U.S. Department of
Transportation

**Federal Railroad
Administration**

**Safety Culture: A Significant Influence on Safety
in Transportation**

Office of Research
Development
and Technology
Washington, DC 20590

DOT SAFETY COUNCIL

SAFETY CULTURE

The shared values, actions,
and behaviors that
demonstrate a commitment
to safety over competing
goals and demands

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. **REPORT DATE** August 2017	3. REPORT TYPE AND DATES COVERED Final Report – July 2015

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
Safety Culture: A Significant Influence on Safety in Transportation	

6. AUTHOR(S) and FRA COTR
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER
U.S. Department of Transportation Federal Railroad Administration Office of Research, Development, and Technology 1200 New Jersey Avenue SE Washington, DC 20590	DOT/FRA/OR-17/09

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
This document is available to the public through the FRA Web site at http://www.fra.dot.gov.	

13. ABSTRACT (Maximum 200 words)

An organization's safety culture can influence safety outcomes. Research and experience show that when safety culture is strong, accidents are less frequent and less severe. As a result, building and maintaining strong safety cultures should be a top priority across the transportation industry. This research paper identifies the most important elements of a strong safety culture, and highlights opportunities for developing the Department of Transportation (DOT) strategy for improving safety culture in transportation.

14. SUBJECT TERMS		15. NUMBER OF PAGES
Safety culture, safety climate, safety, catastrophic accidents, accidents, organizational culture		63
		16. PRICE CODE

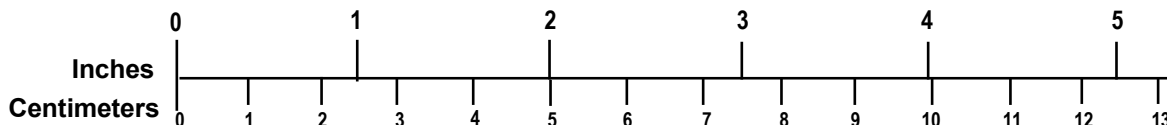| 17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

$[(x-32)(5/9)]$ °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

$[(9/5) y + 32]$ °C = x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION

Inches: 0 1 2 3 4 5

Centimeters: 0 1 2 3 4 5 6 7 8 9 10 11 12 13

QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
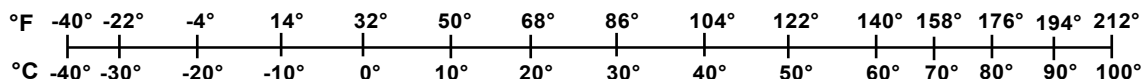
For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

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Executive Summary

An organization's safety culture can impact safety outcomes. Research and experience show that when safety culture is strong, accidents are less frequent and less severe. As a result, building and maintaining strong safety cultures should be a priority across the transportation industry. This research paper: 1) identifies the most important elements of a strong safety culture; and 2) highlights opportunities for developing the U.S. Department of Transportation (DOT) strategy for improving safety culture in transportation. This paper also documents a variety of definitions and current state of knowledge about safety culture—including DOT Safety Council definitions, DOT Internal Safety Policy, and a bibliography from an extensive safety culture literature review, found in the appendices of the report.

While critical elements of safety culture ensure safe operations, they also reflect basic good business practices. Strong and consistent leadership, open communication, trust, and fair decision-making are some of the factors that foster strong safety cultures and strong organizational cultures in general. However, the key indicator of a robust safety culture is that *safety is the priority*. Leaders' attitudes, organizational policies and decision-making, and employees' behaviors should consistently demonstrate that safety is prioritized above other considerations.

The most critical elements of a strong safety culture are as follows:

1. Leadership is clearly committed to safety

2. Open and effective communication exists across the organization

3. Employees feel personally responsible for safety

4. The organization practices continuous learning

5. The work environment is safety conscious

6. Reporting systems are clearly defined and not used to punish employees

7. Decisions demonstrate that safety is prioritized over competing demands

8. Employees and the organization work to foster mutual trust

9. The organization responds to safety concerns fairly and consistently

10. Safety efforts are supported by training and resources

One of the most important components of safety culture is leadership. As an industry thought leader, DOT can significantly influence safety culture of the transportation industry. For example, by starting internally, DOT leaders can ensure that employees fully commit themselves to making safety their highest priority and be dedicated to safety in all aspects of their work. Fostering a strong safety culture within DOT is a first step in asking the same of those that it oversees, collaborates with, and regulates in the transportation industry. This usually begins with a policy statement on safety and safety culture (see Appendix B).

1. Background: What Are the Elements of Safety Culture?

Since the Chernobyl nuclear accident in 1986, safety culture has emerged as a significant factor in many catastrophic accidents. Weak safety cultures were highlighted more recently in BP's 2005 refinery explosion in Texas City, TX, and the 2009 Metro Red Line collision in Washington, DC. Over time, it has become clear that an organization's culture has a strong impact on safety outcomes because it shapes safety attitudes, values, and behaviors.

Safety culture can be a nebulous concept. It may be defined differently, depending on whether it is used in the context of a Federal or State agency, a transportation company, or the general public. Each type of organization is responsible for safety in different ways. Many Federal agencies are beginning to recognize that they have their own unique safety culture, and that understanding their own internal safety culture can be useful for improving safety programs.

Although there may be slight variations in the meaning of safety culture across different industries and in different kinds of organizations, there is value in establishing a shared understanding that can be applied across many contexts. This research paper presents a general definition of safety culture. It also presents a core set of safety culture indicators, which are based on a synthesis of documented research across safety-critical industries within and outside of the transportation sector. By developing a common understanding of the elements that comprise a strong safety culture, the U.S. Department of Transportation (DOT) can have a better basis for improving its safety programs, policies, and strategies in the future.

1.1   Safety Culture Defined

Although many definitions of safety culture exist across different industries, the concept is generally described as a set of shared values, actions, and behaviors that demonstrate a commitment to safety by the individual and collective responsibility of everyone at all levels of an organization. Safety culture is determined by how people feel, what people do, and the organization's safety policies and procedures (Cooper, 2000). The extent to which attitudes, behaviors, and policies align to prioritize safety over competing goals indicates the strength of an organization's safety culture. The DOT Safety Council has developed the following definition of safety culture intended to support development of a broader departmental policy on safety culture:
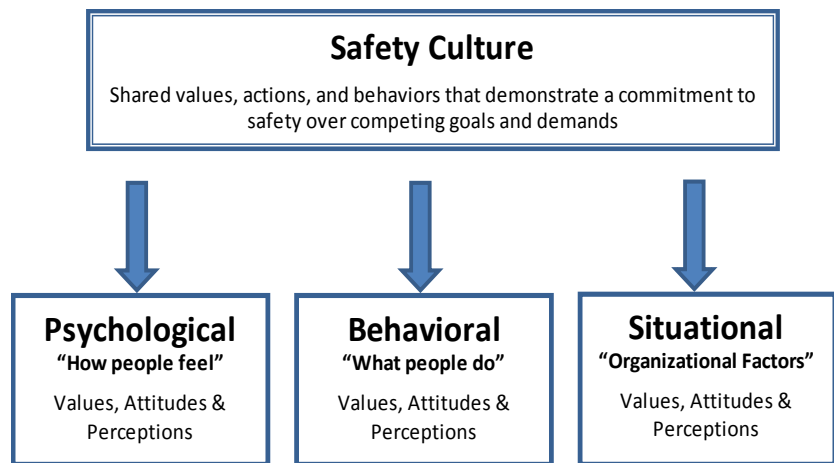
Figure 1. Three-part model of safety culture (adapted from Cooper, 2000)

> **The shared values, actions, and behaviors that demonstrate a commitment to safety over competing goals and demands.**

This was developed after extensive review of definitions used in a wide range of industries and organizations over the past two decades (see Appendix A) and discussion among Safety Council members.

1.2 Critical Elements of Safety Culture

The following elements of safety culture were derived from a review of publications representing a cross section of industries, including aviation, nuclear power, health care, maritime, rail, pipeline, construction, oil and gas, and mining. As expected, their models of safety culture varied greatly, both within and between industries. However, there were also commonalities across models, particularly in more recent publications where investigators adapted the safety culture model developed by James Reason in *Managing the Risks of Organizational Accidents* (1997), and the safety culture factors identified in a 1993 report from the United Kingdom's Health and Safety Commission on the safety of nuclear power operations. For a comprehensive bibliography on safety culture publications, including the sources and approach used in the literature search, see Appendix C.

The safety culture elements from each industry publication were compiled into a master list. The authors reviewed the master list and sorted all the elements into categories by theme. Each category was labeled and assigned a value of "importance" based on the number of elements that fell into that category. For instance, elements such as *safety leadership, management commitment, high-level safety commitment,* and *management involvement* were sorted into the leadership category, and elements such as *learning culture, organizational learning, questioning attitude,* and *continuous improvement* were categorized together. A total of ten thematic categories emerged from this process, with each category represented by at least two different industry models of safety culture. These categories, presented below, represent the most critical elements of safety culture.

Element 1.   Leadership is Clearly Committed to Safety

Since nearly all safety culture models explicitly included some mention of leadership commitment to safety, the importance of leadership in fostering a strong safety culture was clear. Leaders across all layers of an organization must model safety-first attitudes and behaviors. Employees learn what the accepted practices are in an organization by following the examples set by their leaders.

Element 2.   Open and Effective Communication Exists Across the Organization

Employees must feel comfortable communicating to their supervisors about safety issues and communicating with their peers when they see unsafe behaviors. If the organization is not communicating the importance of safety and encouraging their employees to speak up about safety, then safety risks are more likely to develop and less likely to be addressed before an accident occurs.

Element 3.   Employees Feel Personally Responsible for Safety

Employees who feel personally responsible for safety take more ownership in safety procedures and are also more likely to speak up when they see other employees behaving in an unsafe manner. Personal responsibility empowers employees and helps the entire organization identify and correct risks proactively.

Element 4.   The Organization Practices Continuous Learning

A strong safety culture requires a learning-oriented environment that continuously searches for opportunities to improve safety and implements them. Organizations must be able to learn from accidents when they do happen and be willing to make changes that can prevent incidents in the future.

Element 5.   The Work Environment is Safety Conscious

Maintaining a strong safety culture also requires constant vigilance and an elevated awareness of the importance of safety. Employees should be encouraged to raise safety concerns and allowed to raise concerns through reporting systems and procedures.

Element 6.   Reporting Systems are Clearly Defined and Not Used to Punish Employees

Organizations must ensure that reporting systems and lines of accountability are in place, so safety issues can be promptly identified, fully evaluated, promptly addressed, and corrected commensurate with their significance.

Element 7.   Decisions Demonstrate that Safety is Prioritized Over Competing Demands

Organizations with a strong safety culture differ from others because their decision-making processes emphasize that safety is prioritized over competing demands. Organizations with a strong safety culture will consistently choose safety over performance when faced with the choice of cutting corners to increase performance.

Element 8.   Employees and the Organization Work to Foster Mutual Trust

One of the cornerstones of any positive organizational culture is trust. Trust among managers, labor representatives, government regulators and inspectors can go a long way to support safety by facilitating open and honest communication and minimizing fears of reprisal. Employees who have developed a relationship of trust with their supervisors may feel more willing to raise safety concerns in novel situations when they are unsure of how the organization might respond.

Element 9.   The Organization Responds to Safety Concerns Fairly and Consistently

Above and beyond having effective reporting procedures and processes in place, the organization must respond to safety concerns in a manner that employees perceive as fair, just, and consistent. Employees should feel free to raise safety concerns without fear of retaliation.

Element 10.   Safety Efforts are Supported by Training and Resources

Those who manage and operate the system must have up-to-date knowledge about the human, technical, organizational, and environmental factors that determine the safety of the system as a whole, and they must have the tools and equipment to perform their jobs as safely as possible. In addition, the organization must ensure that the personnel, procedures, and other resources needed to ensure safety are available. Understaffing safety-critical positions or not having formal, written procedures for ensuring safety can be just as detrimental as a lack of physical equipment.

2. DOT Safety Culture Strategy: Opportunities to Improve?

2.1 Background

In 2008, a DOT Safety Review was conducted for three surface transportation modes (FRA, PHMSA, and FMCSA) to identify weaknesses and vulnerabilities in three broad areas: risk management strategies and approaches, agency safety culture, and internal control systems. As a result of this initiative, safety culture became one of the founding principles of the DOT Safety Council when it was established in October 2009. The DOT Safety Council institutes cross-modal safety discussion and action. Chaired by the Transportation Deputy Secretary, this council, which is composed of the heads of each DOT modal administration, their senior safety officers, and senior officials from the Office of the Secretary (OST), strives to be widely recognized as the world's leader for safety in transportation. All ten operating administrations unanimously agreed that safety culture should be the Safety Council's top priority for action.

DOT's senior safety leaders selected representatives from each operating administration to serve on the Safety Culture Action Team, based on their expertise and experience with safety programs. Subsequently, the Action Team developed a strategy to improve safety culture, not only within DOT, but also in those entities and organizations with which it works directly and the general public. The sections below summarize that strategy, which is comprised of a problem statement, a set of evaluation questions, and a phased work plan.

Problem Statement:

> Since the nuclear accident at Chernobyl in 1986, safety culture has emerged as an important factor in many catastrophic accidents. A weak safety culture was highlighted more recently in BP's Texas City refinery explosion in 2005, and the Washington, DC Metro Red Line collision in 2009. Over time, it has become clear that an organization's culture has a strong impact on safety outcomes because it shapes safety attitudes, values, and behaviors. However, *there is no common definition of safety culture, nor a common set of attributes that would describe the safety culture in any organization*.

When this problem statement was written, the action team observed that DOT would benefit from a better understanding of how safety culture affects safety outcomes in the organizations it regulates, among state and local government partners and grantees, and across the general public. Specifically, the action team considered the following to be essential: 1) knowing how DOT's *actions* influence safety culture in these domains (both positively and negatively), and 2) how the *organizational culture* within DOT shapes these actions/approaches or otherwise influences these groups. By developing a common understanding of the elements that comprise a strong safety culture, DOT would have a better basis for improving its safety programs, policies, and strategies, and the outcomes and impacts these have.

2.2 Statement of Purpose

This initiative's primary purpose is to develop strategies for improving DOT's safety programs and interventions, including development of an internal organizational culture that will support strategies for how DOT can influence safety culture in organizations with which it works directly and the general public.

The DOT Safety Council identified safety culture as a top priority across the Department. As previously discussed, the Council defined safety culture as *the shared values, actions, and behaviors that demonstrate a commitment to safety over competing goals and demands*.

2.3 Core Evaluation Questions and Phased Work Plan

The core evaluation questions below (and some of the exploratory questions that might help answer them) were developed by the action team using input from cross-modal safety professionals within DOT. They were developed to guide the safety culture initiative's strategic direction.

1. What is the current understanding of safety culture and its influences on safety outcomes?

2. How can DOT's safety culture be defined and measured?

3. How can we develop and implement our programs aimed at improving safety culture in DOT?

4. How do DOT's actions and organizational culture affect the safety culture of industry, the organizations that DOT oversees, state and local government partners, and the general public?

2.3.1 Phase 1 Work Plan: Action Planning

Phase I tasks were devised to answer the core evaluation questions presented in Section 3.3. . The following tasks were identified by the Safety Culture Action Team, and this research paper constitutes the product of Task 2 (see list below).

Task 1. Develop DOT Safety Culture Conceptual Frameworks

To better understand transportation-related safety cultures, we must first develop conceptual frameworks for how DOT influences safety outcomes through its actions, safety programs, and safety culture. This task will begin with the identification of different missions and functions within each of DOT's agencies in order to understand differences and similarities among agencies (e.g., regulatory versus non-regulatory agencies, interactions with state and local governments versus companies or the general public).

Task 2. Synthesize Safety Culture Research Literature

The Safety Culture Action Team will create a concise synthesis of research on safety culture, definitions of safety culture and related terms, the elements of a positive safety culture, and describe how safety culture relates to safety outcomes by leveraging information from other reviews conducted within and outside of DOT.

Task 3. Identify Safety Culture Metrics

One of the goals of the current initiative is to develop and/or adapt measures of safety culture for use by DOT. This task will directly contribute to the internal implementation plan. It will provide the Action Team with a list of potential measures that have been used as indicators of safety culture and with recommendations regarding the relevance of each measure for possible use within federal agencies. The overall purpose of this effort is to develop a

validated toolbox of measures that can be used to assess the safety culture internal to DOT and guide program improvements.

Task 4.   Review and Conduct Case Studies of Safety Culture Best Practices

In concert with the review of safety culture research, a review of best practices and challenges in transforming safety culture will be performed. Where possible, case studies will be conducted that support each of the conceptual frameworks from Task 1 to document best practice information not readily available from other sources.

Task 5.   Develop DOT's Internal Safety Culture Strategic Roadmap and Implementation Plan

The Internal Roadmap and Implementation Plan will complement and support modal agencies' and DOT's strategic plans. This Plan will also provide direction on the development and implementation of a safety culture survey within DOT.

Task 6.   Develop External Safety Culture Strategic Roadmap and Implementation Plan

Concurrently, the Safety Culture Action Team will lead the development of an external strategic roadmap and implementation and evaluation plan. The plan will identify short-term, mid-term, and long-term changes that could be made to DOT programs and policies to encourage the development of positive safety cultures in regulated industries, among State and local government partners and grantees, and potentially across the general public.

2.3.2   Phase 2 Work Plan: Implementation and Evaluation

Phase 2 involves two concurrent but relatively independent projects. Both are derived from the corresponding internal and external implementation plans developed during Phase 1. As of this writing Phase 2 activities have not begun.

Project 1.   Internal Implementation and Evaluation

In this task, the Team will execute and evaluate the strategies described in the Internal Roadmap and Implementation Plan. One of the primary activities that may be conducted in this phase is the development of a safety culture survey for use as a diagnostic tool within DOT.

Project 2.   External Implementation and Evaluation

In this task, the Team will execute and evaluate the strategies described in the External Roadmap and Implementation Plan. The focus will be on short-term, mid-term, and long-term changes that can be made to DOT's safety programs and policies to encourage positive safety cultures in transportation-related industries, state and local governments, and organizations, as well as the public.

3. Conclusion

Safety culture is about prioritizing safety at all levels of an organization through attitudes and actions. Employees should feel that safety is a personal responsibility and be able to communicate concerns to the organization through clearly defined reporting systems and processes without fear of retaliation or reprisal. The most often cited element needed to foster a safety culture is strong leadership. Therefore, leaders need to demonstrate their commitment to safety for their organizations.

Most of the literature on safety culture focuses on organizations that have direct influence on safety outcomes. Process safety (vs. personal or occupational safety) is often examined in those organizations because there is a potential for catastrophic consequences. However, safety culture is not limited to such front-line organizations. Safety culture can be important for any organized group where safety is a concern. The primary mission of the DOT Safety Council is to ensure a safe transportation system for the American people today and in the future. DOT can act as an industry leader by taking steps to improve its own safety culture internally and to influence safety culture externally through the actions it takes. Every DOT employee should be dedicated to safety in all aspects of his or her work, and DOT leadership should ensure that employees can fully commit themselves to making transportation safety their highest priority.

Appendix A. Definitions of Safety Culture

Safety culture is defined in a variety of ways within academic research literature and across different industries and federal agencies in the United States and internationally. The following definitions have been identified as having potential usefulness for other agencies and organizations when crafting their own definition of safety culture.

U.S. Department of Transportation (2011), definition:
> The shared values, actions, and norms that demonstrate a commitment to safety over competing goals and demands.

Nuclear Regulatory Commission (2011) Policy statement for U.S. nuclear industry:
> The core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment.

Transport Canada (2010) Achieving an Effective Safety Culture
> The safety culture of an organization is the result of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management system.
>
> Organizations with a positive safety culture are characterized by communications from various stakeholders founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures.

International Maritime Organization (2008), Policy statement for maritime industry:
> An organization with a "safety culture" is one that gives appropriate priority to safety and realizes that safety has to be managed like other areas of the business.

Richter and Koch (2004), Theoretical definition:
> Shared and learned meanings, experiences and interpretations of work and safety - expressed partially symbolically—which guide people's actions towards risk, accidents, and prevention.

Mohamed (2003), Construction industry:
> A subfacet of organizational culture, which affects workers' attitudes and behavior in relation to an organization's ongoing safety performance.

Weigmann (2002), Theoretical definition based on synthesis of literature:
> Safety culture is the enduring value and priority placed on worker and public safety by 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.

Pidgeon (2001), Theoretical in context of driver behavior:
> The set of assumptions, and their associated practices, which permit beliefs about danger and safety to be constructed.

Cooper (2000), Theoretical definition:
> Safety culture is that observable degree of effort by which all organizational members direct their attention and actions toward improving safety on a daily basis.

Guldenmund (2000), Theoretical definition:
> Those aspects of the organizational culture which will impact on attitudes and behavior related to increasing or decreasing risk.

Hale (2000), Theoretical definition:
> The attitudes, beliefs, and perceptions shared by natural groups as defining norms and values, which determine how they act and react in relation to risks and risk control systems.

Minerals Council of Australia (1999), AU mineral industry:
> Safety culture refers to the formal safety issues in the company, dealing with perceptions of management, supervision, management systems, and perceptions of the organization.

Eiff (1999), US aviation industry:
> A safety culture exists within an organization where each individual employee, regardless of their position, assumes an active role in error prevention and that role is supported by the organization.

Cox & Flin (1998), Theoretical definition:
> The product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management.
> *Also used by Lee (1998), Wilpert (2000)*

Mearns, Flin, Gordon, & Fleming (1998), UK offshore oil and gas industry:
> The attitudes, values, norms, and beliefs which a particular group of people share with respect to risk and safety.

Helmreich & Merritt (1998), U.S. aviation industry:
> A group of individuals guided in their behavior by their joint belief in the importance of safety, and their shared understanding that every member willingly upholds the group's safety norms and will support other members to the common end.

Appendix B. DOT Internal Safety Policy

The DOT Safety Council assembled a Safety Culture Working Group and assisted in the development of the DOT Safety Policy, reproduced on the following page. This policy includes specific encouragement for DOT to model the behaviors it is encouraging its regulated community to follow by adopting safety culture practices.

POLICY STATEMENT ON EMPLOYEE SAFETY 2015

In carrying out our transportation mission, safety is our highest priority. The operation of the Nation's transportation systems depends on a highly skilled and qualified workforce, which is our most valuable asset. Building on a United States Department of Transportation legacy of safety, we must continue to exemplify and promote an employee safety culture in which the values, actions, and behaviors of our employees reflect this priority.

Safety begins within our own Department, and the ability to carry out our statutory responsibilities is directly tied to the health and well-being of our workforce. The safety of our employees is paramount, so we will provide every employee with a safe working environment, and make sure they know how to respond to emergencies and avoid unnecessary risks. We also expect supervisors and managers to provide employees with an environment that freely promotes the open sharing and communication of workplace hazards.

Proactive teamwork is necessary in implementing this policy. It is the responsibility of all employees to conduct themselves in a way that does not pose unnecessary risks, or put themselves or others in danger. By fully embracing this policy, we will build and maintain a high-caliber workforce in which every employee has a safe working environment.

Anthony R. Foxx

Appendix C. Bibliography on Safety Culture

A systematic search of research literature using the Transport Research International Documentation (TRID) database (available at http://trid.trb.org/), and the Scopus database (available at http://www.scopus.com by subscription) produced an extensive bibliography of safety culture and safety climate references.

TRID is an integrated database that combines the records from TRB's Transportation Research Information Services (TRIS) database and the OECD's Joint Transport Research Centre's International Transport Research Documentation (ITRD) database. TRID provides access to over 1 million records of transportation research worldwide.

Scopus is the largest abstract and citation database of research literature and quality Web sources covering of over 21,000 academic journal titles from more than 5,000 publishers. Given the breadth of resources available in Scopus, the search was limited to journal collections in the Physical Sciences, Health Sciences, and Social Sciences and Humanities.

To develop the list below, the search terms "safety culture" and "safety climate" were used to identify relevant resources in the TRID and Scopus databases via a search on titles, abstracts, and key words from papers published between 1980 and February 2011.

Over 2,000 hits were generated using the search terms identified above. Each citation was carefully reviewed to determine if it was related to safety culture. All incomplete and inapplicable citations were removed from the results (e.g., citations with no author or date and irrelevant citations such as those referencing "cultures" in the food sciences and microbiology). The reference list below includes all those citations deemed appropriate and relevant for inclusion in a safety culture bibliography. The included citations are primarily from published papers in national and international academic research journals and published conference proceedings. Unpublished conference presentations, technical reports, and other unpublished web-based resources were not necessarily represented in the databases used in the literature search and were therefore excluded from this bibliography.

Adie, W., Cairns, J., Macdiarmid, J., Ross, J., Watt, S., Taylor, C. L., & Osman, L. M. (2005). Safety culture and accident risk control: Perceptions of professional divers and offshore workers. *Safety Science*, 43(2), 131-145. doi: 10.1016/j.ssci.2005.01.003.

Alaimo, B. (2005). Developing a total safety culture. *Chemical Health and Safety*, 12(2), 44-45. doi: 10.1016/j.chs.2005.01.011.

Alhemood, A. M., Genaidy, A. M., Shell, R., Gunn, M., & Shoaf, C. (2004). Towards a model of safety climate measurement. *International Journal of Occupational Safety and Ergonomics: JOSE,* 10(4), 303-318.

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