

U.S. Chemical Safety and Hazard Investigation Board



Indicators of Process Safety through the lens of Macondo

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Indicators of Process Safety through the lens of Macondo

Macondo Incident Summary

Process Safety Management Concepts

Safety Culture

Process Safety

Indicators

Macondo Process Safety Deficiencies

Consequent Process Safety Indicators



Macondo – Deepwater Horizon



BP – managing owner.

Transocean – driller

48 miles off Louisiana.

Almost a mile deep.

From the seabed, drilled
almost another 3 miles.



Incident Summary

April 20th, 2010

11 deaths

17 serious injuries

~5 mm barrels of oil
spilled into the Gulf





Incident Description

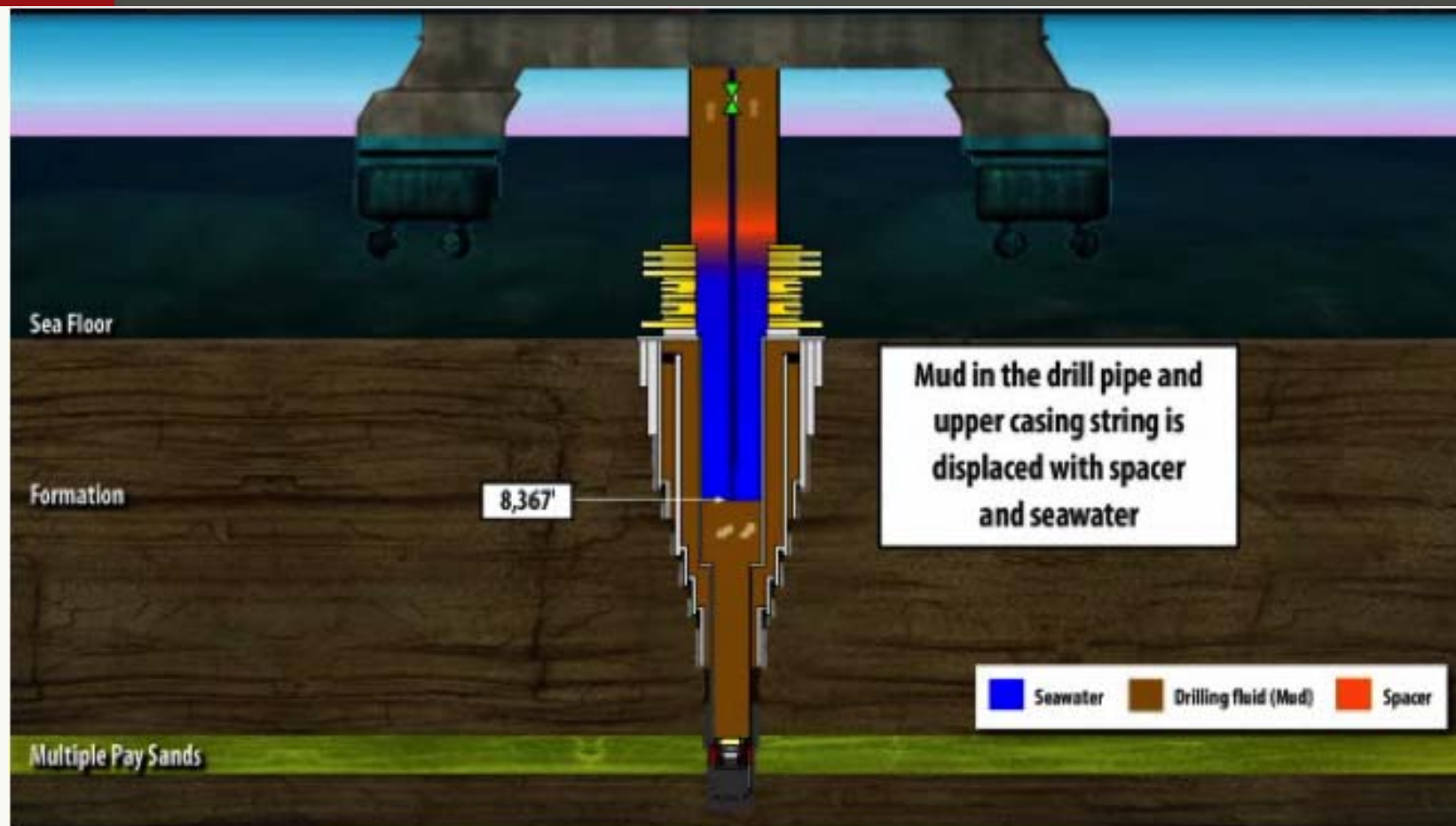


Image taken from Presidential Oil Spill Commission video:
<http://www.oilspillcommission.gov/media/the-event/index.html>



Process Safety Management Concepts





What is Safety Culture?

Is Safety Culture a feeling or attitude?

“It’s our values and beliefs.”

“It is always having Safety in your mind.”

“It’s how each worker feels about Safety.”

“It’s our way of caring for each other.”

“It’s the approach we bring to our job.”

Or can Safety Culture be more quantifiable?



What is Safety Culture?

Andrew Hopkins: Safety, Culture and Risk

Safety Culture is a practice of organizations,
not a practice of individuals.

Leaders create a culture
by what they pay attention to.



What is Safety Culture?

James Reason

A Reporting Culture: Report Errors, Near Misses, Unsafe Conditions, Inappropriate Procedures as a matter of actual practice.

A Just Culture: Blame reserved for defiance, recklessness or malice.

A Learning Culture: Processes information conscientiously and makes changes accordingly.

A Flexible Culture: Decisions made by people best equipped to make them based on urgency and expertise.



Process Safety

A Safety Discipline Distinct from Personal Safety

	Personal Safety	Process Safety
Scope	Individual injuries and fatalities	Complex technical and organizational systems
Risk	Slips, trip, falls, dropped objects, etc.	Incidents with catastrophic potential
Prevention	Procedures, training, PPE	Management systems: design, mechanical integrity, hazard evaluation, MOC
Measurement: Leading & Lagging Safety Indicators	Recordable injury rate, Days away from work, Timely refresher training, # of behavioral observations	HC releases, inspection frequency, PSM action item closure, Safety system activations
Primary Responsibility	Front line workers, supervisors	Senior executives, engineers, managers, operations personnel



Personal Safety

OSHA and Safety Performance



OSHA primarily measures safety performance using personal injury rates, including in high hazard facilities

OSHA's inspection priorities mostly based on personal injury rates

OSHA's premier awards program, VPP, primarily based on personal injury rates

VPP facilities continue to have potentially catastrophic incidents and hazards



Major Process Safety Events

Even when OSHA personal injury rates are low

Examples from CSB Investigations:



Valero McKee Refinery propane fire
Sunray, Texas - 2007



Bayer CropScience
pesticide waste tank explosion
Institute, West Virginia - 2008



Major Process Safety Events

Even when OSHA personal injury rates are low



Tesoro Refinery

Anacortes, Washington - 2010

A few weeks prior
to receiving an
NPRA safety award,
fire and explosion
resulted in
seven fatalities



Process Safety

High Consequence, Low Frequency Events

Risk is difficult to classify

Mitigation is difficult to appraise

Completely define the hazard

Situation

caused by **Initiating Event**
resulting in **Consequence**

Frequency	High	Medium	High	Critical
	Medium	Low	Medium	High
	Low	Low	Low	Medium
		Low	Medium	High
		Consequence		

Don't try to estimate consequence frequency

Estimate **Initiating Event** frequency

Then reduce frequency by **Mitigation Availability**

The Highest Consequence category is unbounded



Safety Indicators

How do you know how well you're doing?

Recall the following Safety Culture components:

Reason

A Reporting Culture: Report Errors, Near Misses, Unsafe Conditions, Inappropriate Procedures as a matter of actual practice.

A Learning Culture: Processes information conscientiously and makes changes accordingly.

Hopkins

Leaders create a culture by what they pay attention to.



Safety Indicators

Measurements of how well you're doing

Lagging Indicators – facts about past events

- Total recordable injury rate

- Safety interlock demand rate

- Loss of containment incident rate

Leading Indicators – predict future performance

- Safety Training percent complete

- Safety interlock maintenance and testing backlog

- Investigation recommendation closure backlog



Macondo – Deepwater Horizon

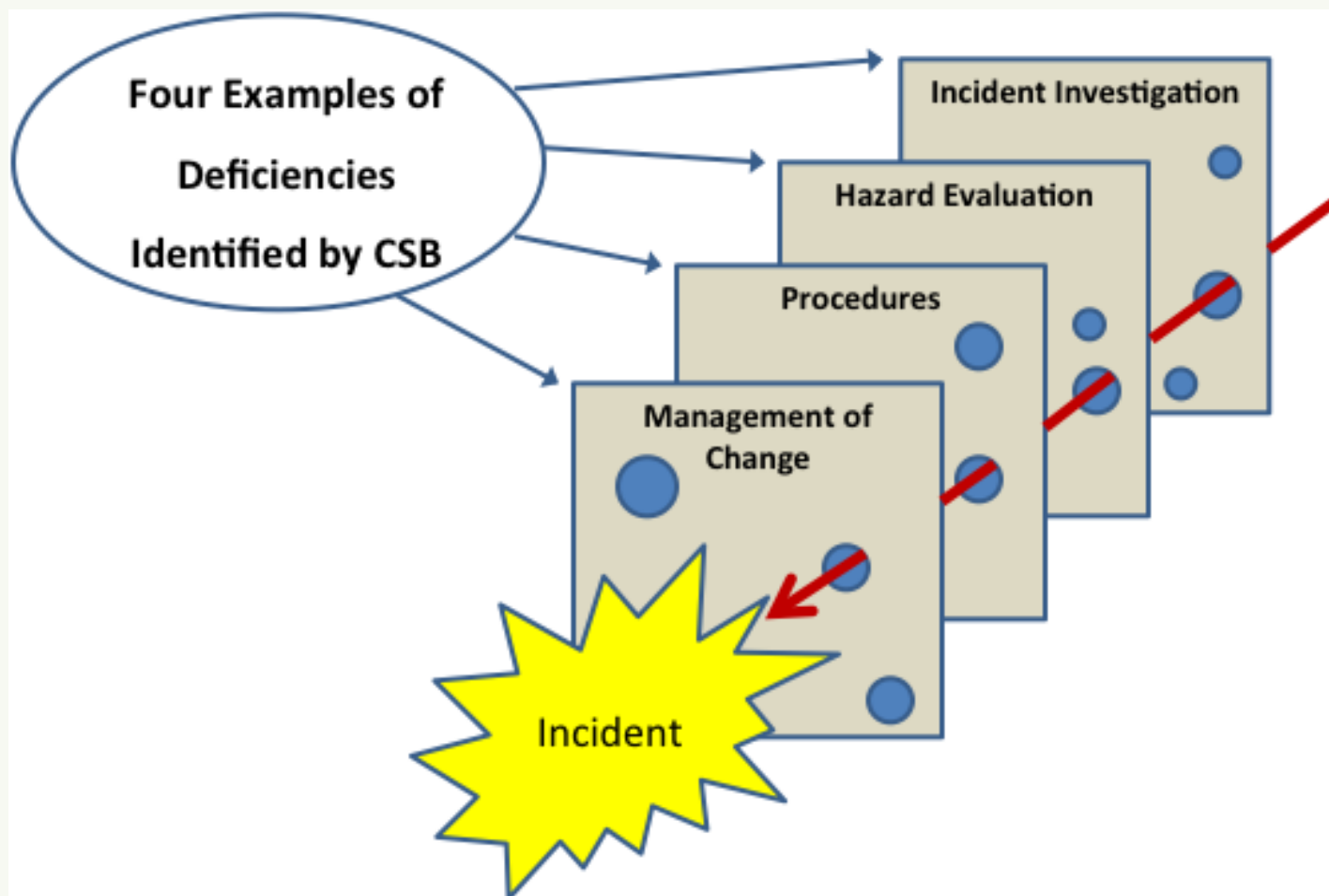


BP and Transocean

Multiple deficiencies in
Process Safety
Management Systems
that contributed to
the Macondo incident



Macondo Process Safety Deficiencies





Management of Change

Temporary Abandonment

The securing of a well so the operator can safely leave, returning later for well completion

Temporary abandonment plan changed at least 5 times in a week without formal risk assessment

Cement plan options lacked formal risk identification

Cement formulation was not fully tested.

No requirements for the Negative Pressure Test



Consequent Process Safety Indicators

Management of Change

MOC training compliance

of “missing MOC” incidents

% MOC findings closure



Procedures

Negative Pressure Test

Verification of the integrity of the cement meant to seal the hydrocarbons at bottom of the well

No written procedures

No criteria for success or safe limits defined

Confusion about how to proceed

Test was executed four times in multiple ways

Success incorrectly assumed, based on an unsubstantiated theory



Consequent Process Safety Indicators

Procedures

Safety system challenge rate

Operations training compliance

Drilling Manual deviation log



Hazard Evaluation: Assessment

Bridging Document

Document the consolidation of differences in safety management systems

Contained just 6 personal safety issues

Did not address major accident prevention, such as control methods specific to the Macondo well

TO and BP did not define key process limits and controls required for the drilling project



Hazard Evaluation: Mitigation

Manual Intervention

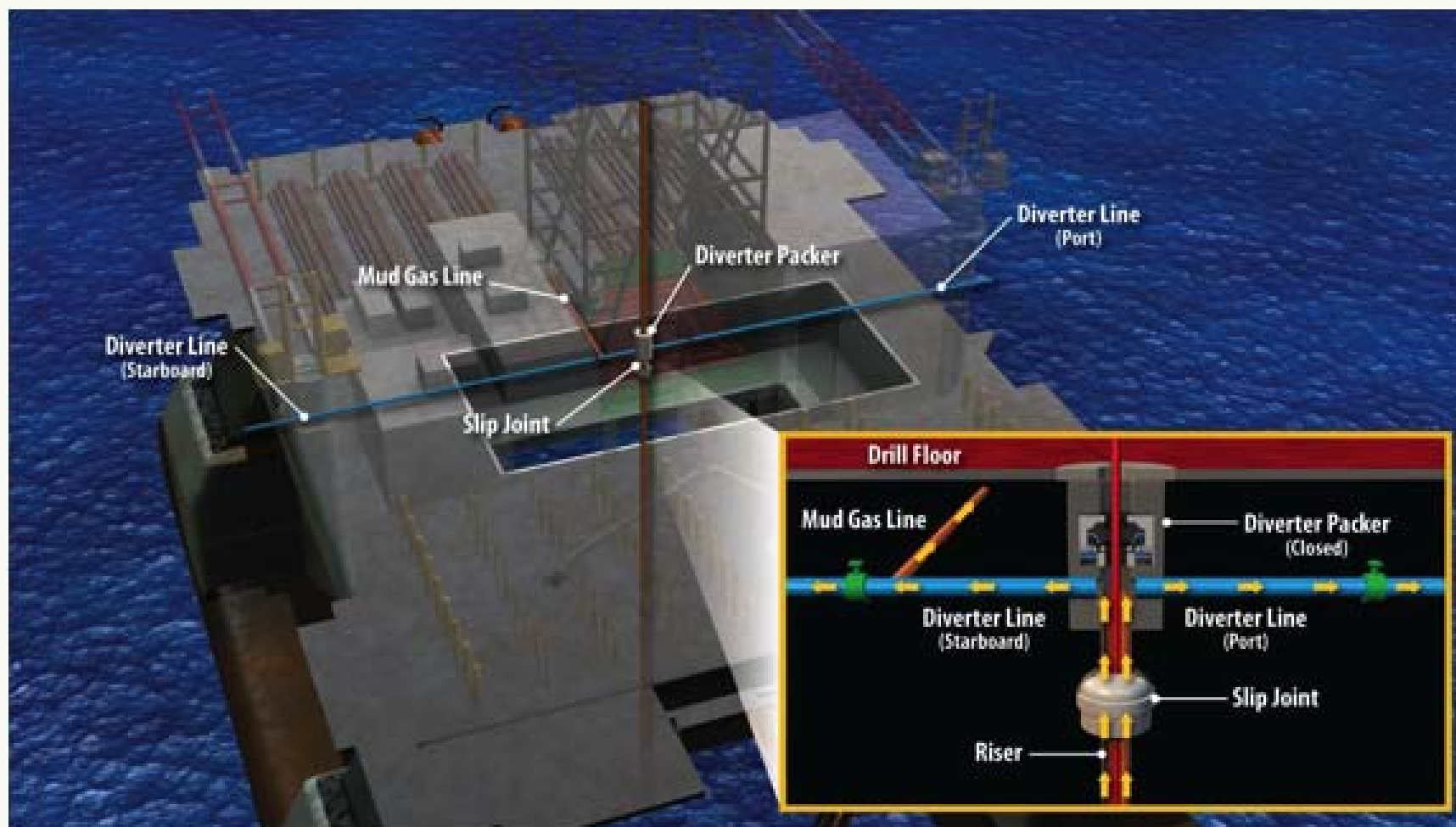


Illustration from Presidential Oil Spill Commission



Consequent Process Safety Indicators

Hazard Evaluation

Causal Factors not in PHA

% Hazard analysis finding closure



Incident Investigation

North Sea: Sedco 711, December 2009

Transocean rig; different operator

Delayed response to kick indicators

Mud and hydrocarbons reached the rig floor

Unlike Macondo

The BOP sealed the well; there was no spill

There was no ignition and no loss of life

Transocean Incident advisory not shared with Deepwater Horizon or any other rig crew outside the North Sea



Incident Investigation: Deepwater Horizon, March 8, 2010

Like Sedco 711, delayed response to kick indicators

BP investigated the incident

Geological “Tiger Team”

Recommendations targeted at well completion

Transocean discussions were verbal and informal

Evidence indicates that Transocean did not
implement any changes



Consequent Process Safety Indicators

Incident Investigation

of near miss incidents

Near miss casual factor Perado chart

investigation recommendations closures



How Do You Make Indicators Effective?

Andrew Hopkins:

Safety Culture is a practice of organizations,
not a practice of individuals.

Leaders create a culture
by what they pay attention to.



Indicators of Process Safety

Safety Culture

Measureable, Top Down,
Organizationally Pervasive

Process Safety

Not correlated with Personal Safety
High Consequence, Low Frequency

Indicators

Leading as well as Lagging
Provides feedback: How you're doing



Deepwater Horizon – April 20, 2010



11 deaths

17 serious injuries

~5 mm barrels of oil
spilled into the Gulf



Deepwater Horizon – April 20, 2010



Jason Anderson, 35

Toolpusher, Transocean



Deepwater Horizon – April 20, 2010



Aaron Dale Burkeen, 37

Crane Operator, Transocean



Deepwater Horizon – April 20, 2010



Donald Clark, 48

Assistant Driller, Transocean



Deepwater Horizon – April 20, 2010



Stephen Curtis, 40

Assistant Driller, Transocean



Deepwater Horizon – April 20, 2010



Gordon Jones, 28

Mud Engineer, M-I-SWACO



Deepwater Horizon – April 20, 2010



Roy Wyatt Kemp, 27

Derrick Hand, Transocean



Deepwater Horizon – April 20, 2010



Karl Dale Kleppinger, Jr., 38
Floor Hand, Transocean



Deepwater Horizon – April 20, 2010



Keith Blair Manuel, 56

Mud Engineer, M-I-SWACO



Deepwater Horizon – April 20, 2010



Dewey Revette, 48

Driller, Transocean



Deepwater Horizon – April 20, 2010



Shane Roshto, 22

Floor Hand, Transocean



Deepwater Horizon – April 20, 2010



Adam Weise, 24

Floor Hand, Transocean

