, April 2016

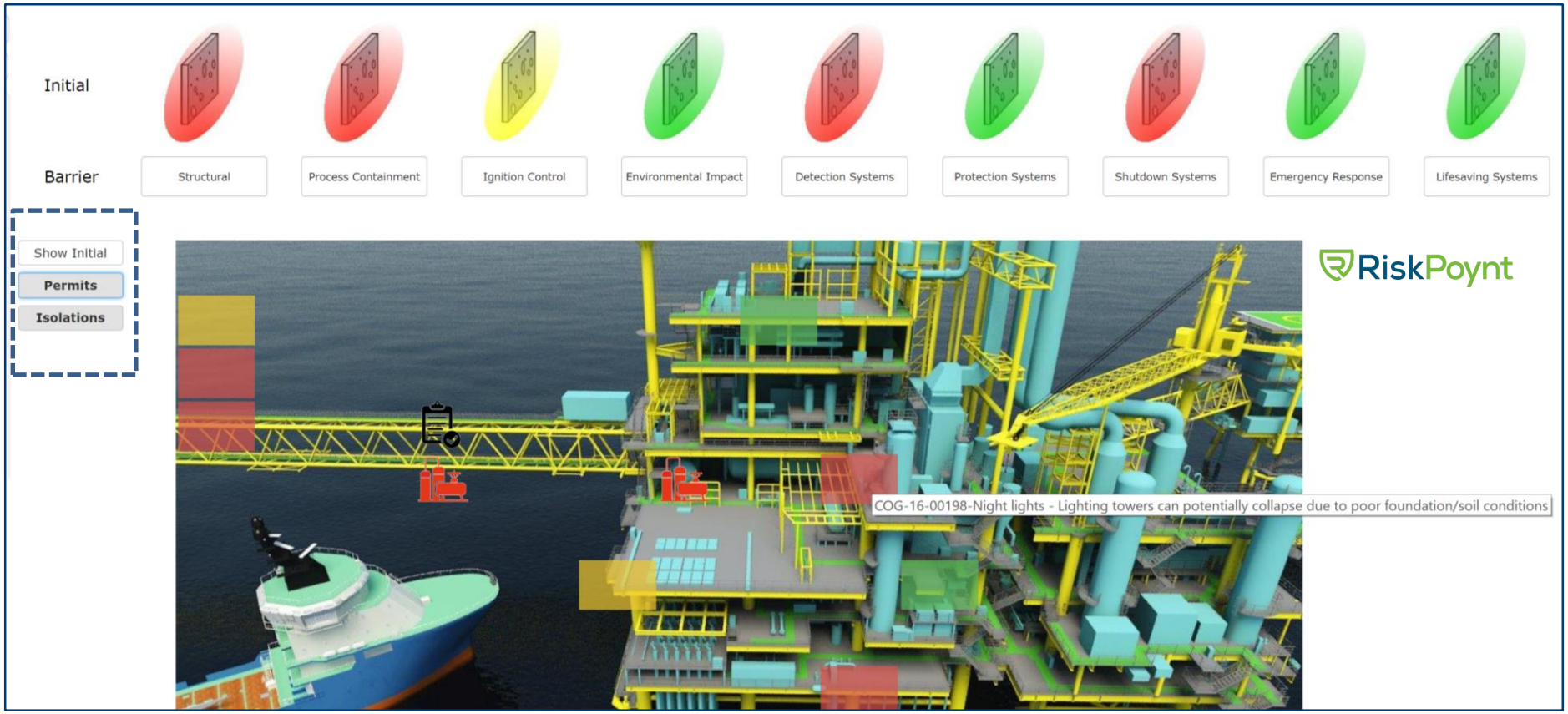
Barrier Health (BH) Assessment

- Focus on “critical” equipment / hardware barriers
- Components provide positive control of operating risks
  - Mitigation elements identified in PHA studies
    - PSVs, ESDVs, F&G D&P systems, PCSs, etc.
  - High-value components
  - Rigorous Preventative Maintenance registered in Maintenance Management System
- Assess the health of critical components in real-time assessments against performance standards

Hardware Barrier Health Models

- Real time BH models have been developed and are in place in a number of operating facilities
- Consultant advanced models in place
  - RiskPoynt
  - Petrotechnics
- Adopt OGP hardware barrier categories
- In-house development at Oxy

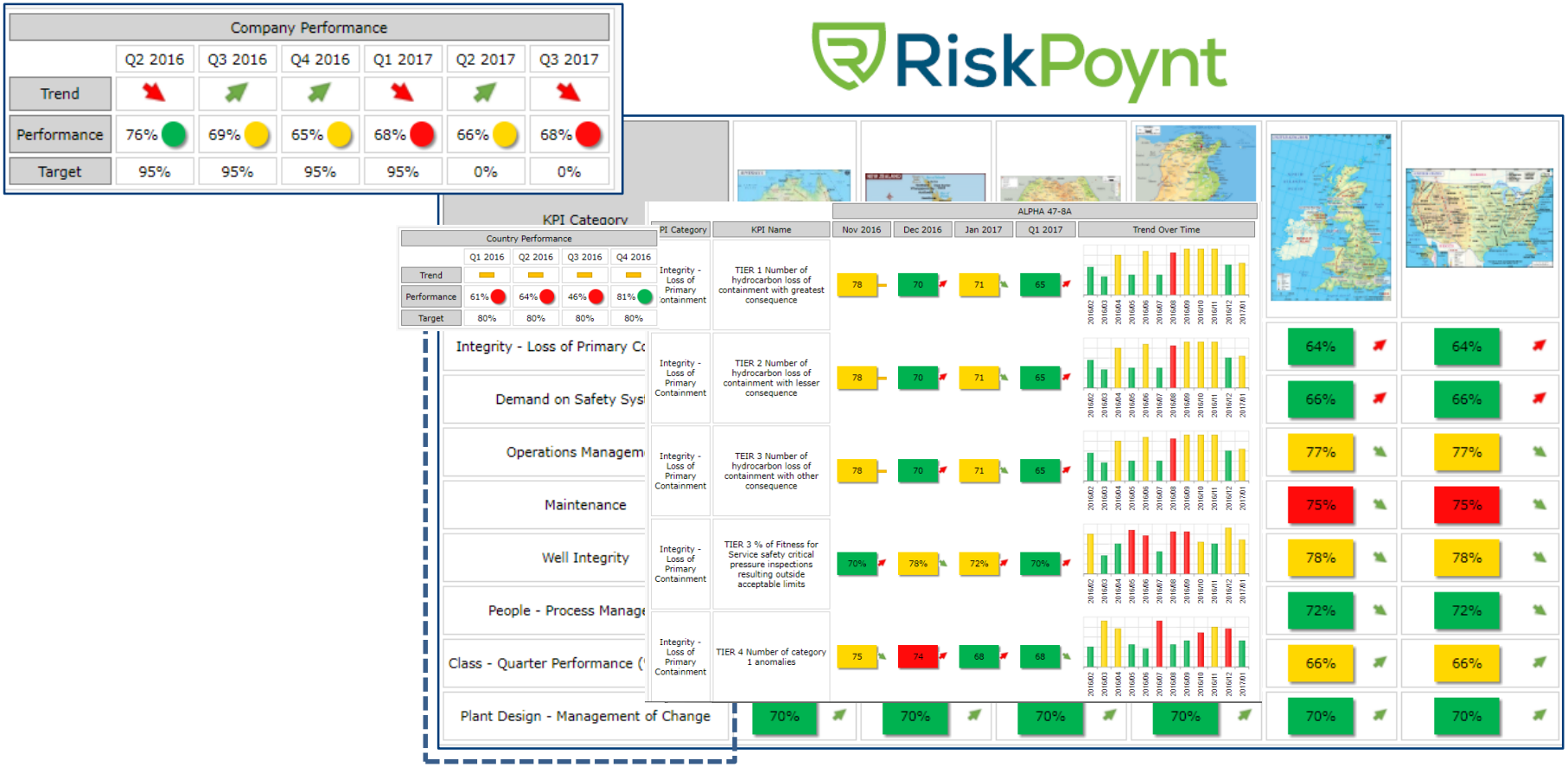
RiskPoynt - Operations Display



Simultaneous area-level view allows operations to view the barrier condition and include permit and isolation information from external permit systems.

Advantage – a clear view of operations hazards with information that is collected daily and stored for future reference.

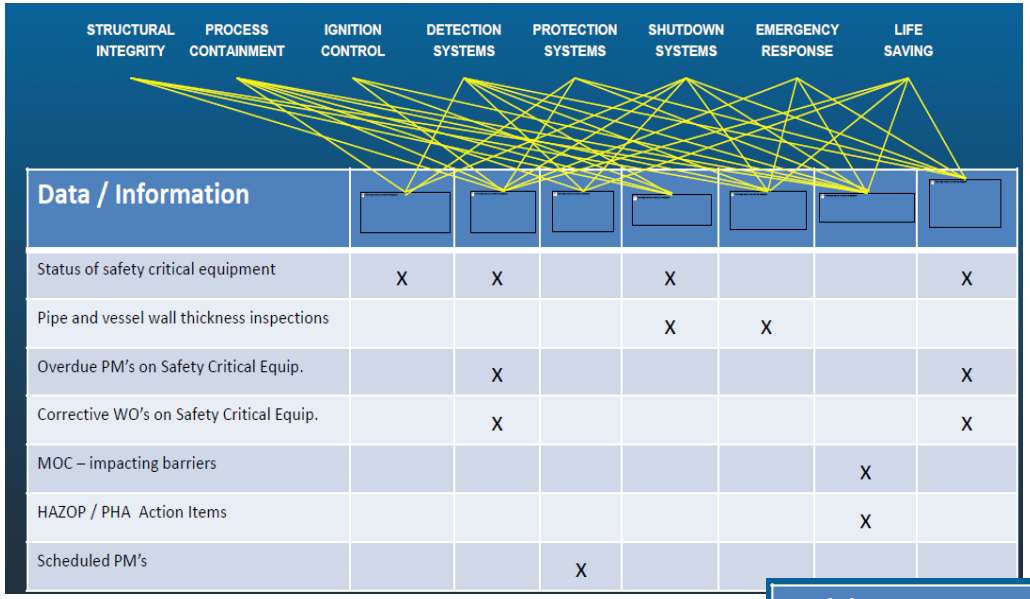
BH Model Key Performance Indicators



API standard process safety KPIs are listed and tracked based on integration from external sources. **Advantage** – reduces reporting time and administration of data collection, and provides a consistent approach to industry related process safety performance measures.

Petrotechnics Barrier Health Model
(mapping systems data to barriers)

Mapping systems data to barriers



Data / Information							
Status of safety critical equipment	X	X		X			X
Pipe and vessel wall thickness inspections				X	X		
Overdue PM's on Safety Critical Equip.		X					X
Corrective WO's on Safety Critical Equip.		X					X
MOC – impacting barriers						X	
HAZOP / PHA Action Items						X	
Scheduled PM's			X				

Mapping work activities to barriers

Activity	STRUCTURAL INTEGRITY	PROCESS CONTAINMENT	IGNITION CONTROL	DETECTION SYSTEMS	PROTECTION SYSTEMS	SHUTDOWN SYSTEMS	EMERGENCY RESPONSE	LIFE SAVING
Hot Work			X					
Breaking Containment		X						
Heavy Lifting		X						
Temporary Defeats				X	X	X	X	
Non Standard Isolations		X					X	
Excavations		X					X	
Critical Permits	X	X	X	X	X	X	X	X

Barrier Health Models

- Focus at the plant level
- Full engagement of O&M staff
- Near real time assessment of barriers health against performance standards
- Focus on managing consequences
- Allows work execution plans to be optimized
- Management access to output

Safety Differently

- Balancing prevention, execution and recovery to reduce chances of serious incidents
  - Implement a bottom-up approach
  - Engage and empower of plant staff
  - Focus on consequence (not hazard) management

- Combine “Stop work” authority with “do not start” work authority
  - Ensure that all the safeguards are in place to “fail safely”
  - Focus on identifying and maintaining controls

- Rigorous risk management focused at the work site

Conclusions

- PSM KPIs have driven improvements in non-fatal and fatal incident rates
- Number of incidents has decreased but the severity of those occurring has increased
- Barrier Health models offer the potential to further reduce number and costs of incidents
- Different focus on safety is needed to help reduce the number of fatal incidents

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Thank you for your attention

Questions?

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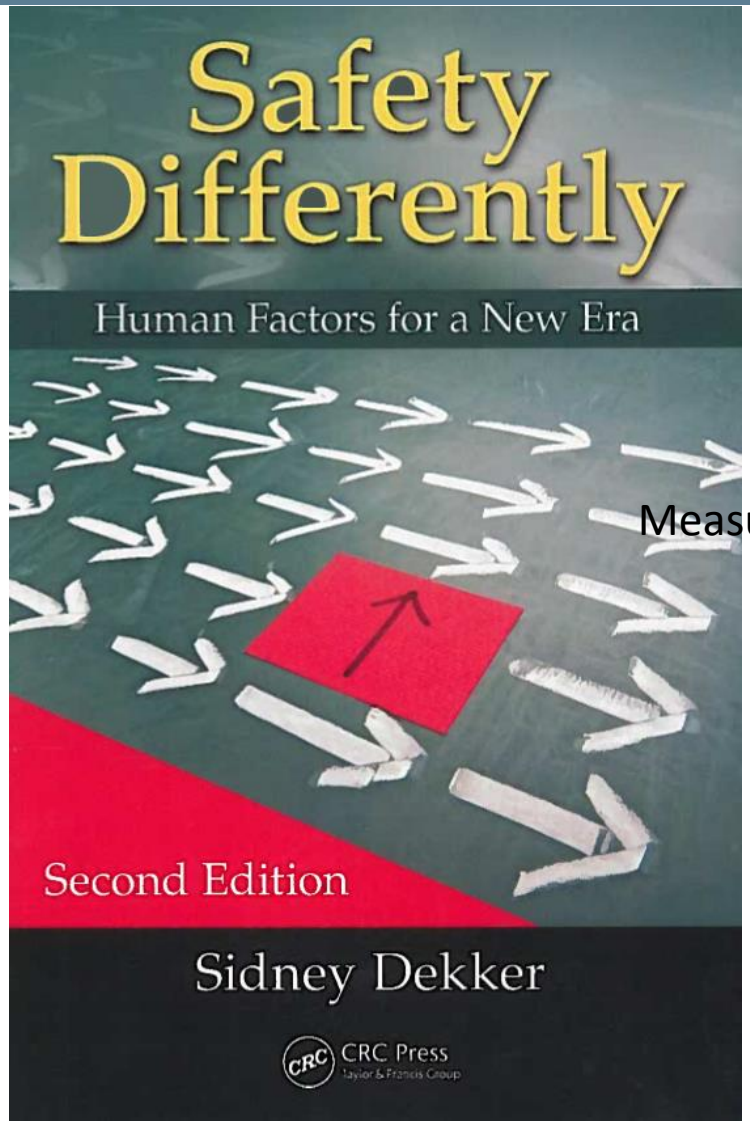
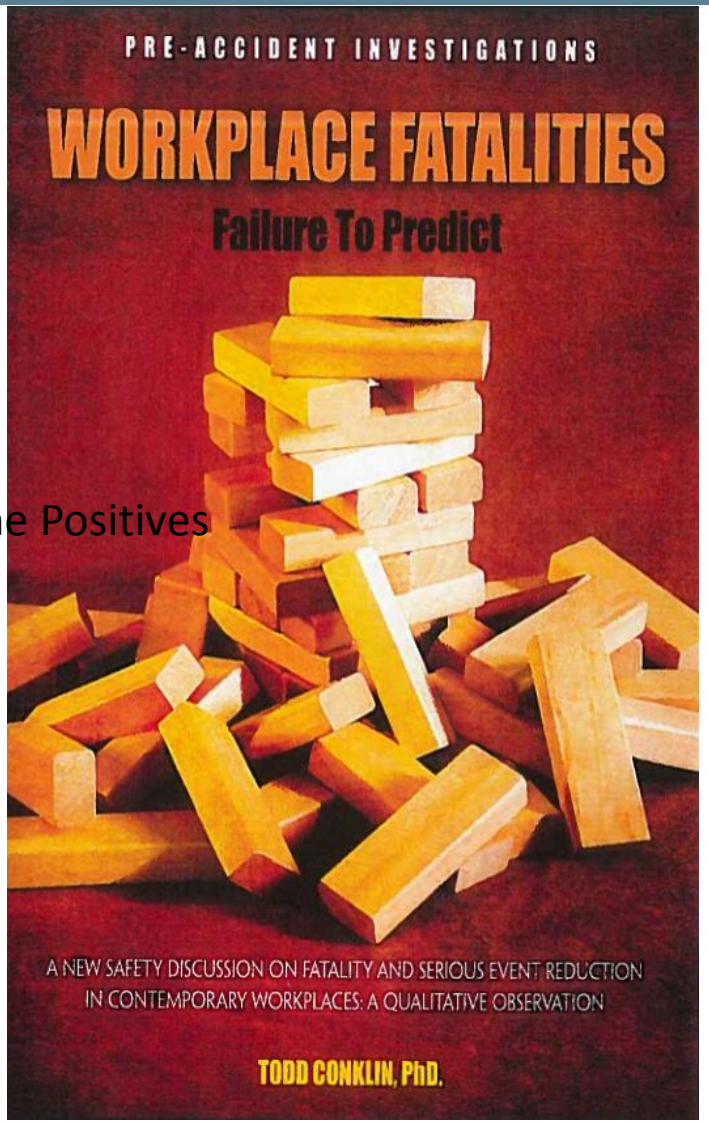
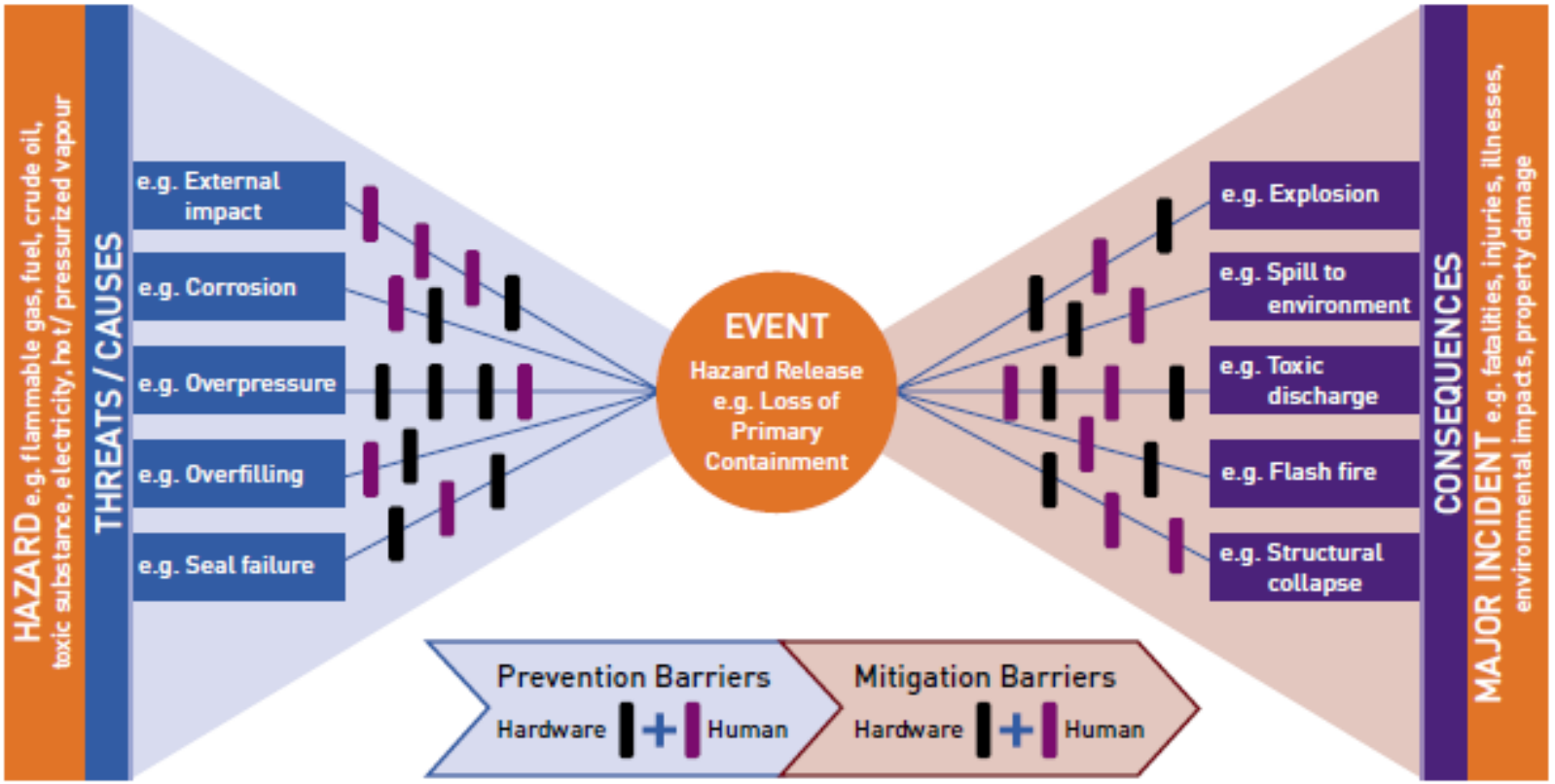


Measuring the Positives



Active Barriers



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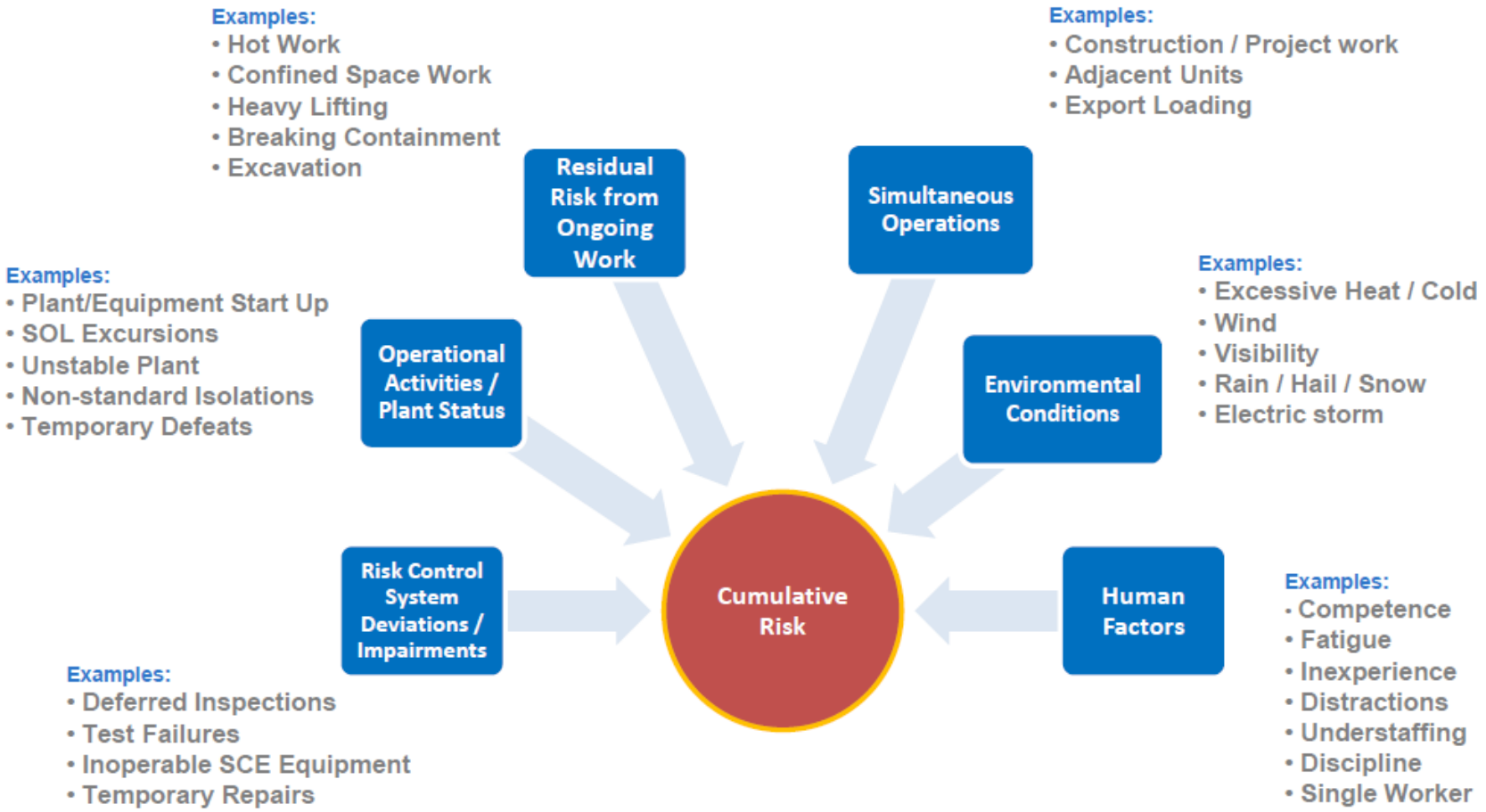
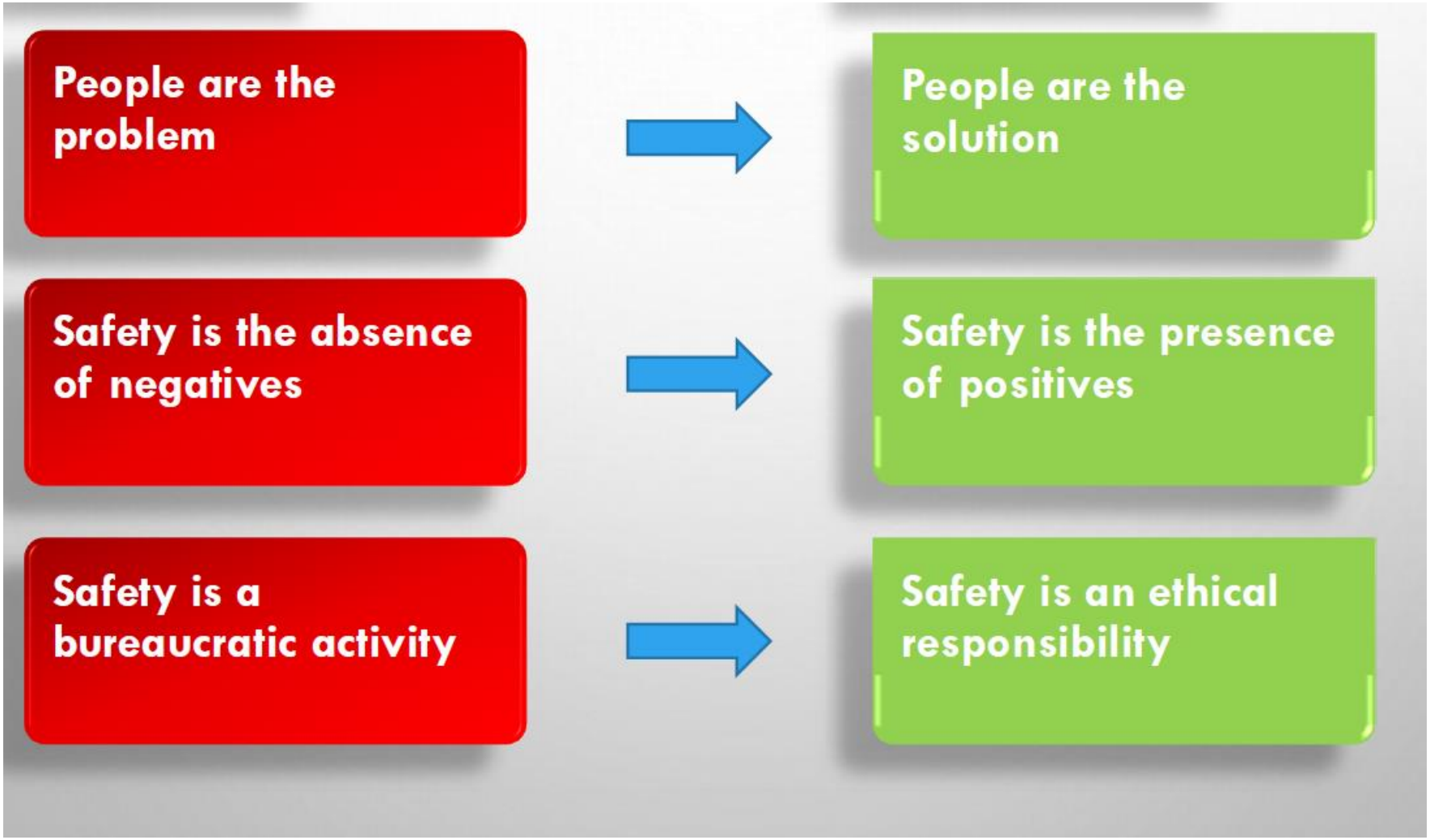
Plant Risk Sources



Reduce FAR Need to See Safety Differently



Sidney Dekker, Oil and Gas Safety in a Post-Truth World, May 2018

Safety Culture Ladder