

Nuclear Safety in Resource Constrained Environments

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Thanks to Dan Bullen, Neysa Slater-Chandler, and Doug Minnema

Safety and Resources



“Real progress on safety can be made by understanding how people create safety, and understanding how ... safety can break down in resource limited systems.”

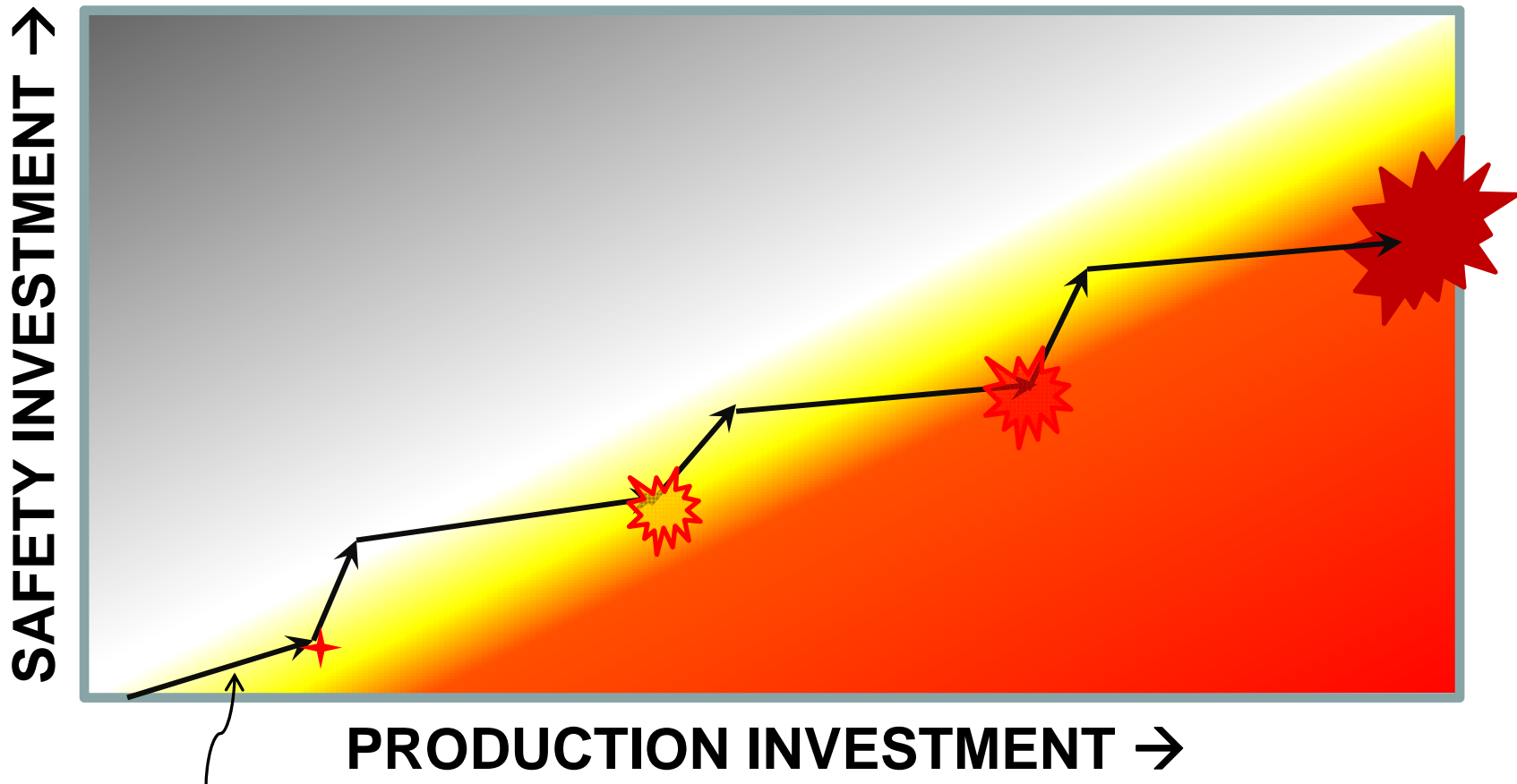
Sydney Dekker

“Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed.”

(Fourth Guiding Principle of ISM, DOE 1996)

A Modified "Reason Model"

(modified from Reason, 1997 and Starbuck, 1988)



The slope and direction of this line is driven by an organization's desire to "economically optimize" the relative cost of safety in the activity.

Winokur, P.; "Leadership and Leading Indicators;" ISM Workshop, Idaho. August 2008.

Efficiency-Thoroughness Trade-Off (ETTO)



(Inspired by Hollnagel, 2004)

Workers are always faced with multiple, changing, and often conflicting goals in the workplace. They are constantly faced with the ETTO challenge:

“How do I get the task done as thoroughly as practical but as efficiently as possible?”

Constrained resources influence such trade-offs:

“It looks okay; I don’t have time for this anyway.”

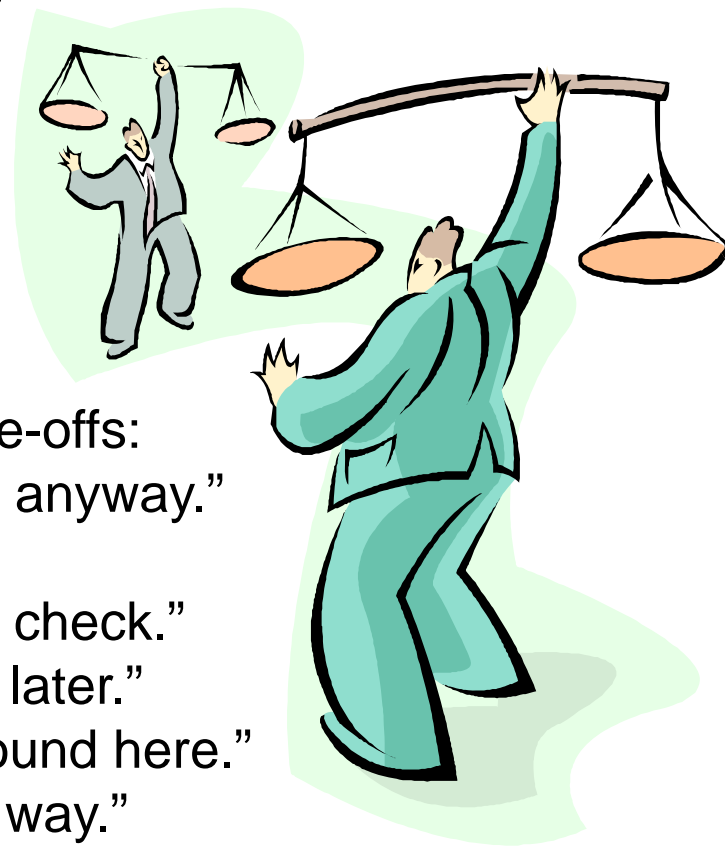
“It’s not quite right but close enough.”

“This always works, no need to double check.”

“Let’s keep moving, we’ll deal with this later.”

“Don’t worry, nothing ever happens around here.”

“I’m not sure but I think this is the right way.”



Pattern of Declining Safety



1. **Over-confidence.** A result of good past performance and unjustified self-satisfaction
2. **Complacency.** Minor events begin to occur but are not adequately assessed; oversight begins to be weakened due to self-satisfaction
3. **Denial.** More significant events begin to occur; negative oversight findings tend to be rejected as invalid; corrective actions not systematically carried out, improvement programs not completed
4. **Danger.** A few potentially severe events occur; organization consistently rejects criticisms; oversight afraid to confront management
5. **Collapse.** Problems become clear for all to see; management is overwhelmed and usually needs to be replaced

Source: IAEA, INSAG-13

Pattern of Declining Safety (cont.)



Plants with significant problems:

- Failed to recognize declining performance
- Did not effectively monitor and trend performance
- Experienced increasing human error rates
- Lacked awareness among top managers about principal deficiencies and corrective actions
- Did not use operational experience feedback effectively
- Did not conduct adequate or sufficient self-assessments
- Failed to effectively supervise and monitor subcontractors

Source: IAEA, INSAG-13

Pattern of Declining Safety (cont.)



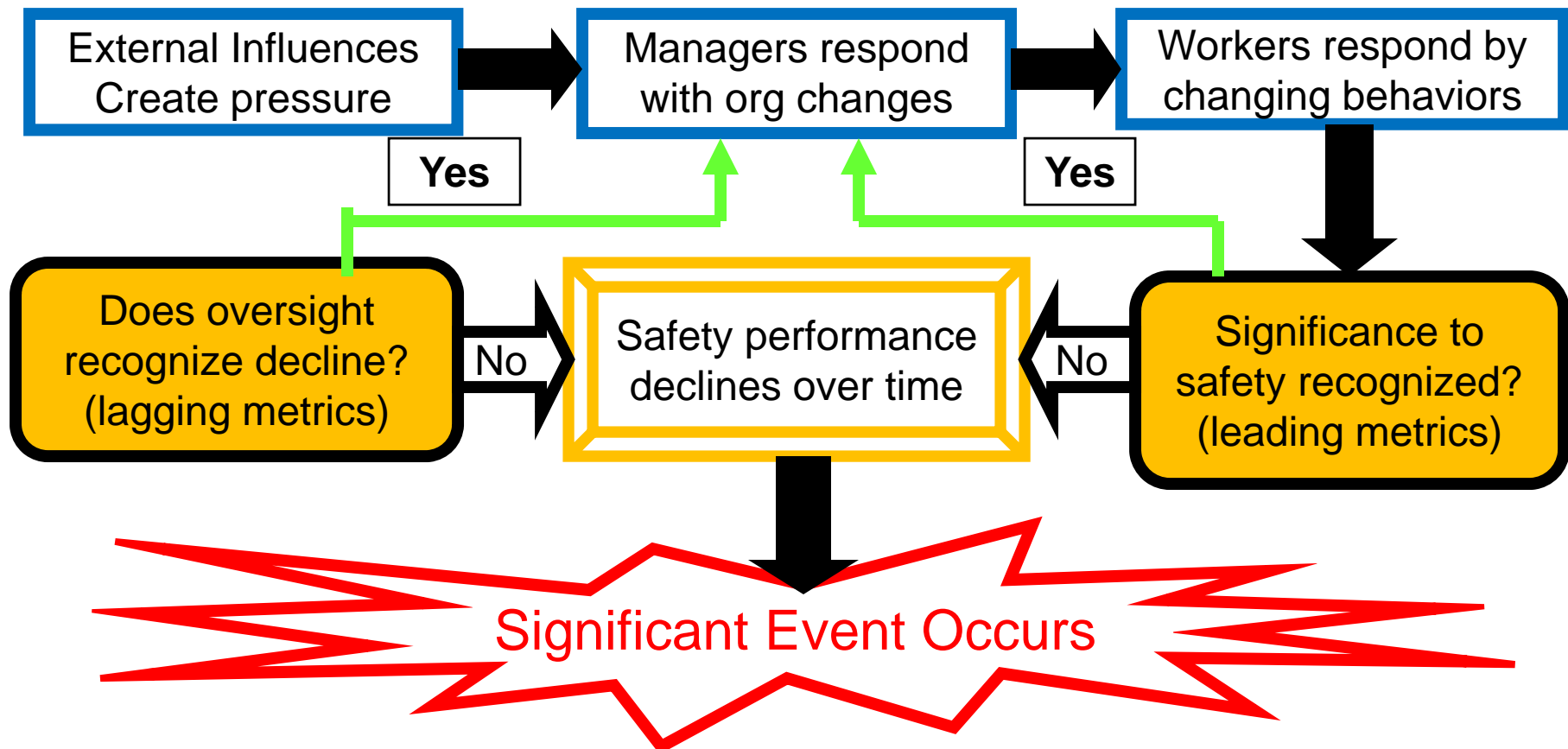
“The belief that the organization places a priority on safety is undermined by employee observations of poor facility conditions, lack of focus on meeting personal needs (work quality of life), and a sense of cronyism.”

-HSS Independent Oversight Assessment of Nuclear Safety Culture at the Pantex Plant

Organizational Accident Progression Model



Organizational accidents often follow the same progression:



Feedback and Improvement is vital for safe and productive operations.

NASA



“Twice in NASA history, the agency embarked on a slippery slope that ended in catastrophe. Each decision ...seemed correct, routine,... insignificant, and unremarkable. Yet in retrospect, the cumulative effect was stunning.”

- “When pressed for cost reduction, NASA attacked its own safety system”
- “There was no schedule margin”
- “NASA was accepting more and more risk in order to stay on schedule”
- “Lapses in leadership and communication ... made it difficult ... to raise concerns or understand decisions”
- “Neither in the O-ring erosion nor the foam debris problem did NASA’s safety system attempt to reverse the course of events”
- “NASA’s ... roles and responsibilities were transferred to contractors ...while simultaneously reducing in-house capability”
- “NASA’s safety system lacked the resources, independence, personnel, and authority”

Columbia Accident Investigation Board

BP Texas City Oil Refinery



“Cost-cutting and failure to invest in the 1990s by Amoco and then BP left the Texas City refinery vulnerable to a catastrophe. BP targeted budget cuts of 25 percent in 1999 and another 25 percent in 2005, even though much of the refinery’s infrastructure and process equipment were in disrepair. Also, operator training and staffing were downsized.”

- “The Texas City disaster was caused by organizational and safety deficiencies at all levels of the BP Corporation.”
- “Warning signs of a possible disaster were present for several years, but company officials did not intervene effectively to prevent it.”
- “Reliance on the low personal injury rate at Texas City as a safety indicator failed to provide a true picture of process safety performance and the health of the safety culture.”
- “OSHA’s capability to inspect highly hazardous facilities and to enforce process safety regulations is insufficient.”

U.S. Chemical Safety Board

Deepwater Horizon



“*Deepwater Horizon* and its owner, Transocean, had serious safety management system failures and a poor safety culture.”

“[The flag nation’s] oversight of safety issues was inadequate and created an environment in which the casualty could occur.”

U.S. Coast Guard

FIGURE 4.10: Examples of Decisions That Increased Risk At Macondo While Potentially Saving Time

Decision	Was There A Less Risky Alternative Available?	Less Time Than Alternative?	Decision-maker
Not Waiting for More Centralizers of Preferred Design	Yes	Saved Time	BP on Shore
Not Waiting for Foam Stability Test Results and/or Redesigning Slurry	Yes	Saved Time	Haliburton (and Perhaps BP) on Shore
Not Running Cement Evaluation Log	Yes	Saved Time	BP on Shore
Using Spacer Made from Combined Lost Circulation Materials to Avoid Disposal Issues	Yes	Saved Time	BP on Shore
Displacing Mud from Riser Before Setting Surface Cement Plug	Yes	Unclear	BP on Shore
Setting Surface Cement Plug 3,000 Feet Below Mud Line in Seawater	Yes	Unclear	BP on Shore (Approved by MMS)
Not Installing Additional Physical Barriers During Temporary Abandonment Procedure	Yes	Saved Time	BP on Shore
Not Performing Further Well Integrity Diagnostics in Light of Troubling and Unexplained Negative Pressure Test Results	Yes	Saved Time	BP (and Perhaps Transocean) on Rig
Bypassing Pits and Conducting Other Simultaneous Operations During Displacement	Yes	Saved Time	Transocean (and Perhaps BP) on Rig

“Decision-making processes at Macondo did not adequately ensure that personnel fully considered the risks created by time- and money-saving decisions. **Whether purposeful or not, many of the decisions ... that increased the risk of the Macondo blowout clearly saved those companies significant time (and money).**”

National Oil Spill Commission Report

Other Observations



- A 1999 NRC study on the relationship between a licensee's financial situation and its operational status concluded:
 - “A site is likely to be discussed at a [Senior Management Meeting] if its revenue factor is below 65 to 70 percent for 2 consecutive years.”
 - “Comparing the trends of .. four [financial] variables to single-unit and multiunit industry trends identifies adverse trends that often preceded decisions to discuss a plant at a [Senior Management Meeting].”
- A 2001 NRC study on safety in deregulated industries noted:
 - “The link between poor profitability and safety problems appears strongest for small and unprofitable companies,” and
 - “Companies having financial difficulties may have increased incentives to cut corners. **Therefore, financial difficulty may be an indicator of declining safety margins in the nuclear power industry.**”

What Does This Mean for DOE?



DOE faces similar stresses and is responding in similar fashion

- DOE believes it is too risk averse and its safety strategies are overly prescriptive, redundant, and burdensome
- DOE perceives that its defense-in-depth is too conservative
- DOE signals that it is willing to accept more risk; however, no specific criteria or hierarchy of management controls exist
- DOE pursues “safety and security reform” based on an “Enterprise Risk Management” model, but no guidance exists
- DOE fails to learn lessons and implement corrective actions on major design and construction projects
- DOE appears to be reinterpreting the concept of “adequate protection” and is weakening DSA’s for defense nuclear facilities

DOE's Cultural Challenges



- External Influences are strong, ever-present, and disruptive:
 - Externally-driven budget and mission constraints
 - Frequent changes in senior leadership
 - Frequent changes in missions, budgets, collateral duties
- Feedback & Improvement processes are not mature or stable:
 - Frequent changes in policies and requirements
 - Frequent shifts in safety responsibilities (Federal <-> Contractor)
 - Perceptions of safety risks vary with “distance” from activity
 - Agency unable to balance risks between dispersed activities
- Extremely diverse and dispersed workforces:
 - Wide range of motivations, no common point of influence
 - Strongly loyal to the “institutions” they work at
 - Weakly loyal to senior leaders, respect position but not person
 - Typically not loyal to corporate entities and managers
 - Workers seek stability, resist change

Aids for Success



- Create a structured means to prioritize the multiple and contradictory goals at all levels for allocating resources
- Ensure that mission and safety goals are well-defined and incentives are properly balanced
- Evaluate organizational changes for safety implications before implementing, and monitor results
- Expect a frequently changing environment, and prepare to anticipate and manage those changes

“In preparing for battle I have always found that plans are useless, but planning is indispensable”

– D. D. Eisenhower