

Precursor for Error

An Analysis of Wildland Fire Crew Leaders' Attitudes about Organizational
Culture and Safety

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Abstract

Following the South Canyon Fire accident in 1994, U.S. fire agencies conducted the Wildland Firefighter Safety Awareness Study, which was completed by TriData Corporation in 1998. This study advocated implementing new training interventions, including Crew Resource Management (CRM) and leadership training to improve fire crew performance and safety.

A privately funded two-phase study was started in 1998 after the government engaged Mission-Centered Solutions, Inc., (MCS) to assist in designing and building training programs. MCS began gathering background cultural data on the U.S. wildland fire industry as a precursor to developing training, using the Crewmember Attitude Questionnaire (CAQ). The CAQ was adapted from the Flight Management Attitudes Questionnaire (FMAQ), a questionnaire built by the University of Texas to measure aviation culture. The CAQ measures organizational culture items that have been shown to link to crew performance and safety on the line.

The goal of Phase I of the CAQ project is to determine attitudes of first-line crew supervisors towards their organization and human factors concepts. In U.S. national land management agencies, first line supervisors oversee the largest number of subordinates in the system and are the ones most responsible educating others to cultural norms and expectations.

Phase II of the project is two-fold: to determine background cultural shifts and to retest previous trainees for attitudinal shifts. The results of both studies are used to guide training delivery and design and also to provide a measurement of cultural shifts for fire agency managers.

The CAQ study is the largest socio-psychological study of U.S. wildland firefighters conducted to date, containing 756 respondents in the Phase I data sample. Phase II will contain approximately 1700 additional respondents, including international groups.

This paper includes the initial findings of the Phase I research. Some preliminary Phase II findings also may be available for publication.

The analysis of the Phase I data includes these findings:

Most firefighters gave low marks to safety personnel, indicating that U.S. safety officers suffer from low credibility and perceived ineffectiveness.

Items regarding the *structure* of safety were endorsed almost universally by firefighters, but items regarding the implementation of safety during operations were typically endorsed by less than half of firefighters. Most firefighters approve of agency safety programs but not with how they are practiced.

Less than half of all respondents endorsed a statement that Incident Management Teams would not compromise safety concerns for accomplishing incident objectives. These scores indicate a mismatched perception between IMTs and fire resources regarding how safety and risk are understood and weighed.

Firefighters rate the level of teamwork lowest between themselves and contractors working on fireline operations. With the planned expanded use of contractors in the U.S., this score indicates a significant weakness in the culture that should be addressed.

Scores measuring stress recognition indicate that, in general, wildland firefighters tend to not recognize the effects of stress and fatigue. Firefighters are willing to acknowledge concern for the effects of stress or fatigue but are less willing to admit to being personally affected by them.

Overview

In 1998 Mission-Centered Solutions, Inc., (MCS) began gathering data on wildland firefighter attitudes affecting crew cohesion and effectiveness. The primary focus of this work, termed Phase I, was aimed at establishing baselines for the evaluation of future leadership and human factors training programs; this work remains an ongoing effort. Phase II of the study will focus on differences between pre- and post-training respondents. The effort uses the Crewmember Attitude Questionnaire (CAQ), a survey instrument based on the Flight Management Attitudes Questionnaire (FMAQ) of the University of Texas (Wilhelm et al. 2001). While MCS conducted this effort, it became apparent that some findings indicated possible cultural weaknesses that may be of interest to agency safety personnel. This paper describes the most noticeable blemishes in an otherwise very strong culture.

The effect of attitudes on firefighter safety has been documented in many, if not most, fire accident investigations reaching from Mann Gulch (1949), when Dodge Wagner could not convince his subordinate firefighters to seek shelter with the escape fire he had set to protect them, to Sadler (1999), when the command team, exhibiting questionable attitudes regarding safety and risk, set into motion a risk-laden chain of operations that resulted in a nearly fatal accident.

The effects of cultural influences on safety and effectiveness have profound significance in operational theatres such as wildland fire and military combat operations. In wildland fire, individuals must balance safety and risk in an ongoing and adaptive manner, often in reaction to events beyond the operation's control. By-rote rules, policies, and regulations can be reasonably applied to repeatable and controllable processes (chocking a tire, wearing a hardhat, and so on), but the high number of operational variables characteristic of wildland fire makes these tools of limited use as the primary instrument for ensuring workforce safety. Under the less predictable conditions often encountered by wildland firefighters, a strong organizational culture can provide a much broader set of guidelines for guiding behaviour and decision making in ambiguous situations.

Firefighting is communication-intensive, often requiring critical coordination between upper and lower organizational levels and peer units; is diverse in its operational requirements and threats; is dynamic in its tempo, the length of exposure, and the location of failure points. Attitudes that negatively impact the ease of communication flow, such as inter- or intra-crew trust and cohesion, and a lack of awareness of human performance limitations are issues that cut to the heart of what enables these organizations to remain effective and safe under stressful conditions. Cultural, or shared, attitudes impacting these areas can pose significant latent risks to the organization as a whole and can set the precursor conditions for catastrophic error and loss of life. Strong organizational cultures that exhibit attitudes of trust, communication, and error tolerance are safer and more error resilient.

Overall, the Phase I analysis of the Crew Attitude Questionnaire (CAQ) found that the cultural health of the wildland fire industry is both very good and very consistent among the participating national fire agencies. When composite scores were compared to domestic and international airlines from previous studies conducted by the University of Texas at Austin Human Factors Research Project (Wilhelm et al. 2001), the U.S. wildland fire industry organizational climate consistently ranked among the very top scoring airline organizations as shown in Figure 1. Further, all participating government agencies in the study scored similarly, indicating U.S. wildland firefighters comprise a single culture with only minor differences among agencies.

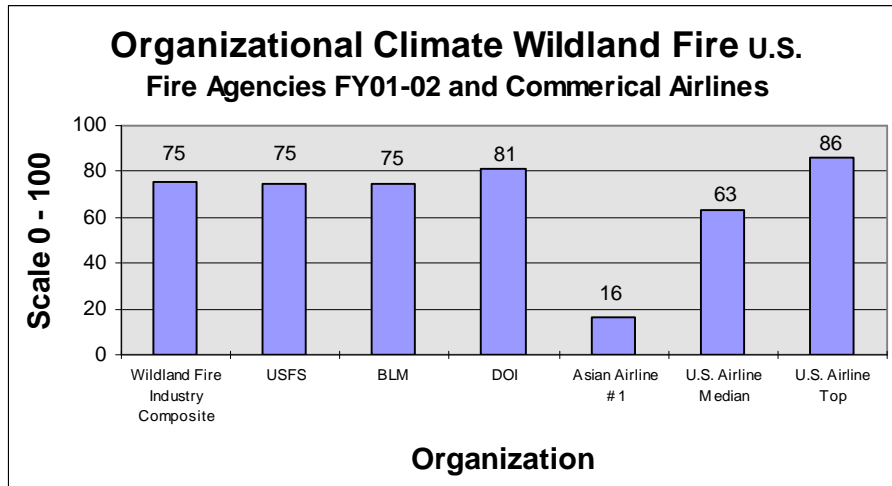


Figure 1

Although the U.S. wildland fire culture is strong when viewed through the CAQ lens, the study detected some weaknesses in particular areas—Safety Culture; Perceptions of Teamwork; Attitudes toward Stress, Fatigue, and Error—indicating that some organizational interventions may be appropriate.

The data collected in this study was gathered before the 2002 fire season during which the Thirtymile Abatement Plan was enacted and the participation of contract fire crews increased substantially.

The full technical report of the U.S. Firefighter Attitudes (McDonald and Shadow 2002) exceeds 200 pages. This paper provides a description of the attitudes reflecting the weakest areas of the wildland firefighter organizational culture where crews are the most susceptible to error.

Attitudes toward Safety Culture

Some items comprising the Safety Culture Scale relate to the ease in which communication is perceived to move upward in the organization and the anticipated reception of voiced safety concerns. These measures of communication quality can mirror line performance. In a recently published paper, J.B. Sexton and J.R. Klinec establish a link between the Safety Culture Scale, observed error management, and overall crew effectiveness during airline flight operations (2001). In other words, the Safety Culture Scale can be used as a tool to make predictions regarding crew performance and effectiveness.

As shown in Figure 2, the U.S. wildland fire agencies had similar scores on the composite Safety Culture Scale and scored slightly higher than the median U.S. airline studied previously by Wilhelm, Helmreich, and Merritt (2001).

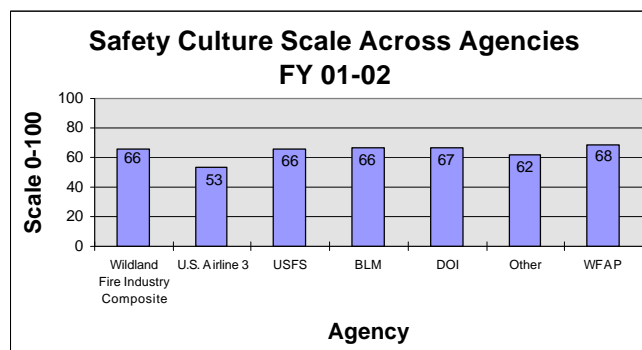


Figure 2

The Wildland Fire Industry Composite (Figure 3) mirrors the pattern of all agencies and provides a solid basis for discussion. Overall, the safety scale scores were brought down by items relating to Incident Management Teams (IMTs), safety officers, and perceptions of management.

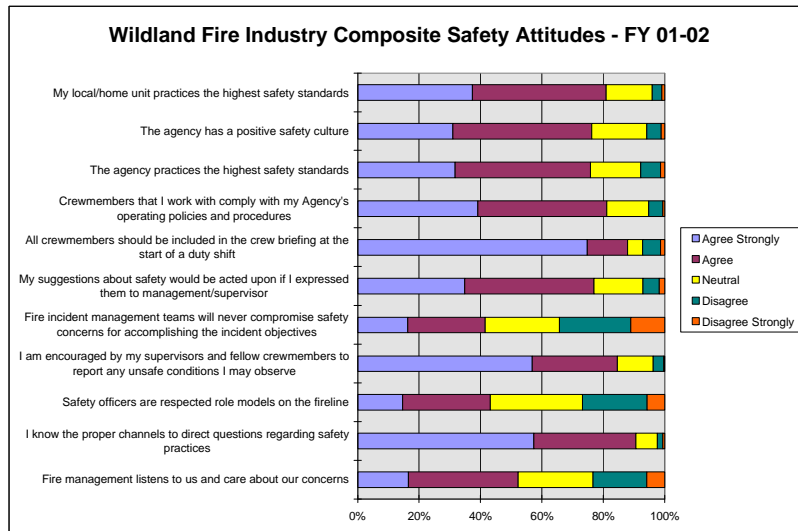


Figure 3

Perception of Safety and Incident Management Teams

The CAQ study measured perceptions of management safety behaviour, with questions distributed between Incident Management Teams (IMTs) and home unit management items. While perceptions of home unit behaviours can have an upstream impact to organizational error and accidents, the actions of IMTs directly affect firefighter safety. The lowest rated safety item was in regard to IMTs: *Fire incident management teams will never compromise safety concerns for accomplishing the incident objectives.* (approximately 40% agree or strongly agree)

Stated conversely, over half of the firefighters felt that IMTs *might* be willing to compromise safety in order to accomplish the incident objectives.

Across resource types, the perception is particularly noticeable among helicopter-based crews (Figure 4), with 80% indicating that IMTs might be willing to sacrifice safety to accomplish incident objectives. The comparatively low number of helicopter crews represented in the survey may influence the result. This trend should be re-examined in Phase II after more helicopter crews complete the CAQ.

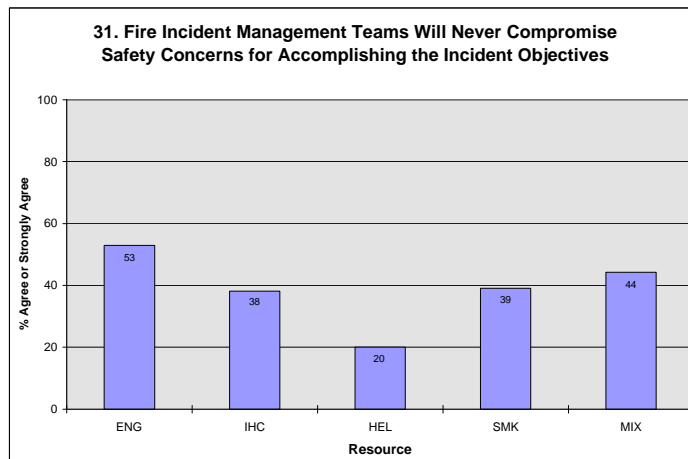


Figure 4

The low level of agreement for this statement is troublesome because it reflects upon the operational command structure and the level of trust between the operational ground units and the command teams. Low scores indicate a mismatch between incident management teams and fire resources regarding how safety and risk are understood and weighed. The responses indicate possible problems with the enforcement of safety policy during incidents or inconsistent training and application of risk management practices with IMTs.

This finding also implies a discrepancy between official safety policy and safety practices in the field and is further supported by accident reports that often reveal that safety concerns are overlooked in the zeal of fighting the fire: South Canyon Fire, July 1994; Sadler Fire, August 1999; Thirtymile Fire, July 2001.

Perceptions of Safety Officers

In the U.S., safety officers have an incident management team position with responsibilities for assuring compliance with safety regulations, advising fire resources regarding risk mitigation, and providing a dedicated macro level view of fire operations and strategy. Through observation and constructive discussion, the incident safety officer serves the crucial role of demonstrating the safety culture to the field during tactical operations. The safety officer's ability to act as a credible role model is the direct result of his or her line behaviour and the length and quality of time spent with resource leaders.

Across all agencies, respondents consistently gave safety officers low scores as role models with just over 40% agreeing or strongly agreeing with this statement: *Safety officers are respected role models on the fireline*. Overall low scores speak directly to the credibility and effectiveness of safety officers and the effectiveness of the line safety programs.

This finding could result from the following conditions:

- Safety officer representation is insufficient on incidents.
- Safety officers are not working effectively with resource leaders to resolve safety or risk issues.
- IMTs are not deploying safety officers to monitor the types of units represented in the study.
- Safety officers do not make great effort to engage more hard to reach or remotely located resources.

A variance in scores among resource types, as shown in Figure 5, lends credence to the last supposition. There appears to be a correlation between exposure to safety officers and the item score. Scores are higher among resource types that interact and communicate more extensively with safety officers—an indication that greater exposure builds credibility.

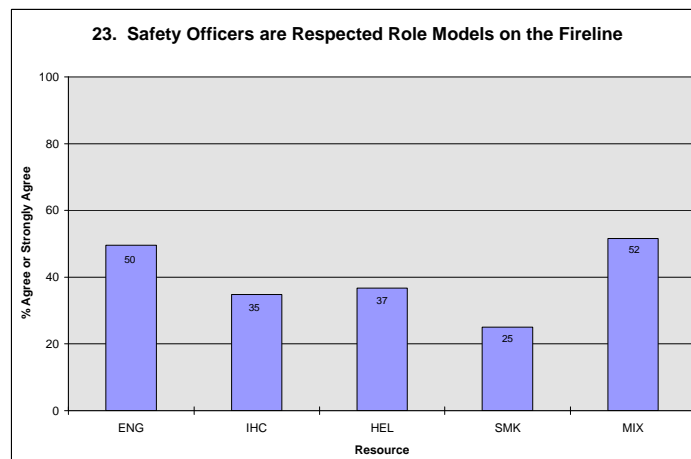


Figure 5

Follow-up interviews with fire resources and some senior safety officers reveal that all of the listed conditions may exist to some degree, presenting questions about the way that safety officers are deployed or trained in the current system.

Although the scores are low, they have shown improvement over the course of the study period. For example, IHC respondent scores on this item increased 100%, from a very low score of 17 in FY98 to a moderately low score of 35 in FY02.

Perceptions of Management

Home unit management structures were also rated in the Safety Culture Scale. The following questionnaire item identifies a third management/safety issue: *Fire management listens to us and cares about our concerns*. The perception of management's willingness to listen affects attitudes relating to trust. Communication must be present to build trust, and trust is a precondition for cohesion and effectiveness. Management also has a role in fostering workforce motivation. Previous studies have demonstrated that both motivation and management attitudes have a positive correlation to accident incident rates (Itoh et al. 2001),

As a whole, a strong connection between the top and bottom of the organization helps to provide conditions where systemic error, or errors initiated at the highest levels, can be corrected or mitigated by the field. Providing this type of connection is a particularly daunting task given the characteristics of the U.S. land management agencies, which are large, widely distributed geographically, and often organizationally complex with regions operating many functions in an interagency structure.

All agencies in the study scored low in the perception of management approachability and commitment. The DOI agencies had the highest scores with approximately 62% of respondents rating management favorably in this area, followed by the USFS at 58%. The industry-wide composite score for this item was 52%.

The reasons for this rating could vary widely, and the investigation team did not pursue this finding further. We intend to watch the responses from this question in Phase II with both pre-training and post-training respondents.

Conclusion regarding Safety Culture

A consistent and pervasive theme emerges in the safety portion of firefighters' CAQ responses: items referring to the *structure* of safety programs are almost universally endorsed by 80% to 90% of firefighters, but items referring to how well safety is implemented during operations were typically endorsed by only 40% to 50% of firefighters. Most firefighters appear comfortable with the agency safety programs but not with the safety program as practiced by personnel in leadership or role model positions.

While the weak areas discussed in this section bear further discussion and suggest a need for improvement, it is important to note that the overall composite safety culture score of the wildland fire industry ranks with the top of organizations examined in previous studies by the University of Texas.

Perceptions of Teamwork

Good teamwork relies on communication, trust, well-defined roles and responsibilities, and adaptive behaviours that allow team members to adjust roles and duties to compensate for each other's needs. The CAQ asks respondents to rate the overall quality of teamwork with other groups in the operational environment. In previous studies, US airline pilots rated teamwork with other cockpit crewmembers and with several ground crews. The vast majority (94%) of pilots rated teamwork and cooperation with other cockpit crewmembers as good or very good. In contrast, a lower percentage of wildland firefighters (76%) rated the quality of teamwork and cooperation between themselves and other members of their crew as high or very high.

Figure 6 shows the Wildland Fire Industry Composite ratings of firefighters for various groups involved in the firefighting effort.

Wildland Fire Industry Composite - Quality of Teamwork and Cooperation Between Crews and...

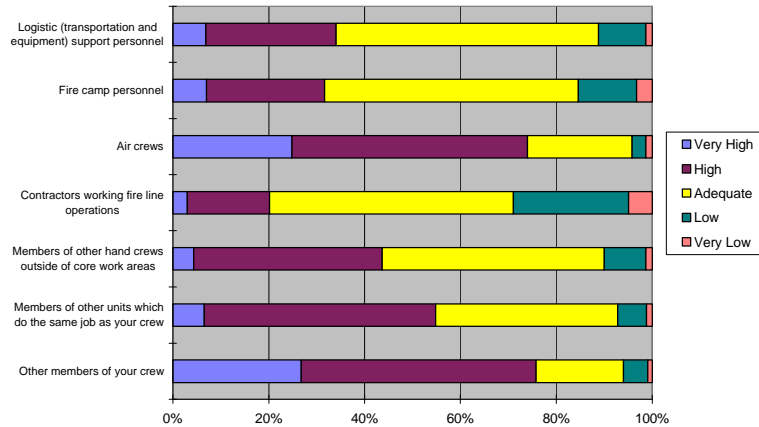


Figure 6

The ratings seem to reflect a natural progression relating to operational distance. Generally, firefighters perceive the highest quality of teamwork among the resources working most closely with them on the fireline. However, this theory does not hold true with one group in particular: contractors. Although contractor crews often work side by side with crews comprised of agency employees, firefighters rated teamwork and cooperation with contractors lowest, with only 20% rating it as good or very good (Figure 6).

Figure 7 shows, by resource, the low ratings of teamwork between crews and contractors.

17. Teamwork and Cooperation Between Crews and Contractors Working Fire Line Operations

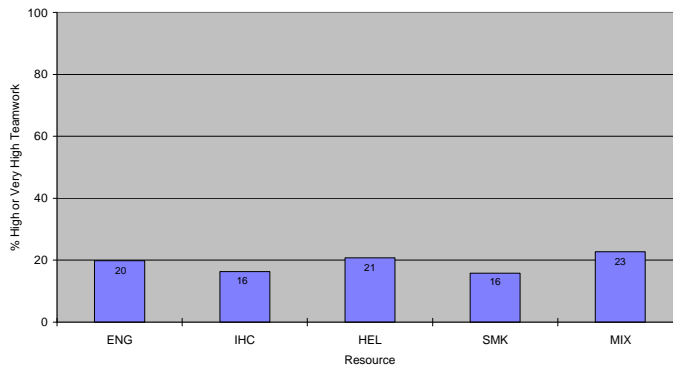


Figure 7

This score indicates a significant weakness in the organizational culture and is cause for concern—particularly because of the recent industry-wide movement toward greater use of contract crews. The integration of contract crews into the fire operations arena poses many unknown risks, and the finding indicates that some of these risks are real and present. In situations that require quick coordination and action on the part of several crews, the lack of inter-crew trust or cohesion could have serious implications for line performance and safety. The poor rating of teamwork and cooperation, whether the result of individual contract crew behaviour or poor integration by management, is a red flag that should be investigated more closely. Limited follow-up conversations with firefighters reveal issues that could foster this attitude, ranging from poor oversight and standards to a system that supports inconsistent value sets. This trend will be closely monitored in the Phase II analysis.

Attitudes toward Stress

The Threat and Error Model of Crew Resource Management (TEMCRM), described by Wilhelm, Helmreich, and Merritt (2001), provides useful concepts for integrating organizational culture and error management. It is based on the premise that everyone is susceptible to error and that making mistakes is an inevitable part of human activity. From this perspective, stress is not a personal weakness to be denied but a universal human reaction to environmental conditions such as time pressure, work overload, uncertainty, fatigue, and personal problems.

Stress produces physical and emotional reactions that diminish attention and cognitive capacity, thereby increasing the likelihood of error. For example, a crew leader who does not recognize the potential impacts of stress may not recognize that they are filtering important communication or information from their decision-making process.

Using a professional approach toward reducing the impacts of human error, organizations can promote efforts to acknowledge vulnerability to stress, take active measures to manage stress, and promote the development and use of individual and team-based countermeasures to guard against diminished performance. The organization can support this process by formally acknowledging that error is inevitable and must be managed.

Twelve items on the CAQ address stress recognition (Figure 8 and Figure 9). This discussion focuses on items falling into three categories: general philosophy toward error, application of mitigation strategies, and personal effects of error.

Wildland Fire Industry - Denial of Stress Items (Disagree is Desired) - FY 01-02

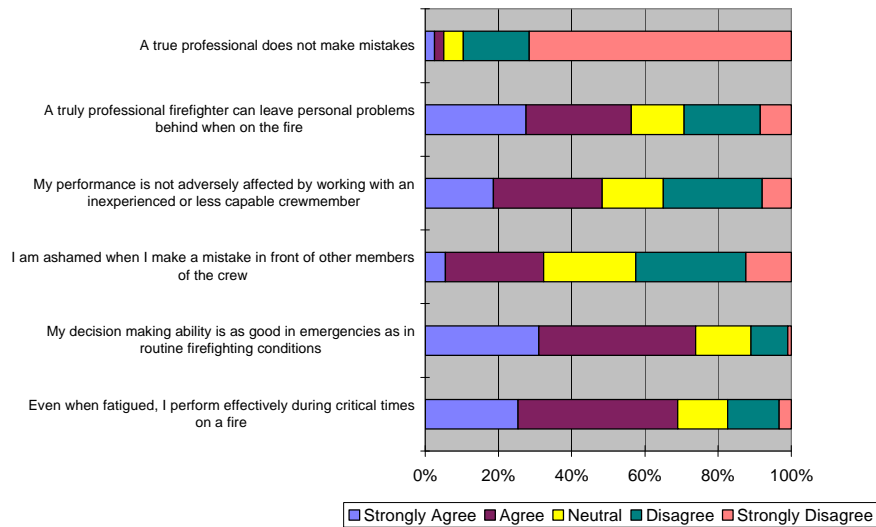


Figure 8

Responses to statements about general error philosophy indicate healthy attitudes toward TEMCRM concepts. For example, the vast majority disagreed with the statement *A true professional does not make mistakes*, reflecting alignment with TEMCRM concepts.

**Wildland Fire Industry - Realistic Appraisal of Stress Items
(Agree is Desired) - FY 01-02**

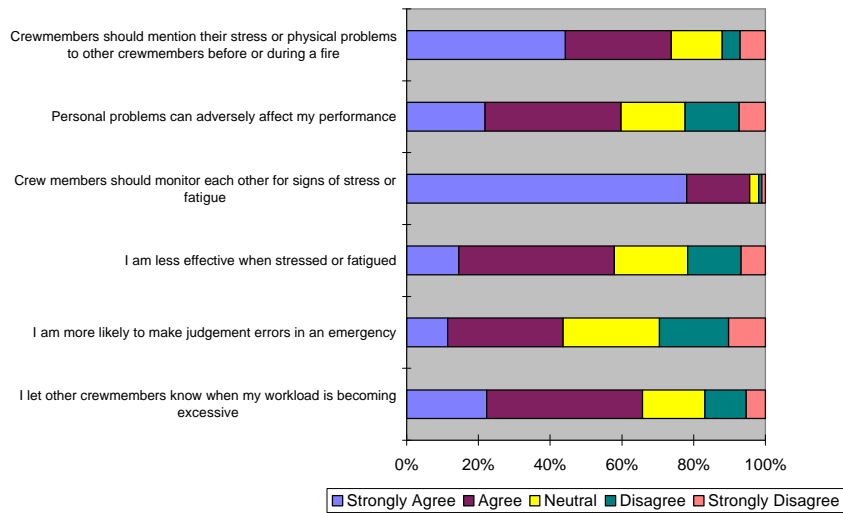


Figure 9

Items measuring effective application of mitigation strategies also show alignment with TEMCRM concepts. For example, the vast majority agreed with the statement *Crewmembers should monitor each other for signs of stress and fatigue*.

However, when the items focus on the personal effects of error, responses begin showing the invulnerability that runs counter to TEMCRM concepts. Note the high agreement (when disagreement shows alignment with TEMCRM concepts) for the following statements:

My decision making ability is as good in emergencies as in routine firefighting conditions. (nearly 80% strongly agree or agree)

Even when fatigued, I perform effectively during critical times on a fire. (roughly 70% strongly agree or agree)

On a theoretical level, respondents accept TEMCRM concepts, but a majority are unwilling to admit that these concepts apply to themselves.

Our findings indicate that, like other high-risk environments, the professional wildland firefighter culture tends to endorse unrealistically *macho* attitudes toward stress. Invulnerability is a common attitude of firefighting and other high-risk cultures; however, these attitudes, which seem to imply that firefighters are unaffected by human limitations, can result in unrealistic human performance expectations and can encourage unnecessary risk. When firefighters accept realistic standards for their profession, then safeguards and countermeasures can be enacted professionally and consistently.

Recommendations

The recommendations listed here suggest some actions to address the weaknesses described in this paper:

- Increase standardization and training of Incident Management Teams regarding risk management practices to provide more consistent guidance and leadership to the field.
- As a means of enhancing the level of trust between IMTs and fire resources, increase training for incident commanders, operations section chiefs, and safety officers to improve constructive discussion of risk and safety in assignments.
- Increase training, mentoring, and assignments that improve the communication skills and effectiveness of safety officers. The CAQ results indicate a potential discrepancy between what safety officers are trained to do and the criteria that ground operators hold them accountable for.
- The issue of contract crew integration is complex and multifaceted. As agencies move to improve their management oversight and program specifications for contract crews, they need to find ways to instruct, emphasize, and monitor the culture, values, standards, and expectations of contract leaders. Crews tend to be the reflection of their leaders. A perception of poor communication and teamwork with another crew most likely indicates a deficiency in communication and teamwork with the crew's leadership. The establishment of meaningful crew leadership oversight and standards may be needed to correct this trend.
- Implement training that increases awareness of TEMCRM and helps firefighters devise strategies to counteract the effects of stress. Routine and frequent training in managing emergencies and abnormal situations should give firefighters increased confidence in their own performance under these conditions, but it should also make them aware that they are not exempt from the laws of human nature. Training must acknowledge the inevitability of error and focus on team communication and detection strategies to mitigate error.

Conclusion and Comments

The U.S. wildland fire culture is both strong and consistent when viewed through the lens of the CAQ. It ranks near the top of previously studied organizations in organizational climate and safety culture, but it is held back by a small number of factors discussed in this paper. Attention to these items by the agencies merits consideration. These items support the need for continuing human factors and leadership training for this group. Phase II, which will study post-training respondents, should provide additional perspective on the impact of these programs.

The data gathered in this study occurred before the bulk of recommendations of the Thirtymile Hazard Abatement Plan were enacted and before *Human Factors on the Fireline*—a TEMCRM program—was widely available. *Fireline Leadership*, another program that integrates TEMCRM material, was available during the last year of the study. Over the course of the study, the scores of pre-training respondents increased slightly in most sectors, indicating that the gamut of safety and cultural initiatives started in the past few years could be starting to take hold.

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