

CAQ Phase II Report—Analysis of Shifts in Wildland Fire Organizational and Safety Culture since 1998

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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 human factors and leadership training programs. Using the Crewmember Attitude Questionnaire (CAQ), MCS began gathering background cultural data on the U.S. wildland fire industry as a precursor to developing training. The CAQ was adapted from the Flight Management Attitudes Questionnaire (FMAQ), a questionnaire built by R. Helmreich, et. al., University of Texas to measure cultural data in aviation industry. The CAQ measures organizational and cultural items that have been shown to link to crew performance and safety on the line.

The goal of the CAQ Phase I project was to determine attitudes of first-line crew supervisors toward 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 I also examined how well the wildland fire industry compared with other industries documented by the CAQ from previous years.

Phase II of the CAQ project identifies changes in attitudes of firefighters during the period of the study (FY1998-FY2004). Phase II includes a re-examination of concern areas identified in Phase I, including attitudes concerning safety officers, contract fire crews, IMT safety climate, and crew leaders' attitudes of invulnerability with regard to stress and fatigue.

The CAQ study continues to be the largest socio-psychological study of U.S. wildland firefighters conducted to date, containing 3460 (primarily) first line supervisor respondents. The analysis of the Phase II data includes these findings:

- The organizational climate and safety climate scores have steadily improved annually since 1998.
- The perception of teamwork between government firefighters and contractors working on fireline operations continues to be a weakness.
- Previous ratings of safety personnel, which indicated that U.S. safety officers suffer from low credibility and perceived ineffectiveness, have improved industry wide in the past two years.
- Pre-training awareness of the effects of fatigue and stress has increased in the general wildland population, but attitudes of invulnerability show little improvement.

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Introduction

History of Project and of the Phase I CAQ Study

In 1998 Mission-Centered Solutions, Inc., (MCS) began gathering data on wildland firefighter attitudes affecting crew cohesion and effectiveness. 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).

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.

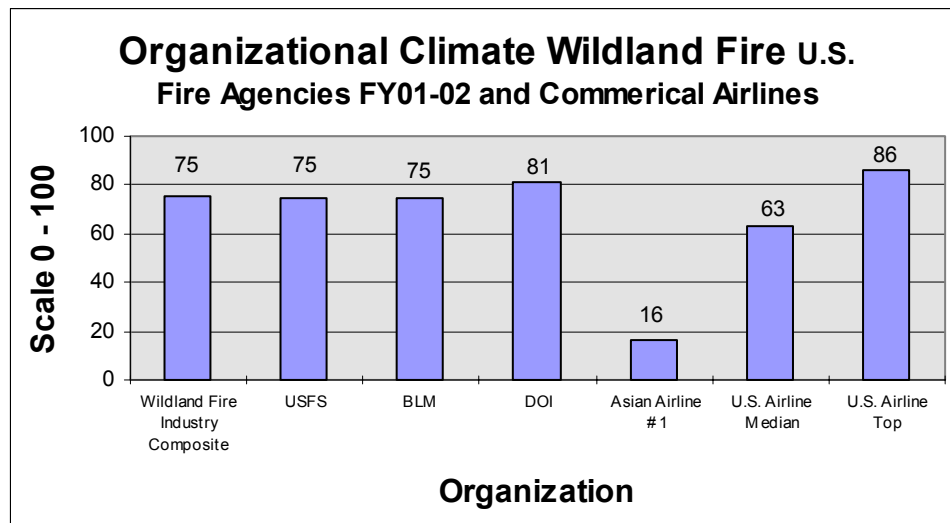
The effects of cultural influences on safety and effectiveness have profound significance in operational theatres such as wildland fire and military combat operations. In wildland fire, individuals must balance safety and risk in an ongoing and adaptive manner, often in reaction to events beyond the 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 limits the usefulness of these tools 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 has unique characteristics: communication-intensive, often requiring critical coordination between upper and lower organizational levels and peer units; diverse in its operational requirements and threats; dynamic in its tempo, the length of exposure, and the location of failure points. Attitudes that negatively impact the ease of communication flow—for example, those affecting inter- or intra-crew trust and cohesion or those contributing to a lack of awareness of human performance limitations—cut to the heart of what enables these organizations to remain effective and safe under stressful conditions. Cultural, or shared, attitudes that negatively impact 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.

Figure 1 Phase I Findings—Organizational Climate



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.

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

Phase II CAQ Study

The Phase II study was started in 2002 with data collected from October 2002 through December 2004. Analysis occurred January 2005. The effort was funded and managed by MCS primarily for internal use.

As with Phase I, the project included *public* objectives with the expectations that these findings would be released to the agencies and firefighting public. Following are the public objectives for Phase II:

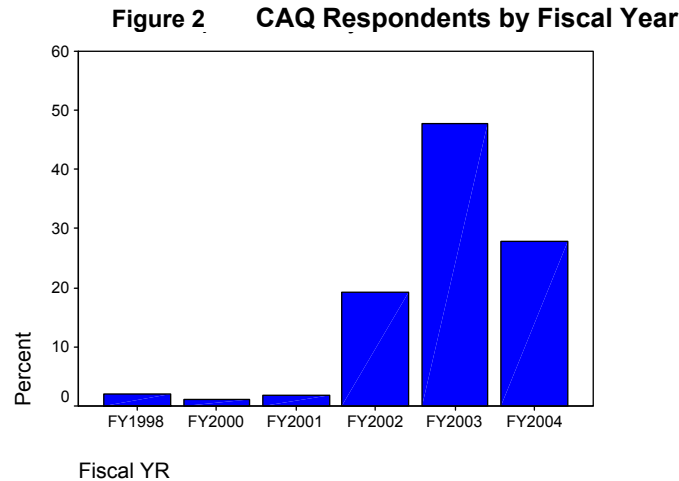
- 1) Identify any significant changes in the culture since the collection of the Phase I data up to FY2002 regarding the overall cultural scales outlined in the CAQ.
- 2) Identify areas when the culture is losing ground and make recommendations for future improvement.
- 3) Revisit and focus on the specific subjects identified in Phase I as weak areas in the culture, and determine if there has been success in strengthening these areas.

Additionally, the investigators desired to determine if continuation of the CAQ study was appropriate or desirable for either internal or public reasons.

Sample

The sample for this report consisted of 112 Interagency Hotshots from FY1998 and FY2000 and 3348 firefighters from a variety of resource types and agencies from FY2001 through FY2004. Respondents subsequently attend MCS's *Fireline Leadership* (NWCG L-380) or *Leading in Fire Management*.

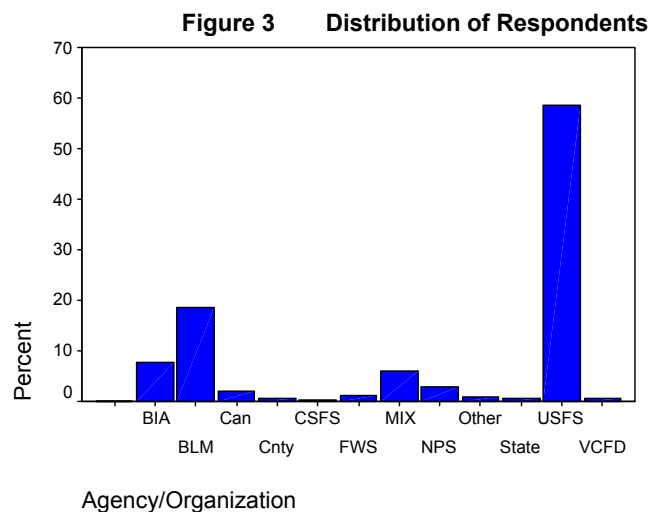
As shown in Figure 2, the number of respondents sampled varied widely across the time period of the study, with most of the sample (95%) collected from FY2002 through FY2004.



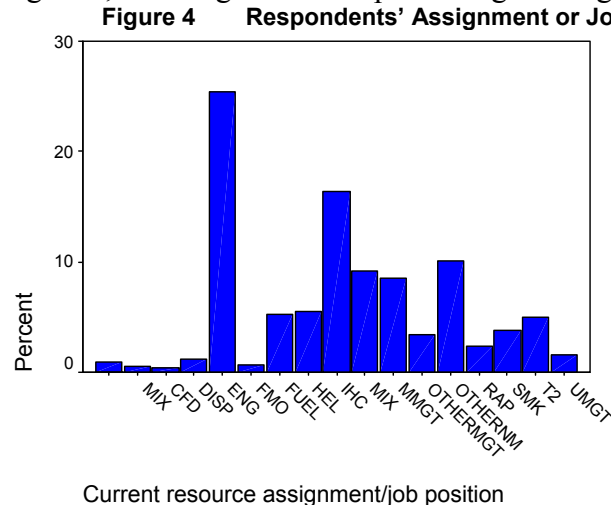
The samples are relatively small in the first three years (FY1998 2.1%, FY2000 1.2%, and FY2001 1.8%). For this reason, more variance in scores is seen in these years.

Note: To reduce the tendency for visual misinterpretation of variance in the early years, the investigators calculated the average of the first three years as the general “baseline” from which to compare subsequent years. Subsequent referrals to the *FY98-01 Baseline* are defined as an average of the scores from FY98, FY00, and FY01.

The CAQ respondents in the sample are primarily first level supervisors, from a broad cross-section of federal and state firefighting agencies. National agency full-time firefighting resources comprise most of the sample and include the Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), National Park Service (NPS), and the U.S. Forest Service (USFS). Mixed (MIX) respondents are national level firefighters who did not disclose their individual agency on the questionnaire. These national resources comprise most of the respondents, with the USFS and BLM comprising the largest numbers of respondents. The sample representation loosely mirrors the actual staffing of first line supervisors in the agencies. The sample also includes respondents from the Governments of Alberta and Northwest Territories, Canada (CAN), various county, municipal, and volunteer fire departments (Cnty, VCFD, other), and state fire organizations (State, CSFS), with the USFS and BLM accounting for 77% of the total sample as shown in Figure 3.



The CAQ respondents represented a broad range of resource types within the wildland firefighting profession; however, respondents in FY1998 and FY2000 were primarily comprised of Interagency Hotshot personnel. IHC and Smokejumper leaders were also heavily represented in the FY2001 sample. Across the study, the mix of resource types approximates that of the national population of firefighters, with engine units representing the largest group (Figure 4).



In the interest of making the study as accurate as possible, the researchers analyzed the total Wildland Firefighting Industry (WFI) sample to determine trends in the industry as a whole and also cross-checked those results with a sub sample of USFS Interagency Hotshot Crew (IHC) respondents. USFS IHC respondents represented the only resource type and agency sampled in each of the years of the study. The cross-check between WFI and IHC results was performed for all of the analyses; however, the results were not reported because no significant differences between WFI and IHC results were found.

Results

Organizational Climate Scale

Organizational climate refers to people's perceptions of their organization's culture. Organizational climate involves firefighters' appraisal of their culture and is based on each individual's personal set of principles. If there is a good fit between a firefighter's values and beliefs and those of the unit, the firefighter is much more likely to feel proud of their organization, like their job, and feel like part of a large family. This alignment, in turn, provides a basis for unit cohesion and communication.

Based on previous work with the FMAQ, Helmreich based the Organizational Climate Scale (OCS) on the following three survey items: *Working at my unit is like being part of a large family; I am proud to work for this organization; Morale is high within my crew.* The scale was calculated by averaging each firefighter's responses to these three items, and converting to a 0 to 100 scale.

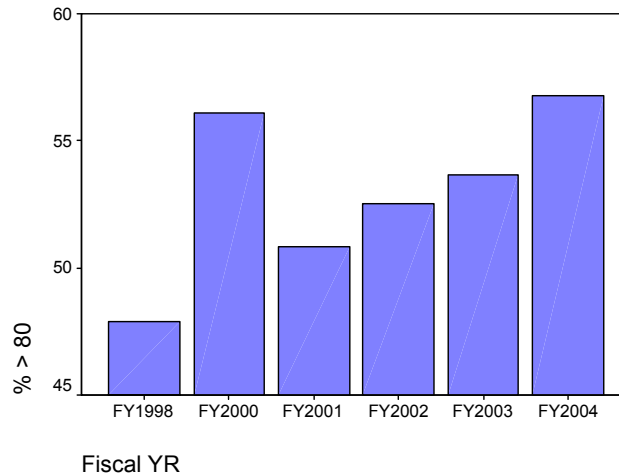
The resulting value can be thought of as a barometer to the general health of the organization. High numbers indicate a positive organizational climate while low numbers would indicate firefighter dissatisfaction with the agency.

In a study that examined the relationship of pilot perceptions of organizational and safety culture to performance, Sexton and Klinec (2001) found that pilots with more positive attitudes toward their organization's culture performed better in the cockpit on safety-related tasks. They

also found an even stronger link between attitudes toward safety culture and pilot performance. Furthermore, the study found that attitudes toward safety and organizational culture are separate but highly related concepts. Therefore, the OCS can also be considered to be an indicator of the safety culture in an organization.

In a previous study (McDonald and Shadow, 2002), an OCS score of 80 and above was found to represent the high end of OCS scores collect previously among U.S. wildland fire agencies. Using that as a benchmark, Figure 5 shows the percentage of OCS scores that equaled or exceeded 80 for each year in the study.

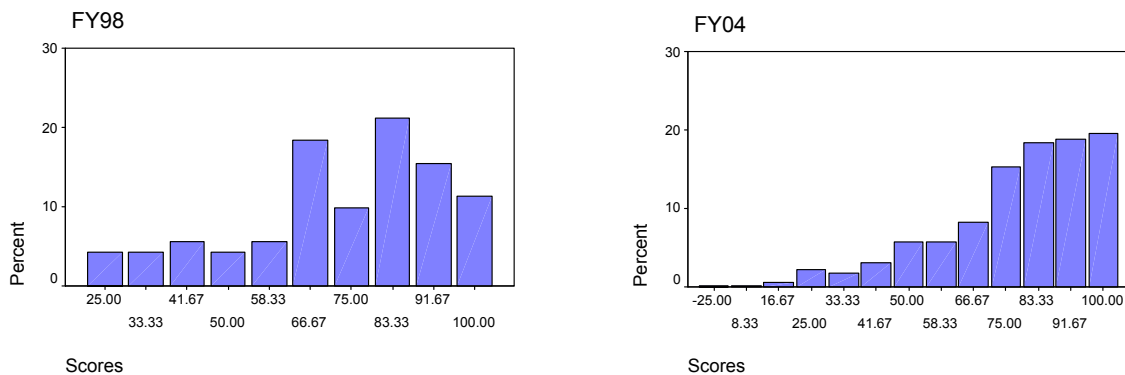
Figure 5 _ Percentage of Organizational Climate Scale Scores >80%



The shift to more positive scores was remarkably smooth and consistent over the last three years of the study. The FY98-01 baseline of 51% compared to the FY04 value of 57% shows a growth of 6 percentage points (+12%) for OCS scores that exceeded 80 for the period of the study.

Figure 6 shows the distribution of OCS scores for the Wildland Firefighting Industry (WFI) for the beginning and end of the study in FY1998 and FY2004 respectively. A comparison of the two charts details the positive shift in attitudes toward the organizations over the course of the study.

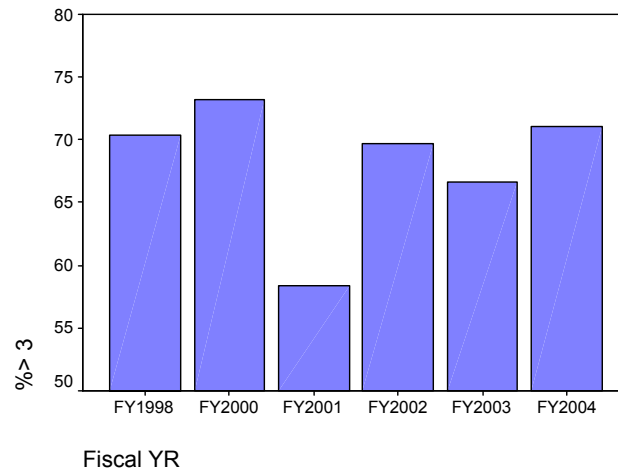
Figure 6 Comparison of FY1998 and FY 2004 Organizational Climate Scale Scores



The three CAQ items comprising the Organizational Climate Scale were examined to determine which items contributed to the improvements. The analysis was accomplished by

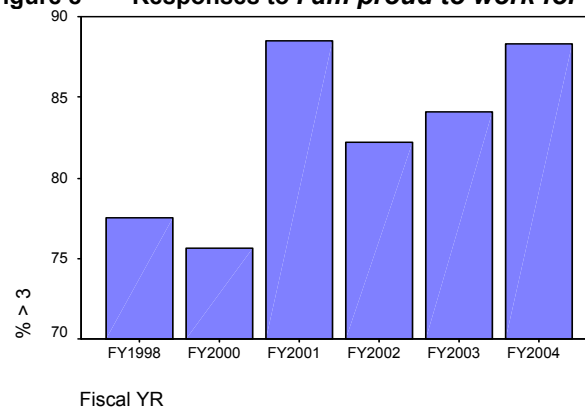
calculating the percentage of positive scores (agree or strongly agree) for each item. As shown in Figure 7, responses to the item *Working at my unit is like being part of a large family* remained unchanged, with approximately 70% of the respondents indicating they agreed or strongly agreed with the statement. (FY98-01 baseline = 67%.)

Figure 7 Responses to *Working at my unit is like being part of a large family.*

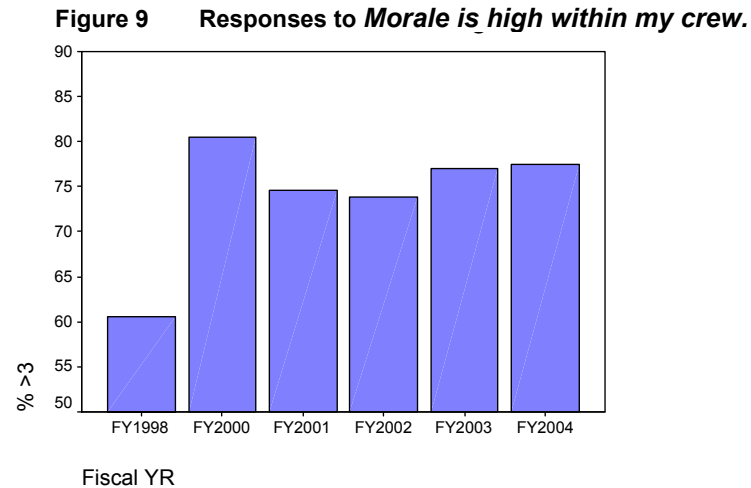


As shown in Figure 8, responses to *I am proud to work for this organization* increased 8 percentage points from the FY98-01 baseline score of 80% to 88% in FY2004 (+10%).

Figure 8 Responses to *I am proud to work for this organization.*



As shown in Figure 9, the FY98-01 baseline score averaged 70 for *Morale is high within my crew* then stabilized at approximately 78% for the remainder of the study (+11%).



In summary, OCS scores showed a noticeable increase over the course of the study. Most of the improvement was attributed to items dealing with pride in the organization and crewmember morale. While the overall standing of the agencies has been improving in the eyes of the respondents, the alignment of values and beliefs at the local unit levels has remained stable.

No items on the OCS showed downward or negative trends.

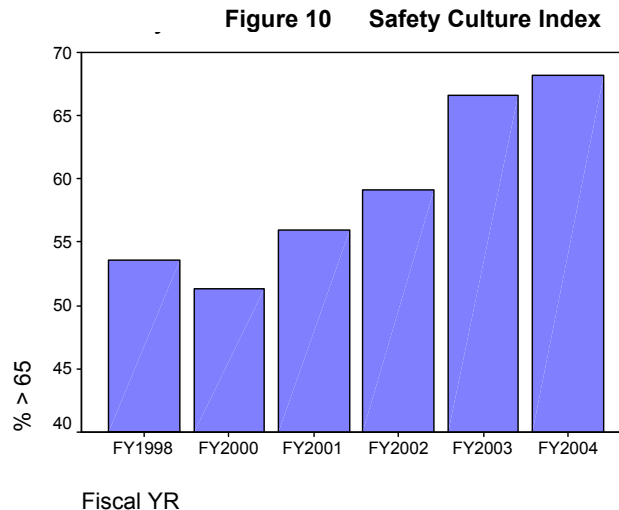
Safety Culture Index

A Safety Culture Index (SCI) was computed in the manner previously described for organizational climate scale and is composed of the following six survey items:

- *I am satisfied with Supervisor availability*
- *I am satisfied with Fire Ops Management at the local unit level.*
- *Fire Management (Forest/Park/District level) listen to us and care about our concerns.*
 - *I am encouraged by my supervisors and fellow crew-members to report any unsafe conditions I observe.*
 - *Fire Incident Management Teams will never compromise safety concerns for accomplishing the incident objectives.*
 - *My suggestions about safety would be acted upon if I expressed them to management.*

The Safety Culture Index also showed a smooth and consistent trend of improvement over the course of the study. In a previous study (McDonald and Shadow, 2003), the authors found that SCI scores for U.S. firefighting agencies ranged from 62 to 67, with a mean of 65.

Figure 10 shows a steady growth in the percent of SCI scores that equaled or exceeded 65. During the period of the study there was an increase of 14 percentage points (26%), from 54% in the FY98-01 baseline to 68% in FY2004.



Analyses of the items that comprise the SCI indicate mixed results, with four of the items receiving an increased percentage of endorsement. Two items relating to the level of satisfaction with local fire operations management (55%) and supervisor availability (60%) remained mostly unchanged over the course of the study. No items indicated a negative trend.

The following survey items which are tied to the SCI received an increased percentage of endorsement over the course of the study:

- *I am satisfied with Fire Ops Management at the local unit level. (+12 percentage points)*
- *Fire Management (Forest/Park/District level) listen to us and care about our concerns. (+14 percentage points)*
- *My suggestions about safety would be acted upon if I expressed them to management. (+14 percentage points)*
- *Fire Incident Management Teams will never compromise safety concerns for accomplishing the incident objectives. (+27 percentage points)*

The questions concerning the level of communication and caring of Fire Management, and trust in Fire Incident Management Teams were identified in Phase I as possible weak areas.

Perception of Safety and Incident Management Teams

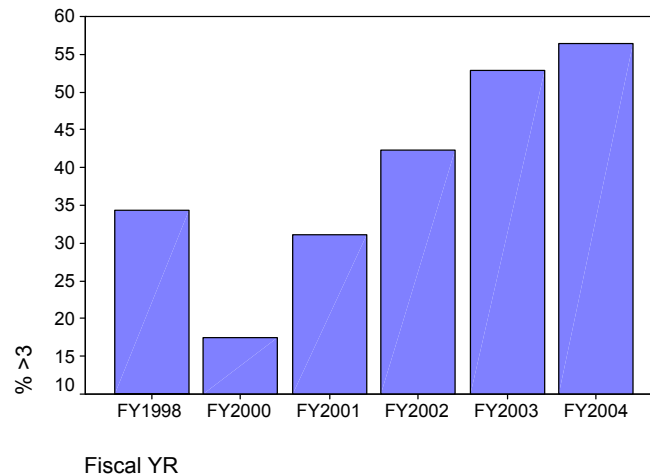
The CAQ study measured perceptions of management safety behavior, with questions distributed between Incident Management Teams (IMTs) and home unit management items. Although perceptions of home unit behaviors can have an upstream impact to organizational error and accidents, the actions of IMTs directly affect firefighter safety. In the Phase I report, the lowest rated safety item related to IMTs: *Fire incident management teams will never compromise safety concerns for accomplishing the incident objectives*. Approximately 30% of respondents agreed or strongly agreed with this statement in Phase I.

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 was particularly noticeable among helicopter-based crews, with 80% indicating that IMTs might be willing to sacrifice safety to accomplish incident objectives. The investigation team felt that the comparatively low number of helicopter crews represented in the survey by FY2002 might have influenced the result and that further examination in Phase II was warranted.

With the sample pool of respondents greatly increased since Phase I, a re-examination of this item regarding IMTs reveals that the percentage of respondents that feel positively toward IMT risk management practices has improved by 27 percentage points (+93%) from an FY98-01 baseline of 29% to 56% in FY04 (Figure 11).

Figure 11 Responses to *Fire incident management teams will never compromise safety concerns for accomplishing the incident objectives.*

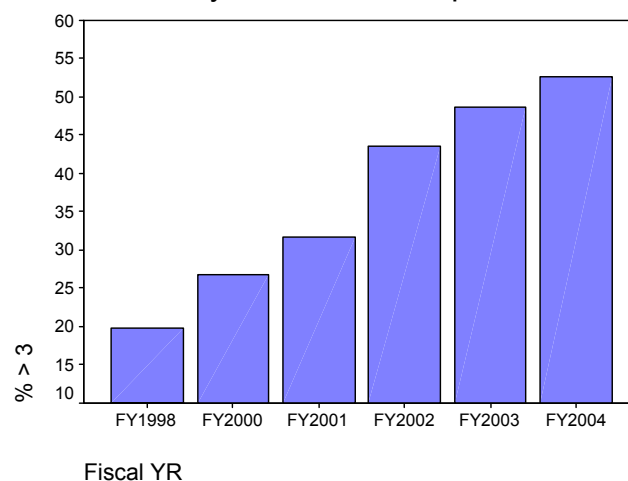


The low scores seen in Phase I with helicopter resources appear to have resulted from a small Phase I sample set. Subsequent helicopter respondents in FY03 and FY04 score near 50% (up from 20% reported in Phase I). IHC respondents, who were the second lowest rating group in Phase I at 35%, remained the lowest of the resource types surveyed with an improved average score of 44% in FY03-04.

Perception of Safety Officers

Also of special interest was the Phase I study result regarding the low acceptance of safety officers as effective role models. Although not a contributor to the SCI, Phase I findings concerning the item *Safety Officers are respected role models on the fireline* has attracted the attention of national agency safety organizations.

Figure 12 Responses to *Safety Officers are respected role models on the fireline.*



As shown in Figure 12, the Phase II study detected a noticeable positive trend in firefighters' perceptions of safety officers. The percentage of firefighters who agreed or strongly agreed with this statement increased 29 percentage points (+112%) from 26 % in FY98-01 baseline to 55% in FY2004.

Overall, all resource types surveyed in Phase I returned better scores on this item during Phase II, with helicopter respondents reporting the most improvement. Smokejumpers, though also improved, remain the least positive group on this item, with only 30% agreeing or strongly agreeing.

Conclusions Regarding Safety Culture

In the Phase I analysis, the structure of safety programs was 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. This gap continues in the FY2003 and FY2004 sample, but it is narrowing. Although the rules and doctrine guiding operational safety have not changed significantly during the study period, it is possible that safety officers have improved their level of effectiveness in the eyes of the firefighters in this survey.

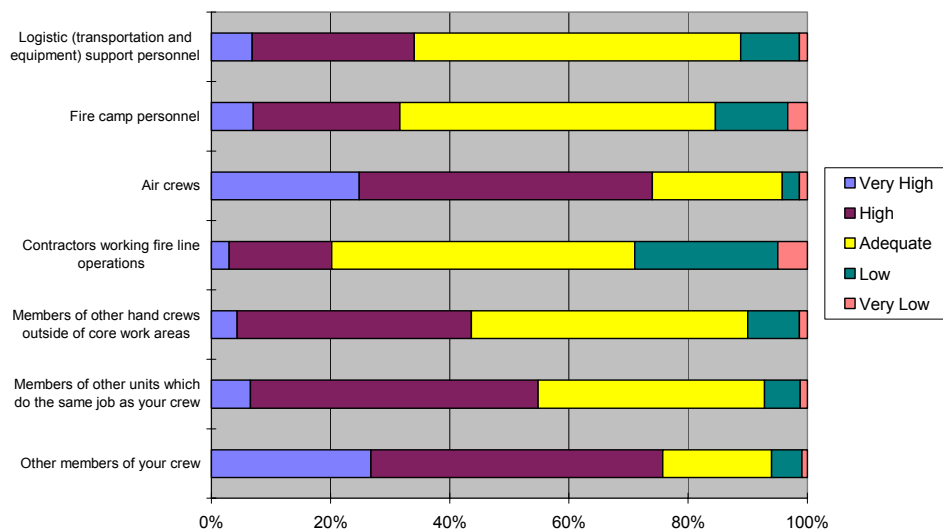
While the industry continues to rate a strong safety culture when compared to other industries, it appears that truly high scores of 70 to 80 may not be achieved for another four to six years at the current trend. For resources such as smokejumpers, this level of improvement may be much further off without specific interventions to engage this group of respondents.

Perceptions of Teamwork

In the Phase I analysis, researchers analyzed respondents' scores that measured the overall quality of teamwork with other groups. Seventy six percent of wildland firefighters rated the quality of teamwork and cooperation between themselves and other members of their crew as high or very high.

Figure 13 shows Phase I respondents' composite ratings for various groups involved in the firefighting effort.

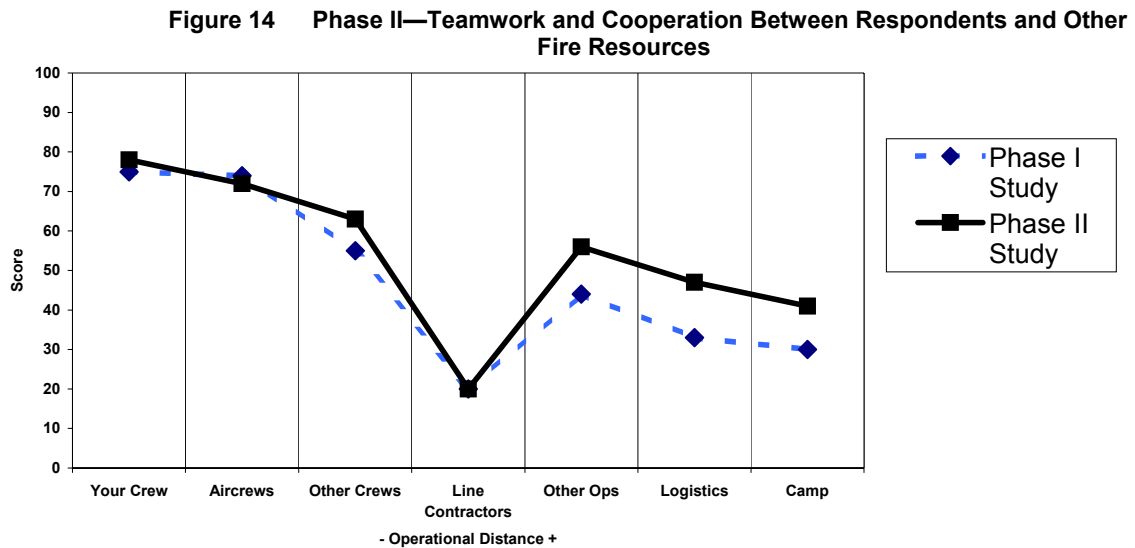
Figure 13 Phase I Findings—Wildland Fire Industry Composite: Quality of Teamwork and Cooperation Between Crews and...



Researchers theorized that the ratings reflected a natural progression relating to operational distance. Generally, firefighters perceived the highest quality of teamwork among the resources

working most closely with them on the fireline. However, in Phase I, this theory did not hold true with one group in particular: contractors. Overall, only approximately 20% of respondents gave a rating of high or very high to cooperation between crews and contractors.

In Phase II, teamwork and cooperation generally improved, especially with support resources such as logistics and other fire camp personnel (Figure 14).



Phase II data revealed the same natural progression of lower scores to increased operational distance as seen in Phase I, with the same exception for relationships with contract units.

Teamwork and cooperation with contractors working fireline operations continues to be the item with the lowest ratings with less than 20% rating it as high or very high in any year. This item shows no sign of change or improvement and indicates that contract crews are poorly integrated with their federal counterparts. When seen from an error management perspective, the item exposes a cultural weakness that potentially could affect safety and performance in operations where inter-crew trust and cohesion is needed (McDonald, 2004).

Attitudes toward Stress

The Phase I analysis on attitudes toward stress was based on the Threat and Error Model of Crew Resource Management (TEMCRM), described by Wilhelm, Helmreich, and Merritt (2001). According to this model, everyone is susceptible to error, and 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.

The Phase I analysis focused on items falling into three categories: general philosophy toward error, application of mitigation strategies, and personal effects of error.

Generally, Phase I researchers found that the majority of respondents showed 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.

Likewise, in Phase I, items measuring effective application of mitigation strategies also showed alignment with TEMCRM concepts. For example, the vast majority agreed with the statement *Crewmembers should monitor each other for signs of stress and fatigue*. Other

questions concerning the need for crewmembers to monitor each other's workload were also scored positively, indicating agreement that people should strive toward error mitigation for human performance failings.

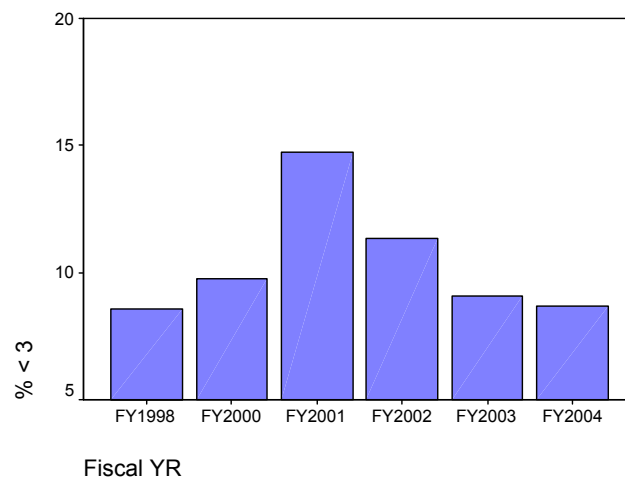
However, when the items focused on the personal effects of error, Phase I responses began showing an invulnerability that runs counter to TEMCRM concepts:

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

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

Phase II analysis found these trends unchanged. Responses continue to indicate a perception of invulnerability. For example, for *My decision making ability is as good in emergencies as in routine firefighting conditions*, only 8% to 15% of the respondents disagreed or strongly disagreed (Figure 15).

Figure 15 Responses to My decision making ability is as good in emergencies as in routine firefighting conditions



The apparent differences between willingness to embrace the premise of TEMCRM and acceptance of personal vulnerabilities may be traced to existing doctrine and training.

In general, the operational environment supports and reinforces the use of team-related error mitigation. In the past few years, human performance terminology and tools have been introduced and have expanded into the operational doctrine and terminology (NWCG IRPG). These human performance concepts and norms have been reinforced through the NWCG Leadership Training Curriculum (NWCG L-180, NWCG L-280, MCS L-380, MCS L-381). In these programs, team and doctrinal mitigations are emphasized more than individual awareness of personal weaknesses and vulnerabilities.

In this study, the direct effects of the leadership curriculum may be minor because most CAQ respondents had not been exposed to any of these programs at the time the survey was administered; however, there is evidence that the curriculum has impacted the operational environment with regard to maintaining critical safety in high risk situations (Southwest Area Incident Management Team, August 2003, and Southwest Area Incident Management Team, July 2004).

Both Phase I and Phase II findings indicate that respondents readily accept team and doctrinally-supported mitigations for stress and fatigue. However, in situations in which team

support is not available, firefighters may be unwilling or unable to enact personal mitigations because they do not have self-awareness that encompasses their personal vulnerabilities to stress and fatigue.

Conclusions and Recommendations

- The data gathered from responses to the CAQ indicates that the wildland fire culture is strong when compared with other industries and has improved over the course of the study. Given the diversity of respondent training and experience represented by CAQ respondents, this improvement likely has not resulted from any specific training program, policy, or doctrinal change but probably reflects a combination of all of the above.
- Of the five areas identified in the Phase I study as being potentially weak, three areas—attitudes about IMTs, Fire Management, and Safety Officers—have shown marked improvement. Safety officer acceptance showed the most improvement but is still relatively low overall. No item on the questionnaire trended negatively from Phase I to Phase II.
- Trust and cooperation between contract crews and federal crews remains weak, even while improving with many other support units. This investigation offers no illumination on why this issue is present; however, it has remained a consistent finding for the past few years. The investigators recommend that the agencies investigate this issue further to validate the finding and identify the root causes of attitudes toward this specific group so that solutions can be found.
- Although the concepts of TEMCRM are widely accepted, respondents have not yet internalized the concepts enough to admit personal vulnerability to stress impacts. Although exposure to these concepts occur during leadership training and respondents were surveyed pre-training, leaders must have enough experience and ongoing performance feedback so that they can begin to recognize and address personal weaknesses and construct mitigations to address them. Beyond formal initial training, leadership development efforts should include ample opportunities for practice, trial and error, and feedback so that personal strengths and weakness can be identified and performance improved independent of the supporting team.

Future of the CAQ Study

The CAQ was implemented in November 1997 to gain a baseline on wildland fire culture, with only vague ideas about where it might lead but with the faith that it would provide a snapshot that could be used later for comparisons. It has provided a good measurement against other industries, and it has provided a general cultural picture of how the organization is seen by its first line supervisors. In addition, it has provided a general picture of where the organization has gone in the past five years. In most cases, it provided the answers that the investigators were seeking.

As a general cultural study, it cannot provide more detailed information on such issues as training effectiveness, management communication with employees, or specific reasons why the culture is perceived the way it is. It has, however, led to questions that need more detailed investigation to illuminate.

In January 2005 MCS management decided to terminate the CAQ study project so that research funding supplied through the MCS Fireline Leadership tuition program could be used for some of the specific investigations called for in Phase I and II of this study. CAQ data will be gathered through the end of the 2005 training season; however, no further analysis is scheduled

on the dataset, which now exceeds 4000 respondents. MCS will retain the data for future analysis if needed. In a few years, a subsequent review may be beneficial to build on the current work, similar to what was accomplished in Phase II. The investigators thank the agencies and the respondents for their assistance with this effort these past years.

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