The Role of Organizational Culture, Safety Culture, and Safety Climate

in Aviation and Aerospace Safety

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Abstract

The lack of organizational focus on safety has been a factor in several accidents in the aviation and aerospace industry, as well as other socio-technical industries such as the nuclear power industry, oil and gas drilling and refining, and other transportation modes. Although accidents in these industries may have different physical causes, the root cause of many these accidents are often related to organizational factors. Safety climate provides a snapshot of employee perceptions of an organization's safety focus, or the lack thereof, and can be a valuable predictor of safety culture. Striving for a safety culture is a continuous journey that involves nine milestones along the way.

In the early morning hours of February 1, 2003, Space Shuttle *Columbia* disintegrated over the skies of the southwestern United States while re-entering the earth's atmosphere. The lives of all seven astronauts were lost. Many will recall that leading to the accident was foam that dislodged and struck *Columbia* during launch, which damaged critical heat tiles. However, the Columbia Accident Investigation Board (CAIB), the Board appointed by President George W. Bush to investigate the accident, found that "NASA's organizational culture and structure had as much to do with this accident as the External Tank foam (CAIB, 2003, p. 177).

This was not the first fatal space shuttle accident experienced by NASA that involved organizational issues. Sixteen years earlier, Space Shuttle *Challenger* exploded shortly after launch. As in the *Columbia* accident where many will remember the technical problem - in *Challenger's* case it was O-rings that failed, allowing hot gasses to penetrate the solid rocket boosters and explode – the *Challenger* accident also involved organizational issues. "Economic strain on the organization together with safety rule violations suggested that production pressures caused managers to suppress information about O-ring hazards, knowingly violated safety regulations in order to stick to the launch schedule" (Vaughan, 1997, p. xii).

von Thaden, Wiegmann, and Shappell (2006) identified 70 organization cause factors in 60 aviation accidents they examined. Organizational factors been implicated in accidents in other socio-technical industries, as well. For example, the U.S. Chemical Safety and Hazard Investigation Board (CSB) determined that a 2005 oil refinery explosion that claimed 15 lives and injured 180 was an "organizational accident" (CSB, 2007). The International Atomic Energy Agency (IAEA) stated the Chernobyl nuclear power plant meltdown "flowed from a deficient safety culture, not only at the Chernobyl plant, but throughout the Soviet design, operating, and regulatory organizations for nuclear power" (International Atomic Energy Agency, 1992, pp. 23-

24). The National Transportation Safety Board (NTSB) classified the 2010 Pacific Gas and

Electric Company gas pipeline explosion in San Bruno, CA, as an organizational accident

(NTSB, 2011). That accident that claimed eight lives, destroyed 38 houses, damaged 80

additional houses (NTSB, 2011). NTSB (2010) also found organizational issues to be causal in

the 2009 multi-fatality subway accident in Washington, DC. The NTSB's report of that accident

stated "the NTSB has on a number of occasions recognized the lack of an organizational culture

of safety within a transportation agency as having contributed to an accident" (NTSB, 2010, p.

98).

The purpose of this paper is to examine how organizational factors can influence safety –

either in a positive or negative fashion and discuss ways that organizational influence can be

used to increase safety in the aviation and aerospace industry.

Organizational Culture, Safety Culture, and Safety Climate

The terms organizational culture, safety culture, and safety climate, are often tossed

around. However, Wiegmann, Zhang, von Thaden, Sharma, and Mitchell (2002) explain that

there are inconsistencies in understanding and defining these topics. This section discusses each

of these.

Organizational Culture

Organizational culture "refers to the values, norms, beliefs, and practices that govern how

an institution functions. At the most basic level, organizational culture defines the assumptions

that employees make as they carry out their work" (CAIB, 2003, p. 177). Schein (as cited in

Meshkati, 1997), defines organizational culture as:

A pattern of basic assumptions -- invented, discovered, or developed by a given group as

it learns to cope with its problems of external adaptation and internal integration -- that

has worked well enough to be considered valid and, therefore, to be taught to new

members as the correct way to perceive, think, and feel in relation to those problems.

(Meshkati, 1997, p. 6).

Synthesized in a simple way, organizational culture is "the way people do things." It is

"deeply rooted in history, collectively held, and sufficiently complex to resist any attempts at

direct manipulation" (Wiegmann, Zhang, von Thaden, Sharma, & Mitchell, 2002, p. 4).

Wiegmann et al. (2002) stated that organizational culture encompasses several

components, "including service culture, creativity culture, motivation culture, and safety culture"

(Wiegmann, et al., 2002, p. 5). For example, an organization such as Apple would likely highly

value its creativity culture; for Ritz-Carlton, a service culture would likely be high on their list of

priorities. For socio-technical industries where low probability - high consequence events can

transpire, such as aviation, nuclear power, and oil and gas industries, it is essential that

organizational culture be aligned with a safety focus.

In the early 1990's, then-NTSB Board Member John Lauber was one of the first to focus

on how organizational factors can influence aviation safety (Meshkati, 1997; NTSB, 1992).

Lauber argued that the cause of a commuter airliner in-flight break-up due to faulty maintenance

should be "the failure of Continental Express management to establish a corporate culture which

encouraged and enforced adherence to approved maintenance and quality assurance procedures"

(Meshkati, 1997, p. 6; NTSB, 1992, p. 54).

Safety Culture

Wiegmann et al. (2002) stated that "conceptualizing and definitions of safety culture have

been derived mainly from the more general notion of organizational culture" (Wiegmann et al.,

2002, p. 3). The term "safety culture" was first used in the IAEA's report of the Chernobyl

nuclear accident (International Atomic Energy Agency, 1992; Meshkati, 1997). Since then, the

term has received widespread use.

> Safety culture is the enduring value and priority placed on worker and public safety by
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> everyone in every group at every level of an organization. It refers to the extent to which
>
> individuals and groups will commit to personal responsibility for safety, act to preserve,
>
> enhance and communicate safety concerns, strive to actively learn, adapt and modify
>
> (both individual and organizational) behavior based on lessons learned from mistakes,
>
> and be rewarded in a manner consistent with these values. (Wiegmann et al., 2002, p. 8)
>
> A more simplistic viewpoint of safety culture is when employees are "doing the right

thing, even when no one is watching" (Sumwalt, 2007, p. 37).

> Meshkati (1999) stated the two main components of safety culture are "the necessary

framework within an organization and the attitude of staff at all different levels in responding to

and benefitting from the framework (Meshkati, 1999, p. 61).

Safety Climate

The term safety climate was first used in 1980 by Dov Zohar and over the years, the

terms safety culture and safety climate have been wrongfully used as interchangeable terms

(Wiegmann et al., 2002). Wiegmann et al. (2002) examined a dozen definitions of safety climate

- those used by academia, practitioners, and government entities. Although there were variances

between the definitions, Wiegmann et al. (2002) looked for commonalities and crafted the

following definition:

> Safety climate is the temporal state measure [in other words, a "snapshot"] of safety
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> culture, subject to commonalities among individual perceptions of the organization. It is
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> therefore situationally based, refers to the perceived state of safety at a particular place at

a particular time, is relatively unstable, and subject to change depending on the features of the current environment or prevailing conditions. (Wiegmann et al., 2002, p. 10)

As denoted by Wiegmann et al.'s definition, safety climate "is a snapshot of the state of safety providing an indicator of the underlying safety culture of a work group, plant or organization" (Flin, Mearns, O'Connor, & Bryden, 2000, p. 178).

While safety culture describes the enduring values of an organization, safety climate describes employee *perceptions* about what is important in the organization (Zohar, 2010). Workers develop these perceptions from what gets rewarded and supported in the organization (Zohar, 2010).

Culture, such as organizational culture or safety culture, requires relatively long periods of time to be established. As such, it cannot be changed or turned-around quickly. Climate, on the other hand, can be changed relatively quickly through changes in leadership priorities. If, for example, management states that safety is their highest priority, but then puts safety aside when production needs intensify, employees develop the perception that production is more important to the organization than safety.

As an example, in analyzing the Washington, DC subway accident, NTSB (2010) found that track workers perceived that moving trains on time was the priority of the railway system. Although a track wayside signal was not working properly, the supervisor of the track construction, installation, and testing told investigators, "the mentality now is move trains" (NTSB, 2010, p. 101). In explaining that behavior, NTSB stated: "The safety behaviors and attitudes of individuals are influenced by their perceptions and expectations about safety in their work environment, and they pattern their safety behaviors to meet demonstrated priorities of organizational leaders, regardless of stated policies" (NTSB, 2010, p. 101).

Because employee perceptions are so important in determining their behaviors, Zohar stated that "safety climate is a robust leading indicator or predictor of safety outcomes" (Zohar, 2010, p. 1521). Measuring safety climate is an effective way of predictive safety condition monitoring, "which may reduce the need to wait for the system to fail in order to identify weaknesses and to take remedial actions" (Flin et al., 2000, p. 178).

Given the premise that safety climate is a valuable predictor of safety culture, how is safety climate evaluated? Flin, Mearns, O'Connor, & Bryden (2000) studied 18 published reports of safety climate surveys. As to be expected, there was wide variation in the items evaluated in these surveys, but Flin et al. (2000) found the most common themes assessed in these 18 surveys were related to employee perceptions of how well management and supervisors attend to safety; safety systems, which encompassed how the employees perceived the organization's safety management; risk, including worker attitudes towards risk and safety; work pressures, such as the impact of cost reduction measures and balancing production against safety; and competence of the workforce.

Can Accidents be Caused by Organizations?

In January 1990, an Eastern Airlines Boeing 727 collided with a Beech King Air on a runway at Atlanta Hartsfield International Airport. The NTSB (1991) determined the probable cause was, in part, "the failure of the Federal Aviation Administration to provide for air traffic control procedures that adequately take into consideration human factors considerations" (p. 42), such as those human factors considerations that led to an air traffic controller's failure to detect and avoid the conflict between the two aircraft. This probable cause statement was adopted by the majority of the NTSB Board Members. In essence, the Board's majority was saying the accident's causation extended beyond simply the error of a front line employee (the air traffic

controller), but instead, had deeper organizational roots. The then-NTSB chairman, however, felt differently and filed a dissenting statement, saying he disagreed that the FAA should be cited in the probable cause. "I also disagree with the notion that agencies cause accidents. Failures of people and failures of equipment cause accidents" (NTSB, 1990, p. 44).

As in the dissenting statement by the then-NTSB chairman, conventional thinking was to identify the errors of those closest to the accident and call it "cause." This line of thinking was (and, unfortunately, in some cases, still is) driven by biases, such as hindsight bias, confirmation bias, and attribution error (Reiman & Rollenhagen, 2011). The problem with attributing error to the individual who provoked the accident is that oftentimes the investigation stops there, in a "We've found the culprit, now our job is done" sort of attitude. But, that attitude is flawed because the systemic problems that snared that individual, like the FAA's failure to develop more error-tolerant air traffic control procedures, as cited by the NTSB's majority in the above accident, remain hidden – thus uncorrected - in the system.

"The new way of thinking is that human error is a symptom of trouble deeper in the system" (NTSB, 2010, p. 99).

Reason (1997) stated there are two types of accidents: individual accidents and organizational accidents. Individual accidents occur when an individual commits an error independent of organizational influences. An example of this type of accident would be an employee who follows company prescribed procedures, but loses his balance and falls off a ladder (Sumwalt, 2012). The damage or injury is confined to this one person, and although the implications may be grim for this person and family, there are likely no widespread implications for the organization or environment.

Organizational accident, on the other hand, "have multiple causes involving many people operating at different levels of their respective companies…[and] can have devastating effects on uninvolved populations, assets and the environment" (Reason, 1997, p. 1). "Organizational accidents arise from the concatenation of several contributing factors originating at many levels of the system" (Reason, 2004, p. ii29).

The April 2010 Deepwater Horizon accident provides a good example of an organizational accident. This disaster created the largest oil spill in U.S. history. In addition to claiming 11 lives, the tragedy resulted in the release of over 200 million gallons of oil into the Gulf of Mexico. The Presidential Commission established to investigate the accident, the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (2011), determined that the accident was not the result of "rogue industry or government officials" (p.122), but instead, was "rooted in systemic failures by industry management … and also by failures of government to provide effective regulatory oversight of offshore drilling" (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011, p.122). As shown, this accident was systemic in nature, involving many layers of the system, and had widespread consequences. In its purest form, this was an organizational accident.

Reason (1997) stated that accidents are often initiated by an active failure of a front line employee, such as the air traffic controller in the above accident example, who may not have precisely followed procedures. However, oftentimes there are deep-seated reasons why front line employees don't follow procedures, such an organizational culture that does not promote following procedures, improper training, or a focus on production or throughput of air traffic instead of a genuine safety focus. Reason (1997) called factors such as these "latent factors" because they oftentimes remain dormant in the system for long periods of time. When active

failures and latent conditions combine, and the system defenses are breached, the result is an accident (Reason, 1997).

So, to the question of, "can organizations cause accidents?" Hopkins (2009) provides the following insight:

Train crashes, space shuttle accidents and oil refinery fires all have very different physical causes. But, at the organizational and cultural levels, the root causes are surprisingly, and distressingly, similar. Mindless cost cutting, incentive schemes that divert attention from safe operations, failure to consider the safety implications of organisational [*sic*] changes – all these are regularly found to have contributed to major accidents. (Hopkins, 2009, p. xi)

Given that organizations can play a role in causing accidents, they can also play a role in preventing them, as well. The next section discusses how creating a safety positive culture can be good insurance for accident prevention.

The Journey to Safety Culture

Reason (2000) made the point that safety culture is not something an organization either has or it doesn't. The pathway to safety culture is a journey, not a destination, and "is a product of continual striving" (Reason, 2000, p. 4).

To get an idea of what the milestones along the journey to safety culture may look like, the author conducted a literature review and found the following attributes to be indicators of an organization with a healthy focus on safety.

Top-Level Management Commitment

Top management support and commitment is probably the single most important attribute of ensuring a safety culture. Schein (as cited in Hopkins, 2005), noted that leaders influence

cultures by "what they systematically pay attention to. This can mean anything from what they notice and comment on to what they measure, control, reward and in other ways systemically deal with" (Hopkins, 2005, p. 8). If leaders say safety is their top priority, but then turn a blind eye on safety when economic or production pressures arise, the employees will quickly understand safety is not the most important value.

> Through its attitudes and actions, management influences the attitudes and actions of all others within a company: Management defines the safety culture of an organization. This safety culture extends all the way to the maintenance shop floor, to the ramp, to the cabin and to the cockpit. (Flight Safety Foundation Icarus Committee, 1999, p. 9)

> Boeing looked at the attributes of a dozen worldwide airlines with strong safety records.

They found that each of these airlines had a strong management commitment and focus on safety that "permeate[d] the entire operation" (Lautman & Gallimore, 1987, p. 2). Wiegmann et al. (2002) stated:

> An organization's upper-level management has long been recognized as playing a critical role in promoting organizational safety culture…. [It] is therefore reflected in the ability of its upper-level management to demonstrate an enduring, positive attitude toward safety, even in times of fiscal austerity, and to actively promote safety in a constant manner across all levels within an organization. When upper-level management is committed to safety, it provides adequate resources and consistently supports the development and implementation of safety activities. (Wiegmann, et al., 2002, p. 11)

Personal Accountability and Empowerment

With this attribute, employees recognize their role in safety promotion and actions, and hold themselves and others accountable (National Archives and Records Administration, 2011;

Wiegmann et al., 2002). "Within the context of safety culture, employee empowerment means that employees have a substantial voice in safety decisions, [and] have the leverage to initiate and achieve safety improvements" (Wiegmann et al., 2002, p. 12). Westrum (2004) noted that one of the reasons for the good safety record of Southwest Airlines, for example, "is a suggestion and reporting system that is strongly supported by a company culture with high empowerment" (Westrum, 2004, p. ii24).

Problem Identification and Resolution

Strong safety-oriented organizations remain keenly aware of potential problems. They realize safety is a journey and not a destination. In the words of Hopkins (2005), they maintain a "collective mindfulness" for potential problems. "Mindful organizations understand that long periods of success breed complacency, and they are therefore wary of success" (Hopkins, 2005, p. 14). When issues are identified that can potentially affect safety, they are "fully evaluated, and promptly addressed and corrected commencement with their significance" (National Archives and Records Administration, 2011, p. 34778). The NTSB stated the following in the Washington, DC subway accident report:

> The best way to assess the health of safety-critical systems is through active monitoring and evaluation of operations and equipment in search of "leading indicators" of system problems. Examples of leading safety indicators include recorded operational data, the results of inspections, safety audits, and employee reports of safety concerns and near-miss events. (NTSB, 2010, p. 103)

Risk Awareness and Work Planning

Safety conscious organizations are constantly seeking-out hazards. Once hazards are found, the risks associated with them are assessed. For those risks that are unacceptable, the

organization places controls on them to reduce the risk to as low as reasonably practical. "The process of planning and controlling work activities is implemented so that safety is maintained" (National Archives and Records Administration, 2011, p. 34778).

Promoting Open Reporting

In order to be aware of problems, organizations need to foster a culture of open reporting of safety-related information. "One of the foundations of a true safety culture is that it is a reporting culture" (Eff, as cited in Wiegmann, et al., 2002, p. 12). To ensure open reporting, employees need assurances that the information provided will be treated confidentially and will be taken seriously (Reason, 1997; Sumwalt, 2012; Wiegmann, et al., 2002). Also, the employee must be confident they will not be ridiculed, or retaliated or discriminated against, for providing such information (National Archives and Records Administration, 2011; Sumwalt, 2012; Wiegmann, et al., 2002). Some organizations have a non-reprisal policy indicating that information provided to the organization will not be used in a punitive fashion. One such policy, as cited by Sumwalt (2012), stated the company "will not use this reporting system to initiate disciplinary proceedings against an employee who discloses in good faith a hazard or occurrence involving safety which is the result of conduct which is inadvertent, unintentional or not deliberate" (Sumwalt, 2012, slide 28). Reason (1997) noted that a key element of ensuring the reporting culture perseveres is to provide feedback to the reporter. "Apart from a lack (or loss) of trust, few things will stifle incident reporting more than the perceived absence of any useful outcome" (Reason, 1997, p. 200).

A Culture of Continuous Learning

Organizations with a healthy safety focus are constantly learning. They learn from their mistakes and those of others. Information regarding prior incidents and accidents is shared openly and not suppressed. "Opportunities to learn about ways to ensure safety are sought out and implemented" (National Archives and Records Administration, 2011, p. 34778).

Using the Proper Metrics

Several accident investigations have highlighted the criticality of using proper metrics to assess safety (CSB, 2007; NTSB, 2010; NTSB, 2011.) The NTSB (2010) found that the Washington DC subway organization was carefully monitoring occupational safety (such as slips, trips, and falls), escalator injuries, and crime in subway stations. These metrics, while important in some sense, did nothing to predict and anticipate anomalies in the rail signaling system that led the collision between two trains. Similarly, the CSB found that in the 2005 BP oil refinery explosion at Texas City, Texas, BP was under the false assumption that because their industrial safety record was good, that meant their oil refining processes were safe, as well. "A very low personal injury rate at Texas City gave BP a misleading indicator of process safety performance. [While] most attention was focused on the [personal] injury rate, the overall safety culture and process safety management program had serious deficiencies" (CSB, 2007, p. 19).

Just Culture

Reason (1997) stated that having a just culture is an essential component of a safety culture. He describes just culture as "an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety-related information – but in which they are also clear about where the line must be drawn between acceptable and unacceptable behavior" (Reason, 1997, p. 195).

Although sometimes confused with a "no-blame culture," a just culture is not a "get out of jail free card" where all errors and unsafe acts are overlooked (Reason, 1997). In a just culture, "honest mistakes" – those by employees who commit an error, despite trying to do the right thing - are typically not punished. On the other hand, appropriate disciplinary action must be applied to those employees who are reckless or are involved intentional misconduct (Reason, 1997).

Questioning Attitude

The NRC lists this attribute as an essential component of safety culture. NRC defined it as one where "individuals avoid complacency and continuously challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action" (National Archives and Records Administration, 2011, p. 34778). An organization "fostering strong safety culture would encourage employees to cultivate a questioning attitude and a rigorous and prudent approach to all aspects of their jobs and to set up necessary open communication between line workers and middle and upper management" (National Academy of Engineering and National Research Council, 2011, p,. 92).

This approach is similar to crew resource management, where everyone is encouraged to speak-up with safety concerns.

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Summary

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History has revealed that organizations can influence safety, and the influence can be positive, or it can be negative. Numerous high consequence, high profile accidents have occurred over the years and vividly illustrate this point. Because organizations can cause accidents, the converse of this is also true – organizations can prevent accidents. To ensure a persevering culture – one that will last over time – top management must make a priority on following

appropriate milestones on the journey towards safety culture. Reason (2000) stated that because

people come and go over time, "only a safe culture can provide any degree of lasting protection"

(Reason, 2000, p. 3).

And, James Reason, the father of examining and explaining organizational accidents,

leaves us with a few ominous words to keep us on our toes:

> If an organization is convinced that it has achieved a safe culture, it almost certainly has
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> not. Safety culture, like the state of grace, is a product of continual striving. There are no
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> final victories in the struggle for safety. (Reason, 2000, p. 4)

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References

CAIB. 2003. *Columbia Accident Investigation Board Report* (Vol. 1). Washington, DC: Author.

Retrieved from http://caib.nasa.gov/news/report/pdf/vol1/full/caib_report_volume1.pdf

CSB. (2007). *Investigation report: Refinery explosion and fire. BP, Texas City, TX.* (CSB Report

No. 2005-04-I-TX). Washington, DC: Author. Retrieved from

http://www.csb.gov/assets/document/CSBFinalReportBP.pdf

Flight Safety Foundation Icarus Committee. (1999, May). The dollars and sense of risk

management and airline safety. *Flight Safety Digest*. *18*(5), 9-14. Retrieved from

http://flightsafety.org/fsd/fsd_may99.pdf

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: identifying

the common features. *Safety Science*. *34*(1-3), 177-192.

National Archives and Records Administration. (2011, June 14). Nuclear Regulatory

Commission. Final safety culture policy statement. *Federal Register. (76)*114, 34773-

34778. Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2011-06-14/pdf/2011-

14656.pdf

Hopkins, A. (2005). *Safety, culture and risk: the organizational causes of disasters.* Sydney:

CCH Australia.

Hopkins, A. (2009). Preface. In A. Hopkins (Ed). *Learning from high reliability organizations*

(p. xi). Sydney: CCH Australia.

International Atomic Energy Agency. (1992). *The Chernobyl accident: updating of INSAG-1.* A

report by the International Nuclear Safety Advisory Group. (Safety Series 75-INSAG-7).

Vienna: Author. Retrieved from

http://www-pub.iaea.org/MTCD/publications/PDF/Pub913e_web.pdf

Lautman, L. & Gallimore, P. (1988, April - June). Control of the crew caused accidents. *Boeing Airliner*. 1-6. Seattle: Boeing Commercial Airplane Company.

Meshkati, N. (1997, April). *Human performance, organizational factors and safety culture.* Paper presented at the National Transportation Safety Board symposium on corporate culture in transportation safety. Arlington, VA.

Meshkati, N. (1999). The cultural context of nuclear safety culture: a conceptual model and field study. In J. Misumi, B. Wilpert, & R. Miller (Eds.), *Nuclear safety: a human factors perspective* (pp. 61-75). London: Taylor & Francis Ltd.

National Academy of Engineering and National Research Council, (2011). *Maconda Well Deepwater Horizon blowout: lessons for improving offshore drilling safety.* Committee on the analysis of the causes of the Deepwater Horizon explosion, fire, and oil spill to identify measures to prevent similar measures in the future. Washington, DC: The National Academies Press.

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. (2011). *Report to the President. Deep Water: The Gulf oil disaster and the future of offshore drilling.* Retrieved from http://www.oilspillcommission.gov/final-report

NTSB. (1991). *Aircraft accident report: Runway collision of Eastern Airlines Boeing 727, flight 111 and Epps Air Service Beechcraft A100, Atlanta Hartsfield International Airport, Atlanta, Georgia, January 18, 1990.* (NTSB Report No. NTSB AAR/91-03). Washington, DC: Author. Retrieved from http://libraryonline.erau.edu/online-full-text/ntsb/aircraft-accident-reports/AAR91-03.pdf

NTSB. (1992). *Aircraft accident report: Britt Airways, Inc., d/b/a Continental Express flight 2574 in-flight structural breakup, EMB-120RT, N33701, Eagle Lake, Texas, September*

11, 1991. (NTSB Report No. NTSB AAR/92-04). Washington, DC: Author. Retrieved

from http://libraryonline.erau.edu/online-full-text/ntsb/aircraft-accident-reports/AAR92-

04.pdf

NTSB. (2010). *Railroad accident report: Collision of two Washington Metropolitan Area*

Transit Authority Metrorail Trains near Fort Totten Station, Washington, DC, June 22,

2009. (NTSB Report No. NTSB/RAR-10/02). Washington, DC: Author. Retrieved from

http://www.ntsb.gov/doclib/reports/2010/RAR1002.pdf

NTSB. (2011). *Accident report: Pacific Gas and Electric Company natural gas pipeline rupture*

and fire, San Bruno, California, September 9, 2010. (NTSB Report No. NTSB/PAR -

11/01). Washington, DC: Author. Retrieved from

http://www.ntsb.gov/doclib/reports/2011/PAR1101.pdf

Reason, J. (1997). *Managing the risks of organizational accidents.* Aldershot, England: Ashgate

Publishing International.

Reason, J. (2000). Safety paradoxes and safety culture. *Injury control & safety promotion. 7(*1),

3-14.

Reason, J. (2004). Beyond the organizational accident: the need for "error wisdom" on the

frontline. *Quality and Safety in Health Care. 13*(Suppl II), ii28-ii33. Retrieved from

http://qualitysafety.bmj.com/content/13/suppl_2/ii28.full.pdf+html

Reiman, T., & Rollenhagen, C. (2011). Human and organizational biases affecting the

management of safety. *Reliability engineering and system safety. 96*(10), 1263-1274. doi:

10.1016/j.ress.2011.05.010.

Sumwalt, R. (2007, July). Do you have a safety culture? *AeroSafety World. 2*(7), 37-38.

Retrieved from http://flightsafety.org/asw/july07/asw_july07_p37-38.pdf

Sumwalt, R. (2012). *Leading organizations safety.* Presentation before California Public Utilities

      Commission, June 26, 2012. Retrieved from

      http://www.ntsb.gov/doclib/speeches/sumwalt/Sumwalt_120626.pdf

Vaughan, D. (1997). *The Challenger launch decision: risky technology, culture, and deviance at*

      NASA. Chicago: The University of Chicago Press.

von Thaden, T.,Wiegmann, D., & Shappell, S. (2006). Organizational factors in commercial

      aviation accidents. *The international journal of aviation psychology. 16*(3), 239-261.

Westrum, R. (2004). A typology of organizational cultures. *Quality and Safety in Health Care.*

      13(Suppl II), ii22-ii27. doi: 10.1136/qshc.2003.009522.

Wiegmann, D., Zhang, H., von Thaden, T., Sharma, G., & Mitchell, A. (2002). *A synthesis of*

      safety culture and safety climate research. Technical report prepared for FAA. (Technical

      Report No. ARL-02-3/FAA-02-2). Savoy, IL: Aviation Research Lab Institute of

      Aviation, University of Illinois at Urbana-Champaign.

Zohar, D. (2010). Thirty years of safety climate research: reflections and future directions.

      Accident analysis and prevention. 42(5), 1517-1522.