FORESTS, FIRES, AND FLIGHTS:

EXAMINING SAFETY AND COMMUNICATION PRACTICES WITHIN AERIAL FIREFIGHTING TEAMS

by

Amber Lynn Marie Scott

A Dissertation Presented to the
FACULTY OF THE USC GRADUATE SCHOOL
UNIVERSITY OF SOUTHERN CALIFORNIA
In Partial Fulfillment of the
Requirements for the Degree
DOCTOR OF PHILOSOPHY
ANNENBERG SCHOOL FOR COMMUNICATION AND JOURNALISM

August 2023

Copyright 2023 Amber Lynn Marie Scott

Epigraph

Famous Friends
Chris Young and Kane Brown
2020

My buddy Brandon holds a record
For single season touchdown throws
And good old Johnny, he's the life of every party
It's like Cheers, they know him everywhere he goes
I've got some famous friends you've probably never heard of
But back in Rutherford County our crowd is second to none
You might not know 'em here in this big city we're in
But when I go back home, I've got some famous friends
Yeah, I do

My buddy Jason, he's the sheriff
He'll flash his lights but let me go
My boy Randy, he's a preacher
My girl Megan, she's been Teacher of the Year
I swear for five years in a row
I've got some famous friends you've probably never heard of
But back in Hamilton County our crowd is second to none
You might not know 'em here in this big city we're in
But when I go back home, I've got some famous friends
Yeah, I do

I got friends in high places on these small-town roads
'Cause 'round here it's all about the people that you know
And I've got some famous friends you've probably never heard of
But back in Davidson County our crowd is second to none
You might not know 'em here in this big city we're in
But when I go back home, I've got some famous friends
Yeah, I do
Yeah, I do

Might not know 'em here in this big city we're in
But when I go back home I got some famous friends, yeah
I've got some famous friends (I've got some famous friends)
Yeah

Dedication

This dissertation is dedicated in honor of three U.S. Marines that each changed my life in vastly different ways.

The untimely deaths of Major Taj "Cabbie" Sareen in 2015 and my Blue Angel #6 teammate Captain Jeff "Kooch" Kuss in 2016 compelled me to leave my U.S. Navy career and research solutions to ongoing high reliability organization and team safety issues. Without the painful loss of these two amazing men this project would never have been started; it is because of these two Marines that this project first took flight.

I finished this study because of a third Marine—Major Mike "V-Dubs" Van Wyk. During the most difficult moments of this project, he reminded me of my purpose and served as my guiding light. I will forever be filled with gratitude for his unending love and unconditional support.

Without all three of these incredible individuals changing my life in different ways, this project never would have become what it is today. I continue to endeavor in this work in honor of their sacrifices and memory.

Semper Fidelis.

USMC MAJ Taj "Cabbie" Sareen
May 7, 1981 - October 21, 2015

USMC CAPT Jeff "Kooch" Kuss
September 9, 1983 - June 2, 2016

Acknowledgements

First and foremost, I wish to thank my partner Mike (aka Porky) for his unending support throughout the roller coaster ride that every dissertation becomes. On the days that I wanted to walk away from it all, you were always there to remind me of my bigger mission and why my work matters. On the days I did not want to listen, you reminded me of Danny Riccardo's sage words and guided me back to my work with coffee and a hug. You carried a significantly larger portion of our lives when my writing and research was all-consuming, and you NEVER complained. EVER. Thank you for being a true partner in every sense of the word – I love you.

I also wish to thank my qualifying exam and dissertation committee members for their helpful feedback and continued guidance, including Professors Michael Cody, Andrea Hollingshead, Sheila Murphy, Patti Riley, and Ryan Bisel. You have all shown me different ways of being a scholar and researcher, and I am grateful for all your unique examples. Patti, thank you for serving as my chair and for giving me five years filled with laughter, commiserating, and lots of great advice. Ryan, thank you for initiating the life-changing conversation during your spring 2006 advanced programs small group communication course when I offhandedly mentioned I had always wanted to get my Ph.D. It is because of you that I started this program, and it is because of your unending support and mentorship that I am finishing it, too. You saw my potential long before I did.

To my entire extended family—thank you for loving me through this process despite not always understanding my journey to leave behind my professional career and become an academic. Thank you for reminding me to always be a good example, and to also stop and have some fun, too. I love you all very much. Sergio, Cali, and Bella—thanks for reminding me that there is life (and meaning) beyond work.

To the many communication scholars who sat through very early presentations of these findings, thank you for your kind and helpful feedback. So many of you helped me see opportunities to make this study better, and I am sincerely grateful to you all, especially Joshua Barbour, Stefi Demetriades, Jody Jahn, and Nathan Walters. I would also like to thank the amazing "pod people" Minkyun "Min" Kim, Cameron Piercy, Sarah Riforgiate, and Brett Robertson for their great mentorship, friendship, food recommendations, and giggles over the past three years. To my "Team Bisel" OU family, especially Ryan Beaty, Rebecca Greer, Maria Howe, William Howe, and Arden Roeder—thank you for adopting me as part of your team. You are the best friends and research collaborators anyone could ask for. To my USC colleagues—I wish you the very best in both fulfilling your potential and following your dreams.

To the men and women of the California Department of Forestry and Fire Protection (CAL FIRE) Aviation Department, THANK YOU. I will never forget any of the stories and moments that we shared over the course of this project, and I will be eternally grateful for every one of you opening yourselves up to me so that I might better understand how you do what you do so well. You have all changed my life for the better, and I am proud to share your stories. Josh Nettles and Mitch Hubbard, you both made this project better than I ever could have imagined, and I am grateful for your ongoing friendship and unfailing support.

To those that I have may have forgotten to mention by name, I ask forgiveness. The 24+ months of this project included many individuals that shaped it but were inadvertently not mentioned. You are still very much adored and appreciated.

Funding for this study was provided by the Annenberg Fellowship for Continuing/Advanced Ph.D. Student research award and the Annenberg Dissertation Fellowship research award.

TABLE OF CONTENTS

List of Tables

List of Figures

Abstract

High reliability organization theory principles (Weick & Sutcliffe, 2015) dictate *deference to expertise* (i.e., migrating decision authority to those with the most expertise, regardless of rank) as a key requirement to operationalizing and preserving safety in high-risk environments, but research has failed to clarify empirically how expertise within high reliability teams is defined, trained, and realized in situ. This study explored how aerial firefighting teams define and train the experts responsible for aerial firefighting operations, and how both training and socialization support efforts to share expertise with authority figures during wildland fires. Utilizing over 220 hours of in-person observations and 43 semi-structured interviews with members of the largest civil aerial firefighting organization in the world, this study found that establishing expertise credibility through specific communication practices prior to an unfolding crisis assists teams in initiating, facilitating, and coordinating expertise during initial attack fires while also preserving safety. This study also identified a new communication method of expertise and authority exchange, named *Appeal to Authority*. Appeal to authority is a communication effort by experts to smooth communication with authority figures that results in a pulling of authority to experts, rather than reliance upon authority figures to push expertise down and around to experts. The implications of this study include: (a) clearer articulation of how the high reliability organization (HRO) theory principle deference to expertise is realized within a high reliability team, (b) explanation of how knowledge transfer unfolds in a high reliability organization built on a primarily oral communication culture, and (c) illustration of how defining expertise supports trust development and reliable communication in high reliability teams. This study contributes a more detailed understanding of the ways high reliability teams enact *deference to expertise*

during high-risk tasks and how communication performances contribute to safe high reliability team operations.

Keywords: High reliability organization theory, high reliability teams, communication and safety, trust and safety

Introduction

This study clarifies elements of high reliability organization (HRO) theory (Weick & Sutcliffe, 2015) as it unfolds in situ within high reliability teams. Specifically, it focuses on explaining how one of the theory's five cultural principles—*deference to expertise*—progresses within a typical HRO, especially during times of organization and team crisis. The study interrogates how expertise is defined, created, trained, and reinforced within a high reliability team (HRT). To date, much of the literature on high reliability organization theory tends to describe *ideal* organizational and team operations, rather than how members interact, communicate and collaborate in *real* culturally-flawed, operationally-overtaxed, or otherwise challenging, material work environments. These organizations are known for their ability to conduct their operations successfully and safely yet there have been unfortunate outcomes in the past that these units analyze and train to prevent in the future.

This study examines the principles and theories of high reliability organizations and uses one of these underlying principles, *deference to expertise,* as a window to frame a case study analysis of a successfully high-performing, but continuously challenged, high reliability organization. This study's analysis serves three important purposes: (a) it moves researchers closer to understanding the theoretical scaffolding that underpins successful and safe organizations; (b) enables the hypothesizing of increasingly successful solutions to outcomes such as preventable fatalities in high-risk organizations or increased speed of information and knowledge sharing; and (c) it successfully argues the inescapable role communication plays in establishing and maintaining organizational reliability.

The Importance of California Aerial Firefighting Teams

As climate change continues to exert pressure on wildland firefighters and extend California's wildfire season, the need to attack and suppress small wildfires quickly is a top priority for firefighting organizations, state politicians and their citizens (State of California, 2022). The term *initial attack* fire refers specifically to the initial firefighting resources dispatched to a fire, whereas the term *extended attack* is used for fires with a complexity level increasing beyond the capabilities of initial attack incident command (United States Department of Agriculture, 2006). The suppression of small wildfires is referred to as an *initial attack*[1] fire response and regularly includes: (a) an *incident commander* (IC) responsible for overall management of the incident, (b) a cadre of crews on the ground inclusive of firefighters and machinery, and (c) an aerial firefighting team of fixed-wing or rotary aircraft led by an *air tactical group supervisor* (ATGS).

In an effort to maintain responsiveness to initial attack fires, the California Department of Forestry and Fire Protection (CAL FIRE) maintains a network of aviation assets designed to have an aircraft over any new fire in a State Responsibility Area (SRA) within 20 minutes of notification (*Air Operations*, 2023). In 2021, California Governor Gavin Newsom invested over $2 billion in wildfire emergency response preparation, which included the addition of 12 exclusive-use firefighting aircraft for the California Department of Forestry and Fire Protection (CAL FIRE) Tactical Air Operations division (State of California, 2021). Tellingly, nine of those aircraft were immediately dispatched to begin combatting wildfires across the state within hours of the funding announcement.

Behind these well-publicized numbers, the true cost of what unfolds when initial attack efforts fail to contain wildfires are sobering. Namely, losses of homes and human lives: In 2022,

[1] For an exhaustive list of all fire terms, please see the glossary on pages 185 through 199.

CAL FIRE reported nine civilian fatalities, 876 structures lost, and more than 363,000 acres burned, with more than 150,000 acres attributed to the three largest fires that year (CAL FIRE, 2022e). Despite its tiny-sounding name, the Mosquito Fire ultimately became the largest California wildfire of 2022, burning more than 76,000 acres and outpacing the McKinney Fire that burned more than 60,000 acres (CAL FIRE, 2022c). The McKinney Fire was a particularly devastating fire for California residents, destroying 185 structures and taking the lives of four citizens (CAL FIRE, 2022b). In each instance, initial attack efforts failed to contain small fires, resulting in tremendous losses.

Background: The State of Fighting Fire: Initial Attack, "Air Attack," and the Incident Commander

The California Department of Forestry and Fire Protection (CAL FIRE) generously offered itself as a case for this study in order to learn from the research and put any new understandings into action. This type of firefighting entity is primarily focused on initial attack wildfire response. Depending on the location and fuels in the area, this could include aerial firefighting teams in addition to the deployment of ground firefighting crews. Within the state of California, CAL FIRE serves as the primary firefighting agency tasked with responding to any fires occurring within a state responsibility area (SRA) and maintains an industry-standard organizational goal of keeping 95% of fires to 10 acres or less (CAL FIRE, 2022d). To reach this goal, aerial firefighting assets are often dispatched at the earliest possible opportunity to ensure smaller fires do not gain traction and grow out of control. A significant part of this effort involves heavy use of aircraft for initial attack, overseen by one key member of the aerial firefighting team: the air tactical group supervisor (ATGS).

The air tactical group supervisor, commonly called an “air attack” in firefighting circles, is defined by policy as responsible for directing, coordinating, and managing all airborne aircraft during a wildfire incident (United States Department of Agriculture, 2006). During an initial attack, the air tactical group supervisor coordinates a cadre of fixed-wing and rotary-wing aircraft in the disbursement of water and fire retardant. Disbursements contain a fire until ground crews can arrive and extinguish the blaze. Although the air tactical group supervisor maintains authority over all aviation assets flying during a fire, the ultimate responsibility for the entire initial attack resides with the incident commander, commonly referred to as the IC.

In the United States, national policy dictated by the National Wildfire Coordinating Group (NWCG) outlines that air tactical group supervisors report directly to incident commanders during an initial attack response. The National Wildfire Coordinating Group sets the standards and position requirements for aerial fire responses, defining the responsibilities of air tactical group supervisors inclusive of “managing the incident airspace and coordinating the fixed- and rotary-wing aircraft operations over an incident” (National Wildfire Coordinating Group, 2022a). While the responsibilities for incident commanders may vary slightly depending on the type of incident response (i.e., differentiation between Type I, II, II and IV fires, as well as complex fires), the general responsibilities for incident commanders include “all aspects of emergency response, including developing incident objectives, managing incident operations, setting priorities, defining the organization of the incident management team, and the overall Incident Action Plan” (National Wildfire Coordinating Group, 2022b). Thus, a rigid hierarchy is clearly defined and designed to ensure all wildfire operation activities facilitate clear communication and a seamless flow of actions for “safe, effective, and coordinated national interagency wildland fire operations.”

During the course of this study, it became clear that the rigidity of this hierarchy can be problematic for supporting safe operations during a crisis such as a developing fire, particularly if those in authority lack appropriate expertise or are unaware of unfolding circumstances. The enactments of expertise and the concurrent leadership decision functions remain a relatively underexplored area of interest within high reliability organizations. Certainly, frameworks have been developed and implemented within the fire service to address some of these commonly known challenges, such as policies and procedures including operational risk management (Branlat et al., 2009; Stonesifer et al., 2014) and crew resource management (Griffith et al., 2015). Yet, the "doing of expertise" during a crisis opens up a fascinating, complex and ephemeral communication phenomenon, among many, that is in need of deep investigation.

Research Questions

The object of this study is to: 1) identify the boundary conditions of high reliability organization theory in the context of aerial firefighting, including how the HRO theory principles unfold in the context of real and messy crisis operations. Through a case study examination of modern high reliability teams (i.e., the aerial firefighters of CAL FIRE) grappling with increasing operational risk and safety pressures largely beyond organizational control (e.g., increased fire severity), this study is the first field study to investigate how the high reliability organization theory principle deference to expertise is enacted outside of idealized models of high reliability organizations.

High reliability teams are grounded in social systems that depend upon reliability to ensure safe operations. Communication scholars continue to be enamored with understanding the innerworkings of these teams, including how wildland fire crews (Jahn, 2016), municipal firefighters (Minei & Bisel, 2012), nuclear power plants (Barbour & Gill, 2017), and emergency

weather forecasters (Roeder, Bisel, & Howe, 2021) manage to operate under dangerous conditions while simultaneously avoiding horrific or costly accidents. High reliability organization theorizing (Weick & Sutcliffe, 2001) established five core principles for high reliability organizing, including preoccupation with failure (i.e., viewing near-miss accidents as opportunities to improve), reluctance to simplify (i.e., rejection of simplification and acceptance of work complexity), sensitivity to operations (i.e., awareness that unfolds in real time that is anchored to the present), commitment to resilience (i.e., the ability to detect, contain, and bounce back from inevitable errors), and deference to expertise (i.e., authority moves to those with the most expertise, regardless of rank). Today, these five core principles grounded in the concept of mindfulness remain the backbone of high reliability scholarship. The study of high reliability organizations and their associated core principles has generated a multitude of communication scholarship and insights, including research on organization assimilation (Myers, 2005; Myers & McPhee, 2006), expertise definitions (Minei & Bisel, 2012), sensemaking (Miller & Horsley, 2009), participatory communication practices (Novak & Sellnow, 2009), and organization collaborations (Rice, 2021), among others. In an effort to expand this broad collection of communication scholarship on high reliability organizations and teams even further, this exploratory field investigation began with a relatively broad research question: *How does high reliability organization theory unfold in a modern high reliability team, and what role does communication play in the enactment of high reliability organization theory*? While many communication scholars have written empirically strong studies of high reliability organization theory relevance (see Barbour & Gill, 2017; Bisel, 2018; Jahn, 2019; Williams & Ishak, 2018), to date no study has primarily centered their investigation on how high reliability organization theory principles might be realized beyond ideal operations, such as a high reliability

organization experiencing increasing internal and external safety challenges. Noting the increasing challenges faced by CAL FIRE including increased interagency dependency, financial constraints, and the impacts of climate change on their overall environment, this research study began by focusing directly on addressing this critical gap in the literature, eventually narrowing the focus to one of the five high reliability organization theory principles: deference to expertise.

Deference to Expertise: Observing Teams in Action at CAL FIRE

With the afore-mentioned question of respectful yielding in mind, I approached the California Department of Forestry and Fire Protection (CAL FIRE) seeking answers to how communication, including high reliability organization theory principles, unfold *in situ* amongst high reliability teams during high-risk operations. The decision to focus on the CAL FIRE organization as a case study for high reliability communication was made for two key reasons: (a) there exists a paucity of research in HRO literature on aerial wildland firefighting operations, and (b) the CAL FIRE organization is the world's largest civil aerial firefighting organization and has maintained an admirable record of reliability and lack of casualties in aerial firefighting—despite increases in safety threats over the previous decade and a record number of global fatalities occurring within similar high reliability organizations (Australian Transport Safety Bureau, 2020; Gilbert, 2022). While the last two decades of HRO theory literature has included communication studies of municipal firefighters (Minei & Bisel, 2012), wildland firefighters (Jahn, 2016, 2019; Jahn & Black, 2017a; Williams & Ishak, 2018; Ziegler, 2007), and aviation crews (Fraher, 2013; Roberts & Bea, 2001; Salas et al., 2001), to date no case study had focused exclusively on the operations of *aerial* wildland firefighting teams. In the state of California, CAL FIRE's Tactical Air Operations (TAO) was established in 2008 to address the organization's reliance on aerial firefighting to combat the unprecedented frequency and

intensity of the state's wildfires (J. Schwartz, 2020), and today the organization serves as the largest dedicated aerial firefighting fleet in the world (CAL FIRE, 2022d).

My expertise as a communication scholar, my advanced knowledge of aviation safety protocol, high reliability team experience, and my decades of experience as a rural resident of southern California made me uniquely qualified to undertake this study. My qualifications earned the endorsement of CAL FIRE Tactical Air Operations to investigate how their aerial firefighting teams operated with a high degree of reliability despite increasing challenges to team safety (e.g., increasing fire severity and aging aircraft), and in the summer of 2021 I began what would amount to more than 15 months of field observations, including embedding with air tanker bases and interagency helitack teams, attending interagency trainings, observing maintenance facilities operations, and observing and participating in training exercises.

During the initial in-person observation period at a southern region CAL FIRE air tanker base exploring the initial RQ_1, the need to further focus the research question with unfolding observations became clear, and RQ_1 was revised:

> RQ_1: How does the cultural principle *deference to expertise* unfold communicatively in a high reliability organization?

The observation period immediately following the revision of the initial research question led to more intense focus on team interactions during fires, where an additional research question arose regarding how expertise is developed and defined within a HRO. Interviews and informal discussions with CAL FIRE personnel at all levels of the team hierarchy proved helpful in clarifying some expertise development questions; of note, during these conversations team members often repeated that the critical expertise the air tactical group supervisor played a decisive role in initial attack success or failure. By narrowing my focus in the field to one type of

expertise enactment during a wildfire response (i.e., the air tactical group supervisor) a second research question emerged designed to better understand how expertise may be developed and shaped by a high reliability organization's culture and how those elements might impact the process of deference:

RQ_2: How is *expertise* defined and trained by members of a HRO?

Key Contributions

After more than fifteen months in the field focusing on these two research questions, analysis uncovered important insights that clarifies HRO theory and how the principle of deference to expertise is supported in an operational team. First, this study uncovered how multiple organizational elements may influence high reliability principle enactment in high reliability teams in ways not previously identified in high reliability principle literature, including the important role that advanced defining of expertise might play in influencing the emergence of deference to expertise in situ. Specifically, this study found that beyond initial expertise (re)definitions that were broadly referenced under the term *street credit*, the refinement of additional expertise definitions occurred during specific socialization and training periods, (i.e., the air tactical group supervisor training and recertification program). Thus, expertise definitions were not constrained within a short period of time, but instead were part of an ongoing process within the CAL FIRE organization, with refinement of air tactical group supervisor street credit expertise occurring during and after the air tactical group supervisor training process.

Second, another objective of this study is focused on providing tangible, practical advice to high reliability teams on how to execute high reliability principles most effectively while attending to real constraints, challenges, and contexts. The findings of this study clarify how

expertise is trained within a HRO that is simultaneously under the extreme pressures of budget constraints, interagency dependency, and climate change. The case study demonstrates how training communication strategies during the early phases of a program are thought to influence how high reliability principles (i.e., deference to expertise) are enacted during crisis (e.g., initial attack fires). Additionally, this case study notes how communication performances can support decision making authority distribution within teams during a crisis. It also provides important considerations for practitioners tasked with safety program creation and implementation and addresses how training to address organizational communication might strongly influence how high reliability principles are realized by a high reliability team during both day-to-day operations and an emerging crisis. These findings support current industry efforts to adopt HRO principles including aviation (Burke et al., 2005), disaster response (Jehn & Techakesari, 2014), firefighting (Barton et al., 2015), and health care (O'Leary et al., 2011; *Veterans Health Administration*, 2021; Wilson et al., 2005).

Chapter 1: Literature Review and Theoretical Frames

High Reliability Organization (HRO) Theory

Current theorizing about high reliability organizations (HROs) in the field of communication is predominately framed by a viewpoint that HROs are a process-driven entity born from environments that are hazardous, unpredictable, and dynamic (see Cantu et al., 2020). In response to these environments, HRO members act in a manner by which they may anticipate, respond, and manage these unpredictable environments with a high degree of reliability and safety. Empirical literature on communication practices that support organizing for high reliability and safety include studies of member assimilation (Myers, 2005; Myers & McPhee, 2006) collaboration translation (Rice, 2021), communication hierarchy pattern development (Jahn & Black, 2017), communicative resilience (Roeder, Bisel, & Morrissey, 2021), crisis communication framework development (Williams et al., 2022), experience borrowing (Ishak & Williams, 2017), floating (Roeder, Bisel, & Howe, 2021), negotiation (Minei & Bisel, 2012), questioning norms (Barbour & Gill, 2017), sensemaking (Williams & Ishak, 2018) and voice enactment (Jahn, 2019), among others (see Scott et al., 2022).

The birth of HRO theorizing began in the 1980s, where two different research movements focused on organizations in high-risk environments (Scott et al., 2022). The first movement investigated the inevitable failure of complex organizational systems, or what became commonly referred to as *normal accidents* (Perrow, 1984). The second movement investigated high-risk organizational systems operating without—or nearly without—failure (see Roberts, 1989; Roberts & Rousseau, 1989; Rochlin et al., 1987). A diverse group of University of Berkeley scholars led a groundbreaking examination of three organizations—the Federal Aviation Administration Air Traffic Control System, U.S. Navy aircraft carriers, and Pacific Gas

and Electric—for similarities in their ability to operate reliably despite their high-risk, complex and dynamic environments (Roberts, 1989a; Roberts & Rousseau, 1989; Rochlin et al., 1987). In 1989, Karlene H. Roberts published the first of several papers that marked these high-risk groups under the term, *high reliability organizations (HROs)* and coined their operational requirements under the theoretical construct of similar name, *high reliability organization (HRO) theory*.

The current HRO theory framework emerged in three phases. First, researchers identified common characteristics of these high-risk organizations, including (a) *hyper-complexity*, (b) *tight coupling*, (c) *extreme hierarchical differentiation*, (d) *large numbers of decision makers in complex communication networks*, (e) a *high degree of accountability*, (f) a *high frequency of immediate feedback*, (g) *compressed time factors*, and (h) *simultaneous critical outcomes* (Roberts & Rousseau, 1989). While many organizations might exhibit some of these characteristics at any given period, the key differentiator of a HRO was the simultaneous presence of *all* characteristics. A decade later, HRO theory shifted from high-risk operations to mainstream organizations outside of a high-risk environment through the addition of the mindfulness concept (Weick et al., 1999). Mindfulness—otherwise known as organizational learning—is an organizational positioning focused towards the "discovery and correction of errors" (Weick et al., 1999, p. 68) through a "rich awareness of discriminatory detail" coupled with a "capacity for action" (Weick & Sutcliffe, 2006, p. 516). In short, organizational mindfulness is the human capacity to detect and correct errors and to adapt to unexpected events before small factors develop into catastrophic failures (Fraher et al., 2017). The introduction of the mindfulness element served to argue that mainstream organizations, such as those in the early stages of organizational life, could find themselves in complex, rapidly changing, and tightly coupled organizational environments just like those of high-risk organizations. Although the

reliability-seeking outcomes of mainstream organizations may often differ from those of high-hazard organizations, both organizations ultimately share the goal of mindful organizing, marking them as more similar than different in terms of organizational processes. Thus, the concept of mindfulness emerged and remained a critical element of high reliability organizing, further enriching the existing HRO model and more strongly connecting communication to HRO theory (Bisel, 2018).

The third phase of the HRO theory model was defined by the identification of five core principles of high reliability organizing. In *Managing the Unexpected* (2001), Weick and Sutcliffe suggest successful high reliability organizations are guided by five key principles that support organizational efforts to enact mindfulness: (1) *preoccupation with failure* (i.e., continuous attention to anomalies that could be symptoms of larger problems in a system), (2) *reluctance to simplify* (i.e., rejection of simplifications in order to remain attended to weak signs of the unexpected), (3) *sensitivity to operations* (i.e., awareness, alertness and action that unfolds in real time and is anchored in the present), (4) *commitment to resilience* (i.e., the ability to detect, contain, and bounce back from inevitable errors that are part of an indeterminate world), and (5) *deference to expertise* (i.e., authority migrates to those with the most expertise, regardless of their rank). These five core principles clarify the organizational member behaviors that establish and maintain high reliability in HROs and remain the backbone of HRO theory today. Communication studies interrogating the operationalizing of HRO principles include Roeder and colleague's examination (2021) of how team cognition enacts reluctance to simplify, sensitivity to operations and deference to expertise, as well as Jahn and Black's analysis (2017) of team communication used to overcome hierarchy challenges and enable deference to expertise, sensitivity to operations, and reluctance to simplify.

Culture of Reliability

The five core principles of high reliability organizing are built through a cultural infrastructure that is focused on enabling and enacting the collective safety-focused capabilities of a high reliability team (Vogus et al., 2010). This cultural infrastructure is built and upheld through behavioral norms, actions, and interactions that support the organization's safety and reliability goals. When team members consistently enact, reenact, and translate these norms into meaningful daily practices and patterns, a culture of high reliability is established and maintained within an organization (Sutcliffe, in press). Although HRO culture is dynamic and will evolve over time, reliability-centered culture consistently includes focusing on an organization's (a) *vulnerability*, (b) *intelligent wariness*, (c) *collective responsibility and accountability* for both safety and reliability, (d) *structured protocols and checklists* to anticipate and respond to mistakes, and (e) *behavioral norms and practices* for relating within the organization (Sutcliffe, 2018, in press; Weick & Sutcliffe, 2007).

Embedding high reliably into an organization's culture requires the crucial elements of both *heedful interrelating* and *respectful interaction* within teams (Sutcliffe, 2011, in press). In HROs, heedful interrelating speaks to the general understanding that high reliability organizations work in chaotic environments where the coordination of actions can rapidly collapse, and thus interactions are social processes that must be approached as a contribution to a system rather than an individual autonomous task (Weick & Roberts, 1993). High reliability organization team members exhibit heedful interrelating when they (a) perceive and understand how *their work* fits into the larger goals of the organization system; (b) perceive and understand how their work connects *to others* in the system to achieve the larger goals of the system; and (c) remain mindful of how their work supports and fits with others in the system, including

willingness to deprioritize individual goals to advance shared organizational goals (Sutcliffe, in press; Weick & Roberts, 1993).

In communication literature, the umbrella term of *respectful interrelating* is used to described how elements such as mutual trust, honesty, respect, and attention are utilized by team members to coordinate information, share insights and concerns, and facilitate team action (Jahn & Black, 2017; Vogus, 2004). Respectful interactions between team members in HROs reduce the possibility for confusion or misunderstandings (Sutcliffe, in press) and have been directly linked to trust, a critical component of HRO culture (Burtscher et al., 2018; Cox et al., 2006; Vogus & Sutcliffe, 2011).

Trust in High Reliability Organizations (HROs)

High reliability organizations operating with a high degree of reliability are characterized by organizational norms of trust and respect (Cox et al., 2006; Jahn & Black, 2017; Sutcliffe, 2011). Norms of trust in HROs serve to support team members in feeling safe and more willing to speak up and use their voice, especially during times of crisis (Vogus & Iacobucci, 2016). Therefore, an important focus of HRO culture is an ongoing effort to cultivate trust in teams (Burtscher et al., 2018). Without trust, team members are less likely to speak up when identifying minor errors or vocalize questions that might indicate emerging problems within the HRO system (Barbour & Gill, 2017; Minei & Bisel, 2012; Rice, 2021). Conversely, when team members feel trusted and respected within a team, they are more likely to contribute their voice to discussions or speak up with concerns (Edmondson, 1999; Edmondson & Lei, 2014; Okuyama et al., 2014) In HROs, trust can counteract tendencies built within rigid hierarchies to limit or silence team member voice (Barbour & Gill, 2017; Jahn, 2019; Jahn & Black, 2017). To limit silencing or voice restraints in high reliability teams, it is critical for HROs to establish norms of

psychological safety, trust, and respect, and to reinforce these norms in daily practices that embed these norms into organizational culture (N. J. Allen & Hecht, 2004; Vogus, 2004; Vogus & Sutcliffe, 2011). Psychological safety is a term used to describe the consequences individuals perceive will occur when taking interpersonal risks in environments such as workplace teams (Edmondson, 1999). A large and expanding collection of empirical literature has identified psychological safety as a crucial factor of many workplace phenomena such as voice enactment (Baker et al., 2006; Minei & Bisel, 2012), teamwork (N. J. Allen & Hecht, 2004), team learning (J. A. Allen et al., 2018; Barbour & Gill, 2017), and organizational learning (Edmondson & Lei, 2014).

High Reliability Organization Theory Principle Deference to Expertise

Of the five identified HRO principles, *deference to expertise* is perhaps most easily linked to HRO communication, because the manifestation of the principle is dependent on productive communication practices realized between individuals. Weick and Sutcliffe (2001) have identified five components required in HROs to create and facilitate communicative deference to expertise including (a) a pattern of *respectfully yielding*, (b) *domain-specific knowledge*, (c) *compressed* and (d) *generalizable experience*, and (e) *relative expertise* (p. 116). Although deference to expertise prioritizes knowledge and experience, it is realized through communication by initiation of *respectful yielding,* a co-production between at least two parties where expertise emerges from conversations where information, ideas, and opinions are discussed, argued, agreed upon, modified, or rejected (Dekker, 2015). When these components are all present and working together, deference to expertise is fully enacted within an HRO, supporting the immediate identification and response to anomalies occurring within the system (Vogus et al., 2010; Weick & Sutcliffe, 2001, 2007, 2015). Alternatively, without deference to

expertise realization in a high reliability team, the expertise and knowledge required to catch small problems or deviations early may not occur, endangering the safe operations of the entire HRO (Jahn, 2019; Minei & Bisel, 2012; Weick & Sutcliffe, 2015).

Despite misleading phraseology, the HRO theory principle deference to expertise does not mean blind or total submission to an expert within an organization. Instead, the practice of deference to expertise unfolds as a collaborative exchange of ideas, where both the person doing the deferring and the person being deferred to are sharing knowledge and exchanging expertise positions collaboratively (Weick & Sutcliffe, 2015). In typical HROs, organizational members communicate in ways that attempt to flatten hierarchy within the HRO as a means of overcoming known barriers to HRO organizing that stratified organization relationships create (Jahn & Black, 2017). For example, although an HRO authority figure may possess some knowledge or expertise related to a respective task, their position as an authority figure is often linked more strongly to organizational hierarchy structures rather than expertise. To operate reliably within a complex system, these authority figures require access to knowledge and expertise that reside with others elsewhere in the organization. Leader and work group communication patterns in HROs assist authority figures in addressing complex, broader organizational goals or missions while also easily accessing the specific types of expertise required to meet those goals, and also enable those constrained by hierarchy to voice their expertise to authority figures in a manner reflective of flat organization hierarchies (Jahn & Black, 2017). Respectful yielding is the key component in this exchange of information, ensuring that individuals in hierarchical positions of authority (i.e., fire incident commanders) push their authority down to others in lower hierarchical positions (i.e., ground crew leaders) as a means of accessing to the most collective knowledge and expertise available for a given situation (Weick & Sutcliffe, 2015). By pushing

authority down, individuals in lower hierarchical positions are empowered to voice concerns, anomalies, or problems before they become dangerous (Jahn, 2019). This communicative process of knowledge sharing, in turn, supports authority figures in making better informed decisions more quickly, especially during high-risk crisis operations. To access this crucial expertise quickly, the communication pattern of respectful yielding is built on relational communication rather than solitary directives, requiring both parties to participate and co-share knowledge (Weick & Sutcliffe, 2015). Most importantly, when respectful yielding is occurring successfully, neither party engaged in respectful yielding is overly deferring or overpowering the other during this critical information exchange (Nembhard & Edmondson, 2006; Vogus et al., 2010).

In addition to respectful yielding, the creation of deference to expertise also depends upon the use of *domain-specific knowledge* (Weick & Sutcliffe, 2015). The presence of domain-specific knowledge indicates firsthand or simulated experiences in contrast to "book knowledge" which is obtained through research or reading, such as after action reports (Weick & Sutcliffe, 2015, p. 116). Working in combination with domain-specific knowledge, *compressed experience* speaks to experience situated within specific boundaries of time and effort (Weick & Sutcliffe, 2015). Compressed experience speaks to knowledge that could be gained with enough time to seek and obtain the required experience. In short, this experience has been "compressed" within an individual expert because of time or effort limitations not available to others in the HRO. Furthermore, the experience that could be gained through similar time and effort is a type of experience that is also *generalizable* – that is, compressed experience retains its same basic form when scaled up to much larger events that are much more consequential in nature (Weick & Sutcliffe, 2015).

The final component of deference to expertise is *relative expertise*. Relative expertise denotes individual knowledge that is applicable and relevant to the situation at hand. For example, experienced firefighting incident commanders agree that the first 30 minutes of a major emergency incident are messy and chaotic, but that this chaos eventually subsides and order emerges (Weick & Sutcliffe, 2015). While experienced incident commanders have the relative expertise to know chaos is to be expected, more novice incident commanders do not. This relative expertise is what allows experienced incident commanders to be clearheaded in their approach to managing the chaos even as they face new or unprecedented fire incidents. Novice incident commanders must grapple to learn this concept by experiencing the chaos firsthand, eventually coming to understand that chaos is an inevitable part of any initial emergency incident, whether they have experienced the specific type (e.g., car fires versus house fires versus chemical fires versus plane crashes) of incident before or not. As they work to learn what is and is not to be expected during the chaos of HRO operations, novices within successful HROs will utilize respectful interrelating to gain access to more experienced team members that possess more relative expertise (Minei & Bisel, 2012).

High Reliability Organization Hierarchy

Early boundary conditions defining HROs included *extreme hierarchic differentiation* as a common characteristics of these high-risk organizations (LaPorte & Consolini, 1991; Roberts & Rousseau, 1989). Subsequent work defining high-risk organizations evolved from this perspective to instead mark HROs as bounded by an emergent process rather than determined or defined by rigid organizational structures (Weick & Sutcliffe, 2001, 2007, 2015). As organizations continue efforts to implement HRO principles and improve reliability within their organizations (see O'Leary et al., 2015; Veazie et al., 2019; Vogus & Iacobucci, 2016 and

others) researchers continue their efforts to clarify how HRO principles—rooted in communicative hallmarks of a flat hierarchy—are operationalized in rigid and stratified organizational hierarchies, such as hospital surgical teams, fire departments, or military units (Jahn & Black, 2017). While multiple studies have examined select elements of hierarchy within high reliability organizations (see Barbour & Gill, 2017; Fraher et al., 2017; Jahn & Black, 2017), hierarchy has been found to both hinder and support HRO theory principle enactment. Studies have identified organizational hierarchy as an obstruction to high reliability organizing, including positional authority causing voice limitations and barriers to communication between supervisors and subordinates (Barton & Sutcliffe, 2009; Brueller & Carmeli, 2011; Nembhard & Edmondson, 2006). Conversely, Bigley and Robert's (2001) examination of Incident Command Systems (ICS), a scalable hierarchical structure that allows an organization to arrange and size management configurations up or down in response to incident demands without jurisdictional boundary hindrance noted that as an incident size or ICS configuration shifts, designated roles within the ICS platform allow responders to move to their new roles and communicate with confidence. Jahn and Black's (2017) analysis of wildland firefighting hierarchies found that the enactment of HRO principles within an HRO is facilitated by specific supervisory and within-group communication patterns and practices that stifle unproductive hierarchical behaviors, such as those created through positional authority or status emphasis. Furthermore, these communication patterns and practices were found to support maintaining the productive aspects of hierarchy necessary for safety in HRT environments, such as identifying problems and managing workloads. Jahn and Black's 2017 study was particularly noteworthy in its advancement of the understanding of the links between communication and high reliability hierarchy, noting that "high reliability organizing can be explained as communicative patterns

and practices that direct member attention, guide inquiry and learning, and call on supervisors and teams to foster affective interactions that help members navigate a chain of command" (Jahn & Black, 2017, p. 358). Their findings suggests that "practices and norms for communication are especially important for addressing concerns, questions, and insights regarding safety and risk in wildland firefighting" (p.374) and that these concerns also likely extend to other emergency service organizations.

Knowledge Generation and Sharing

Generating knowledge in an organization typically incorporates at least one of six lines of effort, including (a) *acquisition*, (b) *rental*, (c) *dedicated resources*, (d) *fusion*, (e) *adaptation*, and (f) *networks* (Davenport & Prusak, 1998). Knowledge *acquisition* refers to the process of bringing additional knowledge into an organization, such as hiring an expert or acquiring a new company or organization asset designed to fill in gaps within the existing organization (Hock-Doepgen et al., 2021; Leonardi, 2015a). *Rental* knowledge is traditionally defined as a process where consultants are hired to bring in expertise and share their specific knowledge with the organization (Jarrahi & Sawyer, 2015; Sutter & Kieser, 2019). Knowledge generation through *dedicated resources* includes organizations with dedicated knowledge development departments such as a research and development (R&D) office ((Audretsch & Belitski, 2020; Mao et al., 2016)). Knowledge generation through *fusion* includes a collaboration process with intentionally designed points of friction, which are incorporated during the knowledge generation process to stimulate new and more creative solutions (Preece et al., 2001; Shafique, 2013; Xu et al., 2016). Friction can include incorporating individuals from different departments to collaborate on a project together, such as a member of the art department, engineering department, and sales department working collaboratively on a solution to a common customer website complaint.

Knowledge generation through *networks* includes the creation and sustainment of communities of common interest (Monge & Contractor, 2003; Pilny et al., 2017; Shumate et al., 2013). To maximize knowledge generation and knowledge sharing within an organization, each type of knowledge generation must receive adequate time and space, and organizational managers must view knowledge generation and sharing as an important part of the organization (Choi et al., 2016; Davenport & Prusak, 1998; Le & Lei, 2017, 2019; Ritala et al., 2018).

Once knowledge is generated within an organization, it can be shared with others to support organizational goals and outcomes. Knowledge sharing is defined as an act of making information available to others within an organization or team (Abzari & Teimouri, 2008, p. 106). Knowledge shared in an organization can include intricate and accrued expertise residing within an organization's individual employees to more structured and explicit content inhabiting organizational products and services (E. F. Cabrera & Cabrera, 2005), and researchers continue to work to identify best practices for knowledge-sharing behaviors within teams and organizations (see Ahmad & Karim, 2019; A. Cabrera & Cabrera, 2002; E. F. Cabrera & Cabrera, 2005; De Vries et al., 2006). For example, the intricate and accrued expertise within an organization's employees, defined by the term *tacit* knowledge, has been found to be particularly difficult to reproduce within an organization, especially through utilization of modern information communication technologies (Castaneda & Toulson, 2021). Tacit knowledge refers to individual knowledge that is developed and internalized in the mind over time and can be transferred through direct personal contact between individuals and their peers such as "chit chat" sessions with colleagues, text messages, and video conferencing (Davenport & Prusak, 1998; Mohajan, 2016). Tacit knowledge can be particularly critical for teams to share in organizations that experience dynamic, ongoing crisis such as firefighting (Ishak & Williams,

2017; Minei & Bisel, 2012). Trust and communication have been identified as important components of tacit knowledge sharing in organizations (Cumberland & Githens, 2012; Okoroafor, 2014), with positive organizational culture and team trust facilitating more tacit knowledge exchanges (Holste & Fields, 2010; Suppiah & Singh Sandhu, 2011) and a lack of trust reducing or creating a barrier to tacit knowledge sharing in teams (Okoroafor, 2014; Rutten et al., 2016; Zhang & He, 2016). Studies of *affect-based trust*, which is centered on mutual care and concern between team members, and *cognition-based trust*, which is centered on team member competence and reliability, have found that teams are more inclined to share tacit knowledge when affect-based trust is present and use tacit knowledge when cognition-based trust is present (Holste & Fields, 2010). Additionally, low affect-based trust has been found to significantly impact overall knowledge sharing in teams, emphasizing the important overall knowledge gains organizations can cultivate by increasing coworkers trust (Rutten et al., 2016). Overall knowledge sharing practices in organizations have also been positively linked to organization structure that promotes communication and trust (Ismail Al-Alawi et al., 2007), underscoring the important role these elements may play in high reliability organizations, where knowledge sharing between team members is paramount to enacting safety and reliability in the organization.

A key element to facilitating knowledge transfer is the need to suit the transfer methods to an organization's culture, including how an organization approaches team communication (Alves et al., 2022). For example, tacit knowledge transfer within a U.S.-based company may include structured, regularly occurring mentorship meetings over coffee, whereas for an organization in Japan, tacit knowledge transfer might occur through late-night karaoke sessions with colleagues (Davenport & Prusak, 1998). Several barriers to knowledge transfer in

organizations have been identified in academic literature including: (a) *lack of common ground,* (b) *absence of trust,* (c) the *status of who is sharing knowledge*, (d) a *lack of knowledge absorption*, (e) *knowledge velocity*, and (f) *knowledge viscosity* (Alves et al., 2022; Davenport & Prusak, 1998; Joia & Lemos, 2010; Li, 2010). Knowledge transfer is significantly eased when members share a common organizational language, training, or experiences in the same area specialty (i.e., common ground), such as a group of cardiac surgeons or a team of wildland firefighters (Davenport & Prusak, 1998; Desmond, 2009). Without this commonality in organization language and experiences, individuals tend to not connect well or find themselves in conflict with each other, inhibiting trust development and preventing knowledge transfer flow (Peltokorpi, 2006; Wei, 2007). Additionally, organizational culture has significant impact on knowledge sharing practices, such as how perceived status of an individual with knowledge can influence how much knowledge is absorbed or disregarded by another individual (Ahammad et al., 2016; A. Cabrera & Cabrera, 2002; E. F. Cabrera & Cabrera, 2005). For example, suggestions on how to develop more technology-driven innovations from a young, junior-ranked colleague might be well received within an organization but suggestions from the same person regarding organizational strategy might be dismissed in favor of more experienced, senior-ranked member suggestions (Li, 2010). In a similar vein, knowledge transfer in an organization is dependent on both the successful transmission and absorption (i.e., use) of knowledge that is shared (Joia & Lemos, 2010). If information is shared but is not put into use because the knowledge receiver is too busy, too prideful, or too afraid to implement knowledge received, then knowledge transfer within the organization will not occur (Connelly et al., 2014; Li, 2010). Furthermore, both the speed at which information is shared and moves around the organization

(i.e., velocity) and is implemented (i.e., viscosity) can serve as barriers or accelerators to knowledge transfer (Cvitanovic et al., 2015).

One underexamined element of knowledge transfer in organizations is the link between individual power and knowledge management (Davenport & Prusak, 1998). Although most professional organizations profess that knowledge sharing is an extremely positive trait in the workplace (Fahey & Prusak, 1998), empirical research continues to demonstrate that knowledge management in organizations can be significantly laden with political motives and hampered by knowledge hiding (Connelly et al., 2019; Davenport, 1997; Issac et al., 2022; Pfeffer, 1981). Researchers have noted the importance of exploring social motives in relation to knowledge sharing and group task performance, including understanding motives that are primarily cooperative, competitive, or individualistic (Witherspoon et al., 2013). Some group researchers have noted that a significant limitation to much of the existing research on group information sharing is that much of the work is predicated on assumptions that individuals within groups are motivated to share information as a means of achieving the best possible outcome for the group (De Dreu et al., 2008; Wittenbaum et al., 2004). This assumption, however, does not fully attend to the idea that for some individuals, information sharing may not be motivated by a desire for a particular group outcome at all, but instead by motivated goals related to individual interests and preferences (D. Ford et al., 2015; Gagné et al., 2019). Thus, some individuals may choose to withhold or distort information in an effort to serve their personal agendas, above group gain (Connelly et al., 2012, 2019). Even within self-professed “flat” organizational hierarchies, knowledge management activities can be threatening or at least concerning, inhibiting knowledge sharing even when power is not an immediate concern (Webster et al., 2008).

However, in hierarchal organizations that support coworker's access to each other for desired knowledge, rigid hierarchy was not found to impede knowledge transfer (Fahey & Prusak, 1998).

Chapter 2: Method

Research Design

To answer the proposed research questions, I employed a case-based ethnographic method of data collection over 15 months, further supported by semi-structured ($N = 42$[2]) and informal interviews. A case study is an empirical in-depth examination of contemporary phenomena where the investigator(s) collect(s) data from a single case through a variety of primary and secondary sources (Lindlof & Taylor, 2017). In case-based investigations, researchers proceed by choosing exemplar cases on the basis of theoretical interest to explore new concepts. This case context (i.e., aerial firefighting teams) was chosen purposely, given its suitability to the posed research questions and the feasibility of the study to address these questions (Tracy, 2019), as well as its unique distinction as a heretofore unexamined team type within the field of high reliability communication studies. Exemplary cases are not necessarily outliers, but sites in which the relevant phenomena can be observed and are likely locations for challenging or extending theory. Case-based research, including focusing on exemplars, has been fruitful in providing insight into the communicative acts unfolding within high reliability organizations and teams (Fraher et al., 2017; Ishak & Williams, 2017; Roeder, Bisel, & Howe, 2021).

Following a four-month period (i.e., June 2021 to September 2021) of discussions and research study feasibility evaluations, I obtained permission from the California Department of Forestry and Fire Protection Tactical Air Operations Chief, legal team, and public information office, as well as approval from my university institutional review board to begin in-person research. Beginning in October 2021, I conducted 237.5 hours of in-person observations at

[2] This figure does not include two interviews that were completed but later removed from the final dataset. See page 32 for additional details.

California Department of Forestry and Fire Protection northern and southern region air attack and helitack operational facilities (n = 5) and tactical air operations training locations (n = 4). To ensure an accurate understanding of the unique team configurations within the California Department of Forestry and Fire Protection Aviation Department's Tactical Air Operations, a total of one air attack base, three combined air attack/helitack bases, one interagency helitack base, and four training sites located across the southern and northern regions of California were selected for observation. The entire California Department of Forestry and Fire Protection Aviation Department consists of 14 air attack bases, 10 helitack bases, and one interagency helitack base (see Appendix A for location illustration) as well as two dedicated training facilities and multiple training sites (e.g., field exercise or conference locations, CALFIRE, 2023).

In-person site visits began in the fall of 2021 and concluded at the start of 2023, incorporating the 2021 and 2022 California state declared fire seasons and winter training periods. Daily periods of observation ranged from 1 to 11 hours. These visits, conducted within three distinct observation periods, yielded 325 single-spaced, typewritten pages of raw data in the form of field notes. During the three observation periods I was included in all activities ranging from morning briefings, physical training (PT), foreign object debris (FOD) cleanup on air attack and helitack bases, daily meal preparation, station cleanup, holiday operations, fire retardant loading on aircraft, air tactical group supervisor training and evaluation flights, field exercises, flight debriefs, and classroom instruction.

Additionally, I conducted 34.2 hours/2,056 minutes of individual (n = 38) and group (n = 4) semi-structured interviews (N = 42) resulting in 799 single-spaced pages of transcripts (Table 1); these figures do not include two completed interviews were voluntarily removed from the

final dataset (see page 32 for detailed explanation). I also captured photo (*N* = 838 photos) and video imagery (*N* = 122 video clips) and accumulated relevant organizational training documents (*N* = 1,232), and survey data (*N* = 5, Table 2). Due to low overall participation, the survey data was excluded from the final dataset.

Table 1

Comprehensive Overview of Study Final Interview Dataset Including Comprehensive Number of Interviews, Interviews Length, and Transcript Pages

Interview Group	Number of Interviews	Comprehensive Interview Length (Minutes)	Comprehensive Transcript Pages (Single Spaced)
Tactical Air Operations/Aviation Maintenance Unit Leadership	8	643	182
Southern Region Air Attack and Helitack Unit Team Member (Individuals)	23*	898	432
Southern Region Air Attack and Helitack Unit Team Members (Groups)	4	99	46
Tactical Air Operations Leadership and Air Tactical Group Supervisor (ATGS) Trainees	7	413	139
TOTAL	**42**	**2,053**	**799**

Note. All interviews were conducted during the first and second observation periods.
* Figure does not include the two interviews conducted during the initial observation period in the southern region that were removed from the final dataset.

Table 2

Comprehensive List of Study Data Collected Across 10 Research Sites (15 months)

Time Period	Observations (Hours)	Interviews* (Minutes)	Field Notes (Single-spaced pages)	Photos	Videos	Organization Documents

Pre-Observation Period	--	565**	--	--	--	22
Initial Observation Period	140.5	997***	187	462	51	2
Second Observation Period	71.5	491	79	340	71	1,198
Third Observation Period	25.5	--	59	36	--	10
TOTAL	**237.5**	**2,056**	**325**	**838**	**122**	**1,232**

Note. All pseudonyms were randomly assigned using an online name generator to protect participant identities.
* See Tables 4, 8, 9 and 10 for additional individualized interview data including the name (pseudonyms), rank, primary role, region, experience range, interview length and number of transcribed pages for each interviewee.
** Denotes all interviews conducted with Tactical Air Operations/Aviation Maintenance Unit leadership prior to the first site visit. One interview with a member of Tactical Air Operations (TAO)/Aviation Maintenance Unit Leadership that was rescheduled from the pre-observation period to the second observation period is counted under the second observation period interview minutes.
*** Figure does not include the two interviews conducted during the initial observation period in the southern region that were removed from the final dataset.

Participants

In-person observations of personnel included California Department of Forestry and Fire Protection (CAL FIRE) Tactical Air Operations (TAO) and Aviation Maintenance Unit (AMU) leadership, air attack and helitack units, agency and interagency partner maintenance staff, aerial firefighting operations staff (e.g., dispatchers), air tactical group supervisor (ATGS) instructors, air tactical group supervisor (ATGS) trainees, contract pilots, air attack and helitack base contractors (e.g., fire retardant providers), interagency partners (e.g., local police units, U.S. Forest Service), and air attack base support staff (e.g., airfield managers). Similar to most firefighting agencies throughout the United States (Jahn, 2016; Minei & Bisel, 2012; Tracy &

Scott, 2006), the California Department of Forestry and Fire Protections observations reflected a workforce population that was overwhelmingly male. Due to the exceptionally small number of females interviewed (n = 1), a choice to change the participants' gender to male in the results reported was intentionally made to ensure anonymity. Additionally, all comments indicating gender-specific interactions (e.g., "She said") were slightly altered to remove identifying information from the final dataset.

In addition to daily interactions through participant observation, semi-structured interviews were conducted; participants were current employees (n = 28) and contractors (n = 7) with the California Department of Forestry and Fire Protection Aviation Department (see Appendix B for a comprehensive list of semi-structured and informal interview participants). Past and present California Department of Forestry and Fire Protection Aviation Department employees (i.e., firefighters) as well as contract employees and interagency partners directly supporting the organization's tactical air operations (i.e., pilots) and former employees of the organization working as contract employees (i.e., trainers) were included as interview participants. The semi-structured interview participants averaged 17.5 years of affiliation with the California Department of Forestry and Fire Protection (CAL FIRE) organization. Due to the uniquely identifiable nature of tenure[3] status of some participants when linked to their region locations, interview participants with less than ten years affiliation with the organization were categorized under the broader category of junior tenure (n = 9) and participants with ten or more years affiliation with the organization were classified under the broader category of senior tenure

[3] Some participants at the observed air attack bases significantly exceeded tenure norms of aerial firefighting flight experience, eliminating the possibility of ensuring their anonymity if air base location or age-linked data was not removed. To overcome this known limitation, aerial firefighting experience was included but grouped into larger, more generalized categories (e.g., junior or senior) and locations were limited to identification of regions (e.g., northern or southern).

(n = 26). Additionally, due to the uniquely identifiable ranks of some participants, all participant ranks were classified utilizing a general firefighter ranking system and its equivalent rank (e.g., a participant would be marked Division Chief instead of Aviation Officer II). In cases of employees that do not have equivalent firefighting ranks (e.g., pilots), the broad term of *contractor* has been assigned.

Participant Exclusions and Limitations

The following paragraphs provide details of three specific instances where concerns over participant consent ultimately necessitated the removal or exclusion of participants from study interviews. Aside from these instances, all other organization members voluntarily participated in the study and provided written and verbal informed consent as required by university policy and qualitative research best practices.

In the first instance, two participant interviews conducted with a single individual were ultimately excluded from the study due to career impact concerns. During the first portion of the observation period (i.e., October 2021), I obtained a signed informed consent form from the individual and conducted two in-person interviews in a private location. The following week, I noted multiple instances of the participant avoiding me in the workplace during my observation period. I approached the participant privately and asked the participant directly if they were comfortable continuing in my study, reiterating the voluntary nature of their participation. During this discussion, the participant disclosed that they were concerned that information shared in their interviews may invoke negative career impacts. Following this discussion, the participant interviews were voluntarily removed from the dataset by the researcher and all documented observations related to the individual were removed from further consideration. Additionally, the participant was directly informed of their removal from the study. As a matter

of caution moving forward, all participants were contacted immediately after interviews (i.e., within 24 hours) to ensure they had no concerns about information shared.

In the second instance of participant exclusion, a participant was approached for an interview and declined, with a stated reason attributed to the participant experiencing an ongoing illness. After this refusal, the participant was subsequently excluded from the study in an abundance of caution.

In the third instance, it was noted that a study participant was difficult to locate after the daily morning briefings with the entire team. These attempts to avoid interacting with me were explicit enough to prompt jokes from others within the unit. While the joking was made with a lighthearted tone, it ultimately prompted me to reflect deeply on the voluntary nature of participation in my study despite participants signing informed consent forms and receiving multiple briefings on the nature of their participation in my study. Recognizing some participants may have concerns of organizational retaliation if they declined participation, I refrained from approaching anyone making efforts to avoid me (i.e., leaving spaces when I would arrive, or working in remote buildings removed from their primary worksite) for interviews. I also limited my observations of potentially hesitant participants to interactions unfolding only within public work settings (i.e., morning briefings).

One additional limitation on approaching interagency partners for interviews was also included in the parameters of this study. Specifically, I was permitted to attend and make observations at inter-agency trainings including federal partners (i.e., U.S. Forest Service employees), but I was not permitted to approach any federal employees for interviews. Prior to conducting my observations at interagency training locations, all U.S. Forest Service employees were informed of my presence by a member of the California Department of Forestry and Fire

Protection leadership team. These U.S. Forest Service employees agreed to permit me to observe their interactions in relation to California Department of Forestry and Fire Protection employees, provided I did not quote them directly by name or request formal interviews. Jottings, field notes, and images referencing U.S. Forest Service employees in relation to interactions with California Department of Forestry and Fire Protection employees were all permitted. Although many friendly and informal conversations with U.S. Forest Service employees during the observation period did occur (e.g., lunchtime banter), no information was captured in field notes outside of conversations conducted within the bounds of training exercises, training class discussions, and public conference presentations. In several instances, U.S. Forest Service employees provided copies of interagency training materials (i.e., class pamphlets and training handouts), which were approved for research use by host organization (i.e., California Department of Forestry and Fire Protection) leadership.

Data Collection and Procedures - Observations

In-person observation data (N = 237.5 hours) was collected within three distinct periods in a 15-month time frame (Table 2). Immediately prior to the three observation periods, a pre-observation period in October 2023 initiated the study through a series of Zoom interviews with Tactical Air Operations (TAO) and Aviation Maintenance Unit (AMU) leadership (Tables 3 and 4).

Table 3

Pre-Observation Period Data – Tactical Air Operations (TAO)/Aviation Maintenance Unit (AMU) Leadership

Site	Observations (Hours)	Interviews* (Minutes)	Field Notes (Single-spaced pages)	Photos	Videos	Organization Documents

Tactical Air Operations (TAO)/ Aviation Maintenance (AMU) Unit Leadership (No Site – Zoom Only)	--	565	--	--	--	22
TOTAL	**--**	**565**	**--**	**--**	**--**	**22**

Note. All pseudonyms were randomly assigned using an online name generator to protect participant identities.
* See Table 4 for individualized interview data including the name (pseudonyms), rank, primary role, region, experience range, interview length and number of transcribed pages for each interviewee.

Table 4

Tactical Air Operations (TAO)/Aviation Maintenance Unit (AMU) Leadership Interviews

Pseudonym	Rank	Experience Range*	Interview Length (Minutes)	Transcript Pages (Single Spaced)
Brenton**	Division Chief	Senior	78	24
Carey	Battalion Chief	Senior	102	30
Christian	Division Chief	Senior	75	24
Dallas	Battalion Chief	Senior	47	12
Doug	Battalion Chief	Senior	71	19
Harold	Battalion Chief	Senior	70	20
Oswald	Division Chief	Junior	114	32
Norris	Battalion Chief	Senior	86	21

TOTAL	**--**	**--**	**643**	**182**

Note. All interviews were conducted during the pre-observation period unless otherwise noted. Pseudonyms were randomly assigned using an online name generator to protect participant identities.
* Less than 10 years of experience working at the California Department of Forestry and Fire Protection have been listed as "junior" and 10 or more years of experience are listed as "senior."
** Interview was conducted during the second observation period due to scheduling conflicts.

The initial site observation period (n = 144.5 hours) beginning in October 2021 and concluding in December 2021 included observations at three California Department of Forestry and Fire Protection sites in the southern region[4], including an air attack base, an interagency helitack base, and a combined air attack and helitack base (Table 5).

Table 5

Initial Observation Period Data – Southern Region

Site	Observations (Hours)	Interviews* (Minutes)	Field Notes (Single-spaced pages)	Photos	Videos	Organization Documents
Air Attack/Helitack Base (Site #1)	4	--	10	67	--	--
Air Attack Base (Site #2)	94.5	533**	117	231	28	--
Interagency Helitack Base (Site #3)	46	464**	60	164	23	2
TOTAL	**144.5**	**997**	**187**	**462**	**51**	**2**

Note. All pseudonyms were randomly assigned using an online name generator to protect participant identities.

[4] See Appendix X for a region locations.

* See Table 8 for individualized interview data including the name (pseudonyms), rank, primary role, region, experience range, interview length and number of transcribed pages for each interviewee.
** Total includes 2 group interviews for each site. See Table 9 for group interview details.

The second observation period (n = 71.5 hours) beginning in March 2022 and concluding in July 2022 focused on observing the California Department of Forestry and Fire Protection air tactical group supervisor training program and included observations of northern region training facilities, northern region maintenance facilities, northern region air attack bases, northern region helitack bases, southern region air attack bases, and a southern region interagency helitack base (Table 6).

Table 6

Second Observation Period Data – Northern Region

Site	Observations (Hours)	Interviews* (Minutes)	Field Notes (Single-spaced pages)	Photos	Videos	Organization Documents
ATGS Refresh Training Facility (Site #4)	25.5	78**	23	30	--	53
Air Attack/Helitack Base (Site #5)	1.5	8	3	3	--	--
ATGS Training Facility (Site #6)	16	405***	23	62	2	1,145
ATGS Field Training Facility (Site #7)	11.5	--	8	119	46	--
Air Attack/Helitack Base (Site #8)	13	--	18	126	23	--

******Southern Region Air Attack Base (Site #2)**	3	--	3	--	--	--
******Southern Region Interagency Helitack Base (Site #3)**	1	--	1	--	--	--
TOTAL	**71.5**	**491**	**79**	**340**	**71**	**1,198**

Note. All pseudonyms were randomly assigned using an online name generator to protect participant identities.
* See Table 10 for additional individualized interview data including the name (pseudonyms), rank, primary role, region, experience range, interview length and number of transcribed pages for each interviewee.
** Interview with a member of Tactical Air Operations (TAO)/Aviation Maintenance Unit Leadership that was rescheduled from the pre-observation interview period.
*** Interviews with air tactical group supervisor trainees were conducted over Zoom following the training program held at ATGS Training Facility Site #7.
*** These sites were in the southern region, but these additional visits fell within the northern region observation period. The primary purpose of these visits was to conduct member checks, but observations were also included.

The third observation period (n = 22 hours) in January 2023 focused on the 2023 California Department of Forestry and Fire Protection Aviation Safety Conference and included observations at California Department of Forestry and Fire Protection northern region training site, a southern region air attack base, and a southern region interagency helitack base (Table 7).

Table 7

Third Observation Period Data – Northern and Southern Region

Site	Observations (Hours)	Interviews (Minutes)	Field Notes (Single-spaced pages)	Photos	Videos	Organization Documents
Aviation Safety	22	--	55	36	--	10

Conference (Site #9)						
Southern Region Air Attack Base (Site #2)	1	--	1	--	--	--
Southern Region Interagency Helitack Base (Site #3)	2.5	--	3	--	--	--
TOTAL	**25.5**	**--**	**59**	**36**	**--**	**10**

Initial Observation Period – Southern Region

I began the initial period of in-person field observations of three California Department of Forestry and Fire Protection southern region air attack, helitack, and interagency base sites in October 2021 (Table 5). A day-long familiarization tour in October 2021 (n = 4 hours) was provided by members of the California Department of Forestry and Fire Protection tactical air operations leadership team at a southern region combined air attack and helitack base to confirm my understanding of general base operations and layout, as well as to facilitate in-person introductions with key members of the southern region units (see Appendix C, D, E and F for examples of key images captured). Following the familiarization tour, in-person field observations began at separate southern region air attack base and interagency helitack base sites with shared staff and personnel. Air attack base observations (n = 94.5 hours) primarily focused on teamwork during daily operations at a rural air attack base during fire season and included 533 minutes of semi-structured interviews with individuals affiliated with the air attack base (e.g., pilots, contractors, firefighters; Table 8). Interagency helitack base observations (n = 46 hours) primarily focused on differences between helitack and air attack base teams and

interagency operations and included 464 minutes of semi-structured interviews with individuals affiliated with the southern region interagency helitack base (e.g., pilots and firefighters; Table 8). The initial observation period of southern region air attack and helitack base sites concluded in December 2021.

Table 8

Southern Region Air Attack and Helitack Unit Team Member Individual Interviews

Pseudonym	Rank	Primary Position/Role	Experience Range*	Interview Length(s) (Minutes)	Transcript Pages (Single Spaced)
Al	Contractor	Pilot	Senior	59	21
Brian	Captain	Unit Operations	Senior	24	14
Cornell	Firefighter I	Unit Operations	Junior	51	17
Danny	Contractor	Pilot	Junior	13, 36	8, 24
Ernie	Withheld	Withheld	Withheld	**Removed from Study	**Removed from Study
Frank	Captain	Air Tactical Group Supervisor	Senior	39	14
Hunter	Contractor	Pilot	Senior	96	56
Jack	Engineer	Unit Operations	Junior	69	37
Jameson	Captain	Air Tactical Group Supervisor Trainee	Senior	6, 39	12, 18
Jared	Contractor	Pilot	Senior	40	13
Jeff	Captain	Air Tactical Group Supervisor Trainee	Senior	28	18

Kasey	Firefighter I	Unit Operations	Junior	28, 34	10, 12
Morris	Firefighter I	Unit Operations	Junior	22	8
Ryan	Battalion Chief	Air Tactical Group Supervisor	Senior	59, 38	26, 14
Tyler	Contractor	Pilot	Senior	68	33
Walker	Firefighter I	Unit Operations	Junior	28	17
Walter	Engineer	Unit Operations	Senior	38	12
Zach	Contractor	Pilot	Senior	83	48
TOTAL	**--**	**--**	**--**	**898**	**432**

Note. All interviews were conducted during the first observation period. Pseudonyms were randomly assigned using an online name generator to protect participant identities.
* Less than 10 years of experience working at the California Department of Forestry and Fire Protection have been listed as "junior" and 10 or more years of experience are listed as "senior."
** These two interviews were removed from the final dataset after completion.

During this first phase of data collection, I regularly reviewed field notes and conducted an iterative process of writing memos, reading relevant literature, and reviewing and re-reading data. This iterative process allowed me to identify promising directions to focus my interviews during the initial observation period and also supported the negotiation for additional site access to new observation locations. For example, minimal fire activity during the first month of the observation period necessitated a longer period of observation to understand how team communication unfolds during an initial attack wildfire response. Considering this circumstance, the host organization and tactical air operations leadership agreed to expand the observation timeline and permit access to additional air attack and helitack bases.

This observation period also incorporated short familiarization tours of facilities and aircraft owned and operated by other local aerial firefighting units adjacent to the sites observed (e.g., firefighting aircraft leased by a local utility company and U.S. Forest Service helitack teams located at the same airfield). These tours were facilitated by representative from the California Department of Forestry and Fire Protection and were granted as a means of better understanding the multiple, complex agencies the California Department of Forestry and Fire Protection tactical air operations teams worked with during wildfire initial attack responses. During these tours, I was strongly encouraged to photograph facilities and equipment (e.g., aircraft, see Appendix G for example) and jottings were captured and later transcribed into field notes, but no formal interviews were conducted in association with these tours.

At the conclusion of the initial three months of field work at the air tanker and interagency helitack bases, I transcribed all onsite interviews and catalogued all imagery data collected (i.e., photos and videos). Details of the dataset captured from this period of field work are listed in Table 5.

Second Observation Period – Northern Region

I began the second phase of in-person field observations at a northern region training facility site in March 2022 and concluded in July 2022. The second phase of observations (n = 71.5 hours) primarily focused on the air tactical group supervisor (ATGS) training program and northern region combined air attack and helitack base team operations. This phase incorporated visits to air tactical group supervisor training locations, training facilities, maintenance facilities, and combined air tanker and helitack bases and also incorporated participant observation such as assisting air tactical group supervisor trainers with conducting fire simulation exercises in the field, participating in graded training flights from inside the aircraft and ground positions, and

attending interagency leadership team social events. One rescheduled in-person recorded interview was conducted with a member of the tactical air operations leadership team during air tactical group supervisor refresher training (*n* = 78 minutes) on general organization topics (see Appendix K). A separate in-person recorded interview was conducted with another member of the tactical air operations leadership team (*n* = 8 minutes) to clarify field observations during air tactical group supervisor initial training. Seven Zoom interviews were also conducted with four air tactical group supervisor trainees (*n* = 405 minutes) as they conducted their training flight requirements to qualify as air tactical group supervisors.

Shadowing proved to be a crucial part of the second period of observation, as it allowed opportunities to observe real-time communication between team members and ask participants to reflect on conversations and events as they occurred or immediately after, an approach that has been supported as ideal to the study of practice (Barbour & Gill, 2017; Leonardi, 2015b). During this second period of observation, hands-on participation in actual and simulation firefighting flights and ground firefighting operations (see Appendix J for examples) also supported this crucial endeavor.

At the conclusion of the second period of observation the second dataset (Table 6) was added to the first dataset (Table 3 and 5), including 1,198 single-spaced pages individual screen captures of online web pages[5] and materials used by air tactical group supervisor trainers and air tactical group supervisor trainees (see Appendix H and I for examples). Member checking (Bisel et al., 2014; Tracy, 2010) with organizational leaders included a strong recommendation to

[5] Some websites and training materials were inaccessible to the researcher. These websites included training programs located on the state and federal firefighting agencies primary training platforms, which can only be accessed through utilization of organizational credentials (i.e., organizational email). These trainings and associated documents were primarily related to materials outside of the scope of this study (i.e., annual basic firefighting recertifications).

conduct additional observations of an annual interagency aviation safety conference hosted by the California Department of Forestry and Fire Protection Aviation Department. This recommendation resulted in a final observation period inclusive of both the annual California Department of Forestry and Fire Protection Aviation Safety Conference and final visits to southern region air tanker and helitack sites in January 2023.

Third Observation Period – Northern and Southern Region

I began the third observation period at the 2023 Aviation Safety Conference in January 2023 followed by a final visit to southern region air attack and helitack sites (Table 7). This final observation period spanned 22 hours; these observations were inclusive of trainings and presentations for representatives of the organization's aerial firefighting teams (i.e., air attack and helitack units), aerial firefighting support staff (e.g., dispatchers), and interagency partners (e.g., U.S. Forest Service, L.A. County Sherriff).

This final dataset (Table 7) was subsequently added to the first (Table 3 and 5) and second dataset (Table 6). No interviews were conducted during this observation period. At the conclusion of this final period of observation, 237.5 hours of in-person field observations were conducted, resulting in 325 single-spaced pages of typed field notes. The final dataset incorporated 2,056 minutes/34.2 hours of semi-structured interviews, resulting in 799 single-spaced pages of transcripts, 838 photos, 122 videos, and 1,232 single-spaced pages of organizational documents and web page screen captures.

Data Collection and Procedures – Interviews

A total of 44 semi-structured interviews were conducted over 15 months (Table 1), with 42 interviews retained in the final dataset. Participants were all directly affiliated with the state firefighting organization and included Tactical Air Operations (TAO) leadership, Aviation

Maintenance Unit (AMU) leadership, air attack and helitack unit team members, contract pilots, interagency helitack pilots, air tactical group supervisor (ATGS) training instructors, air tactical group supervisor (ATGS) trainees, and incident commanders (IC). Interviews lasted between 6 and 114 minutes.

Individual interviews (n = 40) were primarily conducted during work hours in private spaces to ensure other team members and organizational leadership could not overhear participant answers, although several senior participants intentionally chose to leave doors open during interviews in office spaces. A total of 27 individuals participated in interviews; one individual interviewee was excluded from the final dataset due to career concerns (review page 32 for details). Group interviews (n = 4, see Table 9) were conducted within rank peers (e.g., Firefighter Is and Captains) to discuss rank-specific topics in private locations (e.g., Captain's offices, remote outdoor workspace) to ensure both confidentiality and candid discussions. Group interviews lasted between 8 and 43 minutes. The shortest group interview (i.e., 8 minutes) represents an instance where a member of the leadership team unexpectedly returned to their office space located directly across from the discussion location. Their arrival initiated me to voluntarily end the group interview early out of privacy concerns.

Table 9

Southern Region Air Attack and Helitack Unit Team Members Group Interviews

Pseudonyms	Ranks	Primary Position/Roles	Experience Range*	Interview Length (Minutes)	Transcript Pages (Single Spaced)
Cornell, Morris & Shaun	Firefighter Is	Unit Operations	Junior	35	12

Cornell, Dylan & Morris	Firefighter Is	Unit Operations	Junior	8	4
Jeff, Langley & Otto**	Captains	Unit Operations	Senior	43	18
Brian, Jameson, Jeff & Otto**	Captains	Unit Operations	Senior	13	12
TOTAL	**--**	**--**	**--**	**99**	**46**

Note. All interviews were conducted during the first observation period. Pseudonyms were randomly assigned using an online name generator to protect participant identities.
* Less than 10 years of experience working at the California Department of Forestry and Fire Protection have been listed as "junior" and 10 or more years of experience are listed as "senior."
** In these interviews, the primary role of the participant was unit operations. In other circumstances, the primary role of the participant was air tactical group supervisor trainee.

In keeping with institutional review board oversight, each interview participant signed a consent form prior to the start of an interview and the contents of the form was reiterated verbally at the start of each interview. After obtaining informed consent, I digitally recorded interviews utilizing a handheld recording device and/or Zoom audio recording, which I later transcribed into 799 single-spaced pages of text. While Zoom transcription services were initially utilized for Tactical Air Operations (TAO) and Aviation Maintenance Unit (AMU) leadership interviews, I switched to the Trint platform for transcription of all remaining in-person interviews due to the much higher initial transcription accuracy.

After all initial transcripts were created I reviewed the text to ensure transcription accuracy, correct errors, and replace participant names with assigned pseudonyms. Anonymized transcripts were then saved in a digital password-protected folder and a printed copy of each anonymized transcript was stored in locked file cabinet. Original interview files containing

identifying information (i.e., actual names) as well as the digital file containing original names and pseudonym assignments were transferred to a password-protected digital folder separate from the encoded dataset. These original digital files with names will be destroyed one year following publication of this study in compliance with University of Southern California institutional review board regulations.

In addition to semi-structured interviews, informal conversations were held with numerous organization and non-organization (e.g., contractors) members across northern and southern units during all three observation periods. These conversations served to further clarify information or illuminate concepts discussed during formal interviews. These informal discussions were not recorded, but jottings and handwritten notes were taken and incorporated into field notes, providing additional quotations and insights beyond the semi-structured interviews detailed here.

Initial Interviews – Tactical Air Operations (TAO) and Aviation Maintenance Unit (AMU) Leadership

The first group of semi-structured interview participants (n = 8, Table 4) were recruited directly by a member of the California Department of Forestry and Fire Protection's Public Information Office (PIO) in September of 2021. These invited participants represented the senior-ranking members of the California Department of Forestry and Fire Protection's Tactical Air Operations (TAO) and Aviation Maintenance Unit (AMU).

Seven of the eight interviews were conducted within two weeks of initial contact using the Zoom video platform. The final interview was conducted in person during the air tactical group supervisor (ATGS) training held in March 2022. Interview questions followed a general outline beginning with a probing of individual backgrounds (e.g., "Can you tell me about your

background and how you came to work at CAL FIRE?"), followed by open-ended questions related to resource scarcity (e.g., "Can you share an example of how the current CAL FIRE budget and resources available have impacted your job?"), safety (e.g., Can you give me an example of a risk that Tactical Air Operations deal with and how you manage that risk?"), interagency dependency (e.g., "Can you tell me how the CAL FIRE aviation program is impacted by other agencies when fighting wildfires?"), power laxity (e.g., "Can you share an example of a policy or rule that you've seen someone ignore and how you handled the situation?"), and overall aviation organization views (e.g., "Can you share an example of what you see as the biggest challenge facing the CAL FIRE aviation program?"). Although these interviews were guided by a standard set of questions, the questions were adjusted to an individual's role within the organization where appropriate (e.g., discussions of interagency dependency with maintenance leaders were focused on the link between CAL FIRE and other agencies in maintenance procurement, rather than in situ wildfire responses). For the full in-depth interview guide list of questions, see Appendix K. Several participants (n = 3) voluntarily provided additional information or supplemental organizational materials (e.g., safety reports) following these interviews, which were added to the overall dataset (Table 3).

Second Interview Group – Air Attack and Helitack Unit Team Members

The second group of semi-structured interview participants (n = 18, Table 8) were recruited directly by myself following my entry into the southern region observation sites in October through December 2021. I began approaching southern region air attack unit team members during the second week of my in-person observations beginning with team members that I had established strong rapport with. All team members at the unit were approached for potential interviews with the exception of one team member that was observed avoiding me. One

team member was approached for an interview but declined due to illness; this team member was subsequently not approached for interviews following this declaration. Additionally, one team member participated in two interviews but later expressed career concerns and was removed from the study.

Interview questions began with a probing of individual backgrounds (e.g., "Can you tell me about your background and how you came to work at CAL FIRE?"), followed by questions related to the individual's experiences in the organization (e.g., "Can you share an example of how the current CAL FIRE aviation policies have impacted your job?"), safety (e.g., "Can you give me an example of a risk you've dealt with in your job?"), interagency operations (e.g., "Can you tell me how the CAL FIRE aviation program is viewed by other agencies?"), power laxity (e.g., "Can you share an example of a policy or rule that you've seen someone ignore and how you handled the situation?"), safety protocols (e.g., "Have you ever experienced a safety hazard that you needed to speak up about?") and overall aviation organization views (e.g., "Can you share an example of what you see as the biggest challenge facing the CAL FIRE aviation program?"). Questions were adjusted to an individual's role within the organization (e.g., discussions with junior firefighters focused primarily on wildland fire stories, discussions with senior unit leaders focused primarily on policy difficulties) as well as to the natural conversation path that unfolded during conversations. These recorded interviews lasted from 6 to 96 minutes; shorter interviews represent interview interruptions (e.g., incoming fire and rescue calls). Individual interviews were primarily conducted in private spaces within the unit (e.g., offices) to ensure other team members and organizational leadership could not overhear participant answers although several senior participants opted to leave their office doors open[6] during interviews.

[6] Possibly due to perception concerns of being alone in a closed office with a member of the opposite gender. See page 64 for discussion on the potential effect of researcher gender on this study.

Third Interview Group – Air Tactical Group Supervisor (ATGS) Trainees

The third group of semi-structured interview participants (n = 5, Table 10) consisted of one Tactical Air Operations Unit Leadership team member (n = 1) and air tactical group supervisor (ATGS) trainees (n = 4). Interview requests were made to all California Department of Forestry and Fire Protection air tactical group supervisor trainee participants[7] (n = 10) through email by a member of the Tactical Air Operations (TAO) leadership team at the conclusion of the second observation period in May 2022. Interviews with ATGS trainees were conducted in two phases. The first set of interviews (n = 4) were conducted over Zoom in May 2022 immediately following the conclusion of the air tactical group supervisor training. These interviews lasted from 36 to 85 minutes and were conducted over Zoom. A second phase of interviews with trainees from phase one (n = 3) was conducted over Zoom audio at the conclusion of each trainee's air tactical group supervisor qualifying training flights between August and October of 2022 and lasted from 41 to 104 minutes. One trainee participated in an interview during phase one but did not respond to email requests for an additional interview during phase two.

Table 10

Tactical Air Operations Unit Leadership and Air Tactical Group Supervisor (ATGS) Trainee Individual Interviews

Pseudonym	Rank	Primary Position/ Role and Region	Experience Range*	Interview Length (Minutes)	Transcript Pages (Single Spaced)

[7] Due to the exceptionally small number of participants in the California Department of Forestry and Fire Protection air tactical group supervisor training pipeline, some identifying information (e.g., unit location) necessitated additional masking efforts to maximize anonymity. In response to this concern, all participants in this study including air tactical group supervisor trainees were categorized only by their unit's general region location (i.e., southern or northern) rather than by specific unit name, city, or county location.

Carey**	Battalion Chief	Tactical Air Operations Unit Leadership; HQ	Senior	8	3
Dominic	Captain	Air Tactical Group Supervisor Trainee; Northern	Senior	41, 50	11, 14
Dwight	Battalion Chief	Air Tactical Group Supervisor Trainee; Northern	Senior	85, 104	27, 36
Harvey	Captain	Air Tactical Group Supervisor Trainee; Southern	Junior	48, 41	12, 11
Travis	Captain	Air Tactical Group Supervisor Trainee; Northern	Senior	36	25
TOTAL	**--**	**--**	**--**	**413**	**139**

Note. All interviews were conducted during the second observation period. Pseudonyms were randomly assigned using an online name generator to protect participant identities.
* Less than 10 years of experience working at the California Department of Forestry and Fire Protection have been listed as "junior" and 10 or more years of experience are listed as "senior."
** In this interview, questions were directed to the participant in relation to their role as Tactical Air Operations Unit Leadership, although this participant also served as an air tactical group supervisor trainer simultaneously.

Phase one interview questions followed a general outline beginning with a probing of individual histories (e.g., "Can you tell me about your background and how you came to work at CAL FIRE?"), followed by open-ended questions related to air tactical group supervisor training (e.g., "Walk me through a training day during the second half of CASA, from wakeup to going to sleep. What did your day look like?"), general tactical air operations knowledge (e.g., "Is the aviation team at CAL FIRE different than other CAL FIRE teams?"), and general organization questions (e.g., "Can you share an example of teamwork you've experienced within the CAL FIRE aviation program?"). Although these interviews were guided by a standard set of questions, the questions were adjusted to an individual's history and its influence on a trainee's progress (e.g., discussions of previous positions such as a helicopter operations supervisor and large-scale

firefighting). For the full phase one in-depth interview guide, see Appendix L. Phase two interview questions followed an open-ended question format designed to probe the individual experiences with air tactical group supervisor training flights and instructor feedback during the qualifying period (e.g., "What was the qualification process like?"). For the full phase two in-depth interview guide, see Appendix M.

Data Analysis

Data analysis was conducted utilizing an adaptation of Strauss and Corbin's (1998) grounded theory approach and Sarah J. Tracy's phronetic iterative approach (Tracy, 2019). Phronetic iterative analysis inductively elaborates research concepts through a data-driven investigation grounded in theory, with researchers moving back and forth between literature and data. This study initially sought to approach this study solely through grounded theory but pivoted to phronetic iterative analysis after entering the field site and identifying multiple advantages to be gained by shifting to a more phronetic iterative approach.

At the start of this study, interview questions were developed to explore the boundary conditions of HRO theory in relation to common HRO contexts identified within both the California Department of Forestry and Fire Protection and the initial landmark HRO cases of the U.S. Navy. Specifically, the common contexts of resource scarcity, hard power laxity, and interagency dependency within the California Department of Forestry and Fire Protection case were investigated to rule out the possibility that these common non-HRO contexts prevent the straightforward application of HRO principles. In addition to scheduled interviews, the ethnographic case study of CAL FIRE Tactical Air Operations units shares a significant number of defining characteristics as the landmark HRO case studies of U.S. Navy aircraft carriers, providing an excellent initial framework for exploring communication and safety in high

reliability teams while maintaining a manageable scope. To maintain focus, a broad initial research question was developed to examine the issue of how team safety is communicatively created and reinforced within the organization: *How does high reliability organization theory unfold in a modern high reliability team, and what role does communication play in the enactment of high reliability organization theory*?

Following the initial interviews with California Department of Forestry and Fire Protection Tactical Air Operations (TAO) and Aviation Maintenance Unit (AMU) leadership, observations at the first research site (e.g., southern region air attack base #1) focused on collecting data on resource scarcity, interagency dependency, hard and soft power laxity, and organizational safety. Examples of observations and inquiries captured included: "Discussions of paying for meals depending on fire type" (i.e., resource scarcity), "Problems with USFS neighbors are tasked to unit leaders to solve despite being a different service" (i.e., interagency dependency), "Why aren't pilots wearing flights suits when flying?" (i.e., hard and soft power laxity), and "Are junior team members really empowered to speak up about safety issues at this base?" (i.e., organizational safety).

As a recommended best practice by Sarah J. Tracy (2018), I began immersing myself in the entire dataset when I was three-quarters through the first phase of the data collection process. Part of this process included discussion of the direction of my findings with several members of my dissertation committee as well as multiple members of the organization I was observing. This more focused research approach and ongoing collaboration with the organization facilitated efforts to theoretically align initial observations to broad research questions, with a more direct approach to interrogating high reliability theory boundaries beyond current published empirical research. During the fourth week of observations a promising new direction unfolded in the

project as I observed conflicts between stated organizational communication practices and organizational team member behavior surrounding safety discussions. Specifically, field note observations illustrated multiple stories of conflicts during fire responses, including conflicts between experts and authority figures. As a result, I directed focus more intensely towards understanding how conflict was addressed, repressed, or ignored within the southern region air attack teams. Pivoting towards this new direction, a new guiding research question was constructed to support a more clear and targeted investigation of high reliability theory and high reliability team communication:

RQ_1: How does the cultural principle *deference to expertise* unfold communicatively in a high reliability organization?

During the second and third observation periods, interviews were conducted to further explore the revised research question emerging from the initial observation period and data analysis. These interviews (e.g., most notably, the air tactical group supervisor trainees) served as particularly critical for creating new data insights simultaneous to data collection underway. By narrowing my focus in the field to one type of expertise enactment during a wildfire response (i.e., the air tactical group supervisor) a second research question emerged to guide the exploration of how expertise may be developed and shaped by a high reliability organization's culture and how those elements might impact the process of deference:

RQ_2: How is *expertise* defined and trained by members of a HRO?

Throughout this period of data collection and data cleaning, I continued the iterative process of writing memos, reviewing relevant literature, re-reading transcripts, re-examining imagery and organizational documents, and revisiting field notes and jottings. I then restarted primary cycle coding and data reduction within a framework of the revised research questions,

where descriptive first-level codes were identified from a particularly interesting collection of approximately 20% of the interview and field observation data (Tracy, 2018). As an additional best practice of phronetic-iterative analysis, these newly emergent first-level codes were discussed with several expert high reliability organization researchers to validate the most promising directions emerging from the data. These more nuanced insights drawn from the addition of the second set of data were also discussed with California Department of Forestry and Fire Protection organization members of different ranks (i.e., both junior and senior members) and locations (i.e., northern and southern regions) to further facilitate both collaboration and reflexive elaboration of the initial codes and findings (Tracy, 2010). These member checks ultimately opened a candid discussion with organizational leaders on meaningful directions this study should consider, including the strong recommendation for additional observations of an annual interagency aviation safety conference hosted by the California Department of Forestry and Fire Protection Aviation Department. These discussions resulted in a final observation period inclusive of both the annual California Department of Forestry and Fire Protection Aviation Safety Conference and visits to southern region air tanker and helitack sites in January 2023.

To aid in the ease of coding and the overall data reduction process, ten interviews from the entire collection of all interviews with organizational members ($N = 42$) were selected for descriptive primary cycle coding, inclusive of the air tactical group supervisor trainees. The air tactical group supervisor trainees' interviews were selected specifically because they were conducted at the later stage of the observation period and phronetic iterative process, when the research focus was more clearly defined through revised research questions. Additionally, previous interviews with members that had discussed their work as either incident commanders

or air tactical group supervisors were also selected to provide more insight into the air tactical group supervisor role beyond a trainee perspective. The selected interviews (n = 10) represented 23.8% of the interview data; it is recommended qualitative researchers choose approximately 20% of their available data for coding to "best illustrate a maximum variation of meanings across the study-regarding participants, contexts, and types of data (e.g. fieldnotes versus interview transcripts)" (Tracy, 2018, p. 65). To facilitate the coding process, I first utilized NVivo Version 12 data analysis software as a means of identifying emergent and recurrent patterns (i.e., codes).

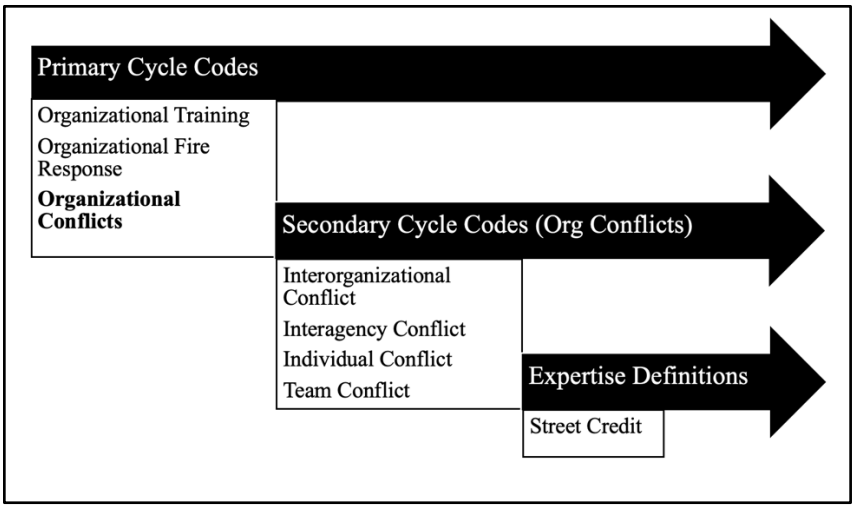
Once the interview transcripts were read, re-read, and coded with several initial descriptive codes, I incorporated all the field notes from the second observation period as well as a smaller subset of field note data from the first and third observation periods into the descriptive primary cycle coding process. The field notes selected were chosen for their relevance to insights identified during the initial coding of the ten interviews (e.g., air tactical group supervisor training exercises). In addition to the field note data, a smaller sampling of photos and videos were also reviewed for descriptive primary cycle coding. Photos and videos were initially selected based on the date they were captured and only for their ability to illuminate concepts discussed in descriptive primary cycle field notes (e.g., images capturing air tactical group supervisor training). Imagery that was not captured on the same day as any of the field notes selected for descriptive primary cycle coding were not included in the analysis (i.e., photos of aircraft from maintenance hangar tours). Finally, at the conclusion of descriptive primary cycle coding of imagery, coding was conducted on a small selection of the organizational training materials (e.g., the organizational training website and all training PowerPoint presentations) provided to trainees during the spring observation periods. These materials, replicating the same selection criteria as the descriptive primary cycle coding of imagery, were only included for

analysis if they reflected either field note observations or interview assertions (e.g., PowerPoint slides on how to correctly talk on a radio). As codes emerged, each was checked for better, negative, or opposite examples across the entire remaining dataset.

After the descriptive primary cycle interview transcripts, field notes, photos, videos, and organizational archival documents were investigated in relation to RQ_1, large primary descriptive coding categories were identified including (a) *organizational training*, (b) *organizational fire response*, and (c) *organizational conflicts*. The dataset was then reviewed a second time and only portions of data containing the broad category of organizational conflicts were kept for secondary coding analysis, providing necessary data reduction and more focused analysis attuned to the emerging potential research questions (Bisel et al., 2014). The decision to narrow my focus to organizational conflicts was made following a review of all data within the primary descriptive coding categories, which illuminated data specifically speaking towards the broad high reliability organization theory concept of *deference to expertise* and RQ_2. Within the corpus *of organizational conflicts data*, specific group types of conflicts were identified including (a) *interorganizational conflict* (e.g., conflicts unfolding between headquarters and members of individual units), (b) *interagency conflict* (e.g., conflicts between contract counties and CALFIRE units), (c) *individual conflict* (e.g., conflicts between individual CALFIRE members), and (d) *team conflict* (e.g., conflicts between helitack team units). Within these groups the repeated use of the term *street credit* was identified across all of the emergent codes and linked to broadly defining expertise within the organization (Figure 1), further clarifying RQ_2.

Figure 1

Primary and Secondary Codes Identified During the Initial Coding Process Leading to Examination of the "Street Credit" Concept



In response to these findings, I returned to the reduced dataset, allowing emerging data to develop an initial coding scheme within the *street credit* concept. During this coding, three primary themes clearly emerged from the dataset as necessary for establishing expertise (i.e., street credit) within the California Department of Forestry and Fire Protection organization: (a) *visual placement*, (b) *command presence*, and (c) *tactical thinking*.

Next, an additional examination was conducted to further sensitize the theoretical concepts underpinning these three primary themes and to allow for more focused codes to emerge. I also developed more specific codes within the broad codes identified and grouped codes together within the data, a process that is commonly referred to in qualitative communication scholarship as either axial (Charmaz, 2014), hierarchical (Tracy, 2019), or secondary coding (Glaser & Holton, 2004). During secondary coding, I identified five broad concepts in support of an individual being perceived at having command presence: (a) *brevity* in communication, (b) *clarity* when communicating information to others, a specific language (c)

tone and (d) *cadence*, and communication (e) *confidence* when delivering information. Additionally, the theme of tactical thinking was found to be supported through (a) *proactive communication* with team members or (b) *the selling of strategies* to individuals in positions of authority. Although subsequent codes were identified detailing the nuances that selling of strategies entails, this data was set aside to maintain a workable scope and breadth to this study; future publications are planned to incorporate this additional data.

During the data analysis process, analytic memos were utilized as a means of consistently reflecting on the analysis process and emerging ideas using a dedicated bullet-type reflection journal. These memos allowed for drawings and sketches to flow more easily and were comprised of handwritten notes, diagrams, and stick figure drawings. Loose analysis outlines (Strauss & Corbin, 1998; Tracy, 2019) were composed during the writing process to assist in linking codes and arguments with the larger research questions of this study. The use of loose analysis outlines allowed me to see dominant data and also allowed me to return to the raw data (e.g., transcripts) for thick descriptions in my written examples. I used thick description in my writing to create resonance in the written observations, a key marker of quality in quantitative research (Tracy, 2010).

Analysis was completed when no new information was unveiled and no new surprising information was uncovered (Glaser & Strauss, 1967; Strauss & Corbin, 1998). At the conclusion of my data analysis, I crystalized my findings by conducting final member checks, reviewing field notes, and revisiting interviews to verify that the analysis accurately represented the organization and its members (Lindlof & Taylor, 2017). By the end of the process, all data were accounted for comprehensively within the theoretical framework presented in the results section, including acknowledgement that despite my best efforts otherwise, researcher perspectives are

inescapably partial and thus always incomplete (Tracy, 2010). Additional discussion of this inescapable partiality is elaborated within the *Researcher Role and Limitations* section of this chapter.

Verification Strategies

Multiple steps were taken to ensure excellent, high-quality qualitative research (Tracy, 2010). First, I engaged in "crystallization," collecting multiple sources of data (i.e., interviews, photos, organizational documents) from multiple vantage points (i.e., varying ranks and positions, separate operational facilities) within the organization to build a clearer picture of the case.

Second, I used a process of peer review throughout the course of this study, including presenting the initial coding scheme to two internationally recognized high reliability communication scholars. These scholars reviewed the plausibility of the coding analysis and provided continuous feedback to further refine my work. During the analysis process, extreme care was taken to ensure healthy detachment from initial hypothesis was maintained, protecting me from "falling in love" (Tracy, 2018, p. 72) with my initial positioning and forcing me to continuously examine alternative positions. To ensure this care remained at the forefront, continuous meetings were held with members of the dissertation committee, including discussions intentionally focused on locating negative case examples and devil's advocate deliberations. Negative case analysis is conducive to strengthening the trustworthiness of an overall analysis, and it also ensures an assortment of viewpoints are represented, not just my own position (Creswell & Creswell, 2017; Creswell & Poth, 2016). Taking a devil's advocate approach also strengthened my arguments by forcing me to consider potential weaknesses in my

arguments and examining the limitations of the claims I am attempting to make with my applied findings (Keyton et al., 2009).

Third, both the field notes and final manuscript included thick descriptions of context and setting of the case, supported by photos and videos captured during field observations. Examples of these thick descriptions have been incorporated throughout this document to further support this claim.

Finally, to ensure accurate depictions of participants' lived experiences and interview responses, I engaged in member checking regularly (see Creswell & Creswell, 2017) with participants by asking a diverse subset of members (i.e., one senior member of the California Department of Forestry and Fire Protection Tactical Air Operations Team, two senior Air Tactical Group Supervisors, two senior members of an air attack unit, and three junior members of air attack unit) to review the initial and final findings. These findings were discussed as preliminary findings prior to the final publication of this document and a study summary of key findings to the California Department of Forestry and Fire Protection Tactical Air Operations leadership cadre. All suggested changes were incorporated into the final version of this paper.

Data Storage

To facilitate an easy review of data during the data analysis process, a data organization system was created to store all data and documents related to the study including notes, photos, videos, organizational documents, and interviews. To start, a master data folder for this study was created with a password required for access to the folder. This data protection measure was set to limit potential data access only to myself even if access to the data storage itself (e.g., laptop) was compromised. For data that was collected throughout the study utilizing other sources (e.g., Zoom transcripts or interview recordings made on recording devices), data was

immediately transferred to the password-protected folder at the end of each day and the original data source (e.g., Zoom recording or recording device mp3) were placed in a separate password-protected digital folder.

Within the master digital data storage file, subfiles were created for each type of data collected. As these subfiles were created, I remained mindful of how the data was organized, carefully considering how the organization of this data would affect my data analysis (Tracy, 2018). Ultimately, I made the decision to organize data on type and location based on the research questions this study seeks to answer. By organizing data by location, I was able to carefully consider similarities and differences that unfolded based on the type of teams present at each location as well as the organizational and geographic location of each team.

All handwritten notes were kept in bullet-journal style notebooks, and these notebooks were locked in a locked file cabinet at the end of each day. During the study, the notebook was never left unattended to ensure no access to the research notes occurred. Additionally, I wrote my notes primarily in long blocks of cursive handwriting, to limit the reading of my handwritten notes surreptitiously (e.g., over my shoulder) when writing in the field.

Every attempt was made to follow the best practice of having all handwritten records from fieldwork transposed within 36 hours into formal fieldnotes (Emerson et al., 2011). The majority of notes were transcribed within 8 hours of a completed site visit to maximize accuracy in the recollection of events noted in the handwritten field notes. In a very small number of instances, however, the rigorous back-to-back schedule of site visits made full transcription within this timeframe impossible. In response to these time constraints, all field notes were transcribed within 7 days of the field site visit, or those handwritten notes were eliminated from further consideration from the study dataset to ensure accurate memory and representation of the

events detailed in the handwritten notes. All drawings made in the handwritten notes (e.g., event spaces or positioning of people within an aircraft seating configuration) were photographed and incorporated into the formal fieldnotes.

Researcher Role and Limitations

As a U.S. military veteran with eight years of active-duty military service on high reliability teams, including two years as the safety officer with a renowned U.S. Navy aviation squadron, this study would not have been as successful as it was at uncovering new insights without this expertise background to assist in clarifying observations, transcript cleaning, coding, and analysis of interview and organizational communication data. My aviation expertise and high reliability team experience as well as safety protocol knowledge developed within an aviation context facilitated rapid credibility and rapport-building within the organization, including members of the tactical air operations units. This rapport-building facilitated additional access to critical training operations not previously open to researchers and led to richer, more developed data. During interviews, transcript cleaning, and data analysis, my aviation and safety knowledge also supported a more nuanced understanding and interpretation of aviation jargon, colloquialisms, and practices within the broader context of the aviation firefighting operations. Admittedly, this knowledge also comes loaded with inherent assumptions and biases, which I made efforts to overcome through regular discussions with my dissertation committee and non-aviation or firefighting associated researchers. These discussions proved fruitful in both checking my inherent assumptions (e.g., the expected presence of a tactical air operations leader during a safety mishap) on communication and behavior patterns identified in the field, as well as also identifying potential weaknesses and biases (e.g., dismissal of gender-link behaviors in field exercises) supporting some of my initial insights.

Beyond these outlined exclusions and limitations, it is noted that researcher gender (i.e., female) inescapably affected at least some portion of data collection throughout this study for multiple reasons outlined in the following paragraph. For example, during initial interviews with several participants, the use of swearing and curse words were sometimes prefaced with phrases including “pardon my language” or concluded with “sorry [for cussing/cursing].” The transcript excerpts of this study, which may appear heavily edited by the researcher, accurately reflect the exact wording used by all participants in interviews and transcribed handwritten notes. Admittedly, however, it is apparent that many participants were potentially self-editing their language during our interactions and discussions, and only a few were completely comfortable speaking phrases of a more offensive or colorful nature. When the topic of edited language was discussed during final member checks, one participant repeatedly reassured me that I “definitely got [the] real talk, not the media talk” in my observations with the teams, and that despite their sometimes-careful word choices, that my study accurately reflected “how [they] talk at work.”

Additionally, during in-person observations and field work, my gender was inescapable from the notice of my participants or myself. During my participation in one safety conference, I noted in my jottings that as I entered the conference hall, more than two hundred pairs of male eyes appeared to stare at me, and I counted only four women in the entire room. While the stares appeared curious and friendly, it proved an unnerving experience. Additionally, my inescapable difference in gender at the event rendered me unable to make observations as subtly as I would have preferred, as anonymity was next to impossible. For example, one participant refused to sit in the front passenger seat of a vehicle during an impromptu lunch outing with the team, despite his rank and position typically affording such courtesies. When I insisted on riding in a back seat, the senior-ranking participant aggressively refused, insisting that “his mother would never

forgive him” for making me sit in the back seat. This same participant continually opened doors for me throughout the course of my observations, regularly reminding me that despite my best efforts to blend in, my gender was never very far from the minds of my participants.

Chapter 3: Findings

This study of aerial wildfire fighting teams brought together crisis response teams, challenging training processes and interagency collaborations into exhilarating, high relief. It illustrates how practices dedicated to the development of trust and voice enactment in high reliability teams underpin safe crisis operations, particularly during exceptionally chaotic and unpredictable circumstances such as aerial firefighting operations. This study illustrates how interlocking elements of organization communication—including training programs, expertise expression, interagency relationships, and trust development—can dissuade or ignite communication issues with authority figures during crisis response. Most crucially, the definitions of aerial firefighting expertise and communication practices of aerial firefighting identified within this study were found to have potentially sizable impacts on the overall outcomes of new wildfires to be slowed, stopped, or substantially grow. Initial communication between experts and authority figures, which is largely predicated on an expert's ability to smooth communication and quickly build trust with an authority figure, later serves to build overall situational awareness that is critical to fast-attack fire responses that achieve the industry standard of keeping 95% of fires contained at 10 acres or less (CAL FIRE, 2022d).

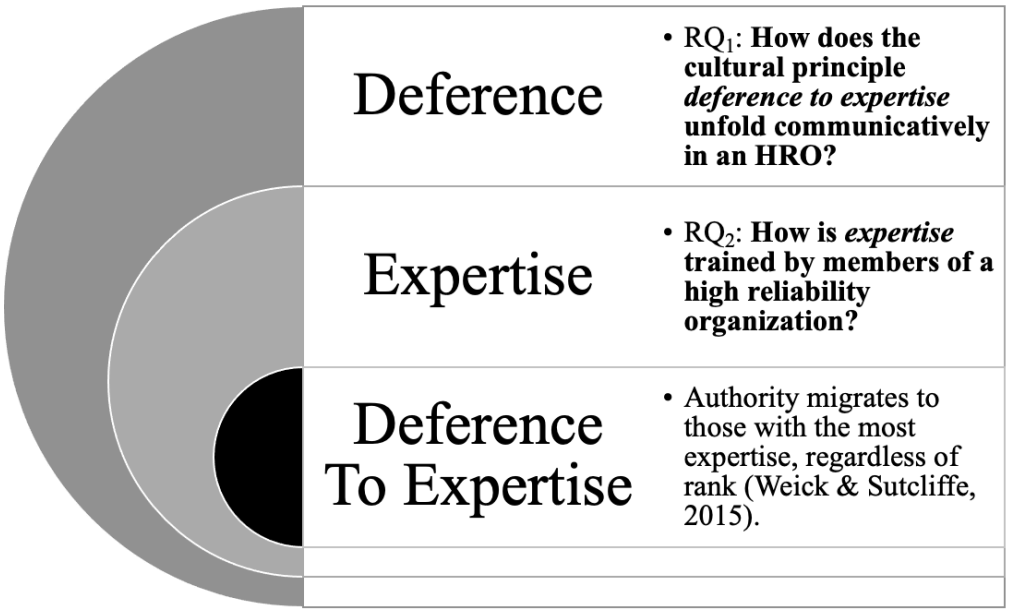
By conducting interagency training programs to teach aerial firefighting experts the specific, preferred ways of speaking prior to a crisis response, aerial firefighting experts learn how to smooth communication between themselves and authority figures. These communication tactics also allow experts to gain critical decision-making autonomy during crises, such as when the initial chaos of a developing fire has the most potential to derail the safety an entire firefighting team. This interagency training effort to teach aerial firefighting experts to "lead up" (Useem, 2001) to authority figures through communication addresses the potentially inherent and

deadly voice challenges that can be present in rigid, hierarchical organizations. Training to specific expertise expectations and definitions, grounded in communication practices, is what ultimately allows experts to both efficiently share situational awareness and expedite positive reception of this information from authority figures during wildfires. This, in turn, allows authority figures to act on these recommendations quickly and limit the potential for small fires to develop into catastrophic, dangerous blazes. In short, the development of situational awareness—grounded in specific expert communication practices—can be a critical tool in preventing small fires from bursting into big, catastrophic blazes.

This study is grounded in the analysis of two research questions which were developed in relation to investigate high reliability organization theory (Figure 1). The findings of this chapter unfold in two parts under the broad concepts of deference and expertise (Figure 2). This two-part chapter provides an in-depth examination of how *deference to expertise* is realized in situ and how expertise definitions and training helps facilitate respectful yielding between team members during one of the most difficult and risky operations faced by aerial firefighting teams—the initial attack response to a fire.

Figure 2

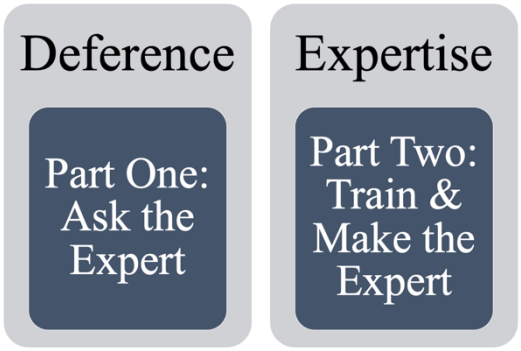
Research Questions Situated in Relation to High Reliability Organization (HRO) Theory Principles



Note. Source: Amber Lynn Scott

Figure 3

Illustration of Findings Chapter Parts 1 and 2 in Relation to the High Reliability Organization (HRO) Theory Principle—Deference to Expertise



Note. Source: Amber Lynn Scott

First, I situate this study within the field of high reliability organization communication research by describing the importance of air tactical group supervisor expertise in relation to aerial firefighting and initial attack fires. Previous studies have broadly explored aspects of high

reliability expertise in the fire service, including experience borrowing (Ishak & Williams, 2017), hierarchy (Jahn & Black, 2017), communication in safety practices (Jahn, 2019), expertise development and meaning (Minei & Bisel, 2012), assimilation (Myers, 2005), failed sensemaking (Weick, 1993), and successful sensemaking after organizational tragedy (Williams & Ishak, 2018). The orientation of this study towards understanding the construction and communication of expertise serves to clarify the importance of the air tactical group supervisor's unique expertise within a team battling an initial attack wildfire, and how that expertise is utilized by the incident commander tasked with coordinating the entire operation. It also clarifies the necessity for the air tactical group supervisor role as a unique and separate position from the incident commander during an initial attack fire and illustrates the difficult and often overwhelming amount of information these individuals coordinate during dynamic, multi-aircraft fire responses. Additionally, part one provides the context necessary to understand the important role communication plays in the realization of the high reliability organization theory principle *deference to expertise* within the CAL FIRE organization during a crisis response.

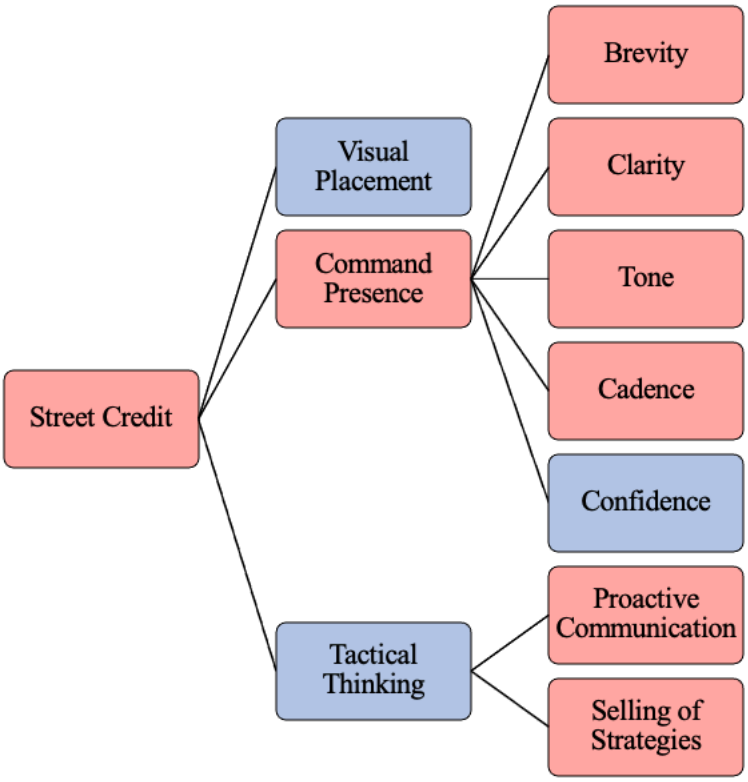
Second, I explain how air tactical group supervisor expertise is defined within the CAL FIRE organization and provide an examination of how the air tactical group supervisor training program also shapes air tactical group supervisor expertise to this definition (Figure 3). During the data analysis, definitions of expertise were identified and were often used in conjunction with the term *street credit*. The term street credit was used within the organization to broadly define expertise, especially expertise related to air tactical group supervisors. Three primary themes clearly emerged as necessary for establishing street credit within the organization: (a) visual placement, (b) command presence, and (c) tactical thinking. Additionally, five broad concepts in support of an individual being perceived at having command presence: (a) *brevity* in

communication, (b) *clarity* when communicating information to others, a specific language (c) *tone* and (d) *cadence*, and communication (e) *confidence* when delivering information. The broad concept of tactical thinking was supported through (a) *proactive communication* with team members or (b) *the selling of strategies* to individuals in positions of authority. Codes inclusive of formal terms used within the organization, including during air tactical group supervisor training, have been illustrated in light red in Figure 3. Emergent terms that were identified through text analysis during the coding process have been illustrated in light blue in Figure 3. While some of the identified terms were introduced in the air tactical group supervisor training program and remained largely consistent in definitions and use throughout the course of an air tactical group supervisor's career (e.g., brevity, clarity, tone, cadence) other terms were found to adapt beyond definitions or examples provided in training (e.g., selling of strategies). For example, while air tactical group supervisor training incorporated specific communication techniques (e.g., general phraseology) for "selling" incident commanders on strategies during initial attack fires, discussions with senior air tactical group supervisors illustrated that these strategies were unique to each individual when deployed in situ. Further illustrating this point, air tactical group supervisor trainees voiced frustration over the inconsistent nature of instructor feedback during their qualification process, which they felt included a strong emphasis on one communication selling technique (i.e., the instructor's way) over other equally effective techniques (i.e., communication strategies learned from others in the organization). In this example, we see how the original discursive constructions of an element (i.e., selling of strategies) of the overall concept of street credit naturally evolves discursively from an official way of sharing knowledge during the air tactical group supervisor training program to a more personalized form that fits each air tactical group supervisor's preferred communication style

once they pass training and become more senior. This discursive adaptation demonstrates how air tactical group supervisors learn to identify elements of street credit that support team safety through communication by remaining fixed to the training curriculum, and which elements improve effective communication when adapted to suit each individuals' communication style.

Figure 4

Primary Codes Identified During Phronetic Iterative Analysis



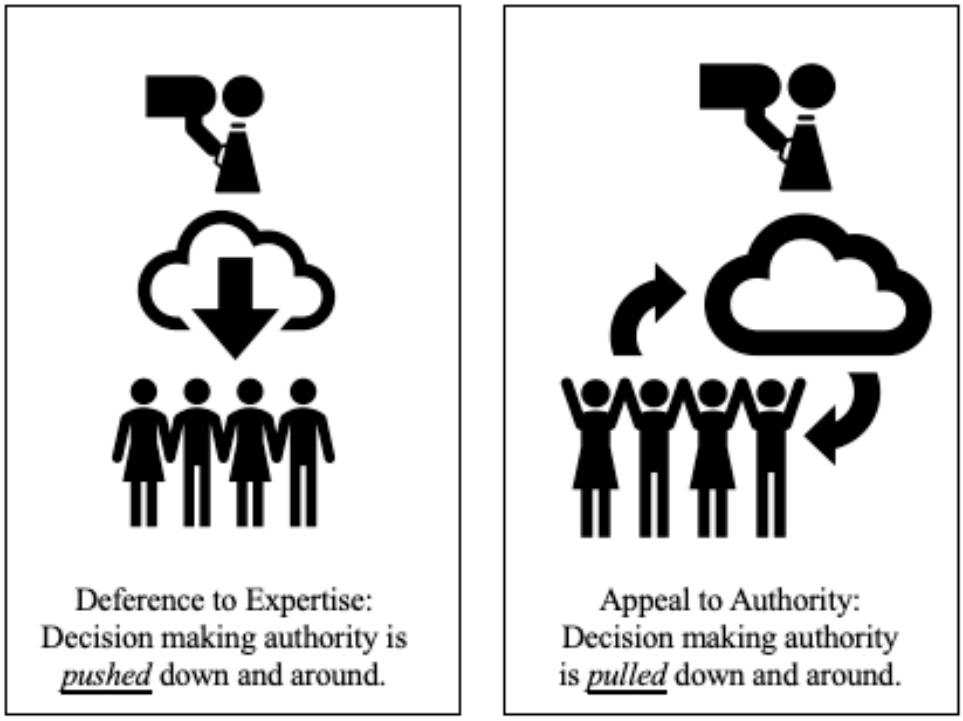
Note. Codes inclusive of formal terms used within the organization are illustrated in light red. Emergent terms invented during the coding process are illustrated in light blue. Source: Amber Lynn Scott

These findings also highlight the important role communication, rather than firefighting tactics alone, plays in defining an air tactical group supervisor as the aerial firefighting expert during initial attack fire responses. Additionally, these findings examine how the high reliability organization theory principle *deference to expertise* unfolds through communication between

individuals who hold authority for decisions (i.e., incident commanders) and persons that possess expertise but not authority (i.e., air tactical group supervisors) during initial attack wildfires. These findings illustrated multiple deference to expertise challenges that experts face, and how they unfold communicatively during crises (i.e., initial attack wildfires) with authority figures. This study identified that air tactical group supervisors are trained to use *appeal to authority* (A2A) as a method of smoothing communication between themselves and incident commanders during fire responses. In utilizing A2A, decision making authority is *pulled* down and around the team by the air tactical group supervisor, rather than through a *pushing down* of decision-making by authority figures through deference to expertise (Figure 4).

Figure 5

Illustrated Decision-Making Models of Deference to Expertise and Appeal to Authority



Note. Source: Amber Lynn Scott

This appeal to authority (A2A) communication effort by air tactical group supervisors (i.e., experts) stands in contrast to previous high reliability literature, where deference to expertise has been defined as a process where decision making authority is *pushed* down and around by authority figures (Cantu et al., 2020; Roeder, Bisel, & Howe, 2021; Weick & Sutcliffe, 2015). This exciting new finding, which further clarifies how communication between experts and authority figures successfully unfolds during crisis, provides a particularly exciting new insight for organizational communication, management studies, and high reliability scholars alike.

Part 1: Ask the Expert: The Critical Role of Air Tactical Group Supervisor (ATGS) Expertise During Initial Attack Wildfire Tactical Air Operations

> The success of the California wildland firefighting community depends upon aggressive initial attack and response…The success of an initial attack operation can significantly influence the ultimate outcome of a wildfire event, and thus place an extraordinary burden and expectation on emergency responders.
>
> — Initial Attack Effectiveness: Wildfire Staffing Study Final Report 2010
> Dr. Matt Rahn, San Diego State University

Air tactical group supervisors (ATGS) play the most critical role in developing and sharing knowledge that supports and reinforces team safety during initial attack fires. They also serve as both firefighting and aviation experts during wildland fire responses that incorporate aircraft as part of the firefighting response. Although the initial attack incident command hierarchy structure dictates that the air tactical group supervisor reports to the incident commander (IC; National Wildfire Coordinating Group, 2022c), during a wildfire response the *expertise* on how to utilize aircraft—including helicopters and air tankers—is drawn from the tacit knowledge and experience of the air tactical group supervisor.

The importance of the air tactical group supervisor position as part of any initial attack wildfire response is well illustrated in the words of Carey, a qualified incident commander, air tactical group supervisor, and senior member of the CAL FIRE Tactical Air Operations leadership team:

> The most influential position in aviation that has the most capacity for influencing outcomes is the ATGS position. You're basically the air traffic controller in the sky. You've got knowledge of the fire on the ground and knowledge of aviation [such as] keeping aircraft separated. You're kind of doing all of those facets. So that position is very difficult to achieve within our organization…I would say that's the hardest qualification to achieve in CAL FIRE aviation.

Beyond Carey's assertion, an examination of the last ten years of CAL FIRE's organizational documents including after action reports (Department of the Interior & U.S. Forest Service, 2023) and incident updates (CAL FIRE, 2022a) as well as interviews and media accounts detailing the causes of catastrophic California wildfires that unfolded within the last two years (Iati & Moriarty, 2021; McDonald et al., 2021; Sheehan, 2022), all identify the crucial role aerial firefighting and thus air tactical group supervisors play in a strong initial attack. Previous research has also noted the crucial importance of strong initial attack firefighting responses and their ability to prevent large-scale wildfires in North America (Cumming, 2005; Reimer et al., 2019), especially in the boreal-type forests that encompass many of the mountain regions of northern and southern California. In 2022, the prevention of large-scale catastrophic wildfires through initial attack firefighting was considered to be a successful endeavor (Cart, 2022) and attributed in part to an increased emphasis on aerial firefighting support (Chapman, 2022; Vacar, 2022). Of the 7,641 wildfire incidents CAL FIRE reported in 2022, only 1.7% of those wildfires (i.e., 129 total wildfires) exceeded 10 acres (CAL FIRE, 2022d), a statistic that far surpasses the annual industry goal of containing 95% of all wildfires to 10 acres or less (Rahn, 2010). Thus, we can surmise from this data that if overall initial attack efforts are linked

to an increase in aerial firefighting support, it is arguably attributed to the success of the team member that in the words of Carey—"has the most capacity for influencing outcomes"—that is, the air tactical group supervisor.

Despite having critical expertise, the air tactical group supervisor is *not* in charge during an initial attack response. The authority for all initial attack decisions—including distribution of aerial firefighting assets—resides with the incident commander. The positioning of the incident commander as the centralized authority, despite a lack of expertise, serves an important function in a high reliability team. It provides a centralized location for the team to turn to for decision making, ensuring the team can coordinate actions quickly. As the person in charge, the incident commander coordinates actions to both quickly and effectively attack an unfolding wildfire. However, the de-coupling of expertise from decision making authority also allows the high reliability team to maintain flexibility needed to attack a wildfire using every tool available.

This important distinction provides critical contextual background supporting the first argument from this analysis, which notes the important role air tactical group supervisors play as expertise supporting an incident commander. This support results in two key outcomes: (a) preventing catastrophic wildfires from emerging from small fires, and (b) ensuring the safety of the entire firefighting team battling the initial attack fire. Without aerial firefighters and the expertise of the air tactical group supervisor leading the coordination of the aerial firefighters' actions, both organization and media accounts have demonstrated small initial attack wildfires can spread quickly and erupt into larger, catastrophic fires. Although additional aircraft assets have been added to CAL FIRE to reduce this possibility (Chapman, 2022), this study has found that it is the air tactical group supervisor who ultimately coordinates the aerial response and

makes recommendations to the incident commander situated on the ground, providing unique tacit knowledge that preserves the reliability of the entire team.

The expertise of the air tactical group supervisor during an initial attack response is particularly crucial to limiting small fire spread, as they utilize both their visual advantage and their firefighting expertise to advise the incident commander on how to utilize aircraft and keep a wildfire to a small and manageable size until ground crews are coordinated to extinguish the blaze. Former incident commander and air tactical group supervisor Norris explains:

> When I say the big picture, [I mean] you get to see the fire. You understand what the fire is doing, what its needs are, and you can help relay that information to the ground resources. If I'm an incident commander on the ground and I'm standing at my truck and the fire's moving out, now it's 5 to 10 miles away. [As the ATGS,] my eyes are in the sky. My experience and how I communicate back to him and then all the people that are working for him, it's helping to mitigate that emergency….It's being part of having a good understanding of what it means to fight the fight on the ground and just supporting those folks. The incident commander, all the way up to the Air Ops branch director, and just reporting back and just letting them know what I think their needs are, what is being effective, where I think the fire is going, when we need to do evacuations, where we can evacuate folks. So the folks in the air have kind of the best seat in the house and we [ATGS'] are just a conduit between the fire and the folks on the ground.[8]

In this example, Norris helps clarify that air tactical group supervisor expertise includes experiences in firefighting tactics, aircraft use, and visual proximity to the fire. Furthermore, Norris' statement begs an obvious question—what exactly makes an air tactical group supervisor more knowledgeable than an incident commander on an initial attack fire? Is it simply the air tactical group supervisor's proximity above the unfolding wildfire? Although the air tactical group supervisor's visual proximity to a fire provides an incident commander critical information they cannot obtain from their own ground position, proximity alone does not equal expertise. Instead, an air tactical group supervisor's knowledge development (i.e., specialized training

[8] For detailed definitions of all fire terminology and phrases used throughout the quotes in this analysis, please see the glossary.

program) and supervision of air assets (i.e., ongoing aerial firefighting responses) underpins their unique expertise development and refinement. This specialized knowledge development of aerial firefighting techniques that is required for the air tactical group supervisor position also prevents important firefighting knowledge from becoming siloed within one key position (i.e., incident commander) during a fire response, instead ensuring distribution of important firefighting knowledge across several key positions. In their position as manager of the aerial fire response, an air tactical group supervisor specializes in aerial firefighting techniques and empowers an incident commander to focus on managing the traditionally larger and more chaotic ground response. While there is admittedly risk in containing aerial firefighting knowledge primarily within the air tactical group supervisor position, the risk would be significantly higher if that same knowledge resided within one individual responsible for both ground and air firefighting tactics. Furthermore, containing that knowledge entirely within an incident commander places the incident commander at risk of becoming overwhelmed with the volume communication requires for managing both a ground and air fire response. Thus, we see how air tactical group supervisor knowledge and expertise is a combination of visual proximity during fires, tacit knowledge, and knowledge gained through both organizational training programs and daily interactions with members of the aviation unit.

Air Tactical Group Supervisor Visual Expertise: It is "Painfully Obvious"

Current air tactical group supervisor and former incident commander Dwight explains that during a fire, the positioning of the air tactical group supervisor aircraft makes it "painfully obvious what the priorities are." He goes on to explain how "there are times that the IC will give you a priority that is not going to put the fire out and it is not going to be the structural protection that the public needs…we're the eyes for the IC." Therefore, we can easily assume that visual

proximity is an essential part of air tactical group supervisor initial attack expertise. However, visual proximity alone is not enough to account for the totality of the air tactical group supervisor's expertise.

The air tactical group supervisor serves as the aerial fire tactics expert when they arrive on scene, given their view from the air of an unfolding wildfire incident and daily proximity to aerial firefighting operations by their assignment to an air attack base. The air tactical group supervisor literally "sits on top of the stack" of aircraft flying above a fire, with the pilot positioning the air tactical group supervisor aircraft[9] above the individuals and aircraft fighting the wildfire. Unlike the incident commander, who can only directly see the fire and crews within their immediate ground position, the air tactical group supervisor has the advantage of being able to simultaneously look at the unfolding wildfire from a wider perspective inclusive of ground crews, firefighting aircraft, and the surrounding terrain and landscape. By the nature of their positioning during the emerging fire, the air tactical group supervisor inherently possesses expertise the incident commander does not, simply because they can see the overall picture in a way the incident commander is unable to do. Conversely, the incident commander maintains a ground view, which when combined with the air tactical group supervisors' view, allows the incident commander to maximize his or her situational awareness and ensure the entire safety of the ground crew during a firefighting response.

The visual positioning of an air tactical group supervisor during an initial attack response is one element used to create situational awareness during a dangerous wildfire, and the importance of team situational awareness should not be overlooked. In aerial firefighting, both

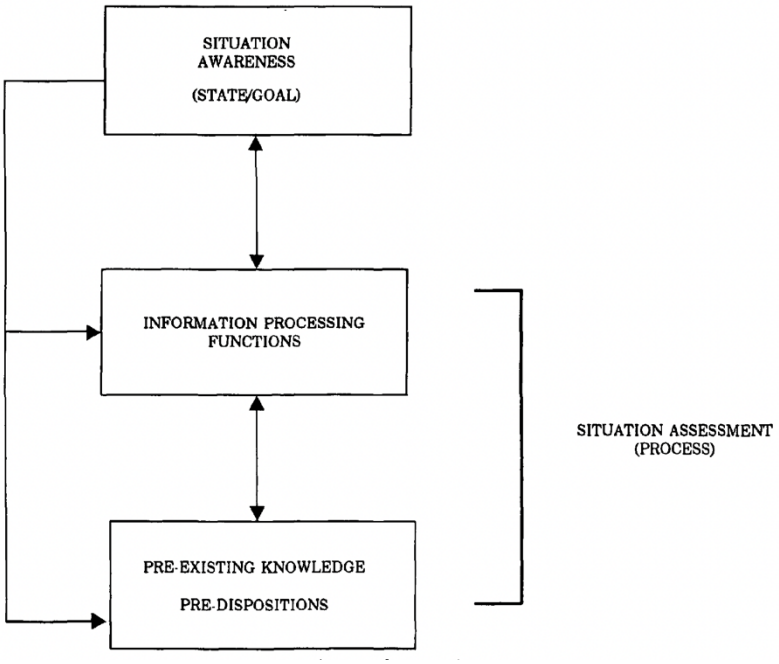
[9] Typically, an OV-10, unless the air tactical group supervisor is still in their qualification phase. During these qualification flights, a King Air 200 is flown to accommodate additional passengers (i.e., the air tactical group supervisor evaluator)

individual and team situational awareness play important roles to supporting team safety, which are largely driven through communication. Situational awareness is defined in human factors literature as “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future” (Endsley, 1988). This perception allows an individual to create an internal model of the surrounding environment at a given point in time, providing the necessary and critical input needed to support quality decision making. Behaviors linked to developing individual situational awareness include "communication, self-critique, preparation and planning, crew briefings, and task distribution" (Salas et al., 1995, p. 129). The situational awareness construct has been described as a three-level effort that builds on preexisting knowledge, as shown in Figure 5 below (Endsley, 1988; Salas et al., 1995). For example, in relation to aviation practices, situational awareness can begin with a military pilot perceiving something in the environment, such as another unfamiliar aircraft, emerging mountain, or warning sound emitting from the cockpit. This first observation represents level one. The pilot’s knowledge of this new element is then put together with other previously known knowledge of other elements to create a holistic picture of the environment. This holistic picture, representing level two, allows the pilot to build significance around the initial perception when contemplated in conjunction with other known elements and also supports the pilot in obtaining the knowledge needed decide on the best course of action. The best course of action represents the third level. During this third level of building situational awareness, the pilot is able to project the significance that has been constructed on to future scenarios, such as seeing a marked enemy aircraft and its proximity to a strategically located ground unit nearby. In turn, the pilot may infer that the enemy aircraft approaching the location might be preparing to deploy an imminent attack of teammates on the ground, and thus

the pilot can respond with the most efficient and probable outcome (i.e., counter maneuvers to save ground teams). Conversely, if the pilot observes that the approaching aircraft is not an enemy aircraft, but a plane marked with a Delta airlines paint scheme and is the size and shape of a 737 airliner, the pilot will likely construct an entirely different projection for a future course of action, including what information they share with units located on the ground. This example illustrates the same general flow of knowledge access, information processing, and assessment that supports situational awareness development in aerial firefighting teams.

Figure 6

Model of Conceptualization of Individual Situational Awareness (Salas et al., 1995)



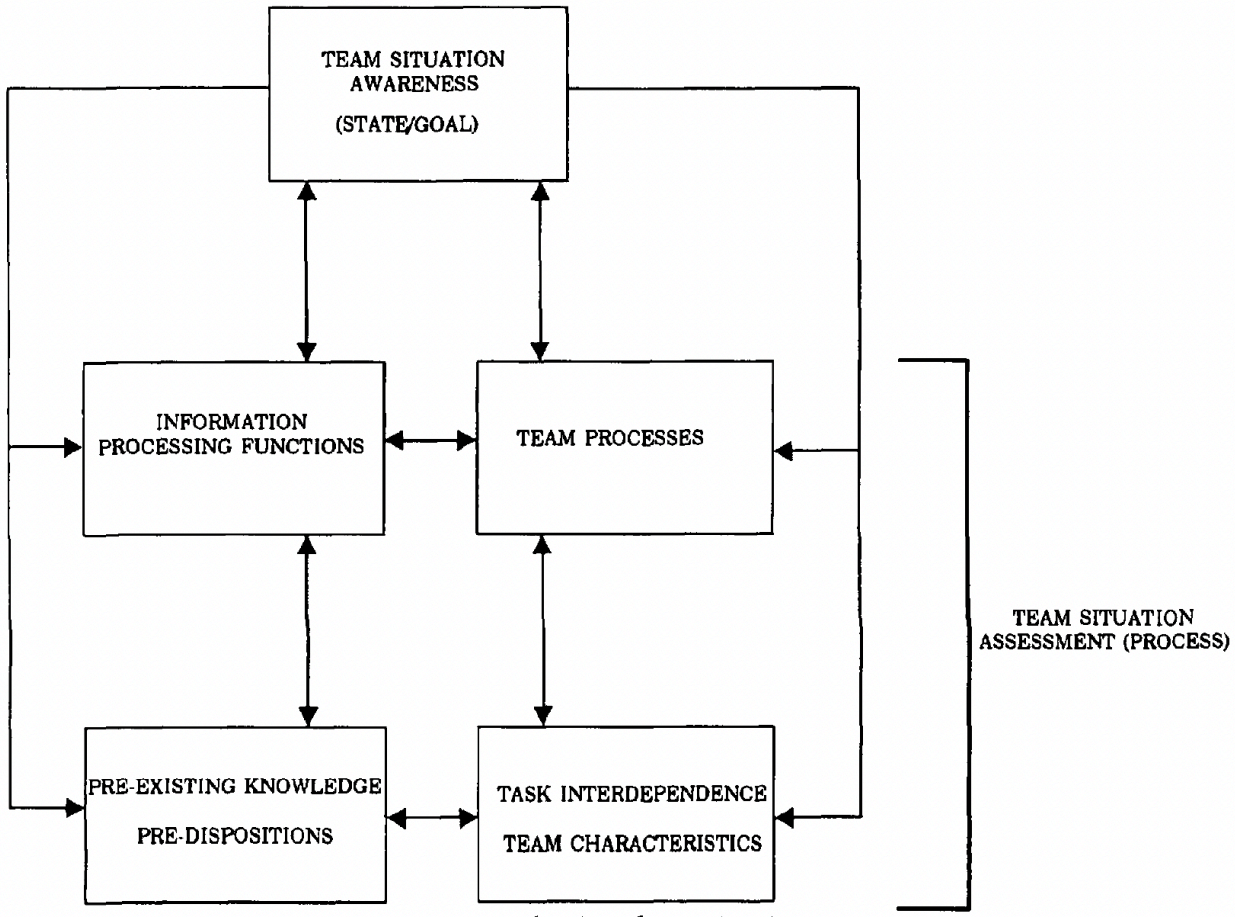
Note. Source: (Salas et al., 1995, p. 126)

As illustrated in the previous example, individual communication can serve as an important component to building team situational awareness (Figure 6). Individual communication of situational awareness to others within a team can play a key role in in affecting team processes, such as providing critical inputs that affect team decision making

(Robertson & Endsley, 1994). Researchers have shown that the quality of communication contributed by individual team members impacts the level of situational awareness an entire team can reach, with incomplete communication from individuals serving to decrease overall situational awareness in aircraft crews (D. Schwartz, 1990). Conversely, processes within teams that support individual communication, such as assertiveness or clarification of details, have been found to build overall team situational awareness (Salas et al., 1995).

Figure 7

Model of Conceptualization of Team Situational Awareness (Salas et al., 1995)



Note. Source: (Salas et al., 1995, p. 126)

Similarly, as aircraft enter the airspace above a fire traffic area (FTA), the air tactical group supervisor gets to work creating a "stack" of airplanes and helicopters to facilitate safe and seamless aerial firefighting operations. Typically, the air tactical group supervisor will sit at the top of the stack[10] flying at 2,500 AGL[11] above the fire location. This position provides a birds-eye view of the developing wildfire and also allows the air tactical group supervisor to keep a close eye on all aircraft entering the FTA. When coordinating an initial attack response, helicopters remain at the lowest part of the stack, where they are restricted to operating at 500 AGL or lower. From this lower position, they share their closer-to-ground observations with the air tactical group supervisor placed far above them., giving additional information and updates the air tactical group supervisor otherwise could not see. Fixed-wing aircraft, including small aerial firefighting tankers[12], operate in the airspace above 1,500 AGL and only enter below this threshold when dropping retardant on a wildfire or exiting the drop site after dropping retardant. These individuals will also contribute information to the air tactical group supervisor, such as how they perceive a particular fire-retardant drop to look as they make a drop, or how wind speeds are affecting the ability to drop fire retardant on desired locations. In turn, the air tactical group supervisor shares feedback with fixed-wing pilots from their perspective, allowing the fixed-wing aircraft to adjust their drops for additional precision or move to a location with more favorable winds.

While a typical initial attack response led by CAL FIRE typically includes at least one helicopter[13] and two small fixed-wing air tankers, it is neither unprecedented nor unusual for an

[10] Colloquial term used in aerial firefighting to denote positioning of aircraft at the top of the fire traffic area.
[11] AGL = Above Ground Level. See glossary for full definition.
[12] e.g., Grumman S-2s
[13] e.g., Bell UH-1 H Super Huey or Sikorsky S70i CAL FIRE Hawk

initial attack response to also incorporate multiple tankers, helicopters, or larger aircraft[14] within minutes of an unfolding wildfire, emphasizing the importance of strong communication as individuals build and share their situational awareness with the larger team coordinator, the air tactical group supervisor. A recent shift in aircraft assignment policy towards this "all hands on deck" aircraft and helicopter approach was attributed by several team members to be a direct response to the state's numerous catastrophic wildfires over the last decade. This shift illustrates both the strong organizational learning patterns underway at CAL FIRE as well as the pressing and important need for strong communication to support the rapid development and distribution of situational awareness across teams.

Dominic, a northern California-based air tactical group supervisor trainee, shared his memories of fire devastation from large-scale California wildfires in 2020 and how this has influenced protocol for air tactical group supervisors to almost immediately order additional aircraft beyond the standard deployment of one helicopter and two Type I[15] fixed-wing air tankers. In his very first initial attack fire response as a trainee, he pressed hard for additional air support after arriving on scene and noting the fire's potential to gain traction in the thick, dry forests that had not yet burned:

> Once they gave me clearance to get tankers in there, I mean, I ordered a bunch…and I already kind of had a plan of where I was going to start, the different tankers I had coming. I had Type I's and Type III's and where I wanted to drop them. So they showed up and there was smoke jumpers also en route to try to get guys on the ground for the night out of [northern California city]. And so, it worked out really good. It was pretty much my first fire with tankers and I just had, you know, five.

[14] e.g., DC-10s or Lockheed C-130H Hercules

[15] At CALFIRE, the use of the term "Type 1's" is shorthand for Type I Airtanker. The most common use of the term Type I refers to C-130H aircraft with a 4,000-gallon capacity for fire retardant. The use of the term "Type 3's" is shorthand for Type III Airtanker: The most common use of the term Type II refers to the Grumman S-2T with a 1,200-gallon capacity for fire retardant.

Dominic's previous knowledge of California's catastrophic wildfires, combined with his training that supported a pre-disposition towards aggressively ordering as many aircraft as possible ultimately serves to facilitate situational awareness of the potential devastation his first fire could unleash. By taking his individual situational awareness and sharing it with the dispatchers serving as incident commanders on this fire, Dominic provides critical individual situational awareness that influences both successful team communication (i.e., the immediate delivery of more aircraft to a dangerous fire location) as well as overall team and community safety (i.e., by getting the maximum number of aerial teams to the fire to put it out quickly and prevent a larger, catastrophic fire from developing). Although visual placement above the fire supports Dominic's efforts to build situational awareness, his story of the response makes it clear that several communication factors were also at play during his first successful response as an air tactical group supervisor.

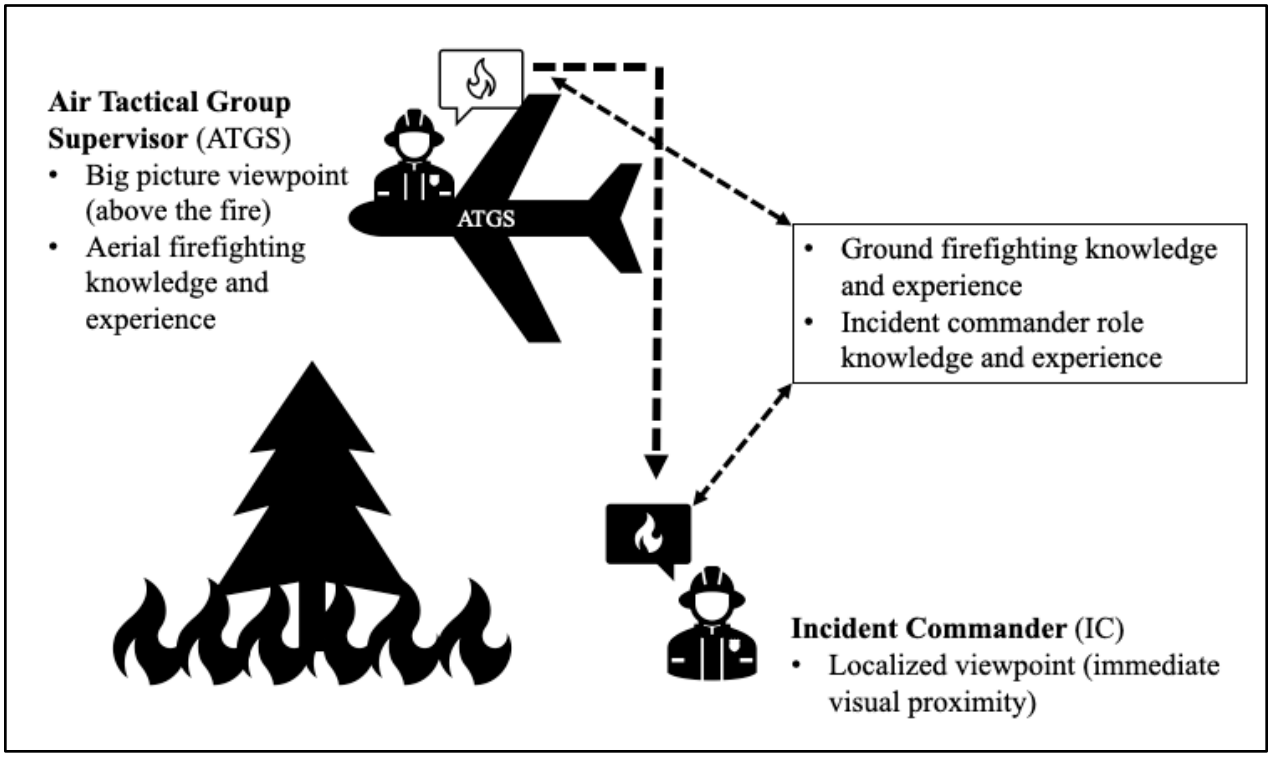
Air Tactical Group Supervisor Expertise: Beyond the "Painfully Obvious"

Further findings from this study support the argument that visual proximity to a fire is only a small part of air tactical group supervisor expertise (See Figure 6, below). In some ways, both incident commanders and air tactical group supervisors share similar training backgrounds, as both have a baseline set of training qualifications they must attain before they can be certified to undertake incident commander and air tactical group supervisor roles. It is important to note that prior to becoming a CAL FIRE air tactical group supervisor, almost all trainees have served as incident commanders on initial attack fires. This tacit knowledge of how fires operate on the ground provides both the air tactical group supervisor and incident commander a common baseline of both knowledge and language by which to draw on and share during initial attack

responses. Most importantly, this baseline is a critical component of the knowledge transfer that is expected to begin when tackling an initial attack fire together.

Figure 8

Illustration of Incident Commander (IC) and Air Tactical Group Supervisor (ATGS) Situational Awareness Distribution During Initial Attack Fire Responses



Note. Source: Amber Lynn Scott

However, the air tactical group supervisor on an initial attack fire also typically possesses tacit knowledge that the incident commander does not, such as how certain aircraft will operate or drop retardant during different weather conditions. Both incident commanders and air tactical group supervisors repeatedly acknowledged that no fire is ever the same. Over time, however, the air tactical group supervisor will learn how weather patterns and conditions affect the capabilities of the respective aircraft they oversee, enhancing their ability to quickly adapt to each new fire as they build situational awareness. The air tactical group supervisor gains this

important tacit knowledge through air tactical group supervisor training and qualification flights, as well as daily interactions with members of the aerial firefighting teams and observations of both successful and failed aerial firefighting attempts. This means that air tactical group supervisors and incident commanders might have the same access to certain types of information during an initial attack fire (i.e., weather conditions, available aircraft) but the tacit knowledge of how these components work best together is typically critical information that only the air tactical group supervisor possesses and must share with the incident commander to ultimately facilitate his or her full situational awareness. Having served in both positions, Norris details the knowledge differences that develop between the two positions through both time and experience, and how the air tactical group supervisor utilizes their domain-specific knowledge, compressed experience, generalizable experience and relative experience (see Weick & Sutcliffe, 2015) to combat wildfires using methods beyond what the incident commander knows:

> We fight fire very, very similar from the air as they do on the ground. You know there's a phrase—anchor, flank, and pinch. So [for] all of our fires, we have to safely anchor them into something that the fire can't burn over or burn around. Like a road, right? You anchor it and then you flank it. We're working parallel to it, and then we hopefully eventually pinch off the head of the fire…you're trying to slow fire progression, and then eventually we get around it and close it off. [Using aircraft] we do the same thing with water dropping out of helicopters and we do the same thing with retardant. So [as ATGS] we have to strategically use aircraft, both fixed wing and rotary wing, to meet that objective. So your fireman skills from the air very much parallel [the ground tactics]. Or you get that experience and exposure a long time ago in your career as you come up through the ranks and then you know, as you get different experience and then you take different classes, different training, you just you end up putting it all together…[As an ATGS] you're really starting to put all those things together and you're supporting the folks on the ground is what you're doing. You're supporting the dozers. You're supporting the hand crews. You're supporting the engines. That's how you become really effective and efficient…as you're working in the camps, the engines and whatnot and just having a good understanding of fighting fire from the ground, [as ATGS] we're able to better support those folks on the ground.

The knowledge and experience divide that grows between the incident commander and air tactical group supervisor—both required training and on-the-job experience obtained through

years of fighting wildfires—begins at the air tactical group supervisor qualification course. Air tactical group supervisors for California's state firefighting agency gain their domain-specific knowledge starting with a training course of approximately 80 hours of instructor-led, in-person training and an average of 40 to 80[16] hours of supervised flight time in the air tactical group supervisor role. This supervised experience as an air tactical group supervisor trainee is overseen by a senior qualified air tactical group supervisor and includes both firsthand and simulated experience. Although the air tactical group supervisor training program does incorporate a significant amount of explicit knowledge transfer through the distribution of content including presentations of organizational documents, rule books, and Federal regulations governing initial attack firefighting, much of the training program is focused on inherently tacit information development. For example, many of the training simulations included immediate feedback to the trainees and incorporated real-world stories from the air tactical group supervisors. These real-world stories, combined with the simulation experience, served to facilitate knowledge transfer between the experienced air tactical group supervisors and trainees, many of whom had not yet experienced the situations described by more experienced aerial firefighting instructors. In high reliability contexts, narratives have been found to be effective at teaching better communication practices when combined with simulations and checklists, such as teaching physicians how to be empathetic communicators during patient-physician interactions (Wear & Varley, 2008).

Once an air tactical group supervisor trainee graduates from the training pipeline and becomes a fully certified air tactical group supervisor capable of responding to fires independently, they continue to gather domain-specific knowledge through every fire response

[16] Actual hours vary based on the trainee. This figure is a ballpark provided by CAL FIRE Tactical Air Operations (TAO) leadership based on averages they have seen over the last several years of air tactical group supervisor (ATGS) qualifying flights. Some students will go as high as 120 hours prior to finishing their task book and obtaining their air tactical group supervisor (ATGS) qualification.

they attend as an air tactical group supervisor. Put simply, the tacit knowledge process continues even after the training process concludes. This collection of domain-specific knowledge truly begins immediately after the initial certification process, where each turn as the air tactical group supervisor on a fire provides an opportunity for almost-qualified air tactical group supervisors to add "slides in the tray" (Ishak & Williams, 2017). Although air tactical group supervisor trainees remain supervised by experienced air tactical group supervisors on fires until they officially reach their sign-off point[17], the instructors are primarily focused on evaluating trainees rather than knowledge transfer. During this qualification process, the exchange of firsthand firefighting response stories with other air tactical group supervisors primarily occurs through post-fire debriefs with air tactical group supervisor instructors and occasional after-action reports (AARs). After air tactical group supervisors successfully complete all of their training flights and obtain full certification, post-fire debriefs conducted over the phone with trusted team members help air tactical group supervisors continue to build their domain-specific knowledge of both wildland firefighting and aviation, although these debriefs are not necessarily codified and do not always occur with regularity. Many air tactical group supervisors shared candidly that once they qualified as air attacks and thus no longer were under supervision by senior air tactical group supervisors, their debriefs largely consisted of discussions between themselves and the pilots flying their aircraft, although some would also make phone calls to others involved in fighting the fires if something particularly problematic occurred. Interestingly, much of the ongoing development of tacit information sharing specific to aerial firefighting is conducted through word-of-mouth or unit-level after-action knowledge distribution (e.g., informal chats between

[17] As previously noted, some students will go as high as 120 hours prior to finishing their task book and obtaining their full air tactical group supervisor (ATGS) qualification.

unit team members at individual bases or morning briefings) rather than through digital training platforms, structured safety conferences, or formal organizational documents (i.e., AARs, SAFECOMS[18]). In recognition of this organizational learning process, CALFIRE continues to find ways to address the recognized challenges associated with this type of word-of-mouth organizational learning. Recent efforts observed in this study included the introduction of several new initiatives by the Aviation Safety Officer, including collecting and compiling SAFECOMS and other important safety-related notices and policies into one comprehensive Safety Management System (SMS). The SMS was developed in recognition of the need to archive and catalogue critical safety updates and mishaps in a user-friendly database accessible to everyone in the CALFIRE organization. In turn, the creation of the database helps ensure transparency in SAFECOM reporting and establishes an ongoing archive of reports and information, overcoming noted limitations such as the occasional instance of SAFECOM reports not being shared across the organization. In one example, an individual team member reported sending three separate SAFECOM reports on an issue, but never saw any of those reports distributed to others within the organization that would benefit from the information. The creation of SMS was instituted in part to address those concerns and facilitate additional transparency and information sharing of important safety notifications beyond word-of-mouth discussions or email notices in the organization.

Several CAL FIRE Tactical Air Operations leaders shared with me their ongoing efforts to formalize tacit knowledge sharing after fires, but the logistical challenges of firefighting and the vast physical distribution of teams across multiple units continued to prove difficult to overcome. For example, during the 2022 CAL FIRE Aviation Safety Conference, a proposal to

[18] A Department of the Interior (DOI) and U.S. Forest Service (USFS) aviation safety reporting system.

create an annual evaluation process for air tactical group supervisors was floated during a fixed wing aircraft breakout session discussion. The proposal was put forward by a member of Tactical Air Operations leadership acknowledging that after obtaining air tactical group supervisor certification, many air tactical group supervisors no longer received any evaluations or feedback designed to further grow their skills. Furthermore, it was noted that air tactical group supervisors would typically never hear or see another air tactical group supervisor in action beyond routine handoffs during extended attack fires, further stifling an opportunity to learn or gain tacit knowledge. Because initial attack and extended attack fires are typically configured with only one air tactical group supervisor, these individuals do not typically interact with other air tactical group supervisors on fires once they have earned their initial certification. This means that in order to gain additional experience and knowledge on aerial fire tactics, they must continue to respond to fires as an air tactical group supervisor or interact with others who are responding to fires in a similar capacity. However, unpredictable fire seasons in the state mean that sometimes air tactical group supervisors may fly only a minimum number of fires during a fire year, or no fires at all if their current positions keep them away from the fire line and tasked with administrative duties. Therefore, the tacit knowledge gained from other air tactical group supervisors becomes even more critical.

Many air bases are organizationally structured with at least two air tactical group supervisors in a unit, facilitating at least some opportunity for tacit knowledge sharing, although work schedules and operational duties (i.e., required trainings, extended attack fire assignments) can mean that these individuals may be constrained in their ability to interact in a manner that facilitates regular ongoing tacit knowledge sharing. To facilitate ongoing learning and knowledge sharing beyond what was already in place, the annual evaluation was proposed to

give certified air tactical group supervisors a built-in feedback and skill assessment mechanism, as well as opportunities for knowledge development beyond their assigned fires. This desire for organizational development and learning is a key feature of transformative leadership, which is grounded in the concept that any member of a team or organization can lead through a "participatory process of creative collaboration and transformation for mutual benefit" (Montuori & Donnelly, 2018, p. 319). These annual evaluations also demonstrate a commitment to organizational foresight (Gordon et al., 2020), which supports CAL FIRE's aerial firefighting teams in strategically repositioning the organization towards more favorable firefighting outcomes, including supporting efforts to anticipate and educate teams about potential risks before they are encountered in the chaos of an initial attack fire.

Catastrophic Fire: What Happens When Air Tactical Group Supervisor Expertise is Removed

News media accounts of how fires unfold also underscore the critical expertise air tactical group supervisors can lend at preventing fires from growing into catastrophic fires (see Brekke, 2021; Singh, 2021), and what can unfold when air tactical group supervisor expertise is refused or not fully utilized. As the aerial firefighting expert, the role of the air tactical group supervisor as the initial attack expert in the air is one fraught with peril, as failure to properly advise or share tacit knowledge with an incident commander on the ground, including how to implement the correct mixture of aerial firefighting assets and tactics in the earliest stages of a wildfire, can ultimately lead to larger, unstoppable blazes that consume acreage, structures, and lives. The potential result of removing an air tactical group supervisor and a critical moment was made clear in the aftermath of the Dixie Fire, where delayed notifications of the unfolding fire, ground firefighter shortages, and a drone incursion complicated initial attack efforts, ultimately resulting in the largest and deadliest wildfire the state had ever experienced (Iati & Moriarty, 2021;

McDonald et al., 2021). A Federal probation judges' investigation into the utility company PG&E's drone use during the initial attack of the Dixie Fire noted: "What should have remained a minor incident has turned into an unstoppable inferno with a series of delays and obstacles coming together to create the perfect storm" (Singh, 2021).

As the initial attack effort on the Dixie Fire began in 2021, aerial firefighting teams led by a CAL FIRE air tactical group supervisor managed to contain the fire within a painted box of fire retardant expertly placed on rugged terrain. This effort to contain the blaze until ground crews arrived was further supported by a helicopter dropping water directly on the fire, slowing the fire progress. Unfortunately, the air tactical group supervisor had to make the difficult decision to end aerial operations before the wildfire was contained. At the time of the blaze, the CAL FIRE organization did not have capabilities to conduct night flying operations, and thus ended all aerial firefighting operations no later than one hour after sunset. This, combined with limited firefighting ground personnel, ultimately led to catastrophic consequences when an additional unexpected crisis unfolded:

> But just when their efforts were on the verge of success, an unidentified drone appeared over the blaze, forcing Cal Fire to suspend air operations. This interference by the rogue drone cost about 45 minutes in firefighting time. And by the time the airspace was declared safe, it was already dark and Cal Fire had to suspend air operations owing to a lack of nighttime air support.
>
> It's worth noting that, at that point, the Dixie Fire was just one to two acres and spreading slowly. It grew to 500 acres overnight. And by 8 p.m. on August 8, the incident's 25th day, the fire had burned 489,287 acres. (Singh, 2021)

Beyond providing aerial firefighting expertise to incident commanders, air tactical group supervisors regularly face decisions requiring the balancing the safety of their teams, the firefighters on the ground, and themselves against the progress of the unfolding wildfire they have been tasked with stopping. Some of this decision making is supported by organization safety policy and practices in place, such as the use of Operational Risk Management (ORM)

processes, which are mandated in the National Wildfire Coordinating Group Standards for Aerial Supervision (National Wildfire Coordinating Group, 2022a) and CAL FIRE 8300 policies[19]. As noted in preceding paragraphs, previous fire experience is also a necessary element supporting this decision making, and a key reason why air tactical group supervisors with previous ground and incident command firefighting experience on wildland fires (rather than fire station experience) are strongly preferred candidates. Team input is also often a significant component of these decisions, particularly between air tactical group supervisors and the air tanker pilots. Current air tactical group supervisor Frank explains: "If I ask the tanker pilots to do something, they don't just do it. They look out and go, 'Oh, I could do that. Okay.' And I give them no grief for that." Frank also shared that pilots and air crews can be incredibly useful at providing him intelligence about what is happening on the ground, further supporting an air tactical group supervisor's ongoing assessment of an unfolding fire and how to fight it safely. "I've asked the pilots to do something," explains Frank, "and they'll go, 'Well, do you see this?' 'No, I don't. Okay. Well, thank you!' So as a team, we're trying to figure it out…I think that's the good thing, that they are a part of that, and the people on the ground who know you, and the helicopter [too]. …so they'll give you stuff and give you intel. So the helitack crew might tell you if the coverage [level] is working or not working."

The challenges of an initial attack fire in particular, which can unfold in unpredictable ways, further underscore the key role air tactical group supervisors play as safety experts both on the ground and in the air. Despite being relatively free from personal risk as they fly approximately 2,500 feet above the fray, air tactical group supervisors are responsible for

[19] The full manual was not publicly available at the time of publication. Previous updates to the 8300 policies can be found on the National Wildfire Coordinating Group website: https://www.nwcg.gov/sites/default/files/committee/docs/iabs-calfire-8300-handbook.pdf

overseeing the operations that carry significant risks to ground crews. Former helitack captain and air tactical group supervisor trainee Travis noted that when it comes to making water or retardant drops:

> The biggest thing is just making sure that you don't get anybody hurt on the ground with our aircraft. Now more than ever, the helicopters we're [using], [we are] trying to clear the line because we're dropping, six, seven, eight [hundred] gallons as opposed to 260 [gallons of water] that we put out of the bucket before…That's the biggest thing, I think, is [to] make sure you don't hurt anybody on the ground. The worry is that one day, you know, the drop 'dead dropped' [on someone] or you drop out of a tree and hurt somebody. That's I think the biggest stressor and fear. [Your job as ATGS] is to make sure that doesn't happen. But you can only do so much, too, on your side. You can ask them to move and not everybody there is [going to move]. They'll say they moved, but they're not [moving], because they want to get that picture.

Air tactical group supervisors are responsible for the safety of the entire aerial firefighting team, but Travis' statement also illustrates the careful balance an air tactical group supervisor must consider as a safety expert during initial attack fires. Although ultimate responsibility for the safety of individuals on the ground is largely relegated to incident commanders and the ground firefighters themselves, some rules governing aerial flying operations also assist the air tactical group supervisor in this process. For example, helicopter pilots are required to activate the siren prior to dropping water in an area where people are visibly present. While this practice provides an additional layer of safety support by alerting individuals of impending water drops, it also operates beyond the air tactical group supervisor's ability to hear or confirm. Thus, the air tactical group supervisor must rely upon individual members of the team to follow established policy and also communicate any complications (e.g., people that refuse to move from a potential drop site) directly back.

Building Air Tactical Group Supervisor Expertise: A Collaborative Effort

Beyond policy and personal experience, the decision-making process of the air tactical group supervisor rests heavily on a significant assumption that if someone on the team sees or

hears a problematic decision, they will speak up and share this information with others. The desire for fuzzy organizational boundaries and flattened hierarchy to overcome bureaucratic challenges in organizations is not unique to HROs or HRTs (Schneider, 2002); research emphasis on voice enactment within firefighting teams (Ishak & Williams, 2017; Jahn, 2019; Minei & Bisel, 2012) including the important role subordinates play in working with leaders to get their day-to-day job done safely underscores this important consideration. Organizational management and leadership researcher Michael Useem coined the terminology *upward leadership* for this type of relationship and notes:

> Leadership has always required more than a downward touch: It needs to come from below as well as from the top, and leaders today must reach up as never before. As organizations decentralize authority, they put a premium on a manager's capacity to muster support above as well as below. Command and control from on high are giving way to insight and initiative down under. Contemporary leaders aren't just bosses. They're self-starters who take charge even when they have not been given a charge (Useem, 2001).

Within the aerial fire service, the emphasis on upward leadership within the fire teams was made clear and observed regularly. Although the air tactical group supervisors were ultimately responsible for all aerial firefighting decisions passed to the incident commander during initial attack fires, this responsibility did not mean that pilots or aerial fire crews operated silently or blindly followed orders from the air tactical group supervisor. Instead, these aerial firefighting teams worked in collaboration to assess risks and consider new information, when necessary. Pilots and aerial fire crews demonstrated upward leadership when working with air tactical group supervisors as a way to mitigate risks and course-correct when problematic strategies were identified. Air tactical group supervisor Carey described the aftermath of an air tanker crash to clearly illustrate this point:

> Probably the biggest things that I took out of that was I had a talk with my tanker pilots after that because I wanted to clear up something in my head. Because when you’re

> the ATGS, you're always the one telling everybody what to do. I'm telling the tanker where to drop. I'm telling the helicopter where to go. I'm telling everybody [what to do]. I'm giving orders, right? …and I asked my tanker pilots [after the crash], "Look, I'm going to tell you where I want the retardant. If you can't do it, *tell me*. Or if you can't do it the way I want, *tell me*."
>
> I guess after that point, I think I was a little bit more cautious. I had previous discussions with my pilots that [said], "Look, I'm not a tanker pilot. I know aviation, but I'm not a tanker pilot and I'm not a helicopter pilot. So if I'm asking you to do something that you don't feel comfortable with or you don't feel that you can safely achieve without some margin of safety, then let me know." My tanker pilot at the time—I'm really good friends with him still today—James[20] told me, 'Look, the thing about being a professional pilot, and especially a professional *tanker* pilot, is it's not all about putting the retardant where you want. I get paid to say no." And that really hit home for me because he's telling me, "I'll do whatever you want me to do, but if there's something that I can't do or don't feel comfortable with, that's what I'm really getting paid for." And that meant a lot to me because I didn't want to feel like I was the one putting them in that situation, where they have this "Oh I gotta do it because the chief said to do it." That's probably the single biggest thing that changed after that incident.

Air tactical group supervisor Frank also illustrated this perspective, albeit from a slightly different standpoint. Whereas air tactical group supervisor Carey described his role as an air tactical group supervisor as "telling everyone what to do" by "giving orders," air tactical group supervisor Frank framed the processes as more collaborative, with his decisions including the pilots' determinations of what may or may not be safe to gain a particular outcome during a fire:

> You have to look at the fire and kind of see what's happening and then talk to the IC and find out what they want, if there is an IC there or established at that point. Okay? So if you get there and they say basically "Do whatever you want," for lack of better verbiage on that, then I look at the area to confirm that there's no one on the ground that could get hurt from what we're about to do or [something] that's an obvious big deal. And then I talk to the tankers and say, "Here's what I want to do" or "I want you to drop retardant in this area." So I'm not telling them how to do their job. I'm just telling them where I would like to go. Okay? And that's that. They're firefighters. At the end of the day, they are.

In another circumstance highlighting the firefighting and aviation expertise that air tactical group supervisors have developed and rely upon, current air tactical group supervisor Carey shares a story about a fire he battled when a problematic scenario unfolded—an in-flight

[20] Name changed to pseudonym

aircraft emergency: “We’re flying above this fire…all of a sudden we heard this huge bang on the airplane. It felt like and sounded like something big hit the airplane…so we did a quick risk assessment and we decided to go back to base.” Recent reports had indicated a large presence of drones in the area, and Carey and his pilot concluded this might be what they felt hitting the aircraft. Protocol dictated that they leave the fire traffic area and return to base immediately to assess the aircraft. This presented a serious problem for Carey as the air tactical group supervisor. Per federal policy, no fixed-wing aircraft are permitted to drop on wildfires overseen by an incident commander without an air tactical group supervisor present. If the air tactical group supervisor left the fire traffic area, the air tankers working Carey’s fire would be required to stop conducting retardant drops until a new air tactical group supervisor could arrive.

In this scenario, the expertise of the air tactical group supervisor was previously recognized and codified through federal policy in order to create efficient tactical air support and coordinate with ground units to achieve highly reliable, successful outcomes. But sometimes, unexpected things happen—particularly in the dynamic and unpredictable world of firefighting, where each fire is considered unique (Weick & Sutcliffe, 2015, p. 118). Although CAL FIRE is an independent state firefighting agency, they voluntarily operate and align under U.S. Forest Service aerial firefighting regulations, which allows both organizations to integrate seamlessly when wildfires move between states and federal lands. In this scenario, we can see how Federal policies governing air tactical group supervisor presence also dictate expertise. An air tactical group supervisor is required to be present when aerial firefighting operations are underway with an incident commander present. In Carey’s situation, his removal from the wildfire airspace to return to base would delay the initial attack fire response currently underway and leave the

incident commander without any fixed-wing aircraft to fight the fire. In short, Carey's critical expertise would be gone.

In a stroke of both quick thinking and luck rooted in a well-designed system, however, Carey prevented a possible deadly delay by shifting the air tactical group supervisor role to the only other aircraft permitted to serve as an air tactical group supervisor—the aerial supervision module (ASM). Traditionally, aerial supervision modules serve as guide planes to larger air tankers dropping fire retardant and are a requirement for any wildfire response on federal lands utilizing aircraft larger than a small fixed-wing air tanker[21]. Additionally, per Federal policy, aerial supervision modules are required to hold an air tactical group supervisor certification. In this scenario, luck was on Carey's side—the available aircraft responding to the fire included several larger planes guided by an aerial supervision module. Larger planes are not always guaranteed for initial attack fires, and in this scenario, Carey was fortunate to be conducting operations in a location that happened to have these larger aircraft, providing an unexpected backup air tactical group supervisor at the exact moment one was needed. Following the brief conversation with his pilot about the in-flight emergency, Carey "did a quick calculation that, 'Hey, if we leave, I can leave the fire to the ASM, I can call the [Emergency] Command Center. I can order another air attack.'" Carey's temporary substitution of the aerial supervision module as the air tactical group supervisor ultimately allows aerial firefighting to continue without interruption, preventing a catastrophic fire from unfolding when an unexpected emergency in his own aircraft occurred. In his retelling of the story, Carey makes it clear that despite knowing the risk assessment protocol for a drone airplane strike, he still initially struggled with the knowledge that if he departed the scene, his critical role as both air coordinator and aerial

[21] e.g., Grumman S-2

wildfire firefighting expert would be unfilled until a new air tactical group supervisor could be ordered[22]. This, in turn, meant the likelihood of keeping the small fire contained could be in danger. Without Carey, the entire team was at risk; if Carey and his pilot remained in the fire traffic area they would be breaking safety protocol and potentially putting themselves at risk. Fortunately, Carey did not have to make the difficult decision between his own safety and the risk of leaving the fire unattended, because organizational policy and a bit of luck ensured that he had a backup air tactical group supervisor available. However, had the fire not included larger firefighting aircraft escorted by an aerial supervision module, Carey undoubtedly would have faced a much more difficult situation. Beyond illustrating how federal regulations can both support and strain air tactical group supervisors during crisis decisions, Carey's story underscores the essential role the air tactical group supervisors play in supporting the incident commander and their initial attack efforts to contain wildfires. Carey's story also illustrates the difficult decisions these key players and experts in initial attack fires often face.

These excerpts and stories illustrate the importance of air tactical group supervisor expertise in relation to the initial attack aerial firefighting effort overseen by an incident commander. Additionally, these examples serve to underscore the particular importance the role of air tactical group supervisor has in providing essential expertise to teams tasked with combatting initial attack wildfires, including the ultimate authority tasked with putting out the fire—the incident commander. This study noted that air tactical group supervisor expertise does not operate in a vacuum, however, and instead relies upon collaboration and teamwork that embraces a position of upward leadership to ensure risk mitigation during the chaos of initial

[22] Arrival time depends on the fire location and locations of nearby air attack bases. The expected time a new air tactical group supervisor (ATGS) aircraft could be ordered, take off, and arrive on scene will average approximately 20 minutes, but this time period can be significantly longer depending on current fire activity in the surrounding area and available aircraft of nearby units.

attack fires. In short, the leadership that emerges from all levels within the aerial firefighting team is what facilitates the expertise and success of the team leader—the air tactical group supervisor. These initial findings clarify how air tactical group supervisors ultimately facilitate key elements of initial attack firefighting for the incident commander to ensure CAL FIRE can reliably and safely meet their goals of holding 95% of all wildfires to 10 acres or less.

In this study, after reviewing how the organization defines air tactical group supervisor expertise outlined in this chapter, I determined a need to further examine the role of air tactical group supervisor as the aerial firefighting expert by starting at the very beginning of the air tactical group supervisor experience—namely, air tactical group supervisor training. In this next phase of exploration, it became clear that establishing the boundaries of what "constructs" air tactical group supervisor expertise begins within the organization as part of a state and federal interagency air tactical group supervisor training program but extends beyond the policies outlined in official doctrine. The annual air tactical group supervisor qualification and tri-annual recertification trainings serve not only to impart air tactical group supervisor trainees with wildland aerial firefighting knowledge, but it also teaches them specific communication practices beyond firefighting tactics that assist incident commander in defining an air tactical group supervisor as a competent aerial firefighting expert. More detailed explanations on how these communication-specific definitions of expertise are created and supported are in the following paragraphs.

Part 2: Train and Make the Expert: Definitions of Air Tactical Group Supervisor (ATGS) Expertise

As demonstrated in part one of this analysis, the importance of the air tactical group supervisor as the dedicated aerial firefighting and safety coordinator between ground and air firefighting personnel is clear within the CAL FIRE organization. Therefore, training the air

tactical group supervisor to optimize their expertise in this role is an important step to ensure the air tactical group supervisor role operates in an efficient manner and that individuals have the required expertise needed to do the job well.

Selecting, training, certifying, and maintaining a qualified air tactical group supervisor is an expensive and time-intensive task for aerial firefighting organizations, largely because of the intense focus the organization places on shaping air tactical group supervisors to be an ideal fit in a complicated organizational ecosystem. The estimated cost of training one air tactical group supervisor in the state of California is upwards of $100,000[23] for the initial training program and certification process. Once trained, they must then continue to be recertified every three years, while also conducting a minimal number of flight hours annually in the air tactical group supervisor role. Beyond the need for aerial experts on wildfires, this real cost to select and maintain personnel underscores how important selection and fit are to the overall future retention of team members who fill these critical roles.

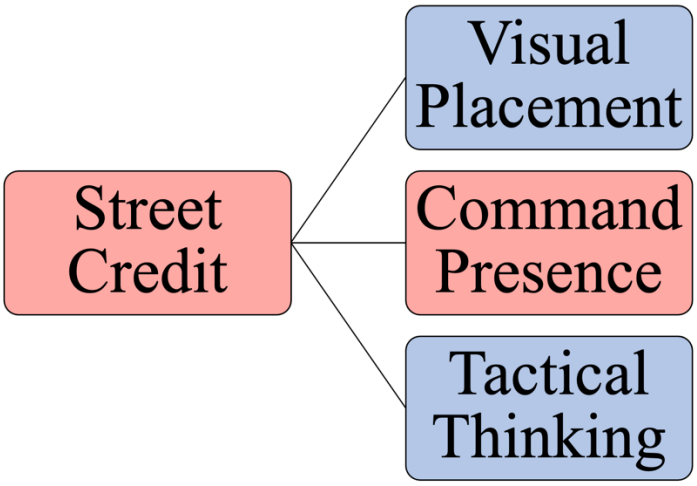
Observations of air tactical group supervisor trainings and interviews with CAL FIRE personnel highlighted several important components required for a team member to be classified as a competent air tactical group supervisors beyond merely passing the required classroom work, task book, and qualification flights. To be defined as an air tactical group supervisor *expert* within the organization, this analysis found that the air tactical group supervisor must have (a) **visual placement during a fire** that allows them to be "eyes in the sky"; (b) **command presence**, which includes the communication skills of delivering information with *brevity* and *clarity*, correct *tone*, *cadence*, and *confidence*; and (c) **tactical thinking**, which includes both

[23] Estimate provided by leadership includes only the cost for the initial two-week air tactical group supervisor training program. This figure does not include subsequent flight hours and instructor supervision required during the task book certification on actual initial attack responses.

proactive communications and *selling of strategies* when appropriate (see Figure 7, below). All three of these key elements are required for an air tactical group supervisor to have what the teams deemed as *street credit* within the organization. The term *street credit* is used routinely in the organization and encompasses the overarching concepts of not only having expertise, but also having the skills to deliver that expertise in a manner that will be effectively received by other team members, such as incident commanders.

Figure 9

Air Tactical Group Supervisor (ATGS) Expertise Primary Elements



Note. Codes inclusive of formal terms used within the organization are illustrated in light red. Emergent terms invented during the coding process are illustrated in light blue. Source: Amber Lynn Scott

Visual Placement: The "Eyes in the Sky"

As discussed in previous sections, the placement of the air tactical group supervisor serves to ensure that they are always the "eyes in the sky" during an incident response. The traditional configuration of the fire traffic area (FTA) places the air tactical group supervisor

aircraft above all other aircraft responding to a fire, excluding fire surveillance aircraft[24]. On the ground, firefighters, bulldozers and fire trucks battle the blaze, which are all directly coordinated by the incident commander. This positioning makes it easy for air tactical group supervisor to see the fire for the incident commander during an initial attack response and has become an important element of air tactical group supervisor expertise. Dwight, a former incident commander and current air tactical group supervisor shared that "air attack[25] gives an overall view and is great eyes for the incident commander. We are the eyes in the sky, looking for hazards and priorities." Dominic, another current air tactical group supervisor, elaborates further:

> Good air attacks can give the IC's all the suggestions and updates on what the fire [is doing and] the size of the fire now. Has it jumped the road? It is spotted? Is it? So I tried to do that the best I could. If the guys, if the IC couldn't see spot fires on the ground or if it was going to bump a road hard or whatever it's going to be, you try to give them those updates that could be trigger points for his resources on the ground where he needs to move them.

Further emphasizing the importance of visual proximity to the fire supporting air tactical group supervisor expertise is an unwritten tactic often deployed by air tactical group supervisor to further assist incident commanders in initial attack response: texted photos. This tactic was not an official air tactical group supervisor task but was something repeatedly mentioned offhandedly by many air tactical group supervisors as something they did during initial attacks when cell phone reception allowed it.

The "eyes in the sky" advantage, however, did not always guarantee a positive relationship between an incident commander and air tactical group supervisor. Air tactical group supervisor Dwight recounted the darker side of the "eyes in the sky" positioning, recalling an

---

[24] Fire surveillance aircraft (FSA) are not traditionally part of the initial attack response aerial firefighting team in the state. Over the course of this study, FSA began to appear more frequently on initial attack fire calls for research purposes, but were utilized infrequently by the initial attack incident commanders and thus remain a novel and irregular part of the aerial firefighting response.

[25] "Air attack" is a colloquial term used in the aerial fire service for the air tactical group supervisor position.

incident where an incident commander demanded to see the fire, requesting one of the helicopters actively fighting the fire pause from its active firefighting and instead pick up the incident command so that they could view the entire fire line themselves. This access, if granted, would have pulled a helicopter dropping water on the active fire line and potentially placed the fire line at risk, but would appease the incident commander's need to obtain the visual situational awareness of the unfolding fire. In this case and many others like it, members of the aerial firefighting team including the air tactical group supervisor would share the relative expertise gained through their visual proximity to the fire by distributing texted photos to the incident commander. These texted photos served as an attempt to head off the requests for incident commanders to gain access to helicopters so that they could see the fire for themselves. Dwight explained this process to me, describing a proactive effort to share situational awareness with an incident commander before the request affected any firefighting operations:

> You know, [if it is] something important, I'll snap a picture of a real target hazard that's going to happen and I'll forward it to the incident commander. I go, "This is what I see." They're like, "Oh, do what you can, we'll get people over there." So, it's just communication. Somehow it being communicated.

Admittedly, texted photos were not always a solution to the need for shared situational awareness. In some remote fire locations, a lack of reliable cell service prevented texted photos from being effectively shared with ground personnel. In these situations, traditional communication efforts to share relative expertise through air tactical group supervisor radio communications back to the incident commander once again became the default.

During air tactical group supervisor training, visual communication via text messages often served as a means of supporting the air tactical group supervisor evaluators' efforts to surreptitiously communicate with ground personnel, including air tactical group supervisor training staff. I discovered during my observations that the use of texting messages, including

photos, was another example of unspoken protocol that air tactical group supervisors were expected to learn and do, although the curriculum itself never dictated this. In an interview with air tactical group supervisor trainee Dominic that occurred months after the initial training course, he noted that his evaluator texted numerous photos back to the ground personnel during most of his initial attack qualification flights:

> The [ATGS] instructor was doing it pretty much every fire. He did. It's not like written in anywhere that you have to do it, but obviously a picture is worth a lot more than trying to explain. I need to get better at that. Just go, get my cell phone out, snap some pictures and get them to the ICs on the ground or the Chief's that have the duty for the units or whatever. They like to see it. They like to see where it's at, what the vegetation is, what the terrain looks like. You know, structure, threats, they like to see all that stuff.

Although the position above a fire is more reflective of air tactical group supervisor logistics than skill, the ability to respond and communicate what they are seeing visually to the incident commander on the ground was found to ultimately be an important component of what defines an air tactical group supervisor as the initial attack expert. From their position above the fire, the air tactical group supervisor holds a unique view of each ground and air asset fighting the fire, as well as a view of the advancing blaze unfolding below. This unique perspective, combined with basic firefighting knowledge of the capabilities of each tool, allows the air tactical group supervisor to advise incident commanders in how to optimize their firefighting response much like being at the controls of an intense video game. Similar to military use of unmanned aerial vehicles (i.e., drones), the placement of air tactical group supervisors above fires was often described by participants as feeling akin to playing a video game. Dominic explains:

> I think looking down from that, from air attack, it's like you can see [everything happening]. You can kind of know, 'Okay, what [is unfolding] and how far is this dozer going to get up the right flank? Should I start retardant there or should I start in the other should where it's going to be harder to get ground guys in to and try to hold it until engines can get in there?' On grass fires it's almost like a video game. You see dozers

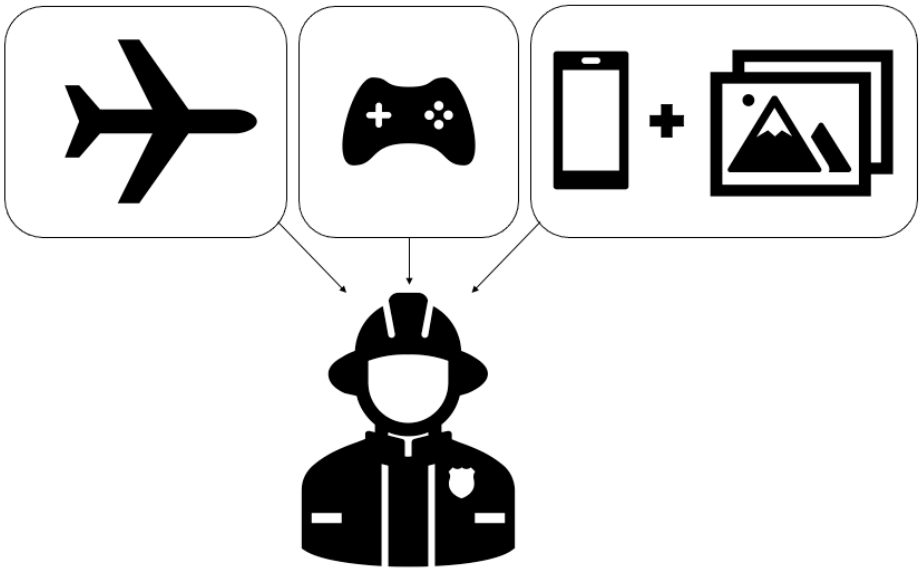
> that are [fighting fire and] you're like, 'Shoot, should I put in a tanker?' because you can see everything under that canopy. And you're seeing the progression of the fire. You're seeing the rate of the hose lay. You're seeing the rate of a dozer. So it's like you're watching it all and just trying to put the puzzle together of where you should put the retardant.

Research has argued that in military operations, this video-game like positioning serves to link those viewing the scene from above with individuals on the ground experiencing the impending danger below (Gregory, 2011), rather than creating a disconnect from danger. It is worth noting here that Dominic's description of the scene as feeling "almost like a video game" does not imply a detachment or remoteness from the scene, but instead highlights how the position reinforces the pressing safety risks for teammates on the ground. Additionally, this positioning underscores the need for precise, careful decisions and actions when planning a fire attack strategy. Dominic admits that prior to becoming an air tactical group supervisor, he viewed the expertise and positioning of the air attack position much differently. It was only once he found himself in the role of air tactical group supervisor that he saw the visual positioning of the air tactical group supervisor as being at an advantage compared to his former spot as a helitack captain. Additionally, his new role as an air tactical group supervisor underscored how visual positioning can shape both a fire response and the perceptions of who actually is fighting the fire most effectively:

> The experience of being a helitack captain and seeing it…that's different than being the air attack where you're seeing it. I was joking about it the other day. We were like, 'Oh, you know, when I was on the helicopter, it felt like we were putting the whole fire out, you know? You're like, you just have pride in your crew and you're like, 'Why are they holding us out?' You know, 'Get that tanker out of there so we can go to work!' (Laughs) And then as air attack, you get up there and you're like, 'Okay. These 'copters are, you know, they're not a pain in the ass, but they're the hardest to manage though.'…It's funny seeing it from when you have four CAL FIRE helicopters all working together, and you've got five tankers or whatever. It's like yeah, that one 'copter is just a part of this. But like when you're that one 'copter, you're like, 'Yeah, we're putting the fire out!'

Figure 10

Advantages of Air Tactical Group Supervisor Visual Placement



Note. Air tactical group supervisors (ATGS) related their visual placement during fires as a crucial element to generating broad situational awareness, developing closer safety connections with ground personnel through "video game" like interactions, and facilitating shared knowledge with incident commanders through image texting. Source: Amber Lynn Scott

Air tactical group supervisor Dwight's previous interactions with incident commanders in different roles during a wildland fire response further underscores the important position visual proximity can play in wildland fire expertise. Before Dwight earned his certification as an air tactical group supervisor he served as both an incident commander and a helicopter coordinator, more commonly referred to as a HLCO[26]. Dwight was often nostalgic about his experiences as a HLCO and regularly shared stories from his battles against many of the large-scale wildfires that plagued northern California over the past decade. It was in the retelling of these incidents that Dwight more clearly showed me how relationships between the incident commander and other

[26] Pronounced "hell-co"

members of the aerial firefighting team would unfold, and how important the visual positioning of being above the fire came in assigning expertise relative to firefighting tactics:

> And here's the biggest one. It's the incident commanders, or our operational personnel. They hop in a type three airframe[27], and they want to fly around the fire. They want to see it. They want to have a bird's eye view and understanding because we have, when you're flying, you have a total understanding of what the fire's doing, where it's going, and what needs to be done. So they want to come see that, too. And sometimes they get real pushy. "Hey, I need to see it. So and so says."
> "No, we're in a firefight. You'll be in the way."
> "Well, we need to come see."
> "No, you can't."

One of the most powerful and frequent themes that emerged in these discussions with Dwight was the relative expertise that air tactical group supervisors and their aviation team members had that incident commanders did not. This relative expertise development was directly linked to the aviation team's ability to see the fire, terrain, and burn patterns for themselves. Rather than accepting the input from the team members that had the relative expertise, incident commanders would instead insist on gaining the relative expertise themselves, at minimum requesting texted photos from above, but more often demanding rides on helicopters so they could see the fire for themselves.

Command Presence: Brevity, Clarity, Tone, Cadence, and Confidence

Beyond visual placement above a fire, a second theme emerging as an overall critical component of air tactical group supervisor expertise was identified as *command presence*. Command presence was described as a key component of being a competent air tactical group supervisor by multiple air tactical group supervisor trainees and instructors, as well as incident commanders, and broadly encompasses a standardized communication performance expected

[27] Type III or Type 3 refers to a class of firefighting helicopters. Type III's are traditionally classified as the smaller helicopters used during an initial attack fire, such as the Bell 407, Bell 206B "Jet Ranger", the Bell 206L "Long Ranger", the Eurocopter AS350 AStar, the MD 500D, the Aérospatiale SA 315B "Lama" and the Aloutte 316B.

from air tactical group supervisors. The term *command presence* is used within CAL FIRE to encompass a broad set of communication traits such as being able to speak over the radio with brevity and clarity, but also in a tone that reflects congenially and respect, with a cadence that is neither too fast or too slow, ultimately projecting a confident presence on the radio (or in person, when not fighting fires). Much of the air tactical group supervisor training program comments observed in this study from instructors appeared to be centered on teaching and critiquing "command presence" skills, rather than critiquing chosen aerial firefighting tactics or debriefing fires.

While CAL FIRE Tactical Air Operations (TAO) leaders and experienced air tactical group supervisors emphasized the intense overall knowledge and training requirements needed to obtain air tactical group supervisor certification to trainees in interviews, the air tactical group supervisor trainees themselves took a very different perspective, with air tactical group supervisor expertise attributed as being able to "speak like an ATGS." For air tactical group supervisor trainees, having air tactical group supervisor expertise was not equated to aviation experience or firefighting tactics beyond those taught to everyone. A funny interview moment illustrates this point: When asked directly about the air tactical group supervisor course training fire behaviors or tactics relative to the air tactical group supervisor position, air tactical group supervisor Dominic paused and then seemed surprised before giving me his response, as if the question of his firefighting knowledge had never been asked before:

> *Interviewer:* How do you learn what firefighting tactics will work best during a fire? Do they teach that during ATGS training? I mean, how do you learn what will work best?
>
> *Dominic:* I think the fire behavior training, I think it's kind of assumed that once students go through the ATGS, you have all different levels of experiences, you know? Some guys, like I said, I've been on helitack crews, some guys have only been crew captains or ECC[28] captains that went to chief. So you have all these different ranks and different

[28] Emergency Command Center

> experiences throughout CAL FIRE that could end up in the ATGS position…There is a requirement for company officer level experience to be able to go through the class. You have to have certain foundation baseline training. S-290[29], it's like intermediate wildland fire behavior. There's a firing class, there's different trainings that you have to have before you can be eligible to go through the class. But like I said, that experience on actually different positions and on different crews—on a crew versus an engine versus helitack, it's all different for individuals. So yeah, I think the fire, the wildland fire behavior is kind of assumed once you start [the ATGS course]. Once you're on the [ATGS] training platform, it's like, yeah, okay. From an instructor perspective, I think they just have to assume like, okay, this individual has seen fire, whatever their experience has been with it. Some more than others. And [the ATGS job,] it's more coordination, you know. The fire behavior part is obviously built into what you're going to do with your aerial resources. But as far as training for fire behavior, there's less of that 'cause it's assumed. You know, it's more—the training is more on radios…radios, GPS, fire traffic area coordination. So it's less on actual fire behavior, I would say.

The assumption of trainees already possessing certain specific types knowledge was a reoccurring theme during my time with CAL FIRE Tactical Air Operations, and something the group was slowly coming to grapple with as potentially being problematic across their organization. One example of these types of assumptions and the unforeseen problems they created presented itself during a discussion at the CAL FIRE 2022 Aviation Safety Conference. A breakout session discussion began with advice for how to train new pilots arriving across air bases. Tactical Air Operations leader Carey shared that when they surveyed the new group of pilots that had arrived and flown at air bases last year, they learned that although these pilots were profoundly competent and adept pilots on their respective platforms, they lacked any expertise in either firefighting tactics or air base protocol. My field notes from that discussion included several noteworthy highlights of how this issue manifested in the field:

> *I overhear someone talking about how someone (presumably a new pilot) brought their dog on base and it "shit all over" the flightline. Someone else told a story about a pilot who brought their family out and they "hung around all day" and "ate all the food." Both of these stories were shared with hostile tones of voice, and it is clear this really upset some of the units a lot.*

[29] S-290 is the numerical reference for the required Intermediate Wildland Fire Behavior course CAL FIRE employees must take as a qualification for specific job assignments or promotions.

> *Carey shared a story of how at his base, he saw the issue firsthand when people assume new pilots know the rules, but no one has actually told them the rules and procedures. For example, at Carey's base, they knew that they needed to stay near the aircraft at all times, because if a fire call came in, they would immediately need to get to the aircraft. However, at Carey's base the FBO office was quite a ways away from the aircraft, and one time a fire call came in and a new pilot was hanging out at the FOB*[30] *and completely missed the call. They were looking around for the pilot and found him at the FOB, where the radios didn't reach. Carey explained, "Everybody just knows you're supposed to be around the base"—everyone it seems, except this new pilot.*

In the discussion surrounding new pilots, many of the air tactical group supervisor and pilots in the room shared that they were surprised when they learned that new pilots that have recently joined the organization had no idea how to approach a fire, or even how much retardant to drop on a fire when they first began making their initial attack flights. This knowledge was something previous CAL FIRE pilots—who were typically hired directly from the U.S. Forest Service after they'd flown years of fires with the organization—had already known and did not need to be trained on. Today, many of the new pilots are hired from other agencies or organizations, such as national commercial airliners or small-scale operations flying remote locations in Alaska. While these pilots had significant flight hours, they did not have the basic fire behavior knowledge that previous new hires possessed. In a similar vein, shifting requirements for the air tactical group supervisor program meant that some knowledge previously assumed to be a baseline of all trainees—such as experience on crews or even in aviation units—were no longer guaranteed.

Experience, however, did not necessarily predict success as an air tactical group supervisor expert during wildfires. Air tactical group supervisor trainee Dominic confided, "I know I have probably more experience and training than some other people who don't. It's a weird position because you see some guys that go through [ATGS training] that don't even have

[30] FBO = Fixed Base Operator. See glossary for full definition.

any aviation experience and they're great at it, you know? ...And then you have other guys go through—helitack captains that were good captains—and it just doesn't [work out]. It's a challenging position and it doesn't work out and they don't finish the training."

In air tactical group supervisor training, one thing became very apparent very early on in my observations: The need for trainees to learn and "stick to the scripts." Throughout the training, expertise as an air tactical group supervisor was defined not by experience in the air or making specific decisions on how to attack a fire using aerial firefighting assets, but instead through the use of specific phrases and utterances. During the initial air tactical group supervisor training program, former helitack captain Dominic told me:

> You know, you got to know it a lot more as an air attack. So at night I would review the material from the day and practice so much of the air attack stuff and just being able to rattle off the scripts and the clearances for the aircraft without it pulling you away, being able to multitask, just like, have a really structured way of doing it, and you know, that's not going to—basically, not having to think too hard about having to do those clearances and what you're going to say and stuff is going to make your life a lot easier…I just kind of review stuff from the day and then try to prepare for the next morning, whatever they're going to throw at you.

Concerns over "doing the script perfectly" continued to be articulated by air tactical group supervisor trainees in almost every discussion and feedback session I attended during the air tactical group supervisor trainings observed. Dominic told me how as an air tactical group supervisor trainee "you want to do it like, perfect, but you have to know you have to give yourself some flexibility of not saying the perfect word every time when you're rushed on talking to four different people."

Although fire behavior and aerial firefighting tactics were not far from the minds of the air tactical group supervisor trainees, few expressed actual concern about being perceived as effectively fighting the simulated fires. Even as fire complexity increased over the course of the training as instructors began to escalate scenarios, the primary concern for trainees remained on

how to correctly speak the script. Perhaps unsurprisingly, this concern was rooted in the air tactical group supervisor training itself, which was built to reinforce the need to learn the scripts and communicate them. Air tactical group supervisor trainees spoke of their annoyance at running training exercises over and over, repeating the same scripts across marginally different scenarios. The emphasis on these exercises was not to gain skills in the use of aerial firefighting techniques or methods, but instead on how to simply communicate with team members and "stick to the script." Dominic recalled the almost endless scenarios and feeling: "'Ugh, another sand table or another simulator or target description'…you kind of feel like as a student like, okay, we just did this. But it's just another opportunity to fine tune and perfect your clearances and it's just more practice."

Even as the training curriculum shifted to prod students into more complex fires, emphasis remained on correctly delivering communication scripts rather than on firefighting tactics. When reflecting back on the most challenging exercise of the air tactical group supervisor training—a live fire simulation called the Buckhorn Incident[31]— Dominic recalled that while on-the-fly decision making of fire tactics was challenging, sticking to the expected script continued to be his most pressing concern:

> It's definitely real life and what the air attack has to be thinking about. Can I work the 'copters on the right flank now? Now the priority is the other flank and you've got to reroute. Put the fixed wing on the other flank. Move the 'copters over. Now, you know, it's like there's so many different factors that are influencing what and how you're going to use each type of aircraft. But the radio stuff – them trying to hail you on air to ground and tankers…They're doing it on purpose, but it's also – I mean, that's total real life. You're going to get overwhelmed and just having to get back to three or four different people trying to talk to you at the same time.

[31] The Buckhorn Incident is an in-person simulated initial attack wildfire training event designed to mimic a real fire, complete with ground crews, smoke machine, hand-lit smoke candles, and aerial firefighting aircraft including S-2 air tankers and helicopters. Water is dropped in place of fire retardant. On occasion, the hand-lit smoke candles would lead to actual small fires, further simulating a realistic initial attack fire response for ATGS trainees.

In short, being able to speak like an air attack is a key yet unwritten component of being certified as an air tactical group supervisor expert in the first portion of the air tactical group supervisor certification training course. The CAL FIRE air tactical group supervisor training, a combined endeavor with the U.S. Forest Service, begins as a two-week course in Northern California. Offered only once a year, trainees spend the first week in the classroom and the second week operating in simulated fire environments. Carey said, "We put them in as much as a real-life aviation firefighting scenario as we can without lighting fire. So there's helicopters coming in dropping crews off. There's air tankers dropping. There's smoke jumpers jumping out of airplanes and doing all that stuff." After completion of the two-week in-person training course, air tactical group supervisor trainees would then begin the second portion of their qualifications individually, which includes responding to a number of actual initial attack fires as part of a task book signoff.

This portion of the training reflected the organization's stated emphasis on both aerial and firefighting expertise, but more telling was the unacknowledged importance communication played on both certifying and working as an air tactical group supervisor, as air tactical group supervisor trainer Carey describes: "It's very objective on the task book side but it's very subjective when it comes to their demeanor over the fire, how they talk on the radio, their command presence over the radio, and how they handle just the overall stress of the situation."

The need to be able to always perform command presence through communication as an air tactical group supervisor was a theme that threaded almost every discussion I had with both incident commanders and air tactical group supervisors. The need for this command presence was most often characterized by both air tactical group supervisors and incident commanders as a way of supporting the incident commander, but it also presented a means by which air tactical

group supervisors could preserve reliability during instances when other team members were presenting potential safety challenges. For example, air tactical group supervisors would demonstrate command presence with problematic team members such as tanker pilots questioning an air tactical group supervisor's wildfire firefighting tactics. By being direct and clear in their radio transmissions, air tactical group supervisors communicatively perform expertise and stop problematic overcommunication endangering a wildfire response. In one scenario a former air tactical group supervisor recalled a tanker pilot that repeatedly and insistently questioned orders to drop retardant near a working bulldozer. Despite receiving the "clear to drop" call from the air tactical group supervisor twice, the pilot continued to engage with the air tactical group supervisor and question the air tactical group supervisor's instructions:

> [The pilot] turns final, and well, he starts jabbering. "Well, there's that dozer there!" and "You know, there's that dozer there and I don't know about this" and I had to be short and sweet with [the pilot]. I said… "Tanker 8-2[32], I got your final. You're clear to drop. I'll worry about the dozer. You do the drop as requested." And that was it. After that, he didn't say anything else. I would say most of the time people are very receptive but if there's times where they're not, it's just—[Pauses]. Direct and to the point.
>
> …The funny part about that story is the other tanker pilot heard that as he was flying back and after the fire was over, he called me and he said, "Dude! That was the funniest thing I've ever heard! I can't believe you told that guy off on final!" I was like, "Hell, he was getting in my way, you know?"

Carey describes the importance of having command presence, which includes knowing the script and then occasionally going off-script as "when you're the ATGS you're always the one telling everybody what to do. I'm telling the tanker where to drop, I'm telling the helicopter where to go. I'm telling everybody, I'm giving orders, right?"

Ultimately, communicatively performing command presence as an air tactical group supervisor came down to a combination of five important elements: (a) *brevity*; (b) *clarity*; (c)

[32] All air tanker numbers referenced in this report have been changed to ensure participant anonymity.

tone; (d) *cadence*; and (e) *confidence* (see Figure 9). Air tactical group supervisor trainees Dominic and Dwight each reiterated these in their own words during discussions held after they passed the initial two-week course and obtained their initial air tactical group supervisor trainee qualification flights.

Figure 11

Air Tactical Group Supervisor Command Presence Elements

Note. Source: Amber Lynn Scott

Dominic explained that elements of the five components of command presence were always in the back of his mind, particularly when reflecting on friends that did not successfully pass their air tactical group supervisor qualifications:

> You know, it's either—it's kind of black and white, whether you can do it or not, in my experience. And like, just my experience doing the training, but also looking back over the last few years with guys who have gone through it and some make it and some don't. I was worried about that because some guys, really dialed individuals go through with tons of experience, even aviation experience and it's just —they don't get through it. So like, in the back of my mind, it's like, you know, there' a little bit as far as like—and it's hard to evaluate yourself in comparison to you know, where you're at through the training process…And then kind of like halfway through the training process, it just kind of like—the timing, the getting ahead of stuff that, you know, that's coming. I had a few

> fires that I felt really good on and it, for me personally, I gained the confidence to really be able to like start performing better because I had a lot more confidence that I could do the job. So it started like really clicking. And I'm still brand new, too. I have tons to learn now even though I'm signed off. But it's like, it started getting, I started getting ahead of things. My comms are better. My, you know, anticipating what's coming next and like, making my life easier for myself got easier throughout the process.

Air tactical group supervisor Dwight also acknowledged the importance of the five components of command presence and their ability to not only facilitate air tactical group supervisor expertise acknowledgement by incident commanders on a fire, but also to ensure the safety of the entire aerial firefighting team while doing so:

> Brevity is one of the huge communication factors, because if you talk, you're taking up airtime for someone to say, 'Hey, watch out for the wires.' The other thing is clear communication: 'Do you have the house that's on fire?' 'Yes.' 'The next house, structure protection. Clear to maneuver.' Now, one thing throughout the day you will hear is you'll hear the pilots…You'll hear concerns in communications, and it's always little quips of information. Now, *what* they said is one. *How* they said it is another. And the third is the *tone* in their voice.

In the following paragraphs, I provide more detail on how the five important elements combine in a manner that creates the framework of the organizational concept of air tactical group supervisor command presence communication performance. Additionally, I explain how air tactical group supervisor training illustrates the importance of each element as a means of facilitating air tactical group supervisor expertise acceptance between an incident commander and air tactical group supervisor, and how these elements are taught to air tactical group supervisors as part of both a formal and informal training curriculum. Each section also includes illustrations of how these elements present in real-life initial attack wildfire air tactical group supervisor and incident commander communication responses.

Command Presence: Brevity

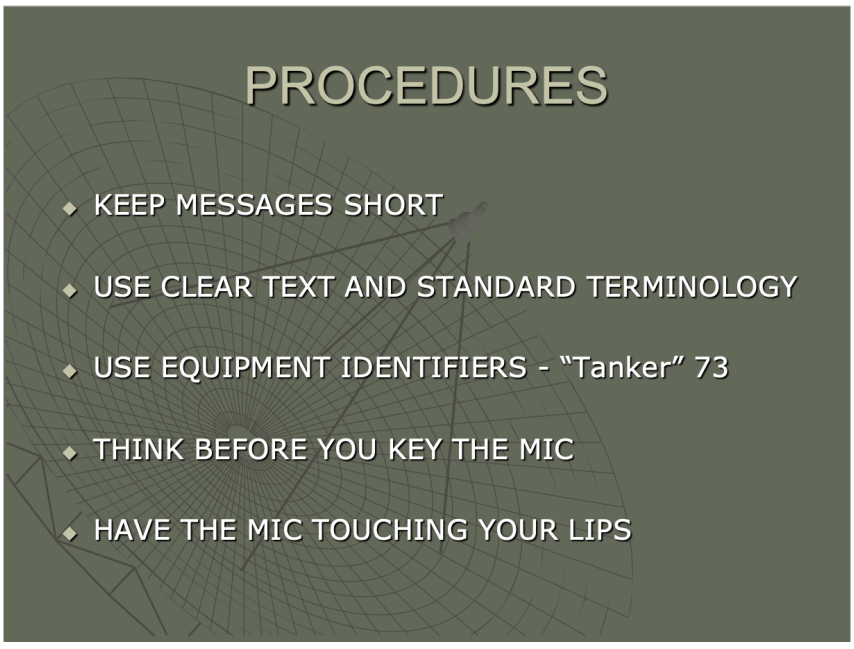
Command presence as an air tactical group supervisor includes a heavy emphasis on **brevity** when communicating during a fire. This brevity is described as striking a balance

between not saying a lot, but also saying enough to get the plan across to team members. “Short, to the point, and out. That’s what air attack should be,” explained Dwight, a former incident commander, HLCO, and current air tactical group supervisor. Another air tactical group supervisor named Dominic described it as: “You hear good air attacks and they make it brief. Their brevity with the ground, it’s just quick, concise. They give it. They give them what they need and then they’re right back for the tankers. They have a way of giving only the information that (laughs) they feel is fit for what’s being requested from the ground.”

During air tactical group supervisor training, brevity is a regular part of the air tactical group supervisor communication instruction training. As part of their unit on communication, a list of procedures begins with “keep messages short” (see Figure 10) a clear nod to the importance of brevity.

Figure 12

Air Tactical Group Supervisor Training PowerPoint Presentation Showing Communication Procedures of Brevity and Clarity



Note. This slide is from the Air Tactical Group Supervisor Unit 10, Communications.

One component of the air tactical group supervisor training program includes exercises called target descriptions. During target descriptions, air tactical group supervisor trainees practice talking an air tanker to a specific drop location in a fire using the shortest amount of communication possible. Air tactical group supervisor trainee Harvey noted that during the training "a lot of the time [the training] was target descriptions, describing targets to your partner, acting as the air attack and then tanker. And you're trying to describe the target with minimal radio traffic…there's always brevity during target description in radio communications, trying to keep your dialogue concise and specific."

The air tactical group supervisor trainers also reflect this brevity in their own communication during the simulated ground and live flight exercises included in the air tactical group supervisor training program. In one instance during a live training flight, air tactical group supervisor instructor Alex watches a potentially dangerous situation unfold when an air tactical group supervisor trainee places his air tanker aircraft at the same flying altitude the air tactical group supervisor aircraft is current flying at. With three aircraft all flying at the same altitude of 3,000 feet and contained within a very small fire traffic area (FTA), the air tactical group supervisor trainer gives the trainee just a few short moments to realize his error. When the realization is clearly not forthcoming, air tactical group supervisor trainer Alex jumps on to the radio and firmly tells the trainee, "Direct your pilot to go up to 4,500." The instructions from air tactical group supervisor trainer Alex are ordered in a short, calm, and clear manner, although I can hear the slightest tinge of stress in the trainer's voice. In this instance, air tactical group supervisor trainer Alex demonstrates through his verbal orders exactly how an air tactical group

supervisor should talk with brevity, delivering the shortest amount of words needed to clearly get the message across.

Brevity in air tactical group supervisor communication is not limited to short bursts of words or brief communication, however. Brevity can also translate into speaking only what needs to be said in a given moment. For example, during the air tactical group supervisor training, air tactical group supervisor instructor Doug shared a story about a time that he once activated the microphone on the plane with his foot without realizing it, transmitting short commentary to the air tanker pilot who just missed a retardant drop. In his telling, Doug inadvertently hot mics his radio with his foot and transmits his analysis of the drop, saying, "Fuck! That was a high drop!" across the radio channel. Later that afternoon after the fire was complete and they all had landed, someone approached him and asked if he meant to transmit the statement across the radio. To his horror, Doug admitted he had not, and it ultimately initiated a sequence of apologies and clarification that Doug did not mean to criticize the pilot but instead was frustrated with the wind gust before the drop, which resulted in the retardant getting caught in the wind and failing to hit the target line they were aiming for. Although the radio transmission that went out by air tactical group supervisor Doug was relatively short and to the point, it underscores the larger argument that brevity isn't enough, and clarity is also an important part of the air tactical group supervisor role when leading an initial attack response. Additionally, air tactical group supervisor Doug's example shows that sometimes brevity is defined by what is *not* said on a fire response, such as limiting feedback to pilots on fire retardant drops when the feedback is ill-timed or not particularly useful in the moment.

Brevity (and lack thereof) on the radios during air tactical group supervisor training was also found to be a cause of conflict amongst the air tactical group supervisor trainers themselves

during portions of the Buckhorn Incident exercise, highlighting the importance of the concept and how it might cause conflict with members of an initial attack team. During the first day of my observations of the Buckhorn Incident training exercise from the air, I heard a lot of chatter on the radio. This chatter was assumed to be intended to simulate the conversations that often unfold during initial attack fires, especially fires fought with ground teams including agencies other that CAL FIRE. In the simulation, several of the trainers were heard pretending to be volunteer firefighting ground units making small talk over the radios, including discussions of how to coordinate getting meals to crews and the need for paperwork to be signed by leadership before the day was done. One of these trainers working on the Buckhorn Incident named Pablo explained to me that much of this chatter was reflective of what you would hear at an actual fire with other agencies or volunteer firefighter units, where their unfamiliarity with the brevity concept often results in overcommunication on radios. These ground units are often unaware that their communication is heard beyond their own teams, bleeding on to other radio channel networks monitored by the air tactical group supervisor in the air and the incident commander on the ground. Because the air tactical group supervisor is tasked with monitoring multiple radio channels simultaneously, this simulated talk was being created by instructors like Pablo to specifically reflect the real-world nonstop chatter over radios that air tactical group supervisor must confront when trying to do their jobs. However, in this case, some of the Federal air tactical group supervisor trainers participating in the training did not agree with Pablo's technique. The Federal trainers took issue with the amount of chatter generated by the CAL FIRE air tactical group supervisor instructors on the ground, including Pablo. This resulted in the Federal air tactical group supervisor trainer generating a complaint within the air tactical group supervisor trainer's group that the communication was lacking brevity and needed to stop immediately. The

Federal air tactical group supervisor trainer claimed that this communication was both unprofessional and confusing to the air tactical group supervisor trainees, some of whom were already significantly struggling in the training program.

The complaint about brevity on the radio resulted in an unexpected shift in communication by some of the air tactical group supervisor trainers, and Pablo in particular. After hearing about the complaint, Pablo refused to speak on the radio at all, ceasing all radio communication during the exercise. When I joined Pablo on the ground the next day, he made several comments to other CAL FIRE air tactical group supervisor trainers that the individual complaining about radio brevity was in fact "the biggest violator of radio talking and talked more than anyone else!" In this scenario, Pablo's attempt to reflect real-life fire talk went against the air tactical group supervisor trainer's desire to teach and reflect brevity in communications, highlighting just how important the concept is for the air tactical group supervisor and the air tactical group supervisor training program curriculum.

The expectation for brevity in communication is uniquely attached to the role of the air tactical group supervisor and how air tactical group supervisor trainers teach communication to the trainees and does not hold across all roles in the initial attack response. Most notably, brevity appears to be an expectation for those associated as part of the air team but is less expected within ground units. When conducting training operations at air tactical group supervisor trainings, team members acting as incident commanders speak with somewhat limited brevity, and instead communicate in a manner that includes more descriptive and drawn-out communication to the air tactical group supervisor. This can be heard in radio transmissions from the incident commander ranging from telling the air attack "people are screaming for water down here" to the incident commander attempting to crack jokes with the air tactical group supervisor

about the incident commander being "one of those green guys[33], but we'll just keep that secret between us."

Conversely, in discussions about the recent incorporation of intelligence and surveillance aircraft on initial attack fires throughout the state, a lack of brevity by intelligence and surveillance aircraft operators served to be a key point of contention during CAL FIRE's annual Aviation Safety Conference. Discussions arose in both leadership Q&A sessions and breakout groups bemoaning the lack of brevity in fire intelligence and surveillance aircraft flying over initial attack fires. The complaints noted how these operators talked entirely too much and at all the wrong times during initial attack fires, sharing information that was not needed (e.g., weather conditions) and interrupting critical communication between the incident commanders and air tactical group supervisors with long soliloquies even when the information was helpful or useful. Complaints on their lack of brevity spanned across multiple members of the aerial response teams, including air tactical group supervisor, helitack crews, and pilots alike. The lack of brevity from these intelligence and surveillance operators presented a unique communication challenge to the air tactical group supervisor on initial attack fires, as the organizational hierarchy is such that the majority of these aircraft (i.e., Fire Integrated Real-time Intelligence System (FIRIS) surveillance aircraft) are operated by the Office of Emergency Services (OES) and not CAL FIRE and thus were outside of both the air tactical group supervisor's and CAL FIRE control. This meant that they fly independent of CAL FIRE and thus could not be ordered to adjust the communication brevity, leading to significant frustration within the entire CAL FIRE aerial operations teams and concerns about the safety impacts created by this incessant

[33] A "green guy" is a reference to a U.S. Forest Service team member. A "blue guy" is a CAL FIRE team member. Casual jokes about "green guy" and "blue guy" differences were ongoing throughout the ATGS trainings observed, as well as other interagency events (i.e., conferences).

chatter. Conversations between CAL FIRE Tactical Air Operations (TAO) leaders and Fire Integrated Real-time Intelligence System (FIRIS) leaders proved somewhat fruitful at reducing some of the chatter, although complaints still arose around the type of information shared and lack of brevity by the Fire Integrated Real-time Intelligence System (FIRIS) operators. The aerial firefighting teams were ultimately told to write this lack of brevity up as a SAFECOM in an effort to flag this communication pattern as problematic to safe outcomes during firefights[34].

Air tactical group supervisors are expected to maintain brevity in all their communication on fires. Dwight explains, as an air tactical group supervisor it is important to give "a lot of information in the shortest amount of words." Some people will "talk until they are comfortable" and this lack of brevity "clogs up the radios." Air tactical group supervisor Dominic shared with me that even in his experience as a helitack Captain, a role he held before becoming an air tactical group supervisor, brevity on fires was a challenge for some agencies outside of CAL FIRE, which complicated the team's firefighting efforts during initial attack fires:

> The different agencies IC's—if you have local government or volunteer guys that maybe aren't as disciplined on the radio as, you know, CAL FIRE or Forest Service, and are asking or wanting some things that are just different from our agency. It's a challenge to be able to prioritize getting back to them and giving them what they want because they are the IC's, versus our agency IC's that are typically Battalion Chiefs that are a little bit more trained in that position.

Command Presence: Clarity

In combination with brevity is **clarity**, which is saying as few words as required but ensuring the actions required are communicated clearly to the rest of the team. In the example of Doug's accidental transmission, it is clear that brevity alone is not enough to make sure the job is done correctly. Air tactical group supervisor training materials reiterate the importance of clarity

[34] This lack of brevity remains an unresolved issued.

in communications, including reminders to “use clear text and standard terminology” and “use equipment identifiers” (see Figure 10) to ensure team members know exactly which aircraft is being addressed.

Clarity of communication from air tactical group supervisor comes up often in the debrief, and air tactical group supervisor trainees are quick to acknowledge their faults when communication is not as clear as the role requires. Dwight noted that in debriefs, “Everybody gets to speak their mind, explain what they thought, [and] how we can do it better. Usually, it’s generally an admission [of things like] ‘Yeah, I didn’t describe that target very well’.” Target description clarity is an important part of air tactical group supervisor operations, and a critical component of the air tactical group supervisor training curriculum. During air tactical group supervisor target description exercises, one air tactical group supervisor trainee is seated at a table in a classroom and pretends to be an air tanker pilot while the second air tactical group supervisor trainee seated at the table gives a description of where the pilot should go and what the area they are aiming for looks like (see Figure 11 for example). Both trainees are separated by a wooden divider to prevent inadvertent nonverbal communication spillover during the exercise, simulating the separation that would exist if the air tactical group supervisor was in one aircraft and the tanker pilot was flying in another. Additionally, each trainee wears a headset playing an audio recording of actual wildfire radio communications to simulate the nonstop audio communication that occurs during a wildfire response (see Figures 12 and 13 for equipment visuals). During the exercise, air tactical group supervisor trainees must verbally guide their partners (i.e., the tanker pilot) into the correct retardant drop location. The exercise emphasizes using only the standard verbal scripts to convey the drop location without extraneous information or generalizations. During these exercises, several air tactical group supervisor

evaluators sit off to the side of the classroom and take notes on how well the air tactical group supervisor guides their partner into the site, rating the clarity of their instructions during each round. At the conclusion of each simulation, it is easy to see how clear an air tactical group supervisor's instructions are based on where their partner simulates dropping retardant—poor air tactical group supervisor clarity in communication results in drops that miss the target or move in an entirely wrong direction.

Figure 13

Air Tactical Group Supervisor Training Target Description Classroom Student Setup

Note. The image shows an air tactical group supervisor (ATGS) trainee practicing the role of a air tactical group supervisor (image left) giving a target description to a fellow air tactical group supervisor trainee posing as an air tanker pilot (image right). A green laser spot indicates the drop location the air tanker pilot believes is the intended drop site based on the communication from the air tactical group supervisor. The air tactical group supervisor trainee posing as the simulated air tanker pilot (right) was cropped out of the photo for privacy protection. Image source: Amber Lynn Scott

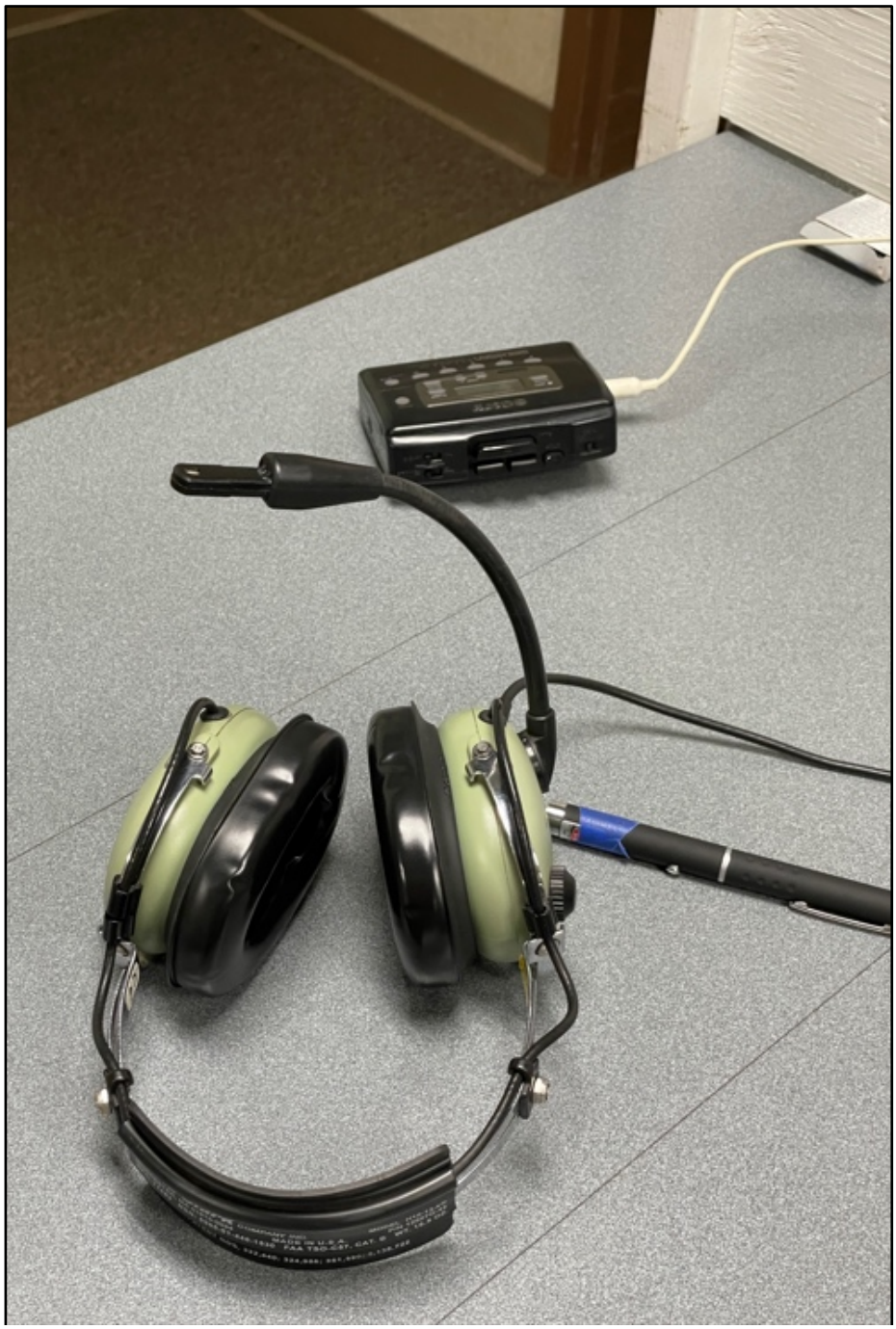
Figure 14

Air Tactical Group Supervisor Training Target Description Classroom Setup

Note. The image shows the setup of the air tactical group supervisor (ATGS) target description classroom training exercise. Image source: Amber Lynn Scott

Figure 15

Air Tactical Group Supervisor Training Target Description Classroom Headset and Recording



Note. The image shows one headset, audio recording, and the laser pen used during the air tactical group supervisor (ATGS) target description classroom training exercise. Image source: Amber Lynn Scott

Air tactical group supervisor training exercises do more than teach clarity of verbal instructions in a classroom setting. They also represent the very real effects of how poor clarity during a fire can result in a fire response being delayed by unclear or missed communication points in the script. My field notes detailing the script of the target description exercise reflects how a lack of clarity during communication in the classroom illustrates this point. Air tactical group supervisor instructor Tom's colorful feedback to an air tactical group supervisor trainee, who keeps missing a specific part of the clearly defined script during each drop simulation, provides an example of how Tom's own mistakes in clarity have had impact on wildfire operations:

> *The air attack gives descriptions of what they want for the drop (this is the target description).*
> *The air attack then gives instructions on what they want for the drop, such as "coverage level 6, full load."*
> *The tanker will ask if they are "clear to maneuver" and the air attack will give the "clear to maneuver" command.*
> *The tanker will say they are "downwind" and the air attack will say they "have your downwind."*
> *The tanker will then say "on base" and the air attack will say "have your base."*
> *The tanker will then say "on final" and the air attack will say "clear to drop."*
> *The tanker makes the drop by saying the words, "drop, drop, drop, drop" and moving the laser pointer.*
> *The air attack will provide feedback on the drop, such as "good start, good line."*
> *The scenario ends and feedback begins.*
> *During the third round of this scenario, the air attack trainee continues to forget to give the command to clear the tanker to drop. In the debrief, the instructor [Tom] says, "I can't tell you how many times I've been sitting there asking tanker 1-5*[35]*, "Why didn't you drop?" and he says, "You didn't clear me to drop!" and I'm like, Awww fuck. I forgot to clear him to drop!*

In Tom's admission captured in my field notes, we see how brevity is, of course, not enough to clearly execute the target description successfully during a fire. . If the air tactical

[35] Tanker number changed to ensure Tom's anonymity.

group supervisor is not clear in each step of communication, from start to finish, the entire firefighting operation may be stalled.

Air tactical group supervisor Dwight understood the importance of clarity and took that skill with him through the air tactical group supervisor training to extend to his initial attack communication script. In sharing his stories of life as an air tactical group supervisor, Dwight highlighted for me how he structured his communication with helicopter pilots specifically to maintain clarity not only during the initial attack fire, but as a means of being prepared and knowing what aircraft were in what position should he immediately need to adjust his tactics:

> Now, one thing throughout the day you will hear the pilots. So the helicopters will say [where they are], and I tell them, "You call off the dip and off the drop" with their call sign. So I know where in space and time they are, in case I need to divert one to a new start or a spot or whatever the case is.

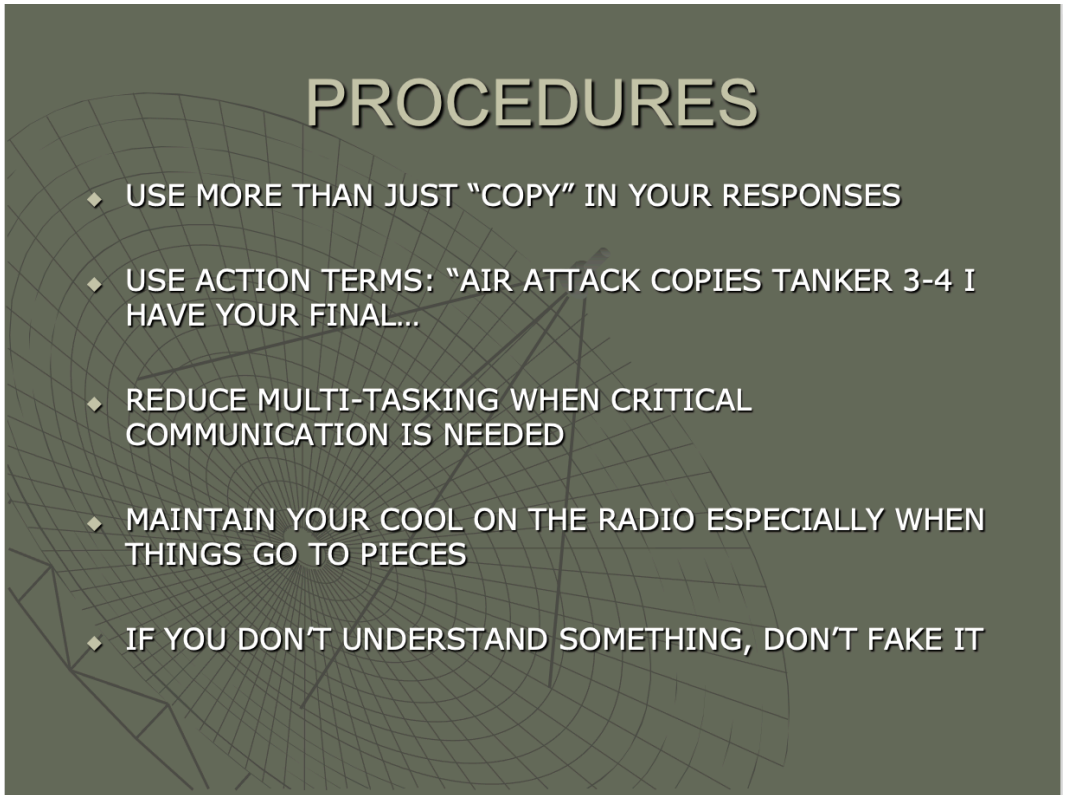
By insisting his helicopter pilots continuously update him on their location both when making water drops on the fire and when they are simply collecting water from the dip site, Dwight establishing clarity of where his aircraft are at all times. This, in turn, allows Dwight to be prepared to adjust his aircraft at a moment's notice if the incident commander contacts him with a change in strategy or tactics, such as the need for aircraft to respond to a newly developing fire in a different location. Beyond simply knowing where his aircraft are at all times, Dwight's communication posture of insisting the helicopters continuously update him on their location allows Dwight to operate with more authority as an air tactical group supervisor speaking with an incident commander, as Dwight is always aware of where his helicopters are in the established loop of either dropping water (i.e., "the drop") or collecting water from a water site (i.e., "the dip").

Command Presence: Tone

When delivering instructions, the **tone** is equally important for an air tactical group supervisor to be considered an expert. As a part of the air tactical group supervisor training module curriculum, air tactical group supervisor trainees are taught the critical importance of tone when speaking on the radios. In one training document, air tactical group supervisor trainees are reminded to "maintain your cool on the radio especially when things go to pieces" (see Figure 14 for example).

Figure 16

Air Tactical Group Supervisor Training PowerPoint Presentation Showing Communication Procedure of Tone and Confidence



Note. This slide is from the Air Tactical Group Supervisor Unit 10, Communications.

Current air tactical group supervisor Dwight says, "I try not to get riled up on the radio. It is very, very important to be the calm voice in the air." The pilots working with air tactical group

supervisor's also recognize the importance of tone in communication. Jon, a current CAL FIRE pilot, shared several stories with me about his many years flying with air tactical group supervisor Brenton, and how they would spend "hours and hours not talking to each other' directly" but that he always knew what Brenton wanted. Jon attribute this to several elements, including a long career of flying with Brenton, and the relationship they built over years of responding to initial attack fires together. Beyond this relationship, however, air tactical group supervisor Brenton and pilot Jon learned to read the nuance of each other's tone when giving the regular commands inherent to every initial attack fire response. This meant that a slight adjustment in pitch would alert Jon to a potential danger with Brenton ever having to articulate the words directly.

In another example, air tactical group supervisor Dwight shared a story with me from his days as a helitack Captain that clearly illustrated just how important tone can be:

> You need to understand how people talk. Their tone, inflections, et cetera. So in real life when you hear them in the air, you know if it is good or bad. For example, and I've done it myself, air attacks ask me, 'Hey, what do you see out there?' There was a fire in northern California[36], it was a real windy day and there were down sloping winds and rollers[37] off of this ridgeline, and we were fighting the fire under it. Air attack, they couldn't see down below, but we're under there. 'Hey, what's going on?' And I said, 'Hey, give us a minute. We're having trouble keeping the aircraft in the air' because it was so turbulent. We're flying, we had the crew on board, and my pilot said, 'Hey, we need to insert the crew so we can lighten up, so we can actually figure out where the fire is, where it's going.' So we came into an LZ[38] and we hit a downdraft and we almost augered[39] in. Now, before that, there was a few tankers that tried to make drops and their comments were, 'Wow, that was kind of bumpy!' That is a red flag. Bumpy is not the problem. It's how he said it and when he said it.

[36] Locations of fire incidents have been generalized to regions ensure participant anonymity.
[37] An informal term for a rolling-type of smoke pattern.
[38] Acronym for "landing zone".
[39] An informal aviation term for crashing catastrophically.

As demonstrated in Dwight's example, the importance of tone was not limited to air tactical group supervisor, but also appeared to be a part of the general communication norm unfolding within CAL FIRE aviation.

In another interview discussing an aborted landing attempt, current helicopter pilot Al shared how he picked up on the hesitancy in firefighter Kasey's voice as he gave final clearance to make a particularly precarious landing. Rather than attempt the maneuver, Al opted to abort the landing based solely on the tone of Kasey's voice, despite the fact that Kasey had given Al permission to make the landing as requested. This story was shared with me by several members of Al and Kasey's unit as an example of how tightly knit the CAL FIRE aviation teams were and how in tune the teams were with each other's tone, where in some instances the team would default to cancelling maneuvers when a team member's tone indicated a maneuver might be more risky than the actual order to proceed would indicate.

Tone plays a very nuanced role in air tactical group supervisor communication, particularly with incident commanders. In his retelling of a particularly demanding incident commander complete with added inflection for emphasis, Dominic recounts how tone alerted both the incident commander of Dominic's impatience with him, and the subsequent attitude the incident commander had towards Dominic following the interaction between the two:

> I learned on one fire in particular. It's just like, [the IC] kept calling, kept calling. And the [ATGS] instructor is like, 'You better tell him to stand by. He's just going to keep [going]. You know, he's talking over you. You're trying to talk to tanker pilots and helicopters and he's talking over you, you know. You can turn him down a little bit, but he's just going to keep coming back.' So you know, he kept calling. I'd say, 'Standby one, I'll get back. I'm dropping tankers. I'll get right back to you.' And then— (Dominic laughs) I'd have more tankers check in! (Laughs)…But [the IC would] just keep hitting me up—hitting me up and [I'd go] 'Standby. I'm dropping tankers. I'll get right back to you!' And he's wanting to know, you know, pivotal information too.
>
> And then you kind of hear it. They're mad at you for not getting back to him, because they're not hearing everything you're doing. And then I ask, then I call [the IC] and he doesn't get back to *me*. And [I'm] like, '*What the hell? This guys' all over [me]*

> *and now he's not talking to me?*'...You can hear it in guys' tones of voices. Disappointment. Or everybody's just worked up, including me.

Command Presence: Cadence

Cadence is another important element of air tactical group supervisor communication. There is a fine line between going too fast and too slow, and much of the air tactical group supervisor training focuses on teaching trainees where this fine line resides.

During air tactical group supervisor training, some of Dominic's self-attributed biggest initial attack fire failures were linked to issues with his cadence when deploying aircraft to a fire, rather than his firefighting tactics or communication with his team. As he describes it:

> I had two very small, simple fires that seemed harder than large, escalating fires. For some reason it was just [an IC] on the ground trying to call you constantly, just the flow of it [was off]. I mean in the end, it kind of just felt like it's your flow. Your timing and your cadence and stuff. It's just like you'd hear yourself being choppy and not saying exactly the right thing, you know?

Air tactical group supervisor instructors emphasized how important cadence can be in a wildfire response during a portion of the training where air tactical group supervisor trainees are responding to a simulated fire about to engulf a home, with a second home nearby but under slightly less threat. After one fire simulation is complete, air tactical group supervisor instructor Tom begins by debriefing the trainee's decision to try to protect a home that was already under severe threat and explains that the better option would be to let that home burn and focus efforts on protecting the home under slightly less threat. In this scenario, the threatened home was inevitably going to burn, whereas the second home had a chance of being saved if the limited air attack resources were diverted toward the second structure. The debrief then evolves to a discussion about the difficulty of making these types of decisions in real life, and how imperative it is to maintain slow, calm communication in these worst-case scenarios. Air tactical group supervisor trainer Tom then shared a story about his experience fighting the Dixie Fire, and the

difficulties he faced in communicating as an air tactical group supervisor, as the scenario moved towards worst-case firefighting response. During these times of increased danger and pressure, Tom tells the air tactical group supervisor trainees how speaking cadence becomes a critical part of the keeping control of a dangerous wildfire response, even as his mind battled a terrible scenario unfolding below: "When you see a house burning down, dogs probably dying, shit's going on—I gotta slow down. Because I think the worst-case scenario. Grandma's probably dying, you know? That's where my mind goes. So I gotta take it slow." In Tom's explanation, keeping communication "slow" allowed him the chance to respond to the unfolding chaos in the most optimal way possible, despite the overall futility that appeared to be unfolding. He acknowledged to the trainees that it can be hard when watching threatened homes begin burning to the ground, but keeping a slow cadence while moving air resources is a part of what allowed him to maintain control of the situation despite the traumatic scenes unfolding below him.

The fine line of cadence is one that some air tactical group supervisor trainees struggled with significantly. During the Buckhorn incident I observed several trainees delivering cadence slow enough for me to make notes in my jottings that the trainee "instructions are delivered in a slow, careful method—no rushed info, very calm tone." Later in my notes I elaborate that compared to other trainees, several clearly are talking at a rate that is much slower than both the air tactical group supervisor instructors and fellow air tactical group supervisor trainees are speaking. When talking to air tactical group supervisor instructor Carey during the training, he tells me that they are having issues with some of the trainees and their tendency to talk "too slow."

In a discussion about what makes an air tactical group supervisor a good initial attack operator, air tactical group supervisor Dwight reiterates "cadences are so important. The

cadences serve as mental ticklers." These mental ticklers assist in prompting others on what to do during a fire, allowing the air tactical group supervisor to retain both brevity and clarity. Thus, the cadence itself helps further underscore other elements of communication. The order that permits an air tanker to begin its fire retardant drop—"Tanker 8-1, you are cleared to drop" can be delivered with different cadence that imports different meaning to the tanker pilot proceeding on final and about to unleash hundreds of gallons of mud[40] on a fire. A rushed delivery can signal an intensity of an imminent drop in a different way than a slower, more deliberate cadence of the same script. When speaking with Dwight, he reiterated frequently that air tactical group supervisor training is really about teaching trainees the proper template for speaking on a fire, where the templates tell air tactical group supervisor how to "give certain information in a certain order." However, beyond simply delivering the information, Dwight also emphasized that a component of delivering the information correctly also came down to the cadence of information delivery: brevity, clarity, and with precise timing relative to everything happening at the initial attack scene, as well as a small dash of something else—confidence.

Command Presence: Confidence

The final piece of air tactical group supervisor communication that creates "command presence" is confidence. Air tactical group supervisor Dominic summarized that when it comes to being a successful air tactical group supervisor with command presence, "It goes back to command. It's like being [commanding]. Taking command. Having confidence. Making decisions." Confidence is a component that is built from the other communication elements, such as brevity. For example, as previously mentioned, air tactical group supervisor Dwight explains that a huge part of being a good air tactical group supervisor is brevity, but that "some people

[40] "Mud" is the colloquial term used in the fire service for fire retardant.

talk until they are comfortable." This is because "they are unsure until they get there what they actually want to say. So they just keep talking." Dwight regularly referenced being able to hear when an air tactical group supervisor would "ball up" communications, essentially failing to communicate with the team. This, in turn, would impact the confidence of the air tactical group supervisor. "You can hear when people are drowning," Dwight explained. In listening to people "ball up" and subsequently start "drowning," the air tactical group supervisor trainees would both physically and verbally become flustered, setting off a series of communication blunders that would impact the entire team.

In one example, I witnessed this series of confidence losses through the "balling up" and subsequent "drowning" of Jeff, a well-respected air tactical group supervisor trainee with a stellar reputation for being a strong helitack Captain back at his home base. Despite his experience in aviation and the confidence many air tactical group supervisor trainers had in Jeff, his training flight during the Buckhorn Incident[41] got "balled up" rather quickly, resulting in Jeff's confidence taking a nosedive.

The first exercise tasked Jeff to identify a simulated lightning strike fire (i.e., a small orange panel signifying a tree on fire) and went seamlessly, with positive feedback from the trainer. In preparation for the next exercise requiring Jeff to navigate a fire truck to a simulated spot fire in the middle of a remote location, information passdown between Jeff and another air tactical group supervisor trainee became jumbled. During several information exchanges, Jeff received incorrect information from the air tactical group supervisor trainee, which Jeff repeatedly questioned and corrected. The air tactical group supervisor trainee sharing

[41] Much later in my project, Jeff disclosed that he had COVID-19 that day but was unaware at the time of the exercise. In later conversations about the difficulty of this exercise in particular, Jeff attributed much of his foggy memory and poor performance during the Buckhorn Incident to his illness.

information with Jeff used a hesitant, high-pitched tone, and you could feel the trainee's nerves radiate through the audio transmission. Jeff replied in a calm, collected tone, maintaining a confident communication pattern even in the middle of the confusion. But as the passdown was complete and the exercise began, Jeff quickly "balls up" his own communication with the ground, and his confident tone takes a more frantic edge.

As the exercise begins, the misinformation that was passed to Jeff initially has confused him, leading him to give confusing directions to the crew on the ground. "Shit, I oriented him to the wrong ridge!" Jeff shouted in the plane before transmitting follow-up information to the team below: "I oriented you to the wrong ridge." Over the course of several minutes, Jeff struggles and fails to communicate clear directions to the ground team, who are driving around and becoming more deeply lost in the wildland forest.

While his words are still brief and direct, the tone shift by Jeff indicates a developing problem—Jeff as the air tactical group supervisor is struggling to get his crew where they need to go. While Jeff eventually navigates the ground team to the correct ridge, the communication between Jeff and the team below completely unravels and it is clear he has been "drowning" throughout the whole exercise. As an underscore to the entire debacle and how terrible Jeff's "drowning" was, the exercise concludes with a particularly poignant moment noted in my field notes:

> After the end of the exercise, Jeff says in frustration, "This is fucking hard." At this point, the vibe in the aircraft has shifted and Alex [the ATGS trainer] tells Jeff, "Look, here's one way you can do it next time"…Jeff starts to explain [to ATGS trainer Alex] why he messed up the last exercise, and he is clearly frustrated. After a minute of talking about how frustrated he was and how he was trying to explain it to the truck but was getting messed up, he realizes that he's on a radio channel that everyone can hear and says, "Shit I just transmitted all of that."…As Jeff passes information to the incoming trainee, he is very bummed out. He then tells us, "Sorry about that, that was a rough one." Both Jeff and the trainee he is talking to sound down and sad.

This experience crushes Jeff's confidence and ultimately impacts the confidence of the next air tactical group supervisor trainee who is receiving his passdown from Jeff.

In Jeff's example, we can see how confidence can be lost during the air tactical group supervisor training. But perhaps more interesting is how the air tactical group supervisor trainers both recognize this confidence loss and work with trainees to rebuild it, acknowledging the key element confidence plays in ensuring the air tactical group supervisor is recognized as the expert during an initial attack response. Following Jeff's disastrous effort to navigate a ground crew to a simulated spot fire, he must now tackle another exercise from the air where he guides a bulldozer to a different simulated fire. This simulation is not without its challenges, and at one point Jeff advises the dozer to turn right, but instead the dozer goes left. Jeff catches this error and gets them turned around to the correct direction, and by the end of the exercise his confidence seems to be building again. The final exercise Jeff confronts is the Buckhorn Incident, where I witness firsthand an air tactical group supervisor trainer actively work to rebuild Jeff's confidence as an air tactical group supervisor. The Buckhorn Incident is a complex and challenging simulated initial attack response that incorporates live air tankers and helicopters making water drops on a simulated fire. For most air tactical group supervisor trainees, the Buckhorn marks the very first time they will experience a true air tactical group supervisor response, and it is incredibly dynamic and fast. As Jeff navigates the initial communication with the incident commander, air tactical group supervisor trainer Alex provides immediate feedback, telling Jeff, "Very good initial report on the incident conditions." This small kudos seems to bolster Jeff's confidence, and he moves through the rest of the exercise with minimal issues. At the end of the simulation, Alex completes his notes and then jumps on the radios and asks Jeff's air tactical group supervisor partner, "What do you think? Think this guy has a job?" while giving a giant grin. Jeff

responds, “Not with that handoff” and laughs while emitting an audible sigh. It is clear that the despite his words, the lighthearted tone and laughter associated with his joke indicate confidence has been restored in Jeff, and that confidence ultimately leads to a successful first air tactical group supervisor response. Air tactical group supervisor trainer Alex then leans over and smacks Jeff on the shoulder while telling him, “That was a great job.” Both smile and grin, and the tension from earlier is broken. Later in his debrief with the entire cadre of air tactical group supervisor instructors, Jeff is complimented on his confidence on the radios, which some attribute to his previous experience as a helitack Captain. While the overall feedback period from the air tactical group supervisor trainers, which includes the incident commanders for the Buckhorn exercise, is brief and largely focused on the other trainee, the fact that the cadre chooses to highlight Jeff’s confidence on the radio as a primary feedback element points to an often under-noticed but critical element of air tactical group supervisor expertise they want to drill into their trainees: confidence.

Confidence in communication was found to be a regular theme across the aviation community and was not exclusive to the air tactical group supervisor role. Organization socialization practices included continued messages in air tactical group supervisor training emphasizing the requirement of confidence as a means by which trainees would be viewed as trustworthy and competent, reflecting previous high reliability organization research in fire departments where confidence was tied to perceptions of a firefighter's ability to take control and remain calm in emergency situations (Myers, 2005). Given the critical position the air tactical group supervisor plays in coordination of an initial attack response, it makes sense that this emphasis on overall confident communication would thus weigh heavily in how air tactical group supervisor expertise is perceived. In the discussion of the intelligence and surveillance

aircraft, Brenton reiterated the point that overcommunication can translate to a lack of confidence or knowing what is unfolding, sharing how "[intelligence and surveillance] pilots want to run on and on and be a part of something…and they overcommunicate." Discussion on how overcommunication is rooted in deep insecurity arose in many conversations throughout my interviews with CAL FIRE aviation teams, as well as at the air tactical group supervisor training and Aviation Safety Conference. In two different discussions with two separate air tactical group supervisors, the tendency to overcommunicate was likened to their wives rambling on and on when they were arguing, making it clear to the husbands that the wives didn't know what point they actually wanted to make in the argument. Marital discord aside, this explanation was used by several Tactical Air Operations (TAO) members to explain how the tendency of an air tactical group supervisor to ramble on until they know what they actually want to say indicates that an air tactical group supervisor is unsure, and thus not confident in the job they have been tasked to do. A lack of confidence indicated from the prolongation of air tactical group supervisor communication is particularly problematic, undermining the positioning of the air tactical group supervisor as the expert during a wildfire response.

Air tactical group supervisor Dominic noted that on the initial attack fires that he classified as his best as an air tactical group supervisor trainee, cadence was a huge part of both delivering a successful initial attack response and also building his confidence as a brand-new air tactical group supervisor:

> What made them feel good, it's like, just the confidence going into it. Like you have all your stuff set up. You've got your altitude stack for your tankers and 'copters and just being ahead of it is what helped the most. You hear yourself give blind calls going into the FTA. It sounds good. It feels good. And the flow of it starts. You drop your tankers, hold your 'copters, bring the 'copters back in. So, it's almost like you can hear how you are performing. And that's what gave me the confidence. Like, 'Okay, I just felt like I did really good on that fire.'

Cadence training as a part of building confidence is also something that occurs even when the air tactical group supervisor trainees are not the lead on a fire response. During the Aviation Safety Conference, several Tactical Air Operations (TAO) leaders reiterated to the group the importance of having air tactical group supervisor trainees fly on fires even if they aren't the air attack assigned, because listening to other air tactical group supervisor is good training. This training insight includes learning how other air tactical group supervisor time their communication and delivery with their air teams; a skill that many air tactical group supervisors do not get to develop after their air attack training is over. Because air tactical group supervisors fly in two-seat aircraft, once they are qualified in the air tactical group supervisor position, they typically won't fly with any other air tactical group supervisor or hear other air tactical group supervisors fighting fires, unless they briefly catch a small number of communications prior to a handoff of responsibility from another air tactical group supervisor. This means that almost all cadence learning for air tactical group supervisor trainees during actual fires is taught only during the initial qualification training period. Because of this tightly compressed learning period, emphasis on learning the scripts of the air tactical group supervisor, which includes the specific cadence expected of air tactical group supervisor by the rest of the air teams, becomes an imperative part of air tactical group supervisor training. Several current air tactical group supervisors noted that because they no longer listen and learn from other air tactical group supervisors, they didn't know if the way they were running their fires was the best way to do so. Therefore, the lack of being able to hear other air tactical group supervisors and check their cadence against others had a tendency to impact their overall confidence in their air tactical group supervisor role, even as exceptionally experienced and qualified air tactical group supervisors working multiple fires each year.

Despite their overall success at the training and presentation as confident firefighting experts, not all the trainees were as comfortable with becoming air tactical group supervisors as they pretended to be to their peers and trainers. Following one particularly long training session and discussion by air tactical group supervisor trainer Mike, I stepped outside to get some fresh air and write down some notes. The brief was unremarkable, save for the fact that it included a lot of stories of Mike's recent efforts battling the Dixie Fire. Many of these stories were harrowing to listen to, and I often chose to remove myself when discussions seemed to get muted or toned down because of my notetaking. After excusing myself from the classroom during a brief break, one of the air tactical group supervisor trainees, joined me outside. Jeff, the air tactical group supervisor trainee, sat down beside me and almost immediately began questioning Mike's comments about selling incident commanders on specific firefighting tactics or approaches when battling wildfires through a subtle offhand comment. In an ironic twist, Jeff made it clear that he wasn't buying what Mike was selling when it came to telling the trainees how easy it is to work with certain incident commanders on initial attack fires.

My strong relationship with Jeff proved especially helpful during my time observing the air tactical group supervisor training, because he would often give me a unique perspective on how difficult the course actually was, despite what I thought I observed. Oftentimes, the trainees appeared to be especially calm, cool, and collected, and it was only later through my casual conversations during coffee breaks and lunchtime chatter that I would be made aware of their true feelings, stress, and concerns. This appeared to be the case with Jeff as he chatted with me about Mike's seemingly innocuous comments in the training we'd just left. Jeff, who was a full rank below Mike, ruminated for several minutes on his annoyance with Mike's earlier suggestion that selling the incident commander would come easily or naturally. As we sat outside sipping

coffee in the sunshine and watching a training sand table exercise unfold in front of us, Jeff leaned over and whispered, “What’s hard is [that] the instructors have been doing it for a while, so its second nature to them.” I recall tilting my head to the side with a raised eyebrow, imploring Jeff to tell me more about the statement he’d just made without asking the question and risking it being overheard. At the time I was afraid to speak up and disturb the sand table exercise, but I was also not sure if Jeff was talking about the exercise in front of us or about what we’d just listened to in the classroom. In an agitated tone, Jeff whispered that the process of speaking up was a lot more “nerve-wracking” than it sounded when Mike explained it in class. I later wrote in my jottings that as he told me this, he seemed to say it quickly, almost as if he wanted to confess it to me to get it off his chest and then immediately move on without further discussion.

As soon as this whispered confession by Jeff ended, that is exactly what happened. I turned back to Jeff and in a whisper asked him how the class had been treating him so far. As if a switch had been magically flipped and his confidence restored, Jeff simply said, “It’s good” and proceeded to start making jokes about the sand table exercise unfolding in front of us. In a blink-and-you’ll miss it moment, I learned a bit more about how difficult teaching air tactical group supervisor trainees how to manage conflict with incident commanders – or even more senior instructors – might be, and that the confidence I’d assumed all trainees possessed might not be as strong as what they presented on the surface of their communication through their brevity, clarity, tone, and cadence.

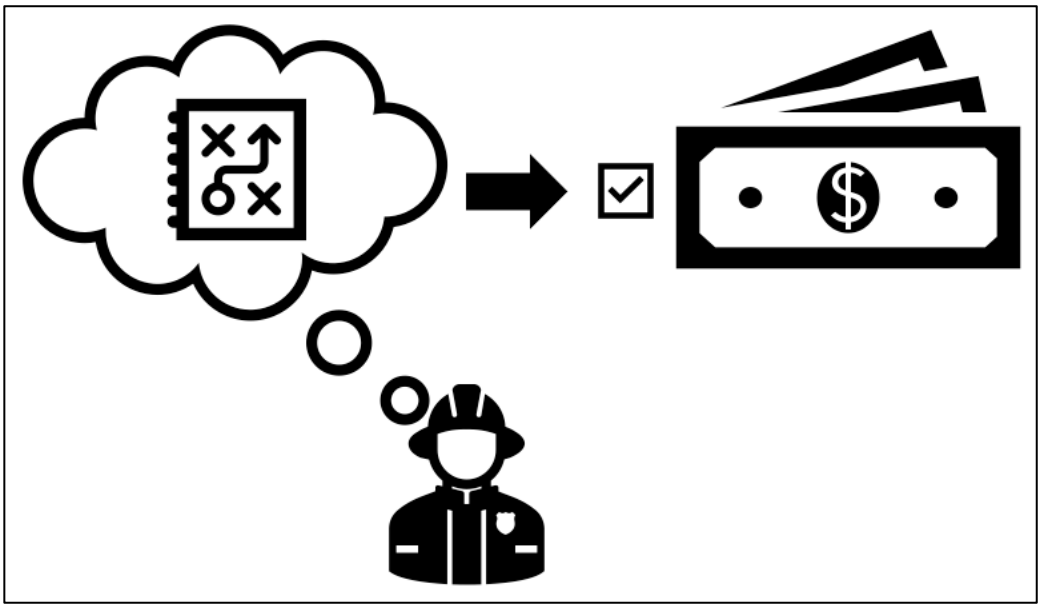
Tactical Thinking: Planning Ahead and “Making the Sale”

The final component required for an air tactical group supervisor to be viewed as possessing expertise was the ability to demonstrate tactical thinking. As an air tactical group

supervisor, tactical thinking was perceived in the organization as consisting of two components: (a) the ability to plan ahead; and (b) "selling" others on tactics or strategies. The following paragraphs provided more details and examples of these two concepts as observed in air tactical group supervisor training and detailed in interview discussions.

Figure 17

Air Tactical Group Supervisor Tactical Thinking Elements Illustrated



Note. Source: Amber Lynn Scott

Tactical Thinking: Planning Ahead

Air tactical group supervisor Dwight explains that as an air tactical group supervisor, when it comes to communicating with incident commanders, "you have to feed them information before they ask for it." This means that during a fire, much of an air tactical group supervisor's time and attention is focused on strategically thinking and planning ahead for what information the incident commander needs before they ask for it:

> So you feed them the information. 'Hey, we're getting a big run toward those structures.' As long as you're feeding the information before they ask for it, your life is good. And

> what I mean by that is, if I'm dropping two tankers, as soon as I get my second tanker dropped, my helicopter lined out, I hit the [IC] up [and] give them an update and what I think the priorities are.

Although the incident commander holds the authority for the fire, as previously argued in this paper, it is the air tactical group supervisor the serves as the expert during an initial attack response. Part of the air tactical group supervisor being accepted as the subject matter expert is an effort by the air tactical group supervisor to proactively get the incident commander the information before the incident commander asks for it. By proactively feeding the information to the incident commander, this allows the air tactical group supervisor to set the initial course of action and also give the incident commander a plan of attack they can immediately act upon. As Carey explained, "When you arrive on scene, as an ATGS, you're the SME. You're the subject matter expert and nobody's going to question you. And that's why we put so much emphasis on the training for that position, because even though on the ICS organizational chart you work for the IC, you're basically giving all the ICs their information." Thus, it is on the air tactical group supervisor to think strategically to make recommendations to the incident commander, including proactively assessing the situation from the air before passing this information to the incident commander. An important part of this process is proactively giving this information to an incident commander before they have to ask for it, demonstrating to the incident commander that this tactical thinking is occurring and is unprompted. This, in turn, allows the incident commander to take the information and immediately put it into action, rather than having to create a plan in collaboration with the air tactical group supervisor and initiate a back-and-forth discussion that eats away at precious time during an initial attack response.

Tactical thinking by the air tactical group supervisor is not a skill that every air tactical group supervisor possesses naturally, however. Much of this tactical thinking is gained both

through previous experience on the ground or air that is subsequently built upon during the air tactical group supervisor training program. In the air tactical group supervisor program an emphasis is made that although air tactical group supervisors work for an incident commander, they are the ones ultimately responsible for figuring out the best way to attack a fire. Air tactical group supervisor trainee Harvey explains:

> …coming up with the plan from the get go. You kind of have to form that plan on where the retardant and helicopters are going to work. And usually in the beginning phases, there is not so much of a plan and the ground crews aren't too established. So you're just kind of starting from scratch and trying to do the best you can and make smart decisions.

Making those smart decisions, however, can be particularly challenging for air tactical group supervisors with limited ground experience. Their lack of experience inhibits their ability to strategize on a large scale, demonstrating a critical skill that is often assumed to be inherent to all air tactical group supervisor trainees. Harvey chose to pause his air tactical group supervisor qualification flights while he considered leaving the air tactical group supervisor program after struggling with the importance of tactical thinking in support of the incident commander, a shortcoming that continued to be identified as he progressed through the air tactical group supervisor qualification program's training flights. In Harvey's recounting of his experience working initial attack and extended attack fires, his lack of experience on the ground as a firefighter and missing division qualification hampered his efforts to think through the unfolding fire quickly and pass the information to the incident commander. While Harvey enjoyed speaking with the rest of the team during initial attack responses and was told he did it well by many team members and trainers, it was the tactical thinking and constant communication required with the incident commander during larger and more complex fires that hampered his ability to finish his qualification, leading him to make the choice to temporarily leave the air

tactical group supervisor training program. When asked why he chose to leave the air tactical group supervisor program so close to obtaining his qualification, Harvey explained his struggles:

> Just interaction with the IC, trying to update him and just kind of struggling on giving him good intel on something he needs. This job would be a lot more [appealing] to me if I didn't have to talk to him on the ground and I could just go drop the tankers. 'Cause I felt like that was, I was doing better at that. And I would get compliments from the tanker pilots that I was doing good with that. It was just talking to and with the ground. Trying to do it all in one was the struggle.

Harvey's case of struggling to think strategically through an aerial fire response illustrates an important nuance that defines air tactical group supervisor expertise beyond mere visual proximity to a fire and articulation of specific communication scripts with correct tone and confidence. In Harvey's case, he was often able to think ahead and assist the team well during initial attack fires, clearly communicating with air tankers pilots how and where to drop their retardant safely. The tanker pilots regularly complimented Harvey, and even his previous supervisors listening to his initial attack response complimented his communication techniques:

> I felt like I was having a lot of fun on the IA fires and I was doing a pretty good job. The last day at [the air base I was assigned to train at], we had an IA fire. I was able to put that out at a couple acres. I had one of my ex-Captains at the air attack [base]. He was listening to the fire, and he said I did great. It's stuff like that…I thought it went well. The tanker pilots thought it went well, but then later that day we went to the [southern region complex] fire and yeah, I definitely struggled on that one and that was one of my last fires I had…I like the 5-to-10-acre IA fires. But then just once they get complex, it's just a lot of, a lot of stuff going on. And yeah. And a lot of, like, stress and anxiety that I just don't know if I want that daily. Or you know, once a week or something.

Harvey's experience also reflected the confidence many air tactical group supervisors spoke about as they moved from trainees to verified air tactical group supervisor. All of the pieces were clearly in place, and yet by his own admission, Harvey struggled in the air tactical group supervisor position when he moved beyond initial attack fires to more complex, larger operations. A reoccurring theme of this identified struggle was rooted in the complex strategizing that occurred and was required on these fires. It is possible that Harvey's struggle was linked to

suffering of high levels of cognitive load, which has been shown to reduce learning in novices as their overloaded working memory reaches saturation (Nicholson & O'Hare, 2014). As Harvey struggled with managing the increased influx of information a complex fire created, he also became unable to articulate what the incident commander needed to hear, breaking apart the aerial firefighting team's ability to lead upward and preserve the safety of the entire team. For an air tactical group supervisor that had firefighting experience on the ground and in the air, this struggle proved manageable. Whereas for an air tactical group supervisor like Harvey that had limited or no ground firefighting experience, the challenge of learning and predicting how the ground firefighters would operate, conducting air tactical group supervisor duties, and strategizing the needs of an incident commander response to more a complex fire proved to be a challenge more difficult to overcome, mentally overtaxing his ability to learn or retain new information while also supporting the upward leadership needs of the team. In Harvey's case, he had intentionally volunteered the previous year to work over 80 continuous days as a means of avoiding getting unintentionally assigned to a complex fire away from his home as part of a strike team. This decision, which in the short term allowed Harvey to maintain a regular schedule and stay close to home, ultimately might have impacted Harvey's ability to gain credibility as an air tactical group supervisor expert, where being part of a strike team operation would have provided valuable experience of fighting a complex fire that overtime on an air base could not. Thus, despite his dedication to working on an air base and developing his experience at an air base, it is his lack of experience on the ground that undermines Harvey's success as an air tactical group supervisor advising an incident commander on a complex fire.

Tactical Thinking: "Making the Sale"

Air tactical group supervisors possess a significant amount of expertise, including knowledge of how aircraft operate and how weather conditions, fire severity, and terrain configuration can work for and against aircraft battling wildfires. This expertise is particularly valuable to incident commanders who are charged with overseeing a fire response and yet do not receive significant training on the aircraft capabilities or capacity that they have at their disposal. Thus, an air tactical group supervisor communicating aerial firefighting expertise with an incident commander ultimately supports the mutually desired team outcome of safe operations and small, quickly extinguished fires—provided the incident commander can access the information in a timely fashion and put it to the ideal use. To this end, it is crucial that the air tactical group supervisor facilitate information sharing from the aerial firefighting team members to the incident commander, including current aircraft capabilities[42] and capacity to impact the advancing fire. This process of information sharing includes careful consideration for how an incident commander might receive the information shared. As change management and leadership researcher Michael Useem notes, air tactical group supervisors face a typical dilemma in their quest to "lead up":

> Sometimes those above you just don't yet see what must be done, and your calling is to spark their attention and move them along a course of change before it is too late...Leading up can also require enormous fortitude and perseverance. Sometimes we fear what the boss will say. Sometimes we question our right to say it. Yet all of us have a transcendent obligation to convey what our superior should hear. Easier said than done, of course...(Useem, 2001, pp. 4–5)

[42] Such as amount of retardant available to drop and ability to maneuver into specific areas relative to ground personnel or weather conditions.

In this study, examples abound of how air tactical group supervisors carefully manage the task of information sharing "up" with incident commanders during initial attack fires. In his first brief to air tactical group supervisor trainees, air tactical group supervisor training instructor Mike casually informed the cohort of students, “We always work for the incident commander. Trumping his orders and going to the command center—I’d always go through him first.” Later on in the class, however, the discussion veered towards an entirely different take on how to communicate with incident commanders, illustrating how trainees in the program first learn the concrete rules and then learn more nuanced communication tactics of "leading up," which was framed in CAL FIRE within the phrase of "selling the IC." While instructor Mike did not outright reject the authority of the incident commander in his later instruction to the trainees, he also made it clear that incident commanders did not always know best and often needed to be guided to the right answer: “Just because an incident commander says, ‘I want this’—sometimes you have to sell them on a tactic.”

Instructor Mike's comment hints at a reoccurring theme and major concept within the training program that all air tactical group supervisor students came to struggle with at some point during the training program—that although air tactical group supervisors “work for the incident commander” as air tactical group supervisors, they also needed to learn how to balance the knowledge that “just because an incident commander says” they want something they may still lack the expertise or knowledge to know what aerial tactic is best to fight a particular fire. In these cases, the trainees needed to learn how to “sell them” on the best tactic.

Instructor Mike's efforts to teach air tactical group supervisors how to "lead up" by "selling the IC" is an safety tactic grounded in communication at CAL FIRE. Despite the well-known aerial firefighting expertise of CAL FIRE's air tactical group supervisors, there have been

identified occasions when incident commanders will not take air tactical group supervisor recommendations and instead press for a course of action that might ultimately hinder their intended outcome of putting out a fire. In these situations, air tactical group supervisors rely upon the tactic of "selling the IC":

> The reason behind that term, 'selling the IC' is based on the ICS[43] chart. The IC is in charge. We're not in charge as the ATGS. They're in charge. So if the IC or even the operations chief makes a determination that they want to go a certain way with a fire, whether it be indirect versus direct, or—that's typically what it is. Like [the IC will say] 'Hey, we're just going to write off this bowl or this ridge and we're going to fall back and put retardant in here.' That may look good on a map, but when you're actually up in the air like, 'No, I don't think we need to write that off. I can support it with helicopters. We can put retardant in there and we can accomplish that objective without writing this whole thing off. And it might save us a couple days' worth of work.' Or you know, another one that happens pretty often is selling the IC to release aircraft. Because the release of resources is still determined by the IC. You have to get their permission in order to do it. We'll do it, we'll do the physical act of contacting the command center to release them, but it's still ultimately the IC's job.

Most often, selling the incident commander is a relatively easy task. Air tactical group supervisor Dwight equated selling the incident commander to an art, where air tactical group supervisors learn how to convince incident commanders through a softening of language framed as mere opinions. In Dwight's retelling of how he handles difficult incident commanders, his air tactical group supervisor recommendations are couched in words that make recommendations sound more like suggestions or opinions than the well-strategized plans air tactical group supervisor are actually presenting: "You don't want to be rude and say, 'No, THIS is what we're doing.' You just simply say, 'hey, I think the priority should [be this] or I see a priority as, and you describe it. Either they buy off on it or they don't."

[43] ICS is an acronym that stands for Incident Command System, a hierarchical system designed to manage any size of wildland fire incident from beginning to end, until the requirement for management no longer exists (U.S. National Park Service, 2017).

In speaking with Dwight over the course of several interviews, training observations, and conferences, he often explained his views of wildland firefighting with aircraft as a type of "dance" or "orchestra" where the air tactical group supervisor serves as the lead or conductor despite the incident commander holding the authority for the fire response. Dwight acknowledged both the need to plan ahead to give the incident commander what they would need, as well as the requirement of working towards a "soft sell" of the incident commander on particular tactics or strategies:

> [As an air tactical group supervisor] you are doing your job coordinating, directing, et cetera and there could be a priority coming up – the head of the fire steaming right towards a housing development. Well, you feed them [the incident commander] the information. 'Hey, you need resources at Ventura Street for structure protection. The fire is going to be there in about a half an hour.' 'Oh, okay.' So you feed them the information. 'Hey, we're getting a big run toward those structures.' As long as you're feeding the information before they ask for it, your life is good. And what I mean by that is, if I'm dropping two tankers, as soon as I get my second tanker dropped, my helicopter lines out, I hit the [incident commander] up, give them an update and what I think the priorities are. Now, they in the class said, 'Hey, make sure you get the priorities from the incident commander.' That is very, very true…However, when you're flying, it's painfully obvious what the priorities are…And there are times that the incident commander will give you a priority that is not going to put the fire out and it is not going to be the structural protection that the public needs. And sometimes that is the articulating dance that you need to describe. 'Hey, I understand the right flank is your priority and your so and so, but we got a slope reverse on the left flank and it's going to run up these homes over on the left flank. So that's when you have to articulate what needs to happen. And sometimes, most of the time, I would say 99% of the time, they go, 'Got it. We're moving equipment. Take action. Let us know what you need.' You know? Because they can't see the fire from the air. So even though the class taught [us] that [doctrine of] 'Hey, what's your priorities on the ground?' That was a politically correct thing, because theoretically we work for the incident commander, but we are [actually] the *eyes* for the incident commander.

Another strategy Dwight mentions that is used to sell the incident commander is air tactical group supervisors paint the picture of what they are seeing from the air, while also incorporating an element of reassurance for the incident commander that the fire is well in hand and not at risk of burning out of control. Air tactical group supervisor Carey was candid in his

admission that he would use complimentary comments to ultimately "butter up" an incident commander and show the incident commander that the course of action recommended by the air tactical group supervisor was the right one:

> Typically what I would say is, you know, 'Hey, your fire is looking pretty good.' Kind of like, butter them up. Like, 'Your fire is looking really good. Division alpha has got no smokes on it. Your hand line on Division bravo is all the way connected.' You know, paint this really good picture for them and then at the end say, 'So, with all that, it's my recommendation we release the air tankers.' And then most of the time they'd be like, 'Oh. Okay. Yeah. Yeah, go ahead and release the air tankers."

But Carey also readily admitted that sometimes, even despite his best efforts of "buttering up" incident commanders, sometimes the incident commander simply didn't want to give up aircraft or change their preference of fire tactics with the air tankers. During visits to air tactical group supervisor training sites, training lectures, and air base operations the theme of conflict between incident commanders and air tactical group supervisor was one that was continuously downplayed by almost everyone I interacted with. However, in my field observations, small cracks in this argument were also evident.

Air tactical group supervisor Dwight was one of the few trainees that was relatively candid with me about his experience with problematic incident commanders. A senior member of CAL FIRE, Dwight had significant rank and experience within Tactical Air Operations, although this also meant that Dwight was labeled a bit of a troublemaker. This branding was well-known to both Dwight and others, and I spent multiple days speaking with Dwight and observing him with other members of his team. As Dwight progressed through air tactical group supervisor training it became clear that Dwight had no problem speaking his mind, but that Dwight also took a firm stance when he believed he was right. His passion for aerial firefighting meant that Dwight shared a lot of insightful stories with me, including how his strong personality might conflict against an incident commander dead-set on a tactic Dwight didn't agree with:

> The problem is that there are some times that the IC's would get so set in their ways that they just can't see what you're seeing. Now, it's not like we can land, have him hop in and go say, 'Hey, look, see this?' 'Oh, yeah.'…That's the problem that I have if there's a relationship issue between air and ground or IC and air attack. They don't see what we're seeing and sometimes they are, excuse the term, hell-bent on doing what they want, when we can see the whole fire. And there are times that, hey, we need to protect this power substation, not those homes. Because if we knock out this power substation, that's going to kill [this major city]. Or if we lose four homes, so sorry but —right? Those are the priorities, and usually those are pretty easily articulated…[but] usually it's rare that they're hell bent on something. Because they understand that we can see the whole thing. And that we're not idiots. We've all been ICs…so most of the time, I would say 90% of the time they will ask us, 'What are our priorities?'…Most of the time they take our input and run with it.

In formal interviews, air tactical group supervisors often hesitated to directly discuss conflict between themselves and incident commanders, especially when those incident commanders were their own agency counterparts rather than Federal or local agency representatives. Reflecting the small, tight-knit community that CAL FIRE is, air tactical group supervisors were more apt to share stories of conflict between non-agency incident commanders and themselves. In almost every instance of incident commander and air tactical group supervisor conflict shared, including during the air tactical group supervisor training scenarios, conflict stories were relegated to incidents occurring only between incident commanders and air tactical group supervisor partners from different organizations. Thus, some air tactical group supervisors may have found that their sales tactics were less necessary on fires with members of their own agency, but more necessary on fires where the incident commander did not necessarily immediately "buy" what the air tactical group supervisor was "selling" in regard to firefighting tactics. This buying-selling conflict was illustrated clearly during one of air tactical group supervisor Dominic's first wildfires as an air attack working through his qualifying flights. In this wildfire scenario, Dominic arrived on a scene where he actively had to engage in "selling" his Federal partners on using firefighting tactics that went against their written policy:

> One of the first ones I got was a fire in a wilderness area up here in Northern California. And you know, in the wilderness areas they typically do not let you use mechanized equipment—dozers, chainsaws—and no fire retardant because it's a natural wilderness area. There's streams and there's protected endangered species and whatnot. They're trying to preserve, obviously, the wilderness areas. So this fire in particular was in a wilderness area and not exactly CAL FIRE's jurisdiction. It's Forest Service wilderness. So, super remote area. We've had fires out there to the east…we basically showed up to this fire and it was already—I think it was like 30 to 40 acres. No one there. And it just surprised me because it had been going for you know, it had been gone for like, a half hour. It was weird, so—to not have an air attack and tankers over it. And it took a minute for me to figure out, okay, whose jurisdiction is this? And they kept passing me off, too. Finally I ended up with a Forest Service jurisdiction and basically gave them reporting conditions…got that sorted out and then, you know kind of, the potential of it to [the Feds]—it is at the bottom of a drainage in a really very, very remote area with predicted north winds the next several days. So if it like, got above a certain elevation in the canyon it was going to take off right towards [that city] in an area that hadn't burned in [that county]. [That] county has been burned up probably the most of any unit in the last five years. And this was the last area that hadn't burned. So, basically painting the picture for the Forest Service. Like, 'Hey, I know there's [wilderness area but]—I requested tankers.' They say negative using retardant. And you weren't going to get any ground people in there at all that night. So I kind of kept repeating that to them, what the potential was. And finally they came back, and I don't know their requirements for getting clearance for [retardant drops in a wildlife area]. Well, it's pretty rare, I'll put it that way.

In air tactical group supervisor Dominic's example, he is able to "sell" the Forest Service on overriding its written policy to never drop fire retardant on wilderness areas by reiterating the potential of the fire to develop into an out-of-control blaze. Although Dominic does not say so outright, his persistence in reiterating the request for retardant over and over touches on a memory almost no one in the fire service can forget—the catastrophic Dixie Fire. During the Dixie Fire, which had initially been a small, contained blaze before exploding into a catastrophic inferno overnight, the U.S. Forest Service had been publicly and privately accused of allowing outdated policies to override best firefighting practices that could have kept the blaze to a manageable level (Brekke, 2021; Iati & Moriarty, 2021; Singh, 2021). Dominic was very aware that this memory was fresh in the minds of his Federal counterparts, which ultimately allowed

him to "sell" them on a tactic that would normally be steadfastly refused for violating written policy:

> I think the Dixie Fire last year…that being fresh in the Forest Service's minds, you know, and knowing like, okay if this goes for—this was early, this was in June so if this goes for several thousand acres and you know, air attack is trying to get retardant in it and they won't check it—I mean, I think that was probably [it]. I'm not badmouthing the Forest Service. I'm just saying for the area, it looked like it had a lot of potential. So I got it. Once they gave me clearance to get tankers in there, I mean, I ordered a bunch.

Air tactical group supervisor Dwight also acknowledged that sometimes the tactic of selling the incident commander is abandoned entirely, creating a troubling situation where air tactical group supervisors would simply do what they wanted without consulting the incident commander for their buy-in. While this worked in the short term—allowing the air tactical group supervisor to get their way and utilize fire tactics they viewed most prudent to slowing a fire—in the long term the tactic did not bode well for the air tactical group supervisor or the relationship between the air tactical group supervisor and incident commanders. In one example of a wildfire involving an interagency team of both CAL FIRE and U.S. Forest Service firefighters, Dwight recounts an incident where teams battled a complex fire burning in a location without enough ground resources available to directly attack the fire and put it out. The incident commander developed a scenario where the aerial firefighting teams led by the air tactical group supervisor would instead indirectly attack the fire. In this scenario, the air tactical group supervisor initially agreed to the incident commander's plan before later independently adjusting the aerial firefighting tactics to a direct fire-retardant drop. This change was made without first gaining the incident commander's approval:

> So this three mile of indirect retardant line dozers were cutting a big line, and we were supposed to put retardant on it so when the fire got there, the crews could drive up and down the dozer line and monitor four miles with like, three engines and one crew. Because we didn't have enough personnel. So there was a lead plane pilot that got in there and…air attack came over the head [of the fire]. And usually, we're all on the same

> page. We do what the IC's generally want because they plan this, that and the other and usually it makes sense. Well, this particular lead plane got in cahoots with the air attack and changed [the plan]. So, they went direct. Wasted retardant. It got over that line and still burnt where the indirect line was put. So there are times that air attacks and lead plane pilots go out of bounds, because they think they know what's best. So it goes both ways.

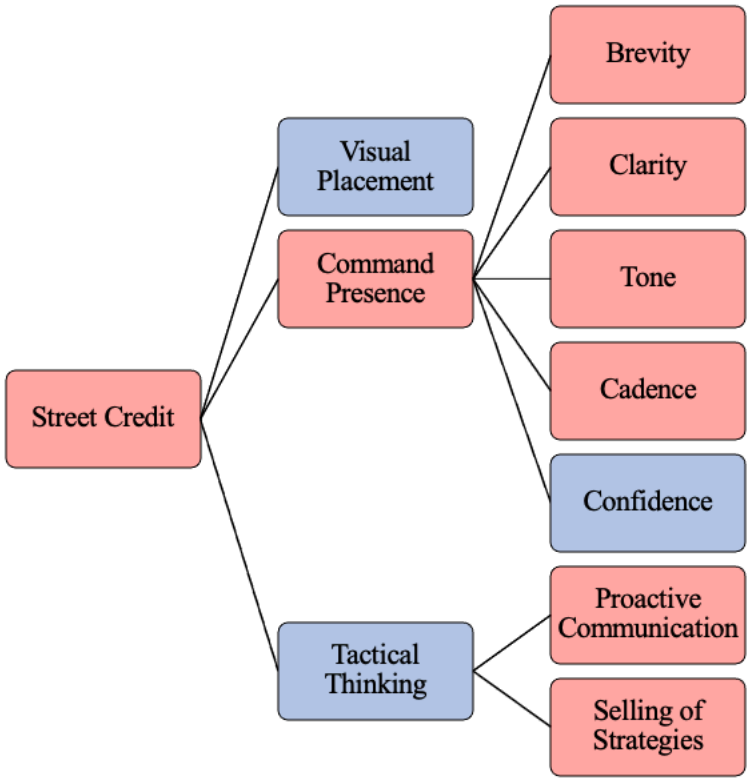
Summary of Air Tactical Group Supervisor Expertise Components

Understanding how an organization defines expertise is an important part of untangling how the high reliability cultural hallmark of *deference to expertise* unfolds communicatively in a high reliability organization. Within the field of wildland firefighting, the definitions of aerial firefighting expertise and communication practices of aerial firefighting were found to have a potentially sizeable impact on the overall outcome of new wildfire development, including the possibility of small fires to develop into uncontrolled, catastrophic blazes like the 2021 Dixie Fire.

First, this analysis found that air tactical group supervisor expertise is defined within the CAL FIRE organization by the term *street credit*. Three primary and seven secondary elements were identified as necessary for establishing street credit within the organization. The three primary elements necessary for establishing street credit include (a) visual placement, (b) command presence, and (c) tactical thinking (Figure 16). The five secondary elements support air tactical group supervisor communicative performance of command presence include (a) *brevity* in communication, (b) *clarity* when communicating information to others, a specific language (c) *tone* and (d) *cadence*, and communication (e) *confidence* when delivering information. Air tactical group supervisor tactical thinking was supported through two secondary elements including (a) *proactive communication* with team members and (b) *the selling of strategies* to individuals in positions of authority.

Figure 18

Air Tactical Group Supervisor (ATGS) Expertise Primary and Support Elements



Note. Codes inclusive of formal terms used within the organization are illustrated in light red. Emergent terms invented during the coding process are illustrated in light blue. Source: Amber Lynn Scott

Second, by investigating how air tactical group supervisors are taught these definitions of expertise and how they communicate these specific definitions of expertise in their role during an initial attack fire, this study uncovered additional factors that facilitate or impede the process of respectful yielding, a hallmark of good high reliability organization practices (Weick & Sutcliffe, 2011). Interagency training programs for air tactical group supervisors were found to teach aerial firefighting experts not only the expected definitions of aerial firefighting expertise, but how to communicate in an expected manner that reflects that expertise in an acceptable style for authority figures. These trainings ultimately show experts how to smooth communication

between themselves and authority figures, which later serves to build trust quickly during crisis operations. This trust, built on the foundation of specific communication practices between experts and authority figures, is what supports the strong safety foundation these high reliability teams maintain with a high degree of reliably during crisis responses.

Previous literature has bound the high reliability cultural hallmark *deference to expertise* to a process where decision making is pushed down and around, with authority migrating from the authority figure to those with the most expertise regardless of rank (Cantu et al., 2020; Roeder, Bisel, & Howe, 2021; Weick & Sutcliffe, 2015). A particularly exciting development of this study was the identification of communication between incident commanders and air tactical group supervisors reflecting communication patterns that facilitate the *pulling* of decision making down and around to experts. This communication pattern, which has been labeled under the new term *appeal to authority (A2A)*, reflects how air tactical group supervisors are trained within the CAL FIRE organization to gain critical decision-making autonomy during crisis by making communication with incident commanders easier and more inviting during initial attack fire responses. Through an interagency training program, aerial firefighting experts are taught to "lead up" (Useem, 2001) to authority figures through a set of specific communication tactics that smooth possible communication friction points early, and instead help convince incident commanders to support expert recommendations. The smoothing of communication, facilitated by experts, is what then supports the *pulling* of decision-making authority down to the expert level. This pulling of authority builds on previous high reliability decision-making authority literature (Barbour & Gill, 2017; Jahn, 2019; Minei & Bisel, 2012; Myers, 2005; Rice, 2021; Roeder, Bisel, & Howe, 2021; Weick & Sutcliffe, 2015), where experts have been found to be reliant upon authority figures to *push* their authority down to lesser-ranked members. This study

discovered that training air tactical group supervisors to specific expertise expectations and definitions, which are grounded in communication practices, is what allows these experts to pull authority to themselves during initial attack fires. Furthermore, the specific strategies for pulling of authority by experts ensures positive reception of expert information by incident commander's despite the unfolding chaos of an emerging wildfire. This set of communication strategies and pulling of authority is what ultimately facilitates critical authority figure support when co-constructing situational awareness rapidly during a wildfire crisis. In summary, this study has identified the specific communication mechanisms that support the development of situational awareness in highly reliable HROs and HRTs, and how those communication mechanisms can be a critical tool in preventing catastrophic outcomes, such as preventing small, manageable wildfires from developing into dangerous blazes that devastate homes, destroy communities, and cost lives.

Chapter 4: Discussion

This study set out to explore how a high reliability organization's cultural principles, with a special focus on *deference to expertise,* unfolds in a high reliability organization that operates with a high degree of safety and effectiveness despite increasing risks, challenges and pressure. Although high reliability organization theory principles incorporate deference to expertise as a critical component to operationalizing and preserving safety in high-risk team operations, research has yet to address empirically how expertise has been communicated, defined, trained, or realized within these high reliability teams.

The following discussion articulates the implications of this CAL FIRE case study for academics and practitioners alike, including: (a) clearer articulation of how the high reliability organization theory principle *deference to expertise* is realized within a high reliability team, (b) explanation of how knowledge transfer unfolds in a high reliability organization built on a primarily oral culture, and (c) illustration of how defining expertise supports trust development and communication in high reliability teams.

From a theoretical standpoint, the results of this investigation offer a clearer articulation of an important aspect of high reliability organization theory that had previously remained unexplored: how enactment of the high reliability organization principle *deference to expertise* unfolds within a high reliability team during unexpected or uncertain incidents. Analysis revealed an important discovery that clarifies how high reliability teams successfully enact deference to expertise during crisis. Additionally, systematic training programs and organizational socialization were also found to support communication performances of expertise that eased communication between authority figures and experts. These communication performances included communication that has been termed *appeals to authority*, where decision

making authority during a crisis is *pulled* down and around team members, easing communication between authority figures and experts. This finding expands on previous research articulating deference to expertise as operationalized through a process where decision making authority is *pushed* down and around to team members during crisis (Bisel, 2010; Weick & Sutcliffe, 2015).

Beyond the theoretical findings noted in previously, this study also provides practitioners with a roadmap of what expertise looks and sounds like in an aerial firefighting organization and how training exercises can assist teams in being more successful in high reliability organization deference to expertise during crisis events. Relative to the field of aerial firefighting and emergency response, the results of this study provide clear insights into how air tactical group supervisor expertise has been defined within the world's largest aerial firefighting organization (i.e., street credit) and what specific attributes define air tactical group supervisor expertise (i.e., visual placement, command presence, and tactical thinking) during initial attack wildfire responses. The definitions of expertise identified in this study can help illustrate to organizations and practitioners the value of clarifying expertise definitions prior to a crisis as a means of facilitating clear expectations amongst team members. To that end, these findings have been integrated into the existing CAL FIRE air tactical group supervisor training program as a means of clarifying ATGS expertise expectations and training future air tactical group supervisors more successfully[44].

From a practical view, this study also illustrates a particularly useful framework for practitioners seeking to better implement and support the high reliability organization theory

[44] In 2023, insights and recommendations from this study, including definitions of air tactical group supervisor expertise, were accepted and used to revise CAL FIRE's existing annual air tactical group supervisor (ATGS) training program.

principle deference to expertise into their teams: As noted in this study, clear definitions of air tactical group supervisor expertise ultimately supported positive and productive communication between incident commanders and air tactical group supervisors despite the intense pressures associated with initial attack fires. By defining air tactical group supervisor expertise across the organization well before a crisis through training and socialization, incident commanders were able to quickly assess the information collected from air tactical group supervisors during a crisis as accurate, useful, and trustworthy, facilitating an overall quick response that is essential during initial attack firefighting operations. For high reliability organizations seeking to gain the benefits of high reliability organization theory culture hallmarks, this study has found that practitioners should ensure that: (a) expertise is clearly defined and understood within a high reliability organization prior to an unexpected event or crisis; and (b) the definition of expertise, once defined, should be trained and reinforced within the high reliability organization and across teams reliant upon the expertise defined prior to an unexpected event or crisis. Finally, this study has demonstrated empirical support for the importance of training programs that define and reinforce expertise, including particularly costly taxpayer-funded interagency training programs like CAL FIRE's annual and tri-annual air tactical group supervisor training exercises.

High Reliability Organization Theory *Deference to Expertise* Enactment in Teams: Heedful Interrelating and Frenetic Interrelating

The historical development of high reliability organization theory thirty years ago began with the concept of heedful interrelating, which was developed by researchers Weick and Roberts (1993) to explain the social processes that permit teams (i.e., U.S. Navy aircraft carrier flight decks) to operating in a nearly error-free manner. The exploration of these types of teams were noteworthy to researchers because "some organizations require nearly error-free operations all the time because otherwise they are capable of experiencing catastrophes" (Weick & Roberts,

1993, p. 357). This initial concept of heedful interrelating was later expanded upon by Weick and Sutcliffe (2005) to incorporate concepts of sensemaking and collective mindfulness in additional high-reliability contexts, resulting in the unique organizing principles of high reliability organizations.

In high reliability teams, heedful interrelating includes actions by team members who work together to understand the actions of others and interrelate their actions to those within the overall organization (Weick & Roberts, 1993). This study found examples of aerial firefighting teams operating with heedful interrelating, but also discovered examples where teams were moving from interactions of heedful interrelating to interactions that were more routine and scripted. As the uncertainty of some fire responses increased, team members began to deviate from heedful interrelating together. As the increasingly chaotic situation progressed, team members would instead revert to scripted communication practices grounded in their organization's routine norms. This more intense form of interrelating, which has been termed *frenetic interrelating*, defines the observed tendency for some aerial firefighting teams to rely upon trained scripts during the chaos of an unfolding fire, which ultimately masked the team's ability to heedfully interrelate together.

For example, although CAL FIRE's *street credit* norms included an expectation that experts make their radio calls with confidence, this same norm occasionally masked the real risks that others were facing and made it difficult for pilots to figure out how much risk was present. Revisiting the example of Harvey, an air tactical group supervisor trainee that receives compliments on his communication but admittedly struggles with managing the response needed for complex fires, illustrates this point well. During several more complex fire responses, the air tanker pilots and previous supervisors listening to Harvey's initial attack radio calls

complimented his communication techniques. However, Harvey admits to me in an interview that on these larger, complex fires, he was struggling tremendously with managing the increased cognitive load:

> ...interaction with the IC, trying to update him and just kind of struggling on giving him good intel on something he needs. This job would be a lot more [appealing] to me if I didn't have to talk to him on the ground and I could just go drop the tankers. 'Cause I felt like that was, I was doing better at that. And I would get compliments from the tanker pilots that I was doing good with that. It was just talking to and with the ground. Trying to do it all in one was the struggle.

In this example, air tactical group supervisor Harvey delivered his orders with a tone confident enough to elicit compliments from both past supervisors as well as the tanker pilots he was in charge of directing. However, the trained expert expectation of confident communication that is a part of the larger street credit at CAL FIRE clearly masks an important safety issue—Harvey is struggling to manage the complex fire response and give the incident commander what they need. By embracing the street credit norm of projecting confidence through his communication, Harvey reduces the pilot's cognitive work of assessing risk, but he also inadvertently masks the very real risk that is emerging as he becomes more and more overwhelmed and less able to give the incident commander on the ground what they need. Since Harvey's communication matches the expected norms, the rest of the team has no idea that they all might actually be interrelating in a manner that is more scripted and prescribed, but overall masking mindfulness (i.e., frenetically interrelating). However, if Harvey delivered his orders in a different manner, such a with hesitation or with less confidence, the pilots or incident commander might immediate become attuned to the anomaly in the system. Although the *street credit* norms ultimately allow teams to engage in intense knowledge sharing and be released from cognitive labor to focus on other tasks, in Harvey's case, the specific norm of confidence may also ultimately may serve to

do the opposite and increase some aspects of knowledge sharing while also decreasing others that are much more important.

This identified pattern termed *frenetic interrelating* demonstrates how high reliability organizations can mask cues and unintentionally create more difficulties in assessing risk during uncertain events. In the case of CAL FIRE, several norms appeared to be longstanding within the organization and developed specifically during wildfire responses that were largely predictable even in their unpredictability (i.e., smaller fires that respond well to aerial firefighting). Aerial firefighting wildfire responses focus primarily on initial attack, with a stated goal of keeping 95% of fires to ten acres or less (CAL FIRE, 2022d). When viewed through Weick's lens of sensemaking (2005), we can see how the street credit norms identified in this study became particularly useful in the initial attack context. As new fires develop and quickly spread, it is critical that aerial firefighting teams begin to operate as fast as possible, particularly if they endeavor to keep fires to 10 acres or less. Brevity, clarity, tone, and confidence in radio communications come to play critical roles in facilitating mindful comprehension within the team. Over time as teams embrace and use these norms during the routine work of initial attack fires, they learn that these norms free up critical cognitive space to facilitate almost effortless firefighting responses that are over within hours and most often meet expected mission requirements (i.e., less than ten acres burned). Thus, we can see how these norms—all linked to fast and efficient communication—historically have become an integral part of what defines initial attack firefighting expertise, and how those norms served to support the high reliability of CAL FIRE's aerial firefighting teams.

Safety challenges linked to the street credit norm were only revealed clearly when contrasted with the new emerging reality of CAL FIRE aerial firefighting operations, which must

now contend with much more dangerous, catastrophic wildfire contexts that move quickly into extended attack fires (Iati & Moriarty, 2021; State of California, 2022). Aerial firefighting communities across the globe are facing similar issues as wildfires become unprecedentedly large, unpredictable, chaotic, and dangerous (see Center for Disaster Philanthropy, 2020; Reuters, 2023). As these fires become less responsive to aerial firefighting techniques due to climate change impacts, remote locations, environmental regulations and overall limited ground personnel to support initial attack aerial firefighting efforts, more fires quickly move beyond initial attack capabilities and necessitate extended attack firefighting responses. However, the street credit norms that have served to free up cognitive operations in aerial firefighting teams are now creating safety issues when firefighting operations shift to extended attack.

The observation of frenetic interrelating in aerial firefighting teams expands high reliability organization theorizing by identifying and explaining the non-linear nature of interactions within high reliability teams that can occur when teams are trying to stabilize a situation that is rapidly becoming more chaotic. Previously literature has clearly described how high reliability organizations manage to interact in ways that support high reliability but has not fully explored the challenges that unfold when HROs streamline cognitive operations through routines developed within specific contexts or climates. This study helps further clarify some of the real challenges high reliability teams experience in situ as their missions change and evolve at a pace that surpasses the organization's ability to also shift norms at the same pace. The findings of this study illustrate how safety routines in high reliability organizations, long surmised to be a critical component to reliable organizing, can also slow or disable a high reliability team's ability to recognize or respond quickly to small anomalies in the system during an increasingly chaotic crisis.

High Reliability Organization Theory *Deference to Expertise* Enactment in Teams: Appeal to Authority

The findings of this study have illuminated a new aspect of high reliability organization communication, contributing exciting new findings that describe how the high reliability organization theory cultural hallmark *deference to expertise* is communicatively enacted within high reliability teams during crisis. Specifically, this study identified how an organizational training program for aerial firefighting experts taught specific tactics designed to *pull* authority towards themselves during crisis responses. This *pulling* of authority by experts from authority figures expands on previous communication literature where authority was found to be pushed from authority figures "down and around" to those with the most relative expertise (Weick & Sutcliffe, 2015).

Previous literature within high reliability organization theory research has illustrated how deference to expertise supports decision making authority being pushed “down and around” to organizational members with the best view of a current situation rather than hierarchy or rank (Bisel, 2018; Weick & Sutcliffe, 2015). Previous examples of research demonstrating decision making authority within high reliability organizations include the use of “floating” in weather forecasting teams for collective decision making (Roeder, Bisel, & Howe, 2021) or expertise delegation to a lead hose firefighter during a structure fire (Minei & Bisel, 2012). The findings within this study build on this communication literature by identifying the use of *appeals to authority* (A2A) by experts, where decision-making authority is *pulled* down and around to experts using specific communication tactics.

Additionally, development and use of A2A by experts was found in this study to be strongly developed through a training program inclusive of communication tactics reflecting the expected organizational norms for experts (called *street credit*) to establish trust. High reliability

organizations operating with a high degree of reliability are characterized by organizational norms of trust and respect (Cox et al., 2006; Jahn & Black, 2017; Sutcliffe, 2011), and norms of trust in high reliability teams have been identified as critical to empowering team members to share their insights and expertise during crisis (Jahn, 2019; Minei & Bisel, 2012; Vogus & Iacobucci, 2016). In aerial firefighting, communicating defined organizational expertise norms (called *street credit* within the organization) facilitated the fast-tracking of trust development between authority figures and experts. Trust is a critical component of establishing and maintaining reliability within teams (Myers, 2005), and research has found it is critical for high reliability organizations to recognize and reinforce norms of psychological safety, trust, and respect, and embed these norms into organizational culture to maintain reliability (N. J. Allen & Hecht, 2004; Vogus, 2004; Vogus & Sutcliffe, 2011). The quick development of trust between experts and authority figures in this study through A2A ultimately clarifies how expert recommendations are quickly accepted and implemented by authority figures in crisis scenarios, particularly scenarios where every second counts (e.g., wildfires). The general set of communication norms identified within this aerial firefighting organization, both formally taught and informally passed down through team members, served as the initial touchpoint for developing team trust. When experts demonstrate street credit, recognized by authority figures as defining expertise within the organization, trust is established. This trust establishment leads to faster communication and crisis responses between authority figures and experts during initial attack fires, and limits negative communication impacts inherent to rigid organizational hierarchy.

Future research on decision making authority and A2A in high reliability teams should closely examine additional high reliability organizations outside of aerial firefighting to

determine if the practice is unique to the incident command structure (ICS) of the firefighting organizations observed in this study. Further research should consider individual communication practices and norms that support or inhibit A2A in teams, such as agency communication norms and intra-team norms. While this study did observe interagency operations between multiple organizations in coordinated aerial firefighting responses, the primary focus was on one organization, and thus observations of A2A between agency team members with strongly dissimilar organizational norms would be a reasonable next area of focus. Researchers should examine how the use of appeal to authority during interagency operations might be impacted by shared or divergent communication norms across different agencies, such as government and nonprofit team interactions during an emergency crisis event.

Knowledge Transfer in an Oral Organizational Culture

The findings of this study also clarify how defining expertise supports successful knowledge sharing and transfer in high reliability organizations, ultimately facilitating the enactment of high reliability organization theory culture principles. Specifically, defining air tactical group supervisor expertise at CAL FIRE and training future experts to that definition enables knowledge transfer more quickly between authority figures and experts during initial attack fires. Previous research has demonstrated that knowledge transfer is significantly eased when members share a common organizational language, training, or experience in the same specialty (Davenport & Prusak, 1998), and the findings of this study support this assertion. Furthermore, the findings of this study affirm how high reliability organizations, including firefighting teams, heavily rely upon both clear expertise definitions (Jahn, 2019; Minei & Bisel, 2012) and embedded knowledge transfer practices (Ishak & Williams, 2017) to support reliability during crisis.

Examples of standardized high reliability team knowledge transfer practices based in shared organizational language include U.S. military debriefs, which have been recently adopted into the health care industry as a best practice for reliability (J. A. Allen et al., 2018). Although debriefs were a noted safety practice adopted at CAL FIRE, a more noteworthy finding of this study points to CAL FIRE's overall reliance on oral communication for knowledge transfer as a method of establishing and maintaining reliability. This finding builds on previous literature underscoring the importance of knowledge transfer to suit the organization's culture (Alves et al., 2022; Davenport & Prusak, 1998; Joia & Lemos, 2010). Successful knowledge transfer in organizations is dependent on both the successful transmission and absorption of knowledge that is shared (Joia & Lemos, 2010); CAL FIRE aerial firefighting knowledge transfer practices reflected this understanding in the ongoing effort to teach new members the importance of communicating orally. This understanding was demonstrated by the significant emphasis in air tactical group supervisor training to emphasize stories, rather than technical manuals or online databases during the training program. Beyond the training program, observations in the field at multiple air attack and helitack facilities further solidified the presence of this finding. For example, discussion on how overcommunication reflects insecurity on fires was an ongoing theme in many of my conversations with CAL FIRE aviation teams. During the aviation safety conference, several team members spoke of the nonstop radio chatter coming from surveillance aircraft and used a story of an angry wife to make their bigger point. In multiple conversations with individuals, surveillance aircraft overcommunication was explained using a story of their "wives rambling on and on" during an argument. These memorable comparisons of surveillance aircraft communication operations speaking as if they were angry spouses were used to illustrate how rambling radio communication was perceived as being insecure and pointless, similar to an

angry wife rambling when she is mad at her spouse but cannot articulate the reason why. This example is but one in a series of stories captured in this study that highlights the overall tendency with CAL FIRE Tactical Air Operation to rely upon oral communication and storytelling to initiate knowledge sharing and knowledge transfer. Additionally, the repeated tendency of these stories to be adopted and shared by other members of CAL FIRE support Ishak and Williams' (2017) findings that noted how firefighters engage in the practice of borrowing experiences to facilitate shared learning.

The discovery of CAL FIRE's reliance on oral communication practices presents an exciting opportunity to build on the limited knowledge of high reliability organization knowledge transfer best practices. Previous literature has noted standardized handoffs between incoming and outgoing medical providers can support reliability, but success is also attributed to implicit knowledge sharing practices rather than reliance on codified training curriculums (Johnson et al., 2011). Furthermore, while several recent high reliability organization communication studies have examined elements of knowledge transfer and knowledge sharing voice enactment (Jahn, 2019), questioning (Barbour & Gill, 2017), mindfulness (Fraher et al., 2017), and generational differences (Ford, 2018), an in-depth investigation on how high reliability organization knowledge sharing occurs in situ has not been fully addressed in communication scholarship. The findings of this study contribute to addressing this noted gap and present an exciting opportunity for future researchers, including investigations into the strengths and weaknesses of knowledge transfer in high reliability teams demonstrating strong cultural preferences for oral knowledge sharing practices.

In addition to clarifying how knowledge transfer and knowledge sharing unfolds in aerial firefighting, this study also helps clarify how defining expertise ultimately supports the process

of respectful yielding, a critical component of the high reliability theory cultural hallmark of deference to expertise. At CAL FIRE, the organization's accepted definition for air tactical group supervisor expertise was broadly referenced by organization members using the term *street credit*. The three main components of air tactical group supervisor street credit were determined through analysis to include: (a) visual placement, (b) command presence, and (c) tactical thinking. Within the broad component of command presence, five sub-components were identified, including: (a) brevity, (b) clarity, (c) tone, (d) cadence, and (e) confidence. Within the broad component of tactical thinking, two sub-components were also identified, including: (a) proactive communication and (b) selling strategy. Taken together as a collective, the three main components and their seven sub-components of street credit serve to define expertise for a CAL FIRE air tactical group supervisor during initial attack fires. Air tactical group supervisor street credit represents a compilation of components from the high reliability theory cultural hallmark *deference to expertise*, including domain-specific knowledge, compressed and generalizable experience, and relative experience (see Table 1 for definitions and Figure 17 for illustration). This compilation of required components was first identified through the well-known seminal high reliability studies of air traffic control centers (Roberts, 1989b), U.S. Navy aircraft carriers (Roberts et al., 1994) and a utility company (Roberts, Karlene H., 1990) that spearheaded the high reliability organization concept.

Table 11

Properties of Deference to Expertise and Their Definitions

Properties of Deference to Expertise	**Definition**[45]

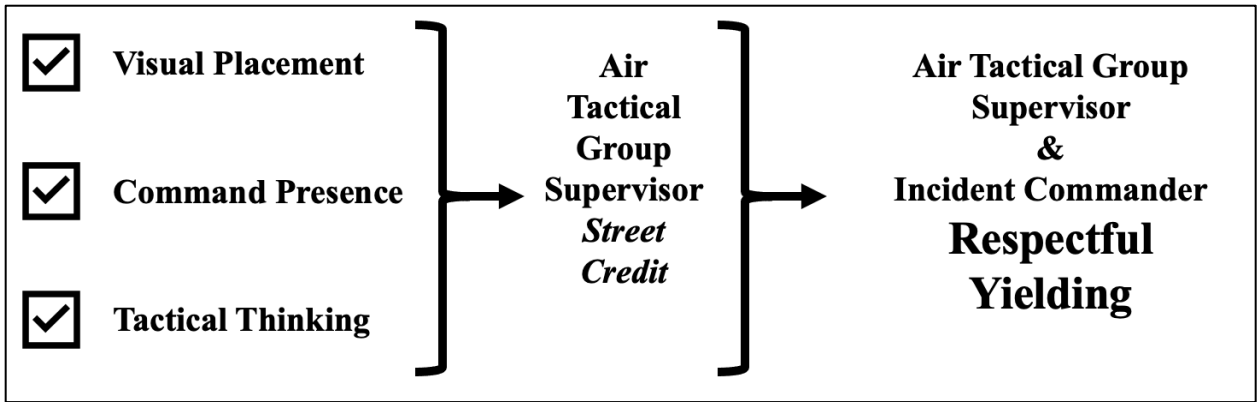
[45] Definitions adapted from *Managing the Unexpected* (Weick & Sutcliffe, 2015).

Respectful yielding	Relational rather than solitary, expertise emerges through a co-production of expert interaction.
Domain-specific knowledge	Includes both firsthand and simulated experience.
Compressed and *generalizable experience*	Knowledge anyone can gain with enough time and access.
Relative expertise	Built from our own experiences (firsthand knowledge) or others' experiences (tactic knowledge).

Note. Source: (Weick & Sutcliffe, 2015)

Figure 19

Visual Depiction of Street Credit Components in Support of Respectful Yielding

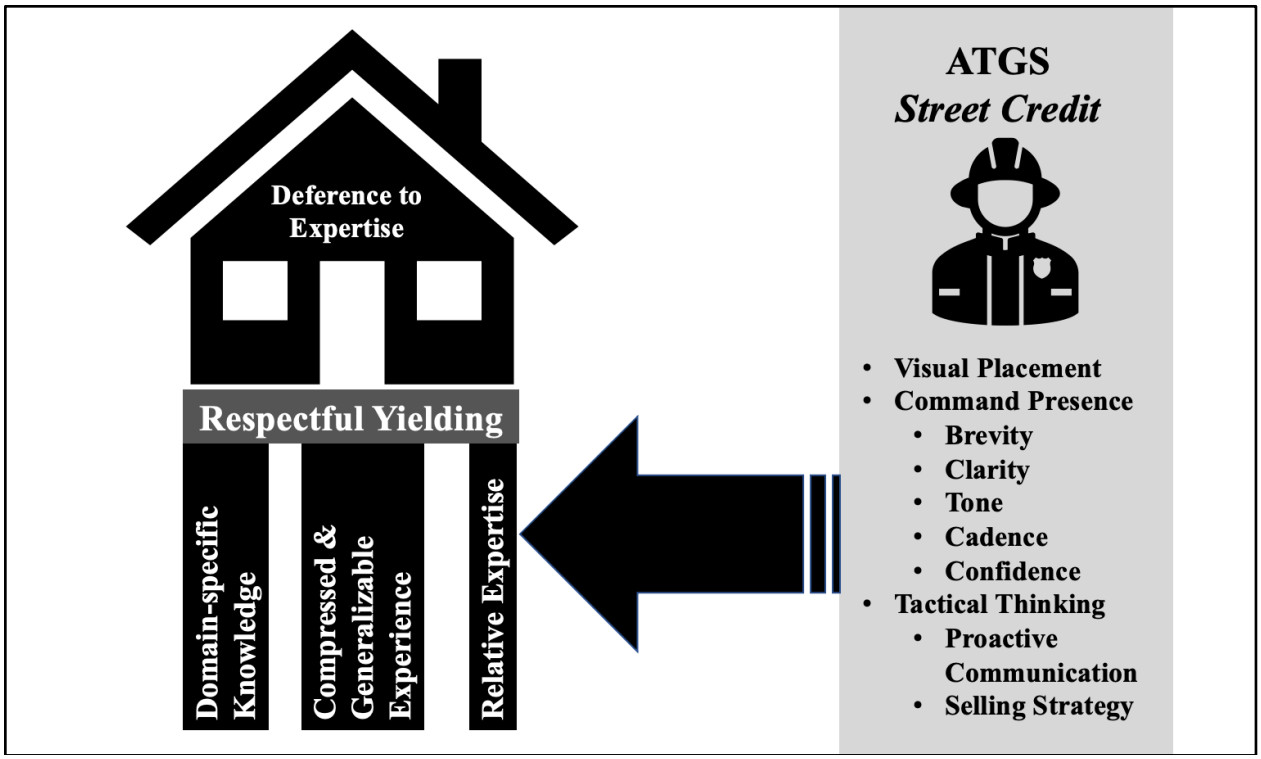


Note. Source: Amber Lynn Scott

Domain-specific knowledge, compressed and generalizable experience, and relative experience (Figure 18) are recognized in high reliability literature as the key requirements for supporting facilitation of respectful yielding (see Weick & Sutcliffe, 2015). Without respectful yielding, deference to expertise cannot be practiced, and the reliability of the team is at risk. At CAL FIRE, the common organizational definition of air tactical group street credit was found to be the key component responsible for upholding the foundation of respectful yielding (Figure 18).

Figure 20

Components of Air Tactical Group Supervisor Street Credit That Support Deference to Expertise (Depicted as a Home) Properties (Depicted as the Foundation and Support Pillars)



Note. Source: Amber Lynn Scott

During the process of deference to expertise, respectful yielding serves as a communication process where two parties co-produce expertise, and "somebody provides an explanation to someone else who asked for it" (Weick & Sutcliffe, 2015, p. 116). Respectful yielding allows expertise to shift back and forth between parties, where the individual with the needed components of domain-specific knowledge, compressed and generalizable experience, and relative expertise can engage with whomever is in a position of authority. Although decision making resides with the incident commander during an initial attack fire, much of the necessary expertise that emerges from an initial attack response will reside with the air tactical group supervisor. Therefore, the foundation of respectful yielding built on the organization's accepted

definition of expertise (i.e., street credit) is what supports deference to expertise at CAL FIRE during initial attack fires. Put more simply, when an air tactical group supervisor exhibits the accepted definition of street credit during an initial attack fire to an incident commander, trust development between an air tactical group supervisor and an incident commander is fast-tracked, allowing expertise to be emergent and yet also occur relatively seamlessly. This seamless communication is the process of respectful yielding. The accepted definition of street credit is what allows the aerial firefighting team to operate quickly and reliably, coordinating their emergent expertise through respectful yielding and facilitating the best (and presumably, safest) response to an initial attack fire.

It is worth noting that not all of the street credit expertise held by an air tactical group supervisor is constructed through firsthand fire experiences or training alone. In fact, much of the expertise air tactical group supervisors bring to their first initial attack fires was found to be gained through the socialization periods of their air tactical group supervisor training. In both formal classroom instruction, flight debriefs, and even stories shared over lunchtime meals, air tactical group supervisor trainees steadily gained more “slides in the tray” (Ishak & Williams, 2017) to support the development of their street credit (i.e., expertise). Future research should explore more nuanced variations and definitions of expertise, and how expertise definitions might evolve within an organization over time. Researchers may also consider how certain elements of expertise (e.g., domain-specific knowledge or relative expertise) may contribute more or less to defining specific organization expertise roles such as those explored in this study. Understanding how certain elements of expertise are more or less valued within a high reliability organization may uncover additional critical elements of how deference to expertise is successfully or unsuccessfully enacted during crisis operations.

Defining Expertise Supports Trust and Communication in High Reliability Organizations

As previous research has demonstrated (Brandon & Hollingshead, 2004; Kanawattanachai & Yoo, 2007; Majchrzak et al., 2007) and this study has empirically supported, expertise enactment is dependent on the progression of trust development during a crisis or unexpected incident. In the case of CAL FIRE, trust is quickly developed between incident commanders and air tactical group supervisors when the expected expertise definition (e.g., street credit) is adhered to. When air tactical group supervisors arrive at an initial attack fire and begin their coordination with incident commanders, their ability to reflect the expected organization definition of an expert becomes the very thing that defines them as such. Thus, by placing themselves in the correct and expected position above a fire (i.e., visual placement) and speaking in a specific manner (i.e., command presence), information begins to flow. This flow subsequently builds trust between the two key members of the initial attack team. By reflecting the organizational norms that both training and others in the organization have shared with them through stories, air tactical group supervisors communicate in an expected manner (e.g., A2A) that prompts the incident commander to trust the information that is being provided.

The seamless flow of information between the incident commander and the air tactical group supervisor is particularly crucial to ensuring both successful containment of an initial attack fire as well as the safety of the entire initial attack response team. Decades of research have noted that flow disruptions, particularly those linked to teamwork and communication failures, to be the strongest predictors of errors in surgical teams (Koch et al., 2020; Parker et al., 2010; Shouhed et al., 2012; Wiegmann et al., 2007). Surgical teams, like aerial firefighting teams, operate under high-pressure, high-stakes conditions where small errors can be catastrophic and costly. Ensuring good communication and teamwork flow between members

not only prevents deviations from the mission, but also ensures the reliability and safety of the team itself. This finding underscores the critical need for communication and teamwork to flow seamlessly within high reliability teams such as aerial firefighting. Good initial flow enables the ongoing communication of air tactical group supervisor expertise (i.e., tactical thinking), where trust is built and firmly established. From this point on, air tactical group supervisors and incident commanders can engage in communication that is grounded in trust and built on shared protocols (i.e., expected communication norms). This ultimately facilitates the process of respectful yielding that the high reliability organization theory principle deference to expertise is built upon. As respectful yielding unfolds, deference to expertise is enabled and the communication between incident commanders and air tactical group supervisors allows for rapid response to the dynamic and unpredictable elements that an initial attack fire presents.

Beyond clarifying the high reliability cultural hallmark deference to expertise, these findings also contribute to extensive literature on negotiated order and communication in teams. Previous examples of negotiated order and high reliability team communication include nuclear power plants (Schulman, 1993) and nursing teams (Apker et al., 2005). Nurses, for example, use discursive processes to manage role contradictions in team interactions, including issues created within their hierarchical role, status, and professional identity (Apker et al., 2005). The findings of this study further clarify how key members of a high reliability team use discursive processes to manage real issues of hierarchy during crisis, explaining how teams manage role and communication tensions created when high reliability teams endeavor to flatten communication hierarchy and yet also maintain deeply ingrained and rigid hierarchical roles during fire responses.

Additional Practical Implications

This study was undertaken with a strong emphasis on developing more concrete insights and understanding into the applied enactment of high reliability organization theory with high reliability organizations and teams, with special attention to the influence communication might play on high reliability organization theory principle enactment. Beyond the theoretical contributions to communication and high reliability theory already discussed in this section, several important and useful implications for high reliability organization practitioners have also emerged from this study. First, this study has clarified for the first time what air tactical group supervisor expertise is defined as and understood as by team members at CAL FIRE. Prior to this study, assumptions about air tactical group supervisor expertise were broadly defined by organization members but remained largely uncodified within the organization beyond national policies inclusive of definitions of position requirements. As a result of this study, air tactical group supervisor expertise definitions are now clearly identified and articulated for this organization. As discovered in this study, within CAL FIRE, air tactical group supervisor expertise is defined by members under the broad term of *street credit*. Although this term is not unique or used exclusively to reference air tactical group supervisors, this term was found within aerial firefighting to encompass the broad traits and communication practices that define air tactical group supervisor expertise.

This study discovered that within CAL FIRE, air tactical group supervisor street credit was recognized by several distinct features, including: (a) *visual placement* during a fire; (b) *command presence*; and (c) *tactical thinking*. More specifically, the feature of command presence included an air tactical group supervisor that demonstrated specific abilities to communicate with both (a) *brevity* and (b) *clarity*, using (c) specific *tone* and (d) *cadence*; as

well as demonstrating overall (e) *confidence* when speaking with incident commanders or other team members during a fire. In addition, air tactical group supervisors possessing street credit demonstrated tactical thinking that included both (a) *proactive communication* during initial attack fires, and when necessary, a (b) *selling strategy* for specific firefighting tactics. The identification of these unique and specific elements of air tactical group supervisor street credit have now been incorporated into organizational training documents and the CAL FIRE air tactical group supervisor curriculum as a means of educating future air tactical group supervisors on the specific components expected by team members from an air tactical group supervisor expert.

Further building on these insights, the results of this study are also useful in assisting CAL FIRE Tactical Air Operations in clarifying and refining what elements of the air tactical group supervisor training program ultimately support expertise development, and what elements are underdeveloped or underemphasized. To this end, air tactical group supervisor instructors can now tailor their respective training modules to better support the desired expertise development and outcomes that previous underdefined expertise narratives did not support. Put simply, training can now focus on developing air tactical group supervisor street credit more directly, ultimately facilitating expertise development and enactment more effectively than previous training methods allowed. For example, previous air tactical group supervisor trainings did not directly address the importance of tone in communication during air tactical group supervisor responses. Moving forward, it may be especially prudent for aerial firefighting programs to more directly incorporate examples, exercises, and evaluations of tone in overall communication delivery, ensuring this critical component to air tactical group supervisor expertise is not assumed or left to be absorbed by trainees through tacit learning initiatives alone.

Additionally, the findings of this study will assist CAL FIRE in identifying opportunities to expand their existing air tactical group supervisor training to be more impactful, effective, and inclusive for air tactical group supervisor trainees. Given the significant and ongoing interagency aspect of CAL FIRE's air tactical group supervisor training programs, the findings of this study also have the potential to shape and refine expertise definitions far beyond one agency or program, potentially assisting aerial firefighting agencies across the globe in better defining and tailoring their training towards expertise development. The clear definitions of expertise expectations within CAL FIRE's aerial firefighting units also highlights what aspects of communication are currently valued in the organization. The recognition of these clear expectations provides the organization an opportunity to ensure that these prioritized communication expectations do not inadvertently limit opportunities to individuals that might not inherently know or exhibit expected expertise norms (e.g., tone). Instead, identification of these known and expected norms provide leadership important touchpoints to examine norms and assess how these norms might be expanded or changed to enable additional talent development and inclusivity within the CAL FIRE organization. Additionally, awareness of these expertise norms might further enable CAL FIRE leaders to identify communication challenges within existing interagency partnerships that are grounded in norm expectations or violations. Existing efforts to address some of these norm-linked communication concerns can be seen through the recent development of the interagency (i.e., U.S. Forest Service and CAL FIRE) air tactical group supervisor training program.

Finally, the insights gained from this study illustrate the importance of tacit knowledge sharing within an organization, including those situated within the aerial firefighting services. As previously noted in literature, (Davenport & Prusak, 1998), tacit knowledge sharing can be a

critical component to organizational success. However, as organizations begin to advocate for prioritization of knowledge management training technologies (e.g., virtual flight simulators), the need for expensive in-person trainings that prioritize or emphasize tacit knowledge sharing and development like the CAL FIRE air tactical group supervisor training program may become more difficult to justify. In response, this study clearly delineates the important role these types of training programs play in both sharing knowledge and developing expertise, and underscores how eliminations of these programs may undermine larger organizational goals such as outcome-based initiatives (i.e., overall fire prevention) or safety (e.g., safe operations within aerial firefighting teams). In the case of CAL FIRE Tactical Air Operations, the air tactical group supervisor training program provides trainees with specific expertise development expected by other team members for their future roles as air attacks (i.e., street credit elements such as tone, brevity, and confidence) that would be difficult to obtain through knowledge management technologies alone. Therefore, this study provides useful and important data for aerial firefighting programs such as CAL FIRE that remain constrained or beholden to the ever-changing political climate that funds their efforts.

Limitations

There are several identified limitations to this case study. First, observations of aerial firefighting during an initial attack fire were not permitted beyond observations made at air attack bases during initial attack fire calls and interviews with participants that had participated in initial attack fire responses. Although some communication between initial attack and air tactical group supervisor was obtained for this study, the primary data utilized focused on interview data and observations made during air tactical group supervisor training exercises. Future studies on communication between air tactical group supervisors and incident

commanders should endeavor to capture in situ communication between incident commanders and air tactical group supervisors beyond the individual air tactical group supervisor or incident commander perspective shared in interviews, allowing for more detailed insights and analysis of communication patterns occurring during a shared initial attack fire response.

Second, a longitudinal analysis of air tactical group supervisor trainees' communication development over the course of their entire training and qualification process would likely enhance and strengthen many of the initial insights gained through this preliminary analysis. As presented, this analysis included observations and interviews during training and qualification, but not a comprehensive or uninterrupted period of observation of all trainees across the entire training program time period. The relatively small sample size of trainee interview participants (n = 4) is also noted and would benefit from a larger overall training cohort. Although this analysis was conducted on one of the largest air tactical group supervisor trainee cohorts to date (n =10), an analysis of air tactical group supervisor training cohorts beyond the single one identified within this analysis would further bolster some of the initial expertise definitions and claims made herein. Furthermore, although this study focused on CAL FIRE air tactical group supervisor trainees, it would be particularly useful to communication researchers to observe multiple and mixed cohorts of air tactical group supervisor trainees inclusive of both Federal and state firefighting organizations participating in the existing joint training program to further identify what communication similarities and differences exist between the two organizations. Observations of air tactical group supervisor training programs outside of the United States would also further refine insights from this study, including clarification of how western-specific culture might influence deference to expertise communication practices. Although the insights of this initial analysis provide a solid initial assessment of how deference to expertise unfolds

within one high reliability organization, researchers across disciplines would certainly benefit from untangling expertise definition development beyond the single organization and positions identified in this analysis.

Third, the failed effort to conduct a survey of high reliability organization practices utilizing the Safety Organizing Scale (Vogus & Sutcliffe, 2007) is a noted limitation that could have provided valuable additional insight into how individuals view the CAL FIRE organizations' support of high reliability safety practices. Although the failure of the survey did not ultimately impact the emergent research questions or subsequent findings of this study, assessment of high reliability organizations and how members view safety culture is likely to provide additional useful data in relation to expertise perception and definition development. In fact, failure of the survey served to reinforce several observations related to the skepticism and rejection of information and communication technologies within CAL FIRE teams. Future researchers interested in surveying high reliability organizations are encouraged to pay careful attention to organizational culture, including overall acceptance or rejection of technology-based communication, prior to deploying an online study survey. The successful deployment of this survey would likely have been much improved had it been conducted through more traditional methods (i.e., paper and pen).

Finally, I acknowledge that my extended presence as a researcher at CAL FIRE and known background as a former Blue Angel safety officer affected some, if not all, of the communicative practices I observed within CAL FIRE teams. Over time, my position with the CAL FIRE teams evolved from merely being viewed as a student researcher to instead being treated as a trusted communication safety expert and friend. Over the extended period of this study, it became clear that my growing relationships with the aerial firefighting teams likely

influenced some, if not all, of the interactions I observed and heard about over the course of this study. Some of this influence resulted in more transparency within the teams, such as advanced disclosure of safety mishaps that were not publicly reported or only minimally profiled in the media. Conversely, several observed interpersonal conflicts were not reported in this dataset in recognition that they were likely shared in confidence as a perceived teammate rather than researcher. Despite these acknowledged limitations, the findings of this study represent a transparent and honest effort to assess deference to expertise communication unfolding within aerial firefighting high reliability teams and significant efforts were made to overcome these identified challenges, as previously noted in the methods chapter of this study.

Future Directions

An unexpected finding in this analysis was that organizational training practices appear to lay the groundwork for teaching or encouraging deference to expertise in ways beyond those currently articulated in the high reliability organization theory literature. Upon deeper readings of the air tactical group supervisor trainings, many of the discussions held between incident commanders and air tactical group supervisors, two key leaders, indicated unseen but deep levels of conflict, particularly around fire response practices. In several instances detailed within this study, incident commanders articulated a desire to have an air tactical group supervisor follow specific orders without requesting input. In short, sometimes air tactical group supervisor expertise was immediately disregarded in favor of a pre-selected course of action by an incident commander during an initial attack fire. These situations meant that air tactical group supervisors either accepted these orders (and the potential consequences) or they had to find ways to push back respectfully. This discovery underscores an important nuance to the high reliability concept of mindfulness (Weick & Sutcliffe, 2015), and how the micro dynamics of mindful organizing

that have heretofore assumed respectful interrelating with deference to expertise (Jahn et al., 2010; Vogus, 2004; Weick & Sutcliffe, 2015) may be a faulty assumption. Future research should further investigate and interrogate how the flow of communication (e.g., agreement versus disagreement) between team members during crises might influence the high reliability organization theory principle deference to expertise. Specifically, future research should press to understand how conflict during crisis might impact the flow of authority migration (i.e., deference to expertise), and how single instances of conflict might result in vastly different outcomes compared to interactions with sustained or regular conflict between team members.

Furthermore, when communication or decision making is highly visible—such as California's aerial firefighting teams were during nightly national news broadcasts in 2021—the consequences of even small decisions and communicative acts become much more important to the outcome a process Weick (2006) called deviation-amplifying loops. For example, decisions related to nighttime firefighting ultimately shaped the tragic circumstances that allowed the 2021 Dixie Fire to explode quickly and become a high-profile national news story (see Brekke, 2021; Iati & Moriarty, 2021; McDonald et al., 2021; Singh, 2021). As decisions linked to high reliability organization operations become more mediated, due to the public's access to posted visuals from drones, and the communication between teams becoming more accessible, it is highly likely that high reliability teams will operate in part with external examination of their decision-making and communication—perhaps comparisons to AI models are in their future. Thus, it is important for researchers across disciplines to continue to explore and collaborate to understand how different facts of high reliability organization theory might unfold in situ, and how different elements of team dynamics might impact the enactment of high reliability organization theory principles including those linked to communication and communication

enactment. Moving beyond the great work that has been done at identifying communication practices within high reliability organizations (e.g., Cantu et al., 2020; Ford, 2018; Fraher et al., 2017; Ishak & Williams, 2017; Roeder et al., 2021, 2021), the effort to shed light into the black box of high reliability organizational culture is much more likely to succeed and bear fruit that future generations can benefit from if we continue to focus on not only expanding high reliability organization theory, but interrogating many of the inherent assumptions that the theory stands upon through case studies of in situ teams.

To that end, this research points to a remarkable new direction for high reliability organization theory research: exploring how transactive memory systems (TMS) initiate, foster, and sustain coordination of expertise and expertise definitions in support of an anticipated crisis or unexpected event (i.e., initial attack fires). This study has articulated a clearer view of high reliability organization theory, including how deference to expertise is realized within high reliability teams and invites consideration of how TMS operate as a possible undercurrent to the communication practice of appealing to authority. This study includes evidence that TMS cultivated and developed during organizational training and socialization later serve to help high reliability teams establish expertise and know which team members should be doing what duties or communication during unexpected or uncertain incidents (e.g., initial attack wildfires). These potential transactive memory systems, first cultivated during initial organizational socialization and training, are surmised to lead to the ideal enactment of the high reliability organization theory principle deference to expertise (e.g., respectful yielding between team members) during crisis responses (e.g., initial attack wildfires). Further investigation is needed to empirically test if this is the case. Answering the call made by Constantinides and colleagues (2008) in their initial work exploring high reliability organizations, expertise coordination, and the role of TMS,

this study opens further avenues for research on how TMS may assist in expertise knowledge sharing and distribution within high reliability teams, especially during unexpected or uncertain incidents. Prior to this study, only limited research has directly investigated transactive memory systems (TMS) in high reliability organizations and focused exclusively on medical settings and examinations of interactions between emergency operators, dispatchers, ambulance crews, and specialty doctors using information and communication technologies (Constantinides et al., 2008). A corollary study built from the general concept of transactive memory introduced the concept of transactive responsibility systems (Xiao et al., 2002) as a means of understanding how teams that operate in high-risk environments manage to perform tasks both safely and successfully. The findings of this study may potentially further build on the initial research of Constantinides (2008), Xiao (2002), and colleagues to articulate the emergent nature of high reliability team expertise outside of technologies or medical practices. Previous work has provided strong evidence of the effects of transactive memory on group performance (Liang et al., 1995; Majchrzak et al., 2007; Moreland & Levine, 2001), and field settings provide an opportunity to measure a range of tasks and domains in relation to group performance. Although this study did not incorporate the transactive memory scale (Lewis, 2003), future field work of this nature should consider deploying the scale in an effort to further examine collective memory systems and how they assist high reliability organizations and teams in maintaining high reliability. Additional research on high reliability teams and TMS will only serve to further substantiate the extent to which findings are both generalizable and useful to other high reliability organizations and teams, and further research from the data collected during this project are planned to address this critical gap.

Conclusion

There are several important takeaways from this study. First, although this study examined only one aerial firefighting organization, the organization studied represents the largest civil aerial firefighting fleet in the world (CAL FIRE, 2022d). As nations across the globe continue to grapple with the effects of catastrophic wildfires (DeWeese, 2023; Reuters, 2023) and firefighting responses include aviation accidents directly linked to communication breakdowns (Clifford, 2023a, 2023b), this case study provides valuable insights on how the leading aerial firefighting organization is successfully maintaining a high degree of reliability and overcoming these known challenges. This case study of CAL FIRE Tactical Air Operations is the first to investigate the complex communication that occurs between incident commanders and air tactical group supervisors during initial attack fires, and how both incident commanders and air tactical group supervisors coordinate their respective expertise to facilitate fast and safe firefighting responses. In this exploration, insights on how the high reliability organization theory principle deference to expertise is embodied during crisis were uncovered.

Additionally, this study more clearly articulated how deference to expertise unfolds within high reliability teams and identified communication performances that support decision making processes. Previous work has identified deference to expertise as a process by which decision making authority is pushed down and around the team, allowing individuals with the most expertise to be in positions of authority regardless of rank or organization hierarchy (Bisel, 2018; Weick & Sutcliffe, 2015). The findings of this study identified an additional systematic means of deference to expertise developed through organizational training, named *appeal to authority (A2A)*, where decision making authority is *pulled* down and around to team members by experts. This pulling of decision making, taught through training, ultimately allows

individuals with the most expertise to apply specific communication practices that smooth interactions with authority holders during crisis. These communication performances were found to be practices both trained through systematic organization training programs and shared through tacit learning from other experts, ensuring consistent performances for all experts within the role. The training of expert communication performances facilitates an ease of communication between authority figures and experts that supports respectful yielding during a crisis, a critical component to deference to expertise embodiment (Jahn & Black, 2017). The findings of this study are the first to identify how experts may engage in communication practices that make deference to expertise easier for authority figures and present an interesting new direction for scholars exploring both expertise co-creation and communication performances.

Furthermore, this study identified the specific components that underpin the definition of aerial firefighting expertise within a state aerial firefighting organization, which were broadly referenced under the universal term *street credit*. Street credit components identified in this study include (a) *visual placement* during a fire; (b) *command presence*; and (c) *tactical thinking*. The feature of command presence was also found to include an air tactical group supervisor that demonstrated specific abilities to communicate with both (a) *brevity* and (b) *clarity*, using (c) specific *tone* and (d) *cadence*; as well as demonstrating overall (e) *confidence* when speaking with incident commanders or other team members during a fire. In addition, air tactical group supervisors possessing street credit demonstrated tactical thinking that included both (a) *proactive communication* during initial attack fires, and when necessary, a (b) *selling strategy* for specific firefighting tactics. Prior to this study, assumptions about air tactical group supervisor expertise were broadly defined by organization members but remained largely uncodified within

the organization beyond national policies inclusive of definitions of position requirements. As a result of this study, air tactical group supervisor expertise definitions are now clearly identified and articulated for this organization. As a result, these more formal articulations of air tactical group supervisor expertise have been incorporated into the latest iteration of CAL FIRE's interagency air tactical group supervisor training, further assisting the organization in its efforts to improve existing training programs and more clearly train practitioners on innovative methods for safe operations.

A larger objective of this study is focused on providing tangible, practical advice to high reliability teams on how to execute high reliability principles most effectively while attending to real constraints, challenges, and contexts. These findings build on earlier efforts by organizations to adopt HRO principles including aviation (Burke et al., 2005), disaster response (Jehn & Techakesari, 2014), firefighting (Barton et al., 2015), and health care (O'Leary et al., 2011; *Veterans Health Administration*, 2021; Wilson et al., 2005). To this end, the findings of this study clarify how expertise is trained within a high reliability organization that is simultaneously under the extreme pressures of budget constraints, interagency dependency, and climate change. This CAL FIRE case study demonstrates how training communication strategies during the early phases of a program are thought to influence how high reliability principles (i.e., deference to expertise) are enacted during crisis (e.g., initial attack fires), and how training programs support experts in easing communication with authority figures. This easing of communication, conducted through communication performances, is what ultimately allows for safe and effective communication during crisis. Beyond all of these contributions, this study also provides important considerations for practitioners tasked with safety program creation and implementation and addresses how communication performance training might strongly

influence how high reliability principles are realized by a high reliability team or organization during both day-to-day operations and an emerging crisis.

The next phase of my research will build on the findings of this study as well as my relationships with members of CAL FIRE, Australia's National Council for Fire and Emergency Services (AFAC), and the National Aerial Firefighting Centre (NAFC) to investigate the adoption and implementation of formal aerial firefighting teams in international communities without the same formalized hierarchy, rules, and regulations of aerial firefighting utilized in the United States. Australia presents a unique opportunity to investigate a transition from informal to formal aerial firefighting organizational structures, as their National Aerial Firefighting Centre (NAFC) is currently exploring efforts to codify additional protocols and systems for aerial firefighting in Australia and New Zealand, including consideration of a sovereign aerial firefighting fleet (Langfield, 2021). Currently, Australia relies upon contracts with commercial specialized firefighting aircraft and a volunteer force of about 195,000 volunteer ground firefighters to protect its communities from bushfires (Cull, 2020). Initiatives are underway to examine how to bolster aerial firefighting efforts in the nation (AFAC, 2021), including the effectiveness of aerial firefighting operations (Natural Hazards Research Australia, 2021, 2023) and how formalized state and national aerial firefighting fleets might impact efforts to prevent and fight bushfires (Seeley et al., 2023). The next phase of this research project is focused on examining efforts to establish aspects of formal aerial firefighting programs not currently utilized in Australia, including discussions of how some states could adopt the U.S. aerial firefighting tactic of assigning air tactical group supervisors during bushfire responses. The potential adoption of the air tactical group supervisor position grew from discussions during a recent visit by New South Wales Rural Fire Service to meet with members of both CAL FIRE Tactical Air

Operations (TAO) and Aviation Management Unit (AMU). This international effort has been focused on identifying and sharing aerial firefighting best practices that are mutually beneficial to both countries. The next planned study will build on the key findings identified in this initial study, including examination of communication norms and practices (i.e., A2A) in high reliability teams outside of a U.S. aerial firefighting context and established aerial firefighting teams. This next phase presents a unique opportunity to explore how expertise and communication norms are developed within an organization (i.e., the Australian fire service) during the initial adoption and implementation phase of bringing established organizational frameworks from outside of their own organization context (i.e., U.S. aerial firefighting rules, regulations, and trainings) and codifying those frameworks within the organization.

Glossary[46]

Above ground level (AGL): Term frequently used in aviation operations, usually in connection with a stated altitude.

Acceptable fire risk: The potential fire loss a community is willing to accept rather than provide resources to reduce such losses.

Action plan: Any tactical plan developed by any element of ICS in support of the incident action plan.

Active resources: Resources checked in and assigned work tasks on an incident. Also called *allocated resources*, *assigned resources, or available resources*.

Advanced Life Support (ALS): Advanced life support skills performed by an EMS practitioner or service (e.g., intravenous fluids and drug administration)

Advancing fire: That portion of the fire with rapid fire spread with higher intensity which is normally burning with the wind and/or up slope. Also called *forward fire* or a *run*.

Aerial detection: A system for, or the act of discovering, locating, and reporting fires from aircraft.

Aerial ignition: Ignition of fuels by dropping incendiary devices or materials from aircraft.

Aerial reconnaissance: Use of aircraft for detecting and observing fire behavior, values-at-risk, suppression activity, and other critical factors to facilitate command decisions on strategy and tactics needed for fire suppression.

After Action Review (AAR): A professional discussion of an event, focused on performance standards, that enables agency administrators and firefighters to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses. An after action review is a tool incident command personnel and units can use to get maximum benefit from every incident. It provides a daily review of the day's actions, including: identification and discussion of effective and non-effective performance; candid insights into specific firefighter, leader, and unit strengths and weaknesses from various perspectives; feedback and insight critical to actions that were not standard operating procedures or those that presented safety problems; and lessons learned and how to apply them in the future.

Air Attack: Refers to the aircraft assigned to a vegetation fire in support of the ground forces. Air tactical planes fly overhead directing the air tankers and helicopters to critical areas of the fire for retardant and water drops.

---

[46] This glossary includes terms and full definitions derived from the California Department of Forestry and Fire Protection Commonly Used Terms pamphlet and the USDA Forest Service Glossary of Wildland Fire Terminology manual.

Air Attack Base: Permanent facility at which aircraft are stationed for use in air attack operations.

Air guard: A common VHF-FM frequency used by natural resources agency aircraft for emergency radio transmissions.

Air Operations Branch Direction (AOBD): This ICS position is responsible for management of an incident's air operations and reports to the Operations Section Chief.

Air Tactical Group Supervisor (ATGS): This ICS position is responsible for directing and coordinating airborne aircraft operations and management of an incident's airspace and reports to the Air Operations Branch Director.

Air tanker: Fixed-wing aircraft certified by FAA as being capable of transport and delivery of fire-retardant solutions.

Aircraft incident: An unplanned even that results in damage which is less than serious aircraft incident criteria, or injuries not requiring medical attention.

Allocated resources: See *active resources*.

Anchor point: An advantageous location, usually a barrier to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the chance of being flanked by the fire while the line is being constructed.

Area ignition: Ignition of several individual fires throughout an area, either simultaneously or in rapid succession, and so spaced that they add to and influence the main body of the fire to produce a hot, fast-spreading fire condition. Also called *simultaneous ignition*.

Assigned resources: See *active resources*.

Attack a fire: Limit the spread of fire by any appropriate means.

Attack line: A line of hose, preconnected to the pump of a fire apparatus and ready for immediate use in attacking a fire. Contrasted to supply lines connecting a water supply with a pump or to feeder lines extended from a pump to various points around the perimeter of a fire.

Available fuel: That portion of the total fuel that would actually burn under various environmental conditions.

Available resources: See *active resources*.

Backburn: Use in some localities to specify fire set to spread against the wind in prescribed burning.

Backing wind: Wind that changes direction in a counterclockwise motion.

Bambi bucket ®: A collapsible bucket slung below a helicopter. Used to dip water from a variety of sources for fire suppression.

Base: (1) The location at which primary logistics functions for an incident are coordinated and administered. There is only one base per incident. (Incident name or other designator will be added to the term "base") The incident command post may be collocated with the base. (2) The location of initial attack forces.

Blow down: An area of previously standing timber which has been blown over by strong winds or storms.

Break Left/Break Right: Turn left of right. Applies to aircraft in flight, usually on the drop run, and when given as a command to the pilot, implies expectation of prompt compliance.

Brush: A collective term that refers to stands of vegetation dominated by shrubby, woody plants or low growing trees, usually of a type undesirable for livestock or timber management.

Brush fire: A fire burning in vegetation that is predominantly shrubs, brush, and scrub growth.

Bucket drops: The dropping of fire retardants or suppressants from specially designed buckets slung below a helicopter.

Burn: (1) An area burned over by wildland fire; (2) a reference to a working fire; (3) an injury to flesh caused by a cauterizing agent, heat from a fire, or heated object; (4) to be on fire; (5) to consume fuel during rapid combustion; (6) a fire in progress or under investigation.

Burn patterns: (1) The characteristic configuration of chat left by a fire. In wildland fires burn patterns are influenced by topography, wind direction, length of exposure, and type of fuel. (2) Apparent and obvious design of burned material and the burning path from the area of origin.

Burning conditions: The state of the combined factors of the environment that affect fire behavior in a specific fuel type.

Burnover: A situation where personnel or equipment is caught in an advancing flame front.

Canopy: The stratum containing the crowns of the tallest vegetation present (living or dead), usually above 20 feet.

CASA: California Aerial Supervision Academy. Typically referenced by the acronym CASA.

Chase truck: Vehicle that carries crew gear, supplies, and operational equipment for initial and extended attack fires.

Check-in: The process whereby resources first report to an incident. Check-in locations include incident command post (ICP), base or camps, staging areas, helibases, or direct to a tactical assignment.

Complex: Two or more individual incidents located in the same general area which are assigned to a single incident commander or unified command.

Contained: The status of a wildfire suppression action signifying that a control line has been completed around the fire, and any associated spot fires, which can reasonably be expected to stop the fire's spread.

Controlled burn: See *prescribed fire*.

Control line: An inclusive term for all constructed or natural barriers and treated fire edges used to control a fire.

Cooperating agency: An agency supplying assistance including but not limited to direct tactical or support functions or resources to the incident control effort.

Coverage level: Recommended amount of aerially applied retardant. For example, coverage level 2 represents 2 gallons of fire retardant per 100 square feet. Levels range from one to six for most fuel models.

Crew: An organized group of firefighters under the leadership of a crew boss or other designated official.

Crown fire: A fire that advances from top to top of trees or shrubs, more or less independent of a surface fire.

Dead fuels: Fuels with no living tissue in which moisture content is governed almost entirely by absorption or evaporation of atmospheric moisture.

Deck: The helibase operational area that includes the touchdown pad, safety circle, cover lanes, and external cargo transport area.

Direct attack: Any treatment applied directly to burning fuel, such as wedding, smothering, or chemically quenching the fire, or by physically separating the burning from unburned fuel. A synonym for *direct line*.

Direct line: See *direct attack*.

Dispatch: The implementation of a command decision to move a resource or resources from one place to another.

Dispatch center: A facility from which resources are assigned to an incident.

Dispatcher: A person who receives reports of discovery and status of fires, confirms their locations, takes action promptly to provide people and equipment likely to be needed for control efforts.

Dozer: Any tracked vehicle with a front mounted blade used for exposing mineral soil.

Drop configuration: The type of retardant drops selected to cover a ground target. Terms that can specify the type of drop configuration include salvo drop and tail drop.

Drop pass: Indicates that the air tanker has the target insight and will make a retardant drop on this run over the target.

Drop pattern: The distribution of an early delivered retardant drop on the target area in terms of its length, width, and momentum as it approaches the ground. The latter determines the relative coverage level of the fire retardant on fuels within the pattern.

Drop zone: Target area for air tankers, helitankers, and cargo dropping.

Dry run: A trial pass over the target area by a lead plane and or an air tanker to pinpoint target areas and warn ground personnel of the impending retardant or extinguishing agent drop.

Escaped fire: The fire which has exceeded or is expected to exceed initial attack capabilities or prescription.

Estimated time en route (ETE): Term used in resource planning and following to estimate time spent between points.

Estimated time of arrival (ETA): Term used in resource planning and resource following to estimate time of arrival at a point.

Estimated time of departure (ETD): Term used in resource planning and following to estimate time of departure from a point.

Event: A planned, non-emergency activity.

Extend: To drop retardant in such a way that the load slightly overlaps and links a previous drop.

Extended attack: Suppression activity for a wildfire that has not been contained or controlled by initial attack or contingency forces and for which more firefighting resources are arriving, enroute, or being ordered by the initial attack incident commander.

Extended attack incident: A wildland fire that has not been contained or controlled by initial attack forces and for which more firefighting resources are arriving, enroute, or being ordered by the initial attack incident commander. Extended attack implies that the complexity level of the incident will increase beyond the capabilities of initial attack incident command.

Extinguishing agent: Substance used to put out a fire by cooling the burning material, blocking the supply of oxygen, or chemically inhibiting combustion.

Extreme fire behavior: Extreme implies a level of fire behavior characteristics that ordinarily precludes methods of direct control action. One or more of the following is usually involved: high rate of speed, prolific crowning and or spotting, the presence of fire whirls, strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously.

Federal Aviation Regulation: Refers to the regulations governing all aviation activities of civil aircraft within the United States and its territories.

Final approach: The flight path and the direction of the landing along the extended runway center line from the base leg to the runway.

Final run: An air tanker is "on final" when it is online with the target and intends to make the drop on that pass.

Fire agency: Official, group, or organization compelled and authorized under statutes or law to control fires within a designated area or upon designated lands.

Fire behavior: The manner in which a fire reacts to the influences of fuel, weather, and topography.

Fire climate: Composite pattern of weather elements overtime that affect fire behavior in a given region.

Fire concentration: Generally a situation in which numerous fires are burning in a locality. More specifically, this refers to the number of fires per unit, area, or locality for a given period (generally a year).

Fire crew: General term for two or more firefighters organized to work as a unit.

Fire danger: Some of content, some of consistent. The constant danger and variable danger factors affecting the inception, spread, and resistance to control, and subsequent fire damage. Often expressed as an index.

Fire risk: 1. The chance of fire starting, as determined by the presence and activity of causative agents. 2. A causative agent. 3. A number related to the potential number of firebrands to which a given area will be exposed during the rating day (National Fire Danger Rating System).

Fire season: Period of the year during which wildland fires are likely to occur, spread, and affect resources values sufficient to warrant organized fire management activities. A legally enacted time during which burning activities are regulated by federal, state, or local authority.

Fire service: The organized fire protection service; its members, individually and collectively; allied organizations assisting protection agencies.

Fire severity: Degree to which the site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time.

Fire suppressant: Any agent used to extinguish the flaming and glowing phases of combustion by direct application to the burning fuel.

Fire suppression: All work and activities connected with control and fire extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

Firefighter: A person whose principal function is fire suppression.

Firefighting forces: Qualified firefighters, together with their equipment and material, used to suppress wildland fires.

Fire line: The part of a containment or control line that is scraped or dug to mineral soil.

FIRESCOPE: Firefighting resources of California organized for potential emergencies. A multi-agency coordination system designed to improve the capabilities of California's wildland fire protection agencies. Its purpose is to provide more efficient resources allocation, and utilization, particularly in multiple or large fire situations during critical burning conditions.

Fire traffic area (FTA): Typically referenced by the acronym FTA. The standard fire traffic area utilizes a minimum 5 NM radius from the incident latitude and longitude, although a radius greater than 5 NM may be utilized if needed by the incident. he FTA was developed by aerial firefighting personnel to provide a standardized initial attack airspace structure and protocol to enhance traffic separation over wildfires or other incidents.

Flank fire: A firing technique consisting of treating an area with lines of fire set into the wind which burn outward at right angles to the wind.

Flanking fire suppression: Attacking a fire by working along the flanks either simultaneously or successively from a less active or anchor point and endeavoring to connect two lines at the head.

Flanks of a fire: The parts of a fires perimeter that are roughly parallel to the main direction of spread. Flare up: Any sudden acceleration in rate of spread or intensification of fire.

Flight following: The method and process through which an aircraft is tracked from departure point to destination. Flight following is the knowledge of the aircraft location and condition at regular intervals with a reasonable degree of certainty such that, in the event of a mishap, those on board may be rescued.

Flight path: 1. Track of an aircraft over the Earth's surface. 2. Specified information relating to the intended flight of an aircraft that is filed orally or in writing with an air traffic control facility.

Flight time: The time from the moment the aircraft first moves under its own power for the purpose of flight until the moment it comes to rest at the next point of landing.

Foreign Object Debris (FOD): Any object, live or not, located in an inappropriate location within an aircraft or an airport environment that could cause injury to a person or aircraft.

Forced landing: Landing necessitated by failure of engines, systems, or components which makes continued flight impossible, and which may not result in damage.

Forest Service: Generally understood to mean an agency of the U.S. Department of Agriculture. However, some states also use Forest Service. E.g., Colorado State Forest Service.

Forward fire: See *advancing fire*.

Fuel: Any combustible material, especially petroleum-based products and wildland fuels. Flammable materials existing in a natural or human built environment. Often refers to all vegetation in wildlands, including dead and live vegetation. Can refer to other flammable materials in the human built environment.

Fuel Break: Fuel breaks are an area of modified vegetation that provides a safe location from which to fight fire and reduces fire spread, duration, and intensity. Fuel breaks can have flammable vegetation.

Grass fire: Any fire in which the predominant fuel is grass or grass like.

Ground effect: Reaction of a rotor downdraft against the ground surface, forming a “ground cushion” that increases lifting capability of that section of air.

Ground fire: Fire that consumes the organic material beneath the surface litter ground, such as a peat fire.

Handcrew: A number of individuals that have been organized and trained and are supervised principally for operational assignments on an incident.

Hands line: Fire line, constructed with hand tools.

Hazard: Any real or potential condition that can cause injury, illness, or death of personnel, or damage to, or loss of equipment or property.

Hazard assessment: A process by which you assess hazards to determine risks. Assess the impact of each hazard in terms of potential loss, cost, or strategic degradation based on probability and severity.

Hazard fuel: A fuel complex defined by kind, arrangement, volume, condition, and location that presents a threat of ignition and resistance to control.

Hazard reduction: Any treatment of living and dead fuels that reduces the potential spread or consequences of fire.

Hazardous areas: Those wildland areas where the combination of vegetation, topography, weather, and the threat of fire to life and property create difficult and dangerous problems.

Head fire: A fire spreading or set to spread with the wind.

Head of a fire: The most rapidly spreading portion of a fire's perimeter, usually to the leeward or up slope.

Heavy fuels: Fuels of large diameter such as snags, logs, large limb wood, which ignite and are consumed more slowly than flash fuels. Also called *coarse fuels*.

Helibase: The main location within the general incident area for parking, fueling, maintenance, and loading of helicopters. It is usually located at or near the incident base.

Helibase crew: A crew of individuals who may be assigned to support helicopter operations.

Helicopter: An aircraft that depends principally on the lift generated by one or more rotors for its support in flight.

Helicopter coordinator: This ICS position is responsible for coordinating tactical and logistical helicopter missions at the incident and reports to the air tactical group supervisor. This position can be airborne or ground base with one or more assigned to an incident, depending on the number and type of missions to be accomplished.

Helitack: The utilization of helicopters to transport crews, equipment, and fire retardants or suppressants to the fire line during the initial stages of a fire. The term also refers to the crew that performs helicopter management and attack activities.

Helitack crew: A crew of firefighters specially trained and certified in the tactical and logistical use of helicopters for fire suppression.

Helitank: Specially designed tank, generally of fabric or metal, fitted closely to the bottom of a helicopter and used for transporting and dropping suppressants or fire retardants.

Helitanker: A helicopter equipped with a fixed tank, air tanker board certified, capable of delivering a minimum of 1,100 gallons of water, foam or retardant.

Hot spot: A particularly active part of a fire.

Hover: A stationary in flight condition for helicopters when no directional flight is achieved.

Ignition pattern: Manner in which a prescribed fire is ignited. The distance between ignition lines or points and the sequence of igniting them is determined by whether fuel, topography, firing technique, and other factors which influence fire behavior and fire effects.

Implementation plan: The design and definition of all the activities, resources, limitations, and contingencies required for successful wildland fire management.

Incendiary: A burning compound or metal used to produce intense heat or flame like a bomb.

Incendiary device: Contravariance designed and used to start a fire.

Incendiary fire: A fire that is deliberately ignited under circumstances in which the person knows that the fire should not be ignited. An incendiary fire is not necessarily a fire that meets the legal definition of an arson fire.

Incident: An occurrence, either human caused or natural phenomenon, that requires action or support by emergency service personnel to prevent or minimize loss of life or damage to property and or natural resources.

Incident Command Post (ICP): Location at which primary command functions are executed. The ICP may be collocated with the incident base or other incident facilities.

Incident Command System (ICS): A standardized on-scene emergency management concept specifically designed to allow its users to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents without being hindered by jurisdictional boundaries.

Incident Commander: This ICS position is responsible for overall management of the incident and reports to the agency administrator for the agency having incident jurisdiction. This position may have one or more deputies assigned from the same agency or from an assisting agency.

Incident Management Team: The incident commander and appropriate general and command staff personnel assigned to an incident.

Initial attack: Refers to the initial resources dispatched to fire. The number of resources sent on the first dispatch to a wildfire depends upon the location of the fire, the fuels in the area (vegetation, timber, homes, etc.) and current weather conditions. Most fires are caught within the first burn period (the first two hours). The majority of the fires CAL FIRE responds to are considered initial attack fires.

Initial attack crew: Specially trained and equipped fire crew for initial attack on a fire.

Initial attack fire (IAF): Fire that is generally contained by the attack units first dispatched without a significant augmentation of reinforcements within two hours after initial attack and full control is expected within the first burning period.

Initial attack incident commander (IAIC): The incident commander at the time the first attack forces commenced suppression work on a fire.

Jettison: Disposing of cargo, fuel, water, or retardant overboard to lighten an aircraft or to improve its stability.

Large aircraft: Aircraft in which maximum certified gross weight at takeoff exceeds 12,500 pounds.

Large fire: (1) For statistical purposes, a fire burning more than a specified area of land (e.g., 300 acres). (2) A fire burning with a size and intensity such that its behaviors is determined by interaction between its own convection column and weather conditions above the surface.

Lead line: Line or set of lines made of rope, webbing or cable and used in helicopter external load operations. Usually placed between a swivel or the cargo hook and the load.

Lead plane: Aircraft with pilot used to make trial runs over the target area to check wind, smoke conditions, topography, and to lead air tankers to targets and supervise their drops.

Limited containment: Halting a fire spread at the head or that portion of the flanks of a prescribed fire that is threatening to exceed prescription criteria and ensuring that this spread rate will not be encountered again.

Live fuels: Living plants such as trees, grasses, and shrubs, in which the seasonal moisture content cycle is controlled largely by internal physiological mechanisms rather than by external weather influences.

Load and hold: Order given to the air tanker pilot to pick up another load of retardant or water and hold at the reload base. The tanker is still committed to the fire.

Load and return: Order given to the air tanker pilot to pick up another load of fire retardant or water and return to the fire.

Local responsibility area: Lands on which neither the state nor the federal government has any legal responsibility for providing fire protection.

Long line: A line or a set of lines, usually in 50-foot increments, used in external load operations that allow the helicopter to place loads in areas in which the helicopter could not safely land.

Main ridge: Prominent ridge line separating river or creek drainages. Usually has numerous smaller ridges extending outward from both sides.

Major disaster: Any natural catastrophe, or regardless of cause, any fire, flood, or explosion in any part of the United States, which, in the determination of the President, causes damage of sufficient severity and magnitude to warrant major disaster assistance.

Managed burn: See *prescribed fire*.

Mass fire: A fire resulting from many simultaneous ignitions that generates a high level of energy output.

Mean sea level (MSL): Average height of the surface of the sea for all stages of the tide over a 19-year period. Note: When the abbreviation MSL is used in conjunction with a number of feet, it implies altitude above sea level (e.g., 1,000 feet MSL)

Medivac: Mobile medical treatment and transportation.

Message center: The message center is part of the incident communications center and is co-located or placed adjacent to it. It receives records and routes information about resources, reporting to the incident, resource status, and administrative and tactical traffic.

Modular Airborne Firefighting System (MAFFS): A manufactured unit consisting of five interconnecting tanks, a control palette, and a nozzle palette with a capacity of 3,000 gallons. Designed to be rapidly mounted inside an unmodified C-130 (Hercules) cargo aircraft for use in cascading retardant chemicals on wildfires.

Multi-agency incident: An incident where one or more agencies assist a jurisdictional agency or agencies. May be single or unified command.

Multijurisdiction incident: An incident requiring action from multiple agencies that have a statutory responsibility for incident mitigation. In ICS, these incidents will be managed under unified command.

Mutual aid: Assistance in firefighting or investigation by fire agencies without regard for jurisdictional boundaries.

Mutual aid agreement: Written agreement between agencies and or jurisdictions in which they agreed to assist one another upon request by furnishing personnel and equipment.

National forest lands: Public lands, generally forest range or other wildland administered by the Forest Service, USDA.

National Interagency Fire Center (NIFC): A facility located at Boise, Idaho, jointly operated by several federal agencies dedicated to coordination, logistical support, and improved weather services in support of fire management operations throughout the United States.

National Park: A federal reservation administered by the National Park Service of the U.S. Department of the Interior in order to conserve unique scenery, flora, and fauna, and any natural and historic objects within its boundaries for public enjoyment in perpetuity.

National resource lands: Public lands administered by the Bureau of Land Management. U.S. Department of the Interior.

National Wildfire Coordinating Group (NWCG): A group formed under the direction of the secretaries of the Interior and Agriculture to improve the coordination and effectiveness of wildland fire activities and provide a forum to discuss, recommend appropriate action, or resolve issues and problems of substantive nature.

Natural fuels: Fuels resulting from natural processes and not directly generated or altered by land management practices.

Near miss: Any potential accident which through prevention, education, hazard reduction or luck did not occur.

Night: The time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time.

Notice to Airmen (NOTAM): Notice identified as either a NOTAM or Airman Advisory containing information concerning the establishment, condition, or change in any component of or hazard in the national airspace system, the timely knowledge of which is essential to personnel concerned with flight operations.

Operations Branch Director (OPBD): This ICS position is responsible for implementing that portion of an incident action plan appropriate to a designated operational branch and reports to the Operations Section Chief.

Operations Section Chief: This ICS position is responsible for supervising the operations section. Reports to the incident commander and is a member of the general staff. This position may have one or more deputies assigned.

Outside aid: Firefighting assistance given to adjacent areas and nearby communities by contract or other agreement that covers conditions and payment for assistance rendered and services performed. Contrasted with mutual aid, in which neighboring firefighting organizations assist each other without charge.

Overhead: Personnel assigned to supervisory positions including incident commanders, command staff, general staff, branch directors, supervisors, unit leaders, managers and staff.

Payload: Weight of passengers and or cargo being carried by an aircraft.

Peak fire season: That period of the fire season during which fires are expected to ignite most readily, to burn with greater than average intensity, and to create damages at an unacceptable level.

Pilot in command: Pilot responsible for the operation and safety of an aircraft during flight time.

Plan of attack: The selected course of action and organization of personnel and equipment in fire suppression as applied to a particular fire or to all fires of a specific type.

Plume: A convection column generated by combustion of wildland fuel.

Precautionary landing: A landing necessitated by apparent impending failure of engines, systems, or components which makes continued flight unadvisable.

Prescribed burning: Application of prescribed fire.

Prescribed fire: The planned and controlled application of fire to a treatment area and ignited under a set of conditions that considers the safety of the public, firefighters, weather, community values and management objectives. Sometimes called a *controlled burn*, *prescribed burn*, *managed burn*, or *Rx/prescription burning*.

Public aircraft: Aircraft use only in the service of a government or political subdivision. It does not include any government-owned aircraft engaged in carrying persons for commercial purposes.

Range fire: Any wildfire on rangeland.

Reload base: An airfield where air tankers are reloaded but not permanently stationed.

Retardant coverage: Area of fuel covered and degree of coverage on the fuel by a fire retardant, usually expressed in terms of gallons per 100 square feet (liters per square meter).

Retardant drop: Fire retardant cascaded from an air tanker or helitanker.

Return and hold: An order to an air tanker pilot to return to the retardant base and await further instructions. Shorthand for mission completed, further loads not required.
Rotor blast: Air turbulence occurring under and around the maiden rotor of an operating helicopter. Also called rotor downwash.

Run: Rapid advance of the head of a fire characterized by a marked transition and fire line intensity and rate of spread with respect to that noted before and after the advance. See *advancing fire*.

Running fire: behavior of a fire spreading rapidly with a well-defined head.

SAFECOM: A Department of the Interior (DOI) and U.S. Forest Service (USFS) aviation safety reporting system.

SAFENET: A form and process used by wildland firefighting agencies for reporting and resolving incidents relating to firefighter safety. The information collected is used to determine long-term trends and problem areas within the wildland fire industry.

Safety briefing: A safety briefing emphasizes key safety concerns on the incident and is presented at each briefing session. The safety briefing should contain information to alert incident personnel of potential risk hazard considered to be most critical.

Safety bulletin: A safety alert containing a factual confirmation of a serious wildland fire accident, incident or fatality.

Salvo: Dropping by an air tanker of its entire load of fire retardant at one time.

Salvo drop: Total retardant or water load dropped all at once. Usually done to knock down a hot spot.

Sand table exercise: A tactical decision game that employs a three-dimensional terrain model made from sand and various props to provide a visual representation of the situation described in the tactical decision game.

Serious aircraft incident: An incident or malfunction that could adversely affect the safety of flight.

Significant fire event: An event measured by the occurrence of fire that requires mobilization of additional resources from outside the fire event area.

Simultaneous ignition: See *area ignition*.

Small aircraft: An aircraft of 12,500 pounds or less maximum certified takeoff weight.

Snorkel tank: A fixed tank attached to the belly of the helicopter that has a pump driven snorkel attached. The helicopter hovers over the water source with the end of the snorkel immersed. The pump then fills the tank.

Sortie: Single round trip made by an air tanker from a tanker base to a fire and return.

State forests: Forest owned and administered by a state and not by a federal government.

Traffic pattern: Traffic flow that is prescribed for aircraft landing at, taxiing on, and taking off from an airport. Usual components of a traffic pattern are upwind leg, crosswind leg, downwind leg, base leg and final approach.

Type I Airtanker: Also called a Large Air Tanker or LAT. At CALFIRE, the most common use of the term Type I refers to C-130H aircraft with a 4,000 gallon capacity for fire retardant.

Type III Airtanker: At CALFIRE, the most common use of the term Type II refers to the Grumman S-2T with a 1,200 gallon capacity for fire retardant.

Watershed: An area of land that channels rainfall and snowmelt to creeks, streams, and rivers, and eventually to outflow points such as reservoirs, bays, and the ocean.

Wildland fire: Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildfire use, and prescribed fire.

References

Abzari, M., & Teimouri, H. (2008). The effective factors on knowledge sharing in organizations. *The International Journal of Knowledge, Culture and Change Management*, *8*(2), 105–113.

AFAC. (2021, July 5). *Grant boosts aerial funding to almost $80 million*. AFAC: National Council for Fire and Emergency Services. https://www.afac.com.au/auxiliary/publications/newsletter/article/grant-boosts-aerial-funding

Ahammad, M. F., Tarba, S. Y., Liu, Y., & Glaister, K. W. (2016). Knowledge transfer and cross-border acquisition performance: The impact of cultural distance and employee retention. *International Business Review*, *25*(1, Part A), 66–75. https://doi.org/10.1016/j.ibusrev.2014.06.015

Ahmad, F., & Karim, M. (2019). Impacts of knowledge sharing: A review and directions for future research. *Journal of Workplace Learning*, *31*(3), 207–230. https://doi.org/10.1108/JWL-07-2018-0096

Air Operations. (2023). [County Government]. County of Placer. https://www.placer.ca.gov/7653/Air-Operations

Allen, J. A., Reiter-Palmon, R., Crowe, J., & Scott, C. (2018). Debriefs: Teams learning from doing in context. *American Psychologist*, *73*(4), 504–516. https://doi.org/10.1037/amp0000246

Allen, N. J., & Hecht, T. D. (2004). The 'romance of teams': Toward an understanding of its psychological underpinnings and implications. *Journal of Occupational and Organizational Psychology*, *77*(4), 439–461. https://doi.org/10.1348/0963179042596469

Alves, J. L., Nadae, J. de, & Carvalho, M. M. de. (2022). Knowledge management enablers and barriers: Exploring the moderating effect of communication barriers. *International Journal of Managing Projects in Business*, *15*(7), 1091–1122. https://doi.org/10.1108/IJMPB-02-2022-0047

Apker, J., Propp, K. M., & Zabava Ford, W. S. (2005). Negotiating status and identity tensions in healthcare team interactions: An exploration of nurse role dialectics. *Journal of Applied Communication Research*, *33*(2), 93–115. https://doi.org/10.1080/00909880500044620

Audretsch, D. B., & Belitski, M. (2020). The role of R&D and knowledge spillovers in innovation and productivity. *European Economic Review*, *123*, 103391. https://doi.org/10.1016/j.euroecorev.2020.103391

Australian Transport Safety Bureau. (2020). *A safety analysis of aerial firefighting occurrences in Australia, July 2000 to March 2020* (AR-2020-022). Australian Transport Safety Bureau. https://www.atsb.gov.au/publications/2020/ar-2020-022

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research*, *41*(4p2), 1576–1598. https://doi.org/10.1111/j.1475-6773.2006.00566.x

Barbour, J. B., & Gill, R. (2017). Questioning as regulatory work practice: The communicative accomplishment of reliability and safety in the oversight of nuclear power plants. *Communication Monographs*, *84*(4), 466–487. https://doi.org/10.1080/03637751.2017.1322212

Barton, M. A., & Sutcliffe, K. M. (2009). Overcoming dysfunctional momentum: Organizational safety as a social achievement. *Human Relations*, *62*(9), 1327–1356. https://doi.org/10.1177/0018726709334491

Barton, M. A., Sutcliffe, K. M., Vogus, T. J., & DeWitt, T. (2015). Performing under uncertainty: Contextualized engagement in wildland firefighting. *Journal of Contingencies and Crisis Management*, *23*(2), 74–83. https://doi.org/10.1111/1468-5973.12076

Bigley, G. A., & Roberts, K. H. (2001). The Incident Command System: High-reliability organizing for complex and volatile task environments. *Academy of Management*, *44*(6), 1281–1299. https://doi-org/10.2307/3069401

Bisel, R. S. (2010). A communicative ontology of organization? A description, history, and critique of CCO theories for organization science. *Management Communication Quarterly*, *24*(1), 124–131. https://doi.org/10.1177/0893318909351582

Bisel, R. S. (2018). *Organizational moral learning: A communication approach*. Routledge, Taylor & Francis Group.

Bisel, R. S., Barge, J. K., Dougherty, D. S., Lucas, K., & Tracy, S. J. (2014). A round-table discussion of "big" data in qualitative organizational communication research. *Management Communication Quarterly*, *28*(4), 625–649. https://doi.org/10.1177/0893318914549952

Brandon, D. P., & Hollingshead, A. B. (2004). Transactive memory systems in organizations: Matching tasks, expertise, and people. *Organization Science*, *15*(6), 633–644. https://doi.org/10.1287/orsc.1040.0069

Branlat, M., Fern, L., Voshell, M., & Trent, S. (2009). Understanding coordination challenges in urban firefighting: A study of critical incident reports. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *53*(4), 284–288. https://doi.org/10.1177/154193120905300426

Brekke, D. (2021, July 22). *Why it took PG&E 9.5 hours to get to the scene where Dixie Fire started*. KQED. https://www.kqed.org/news/11881837/why-it-took-pge-9-5-hours-to-get-to-the-scene-where-dixie-fire-started

Brueller, D., & Carmeli, A. (2011). Linking capacities of high-quality relationships to team learning and performance in service organizations. *Human Resource Management*, *50*(4), 455–477. https://doi.org/10.1002/hrm.20435

Burke, C. S., Wilson, K. A., & Salas, E. (2005). The use of a team-based strategy for organizational transformation: Guidance for moving toward a high reliability organization. *Theoretical Issues in Ergonomics Science*, *6*(6), 509–530. https://doi.org/10.1080/24639220500078682

Burtscher, M. J., Meyer, B., Jonas, K., Feese, S., & Tröster, G. (2018). A time to trust? The buffering effect of trust and its temporal variations in the context of high-reliability teams. *Journal of Organizational Behavior*, *39*(9), 1099–1112. https://doi.org/10.1002/job.2271

Cabrera, A., & Cabrera, E. F. (2002). Knowledge sharing dilemmas. *Organizational Studies*, *23*(5), 687–710. https://doi.org/10.1177/0170840602235001

Cabrera, E. F., & Cabrera, A. (2005). Fostering knowledge sharing through people management practices. *The International Journal of Human Resource Management*, *16*(5), 720–735. https://doi.org/10.1080/09585190500083020

CAL FIRE. (2022a). *2013-2022 Fire Incident Database and Annual Fire Season Overview*. CAL FIRE Fire Incident Database. https://www.fire.ca.gov/incidents/

CAL FIRE. (2022b). *McKinney Fire Incident Report*. McKinney Fire Incident. https://www.fire.ca.gov/incidents/2022/7/29/mckinney-fire/

CAL FIRE. (2022c). *Mosquito Fire Incident Report*. 2022 Mosquito Fire Incident. https://www.fire.ca.gov/incidents/2022/9/6/mosquito-fire/

CAL FIRE. (2022d, June 22). *Aviation Program*. CAL FIRE. https://www.fire.ca.gov/programs/fire-protection/aviation-program/

CAL FIRE. (2022e, December 28). *2022 Fire Season*. CAL FIRE: 2022 Fire Season Incident Archive. https://www.fire.ca.gov/incidents/2022/

CALFIRE. (2023). *What We Do: Fire Protection*. CA.Gov. https://www.fire.ca.gov/what-we-do/fire-protection

Cantu, J., Tolk, J., Fritts, S., & Gharehyakheh, A. (2020). High Reliability Organization (HRO) systematic literature review: Discovery of culture as a foundational hallmark. *Journal of Contingencies and Crisis Management*, 1468–5973. https://doi.org/10.1111/1468-5973.12293

Cart, J. (2022, December 1). By the numbers: California's mild 2022 wildfire season. *CalMatters*. http://calmatters.org/environment/california-wildfires/2022/12/california-wildfires-2022/

Casler, J. G. (2014). Revisiting NASA as a High Reliability Organization. *Public Organization Review*, *14*(2), 229–244. https://doi.org/10.1007/s11115-012-0216-5

Castaneda, D. I., & Toulson, P. (2021). Is it possible to share tacit knowledge using information and communication technology tools? *Global Knowledge, Memory and Communication*, *70*(8/9), 673–683. https://doi.org/10.1108/GKMC-07-2020-0102

Center for Disaster Philanthropy. (2020, October 14). *2019-2020 Australian Bushfires*. Center for Disaster Philanthropy. https://disasterphilanthropy.org/disasters/2019-australian-wildfires/

Chapman, M. (2022, May 5). *Fighting fire from the sky: Aerial exercises prepare for upcoming season*. Redding Record Searchlight. https://www.redding.com/story/news/2022/05/05/cal-fire-air-tankers-fire-season-wildfires-california-redding/9651841002/

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). SAGE.

Choi, S. B., Kim, K., Ullah, S. M. E., & Kang, S.-W. (2016). How transformational leadership facilitates innovative behavior of Korean workers: Examining mediating and moderating processes. *Personnel Review*, *45*(3), 459–479. https://doi.org/10.1108/PR-03-2014-0058

Clifford, J. (2023a, March 21). American pilot felt pressure from the NSW RFS to keep flying during 2019-20 fires, inquiry hears. *ABC News*. https://www.abc.net.au/news/2023-03-21/nsw-bushfires-coronial-inquiry-american-pilot-felt-pressured/102125956

Clifford, J. (2023b, March 22). RFS radio operator changed log following deadly plane crash, inquest hears. *ABC News*. https://www.abc.net.au/news/2023-03-22/black-summer-bushfire-coronial-inquest/102131130

Connelly, C. E., Černe, M., Dysvik, A., & Škerlavaj, M. (2019). Understanding knowledge hiding in organizations. *Journal of Organizational Behavior*, *40*(7), 779–782. https://doi.org/10.1002/job.2407

Connelly, C. E., Ford, D. P., Turel, O., Gallupe, B., & Zweig, D. (2014). 'I'm busy (and competitive)!' Antecedents of knowledge sharing under pressure. *Knowledge Management Research & Practice*, *12*(1), 74–85. https://doi.org/10.1057/kmrp.2012.61

Connelly, C. E., Zweig, D., Webster, J., & Trougakos, J. P. (2012). Knowledge hiding in organizations. *Journal of Organizational Behavior*, *33*(1), 64–88. https://doi.org/10.1002/job.737

Constantinides, P., Kouroubali, A., & Barrett, M. (2008). Transacting expertise in emergency management and response. *ICIC 2008 Proceedings*, *15*, 1–17.

Cox, S., Jones, B., & Collinson, D. (2006). Trust relations in high-reliability organizations. *Risk Analysis*, *26*(5), 1123–1138. https://doi.org/10.1111/j.1539-6924.2006.00820.x

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th Ed.). SAGE Publications.

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. SAGE Publications.

Cull, M. (2020, January 22). *Value beyond money: Australia's special dependence on volunteer firefighters*. The Conversation. http://theconversation.com/value-beyond-money-australias-special-dependence-on-volunteer-firefighters-129881

Cumberland, D., & Githens, R. (2012). Tacit knowledge barriers in franchising: Practical solutions. *Journal of Workplace Learning*, *24*(1), 48–58. https://doi.org/10.1108/13665621211191104

Cumming, S. G. (2005). Effective fire suppression in boreal forests. *Canadian Journal of Forest Research*, *35*(4), 772–786. https://doi.org/10.1139/x04-174

Cvitanovic, C., Hobday, A. J., van Kerkhoff, L., Wilson, S. K., Dobbs, K., & Marshall, N. A. (2015). Improving knowledge exchange among scientists and decision-makers to facilitate the adaptive governance of marine resources: A review of knowledge and research needs. *Ocean & Coastal Management*, *112*, 25–35. https://doi.org/10.1016/j.ocecoaman.2015.05.002

Davenport, T. (1997). Known evils: Common pitfalls of knowledge management. *CIO (Framingham, Mass.)*, *10*(17), 34.

Davenport, T., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Harvard Business School Press.

De Dreu, C. K. W., Nijstad, B. A., & van Knippenberg, D. (2008). Motivated information processing in group judgment and decision making. *Personality and Social Psychology Review*, *12*(1), 22–49. https://doi.org/10.1177/1088868307304092

De Vries, R. E., Van Den Hooff, B., & De Ridder, J. A. (2006). Explaining knowledge sharing: The role of team communication styles, job satisfaction, and performance beliefs. *Communication Research*, *33*(2), 115–135. https://doi.org/10.1177/0093650205285366

Dekker, S. (2015). *Safety differently: Human factors for a new era* (2nd ed). CRC press.

Department of the Interior & U.S. Forest Service. (2023). *SAFECOM: Aviation Safety Communiquè*. SAFECOM: Aviation Safety Communiquè. https://www.safecom.gov/

Desmond, M. (2009). *On the fireline: Living and dying with wildland firefighters*. University of Chicago Press. https://press.uchicago.edu/ucp/books/book/chicago/O/bo5186407.html

DeWeese, C. (2023, June 9). *The wildfire problem is a global problem*. The Weather Channel. https://weather.com/news/climate/news/2023-06-09-wildfire-problem-global-problem-smoke-climate-change-air-quality

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly*, *44*(2), 350. https://doi.org/10.2307/2666999

Edmondson, A., & Lei, Z. (2014). Psychological safety: The history, renaissance, and future of an interpersonal construct. *Annual Review of Organizational Psychology and Organizational Behavior*, *1*(1), 23–43. https://doi.org/10.1146/annurev-orgpsych-031413-091305

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (2011). *Writing ethnographic fieldnotes* (2nd ed.). University of Chicago Press.

Endsley, M. R. (1988). Design and evaluation for situation awareness enhancement. *Proceedings of the Human Factors Society Annual Meeting*, *32*(2), 97–101. https://doi.org/10.1177/154193128803200221

Fahey, L., & Prusak, L. (1998). The eleven deadliest sins of knowledge management. *California Management Review*, *40*(3), 265–276. https://doi.org/10.2307/41165954

Ford, D., Myrden, S. E., & Jones, T. D. (2015). Understanding "disengagement from knowledge sharing": Engagement theory versus adaptive cost theory. *Journal of Knowledge Management*, *19*(3), 476–496. https://doi.org/10.1108/JKM-11-2014-0469

Ford, J. L. (2018). Revisiting high-reliability organizing: Obstacles to safety and resilience. *Corporate Communications: An International Journal*, *23*(2), 197–211. https://doi.org/10.1108/CCIJ-04-2017-0034

Fraher, A. L. (2013). Airline downsizing and its impact on team performance. *Team Performance Management: An International Journal*, *19*(1/2), 109–126. https://doi.org/10.1108/13527591311312123

Fraher, A. L., Branicki, L. J., & Grint, K. (2017). Mindfulness in action: Discovering how U.S. Navy SEALs build capacity for mindfulness in High-Reliability Organizations (HROs). *Academy of Management Discoveries*, *3*(3), 239–261. https://doi.org/10.5465/amd.2014.0146

Gagné, M., Tian, A. W., Soo, C., Zhang, B., Ho, K. S. B., & Hosszu, K. (2019). Different motivations for knowledge sharing and hiding: The role of motivating work design. *Journal of Organizational Behavior*, *40*(7), 783–799. https://doi.org/10.1002/job.2364

Gilbert, G. (2022, March 6). *Canada TSB reports aviation accidents increased in 2021*. Aviation International News. https://www.ainonline.com/aviation-news/aerospace/2022-03-06/canada-tsb-reports-aviation-accidents-increased-2021

Glaser, B. G., & Holton, J. (2004). Remodeling grounded theory. *Forum: Qualitative Social Research*, *5*(2). http://www.qualitative-research.net/fqs/

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of Grounded Theory: Strategies for qualitative research*. Aldine Publishing Company.

Gordon, A. V., Ramic, M., Rohrbeck, R., & Spaniol, M. J. (2020). 50 years of corporate and organizational foresight: Looking back and going forward. *Technological Forecasting and Social Change*, *154*, 119966. https://doi.org/10.1016/j.techfore.2020.119966

Gregory, D. (2011). From a view to a kill: Drones and late modern war. *Theory, Culture & Society*, *28*(7–8), 188–215. https://doi.org/10.1177/0263276411423027

Griffith, J., Roberts, D., & Wakeham, R. (2015). A meta-analysis of crew resource management/incident command systems implementation studies in the fire and emergency services. *Journal of Aviation/Aerospace Education & Research*, *25*(1), 1–25. https://doi.org/10.15394/jaaer.2015.1647

Hock-Doepgen, M., Clauss, T., Kraus, S., & Cheng, C.-F. (2021). Knowledge management capabilities and organizational risk-taking for business model innovation in SMEs. *Journal of Business Research*, *130*, 683–697. https://doi.org/10.1016/j.jbusres.2019.12.001

Holste, J. S., & Fields, D. (2010). Trust and tacit knowledge sharing and use. *Journal of Knowledge Management*, *14*(1), 128–140. https://doi.org/10.1108/13673271011015615

Iati, M., & Moriarty, D. (2021, September 17). *Anatomy of a wildfire: How the Dixie Fire became the largest blaze of a devastating summer*. Washington Post. https://www.washingtonpost.com/climate-environment/interactive/2021/dixie-fire/

Ishak, A. W., & Williams, E. A. (2017). Slides in the tray: How fire crews enable members to borrow experiences. *Small Group Research*, *48*(3), 336–364. https://doi.org/10.1177/1046496417697148

Ismail Al-Alawi, A., Yousif Al-Marzooqi, N., & Fraidoon Mohammed, Y. (2007). Organizational culture and knowledge sharing: Critical success factors. *Journal of Knowledge Management*, *11*(2), 22–42. https://doi.org/10.1108/13673270710738898

Issac, A. C., Bednall, T. C., Baral, R., Magliocca, P., & Dhir, A. (2022). The effects of expert power and referent power on knowledge sharing and knowledge hiding. *Journal of Knowledge Management*, *27*(2), 383–403. https://doi.org/10.1108/JKM-10-2021-0750

Jahn, J. L. S. (2016). Adapting safety rules in a high reliability context: How wildland firefighting workgroups ventriloquize safety rules to understand hazards. *Management Communication Quarterly*, *30*(3), 362–389. https://doi.org/10.1177/0893318915623638

Jahn, J. L. S. (2019). Voice enactment: Linking voice with experience in high reliability organizing. *Journal of Applied Communication Research*, *47*(3), 283–302. https://doi.org/10.1080/00909882.2019.1613555

Jahn, J. L. S., & Black, A. E. (2017). A model of communicative and hierarchical foundations of high reliability organizing in wildland firefighting teams. *Management Communication Quarterly*, *31*(3), 356–376. https://doi.org/10.1177/0893318917691358

Jahn, J., Putnam, L., & Black, A. (2010). *The communicative construction of safety in wildland firefighting* (Joint Forest Service Project Research Project Reports No. 10-3-01–4).

Jarrahi, M. H., & Sawyer, S. (2015). Theorizing on the take-up of social technologies, organizational policies and norms, and consultants' knowledge-sharing practices. *Journal of the Association for Information Science and Technology*, *66*(1), 162–179. https://doi.org/10.1002/asi.23161

Jehn, K. A., & Techakesari, P. (2014). High reliability teams: New directions for disaster management and conflict. *International Journal of Conflict Management*, *25*(4), 407–430. https://doi.org/10.1108/IJCMA-02-2014-0019

Johnson, J. K., Arora, V. M., Bacha, E. A., & Barach, P. R. (2011). Improving communication and reliability of patient handovers in pediatric cardiac care. *Progress in Pediatric Cardiology*, *32*(2), 135–139. https://doi.org/10.1016/j.ppedcard.2011.10.012

Joia, L. A., & Lemos, B. (2010). Relevant factors for tacit knowledge transfer within organisations. *Journal of Knowledge Management*, *14*(3), 410–427. https://doi.org/10.1108/13673271011050139

Kanawattanachai, P., & Yoo, Y. (2007). The impact of knowledge coordination on virtual team performance over time. *MIS Quarterly*, *31*(4), 783–808. https://doi.org/10.2307/25148820

Keyton, J., Bisel, R. S., & Ozley, R. (2009). Recasting the link between applied and theory research: Using applied findings to advance communication theory development. *Communication Theory*, *19*(2), 146–160. https://doi.org/10.1111/j.1468-2885.2009.01339.x

Koch, A., Burns, J., Catchpole, K., & Weigl, M. (2020). Associations of workflow disruptions in the operating room with surgical outcomes: A systematic review and narrative synthesis. *BMJ Quality & Safety*, *29*(12), 1033–1045. https://doi.org/10.1136/bmjqs-2019-010639

Langfield, M. (2021, March 1). *Government requirements and the use of private contractors for aerial firefighting*. AirMed&Rescue. https://www.airmedandrescue.com/latest/long-read/government-requirements-and-use-private-contractors-aerial-firefighting

LaPorte, T. R., & Consolini, P. M. (1991). Working in practice but not in theory: Theoretical challenges of "High-Reliability Organizations." *Journal of Public Administration Research and Theory: J-PART*, *1*(1), 19–48. JSTOR.

Le, P. B., & Lei, H. (2017). How transformational leadership supports knowledge sharing: Evidence from Chinese manufacturing and service firms. *Chinese Management Studies*, *11*(3), 479–497. https://doi.org/10.1108/CMS-02-2017-0039

Le, P. B., & Lei, H. (2019). Determinants of innovation capability: The roles of transformational leadership, knowledge sharing and perceived organizational support. *Journal of Knowledge Management*, *23*(3), 527–547. https://doi.org/10.1108/JKM-09-2018-0568

Leonardi, P. M. (2015a). Ambient awareness and knowledge acquisition: Using social media to learn "Who knows what" and "Who knows whom." *MIS Quarterly*, *39*(4), 747–762.

Leonardi, P. M. (2015b). Studying work practices in organizations: Theoretical considerations and empirical guidelines. *Annals of the International Communication Association*, *39*(1), 235–273. https://doi.org/10.1080/23808985.2015.11679177

Lewis, K. (2003). Measuring transactive memory systems in the field: Scale development and validation. *Journal of Applied Psychology*, *88*(4), 587–604. https://doi.org/10.1037/0021-9010.88.4.587

Li, W. (2010). Virtual knowledge sharing in a cross-cultural context. *Journal of Knowledge Management*, *14*(1), 38–50. https://doi.org/10.1108/13673271011015552

Liang, D. W., Moreland, R., & Argote, L. (1995). Group versus individual training and group performance: The mediating role of transactive memory. *Personality & Social Psychology Bulletin*, *21*(4), 384–393. https://doi.org/10.1177/0146167295214009

Lindlof, T. R., & Taylor, B. C. (2017). *Qualitative communication research methods* (4th Ed.). SAGE Publications.

Majchrzak, A., Jarvenpaa, S. L., & Hollingshead, A. B. (2007). Coordinating expertise among emergent groups responding to disasters. *Organization Science*, *18*(1), 147–161. https://doi.org/10.1287/orsc.1060.0228

Mao, H., Liu, S., Zhang, J., & Deng, Z. (2016). Information technology resource, knowledge management capability, and competitive advantage: The moderating role of resource commitment. *International Journal of Information Management*, *36*(6, Part A), 1062–1074. https://doi.org/10.1016/j.ijinfomgt.2016.07.001

McDonald, B., Burrous, S., Weingart, E., & Felling, M. (2021, October 11). Inside the massive and costly fight against the Dixie Fire. *The New York Times*. https://www.nytimes.com/interactive/2021/10/11/us/california-wildfires-dixie.html

Miller, B. M., & Horsley, J. S. (2009). Digging deeper: Crisis management in the coal industry. *Journal of Applied Communication Research*, *37*(3), 298–316. https://doi.org/10.1080/00909880903025903

Minei, E., & Bisel, R. (2012). Negotiating the meaning of team expertise: A firefighter team's epistemic denial. *Small Group Research*, *44*(1), 7–32. https://doi.org/10.1177/1046496412467830

Mohajan, H. (2016). Sharing of tacit knowledge in organizations: A review. *American Journal of Computer Science and Engineering*, *3*(2), 6–19.

Monge, P. R., & Contractor, N. S. (2003). *Theories of communication networks*. Oxford University Press.

Montuori, A., & Donnelly, G. (2018). Transformative Leadership. In J. Neal (Ed.), *Handbook of Personal and Organizational Transformation* (pp. 319–350). Springer International Publishing. https://doi.org/10.1007/978-3-319-66893-2_59

Moreland, R. L., & Levine, J. M. (2001). Socialization in organizations and work groups. In M. E. Turner (Ed.), *Groups at work: Theory and research* (pp. 69–112). Erlbaum.

Myers, K. K. (2005). A burning desire: Assimilation into a fire department. *Management Communication Quarterly*, *18*(3), 344–384. https://doi.org/10.1177/0893318904270742

Myers, K. K., & McPhee, R. D. (2006). Influences on member assimilation in workgroups in High-Reliability Organizations: A multilevel analysis. *Human Communication Research*, *32*(4), 440–468. https://doi.org/10.1111/j.1468-2958.2006.00283.x

National Wildfire Coordinating Group. (2022a). *NWCG Standards for Aerial Supervision* (PMS 505, NFES 002544; p. 131). https://www.nwcg.gov/sites/default/files/publications/pms505.pdf

National Wildfire Coordinating Group. (2022b, August 8). *Incident Commander Type 1*. National Wildfire Coordinating Group. https://www.nwcg.gov/positions/ict1

National Wildfire Coordinating Group. (2022c, November 21). *Air Tactical Group Supervisor Position Description*. National Wildfire Coordinating Group. https://www.nwcg.gov/positions/atgs/position-ipd

Natural Hazards Research Australia. (2021). *Using earth observation to better understand the effects of aerial firefighting*. Natural Hazards Research Australia.

https://www.naturalhazards.com.au/research/research-projects/using-earth-observation-better-understand-effects-aerial-firefighting

Natural Hazards Research Australia. (2023). *Why fly? How do we know that aerial firefighting operations are effective and efficient?* Natural Hazards Research Australia. https://www.naturalhazards.com.au/research/research-projects/why-fly-how-do-we-know-aerial-firefighting-operations-are-effective-and

Nembhard, I. M., & Edmondson, A. C. (2006). Making it safe: The effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams. *Journal of Organizational Behavior*, *27*(7), 941–966. https://doi.org/10.1002/job.413

Nicholson, B., & O'Hare, D. (2014). The effects of individual differences, prior experience and cognitive load on the transfer of dynamic decision-making performance. *Ergonomics*, *57*(9), 1353–1365. http://dx.doi.org/10.1080/00140139.2014.933884

Novak, J. M., & Sellnow, T. L. (2009). Reducing organizational risk through participatory communication. *Journal of Applied Communication Research*, *37*(4), 349–373. https://doi.org/10.1080/00909880903233168

Okoroafor, H. (2014). The barriers to tacit knowledge sharing in franchise organizations. *Knowledge Management Research & Practice*, *12*(1), 97–102. https://doi.org/10.1057/kmrp.2013.30

Okuyama, A., Wagner, C., & Bijnen, B. (2014). Speaking up for patient safety by hospital-based health care professionals: A literature review. *BMC Health Services Research*, *14*(1), Article 1. https://doi.org/10.1186/1472-6963-14-61

O'Leary, K. J., Creden, A. J., Slade, M. E., Landler, M. P., Kulkarni, N., Lee, J., Vozenilek, J. A., Pfeifer, P., Eller, S., Wayne, D. B., & Williams, M. V. (2015). Implementation of unit-based interventions to improve teamwork and patient safety on a medical service. *American Journal of Medical Quality*, *30*(5), 409–416. https://doi.org/10.1177/1062860614538093

O'Leary, K. J., Sehgal, N. L., Terrell, G., & Williams, M. V. (2011). Interdisciplinary teamwork in hospitals: A review and practical recommendations for improvement. *Journal of Hospital Medicine*, *7*(1), 48–54. https://doi.org/10.1002/jhm.970

Parker, S. E. H., Laviana, A. A., Wadhera, R. K., Wiegmann, D. A., & Sundt, T. M. (2010). Development and evaluation of an observational tool for assessing surgical flow disruptions and their impact on surgical performance. *World Journal of Surgery*, *34*(2), 353–361. https://doi.org/10.1007/s00268-009-0312-z

Peltokorpi, V. (2006). Knowledge sharing in a cross-cultural context: Nordic expatriates in Japan. *Knowledge Management Research & Practice*, *4*(2), 138–148. https://doi.org/10.1057/palgrave.kmrp.8500095

Perrow, C. (1984). *Normal accidents: Living with high-risk technologies*. Basic Books.

Pfeffer, J. (1981). *Power in organizations*. Pitman Publications.

Pilny, A., Proulx, J. D., Dinh, L., & Bryan, A. L. (2017). An adapted structurational framework for the emergence of communication networks. *Communication Studies*, *68*(1), 72–94. https://doi.org/10.1080/10510974.2016.1262886

Porter, T., Richwine, M., & Batjer, M. (2021). *California Power Line Fire Prevention Field Guide* [Field Guide].

Preece, A., Hui, K., Marti, P., Bench-Capon, T., Cui, Z., & Jones, D. (2001). KRAFT: An agent architecture for knowledge fusion. *International Journal of Cooperative Information Systems*, *10*(01n02), 171–195. https://doi.org/10.1142/S0218843001000308

Rahn, M. (2010). *Initial attack effectiveness: Wildfire staffing study* (No. 2; p. 52). San Diego State University.

Reimer, J., Thompson, D. K., & Povak, N. (2019). Measuring Initial attack suppression effectiveness through burn probability. *Fire*, *2*(4), Article 4. https://doi.org/10.3390/fire2040060

Reuters. (2023, June 6). *Canada on track for its worst-ever wildfire season*. Reuters. https://www.reuters.com/world/americas/canada-track-its-worst-ever-wildfire-season-2023-06-05/

Rice, R. M. (2021). High reliability collaborations: Theorizing interorganizational reliability as constituted through translation. *Management Communication Quarterly*, *35*(4), 471–496. https://doi.org/10.1177/08933189211006390

Ritala, P., Husted, K., Olander, H., & Michailova, S. (2018). External knowledge sharing and radical innovation: The downsides of uncontrolled openness. *Journal of Knowledge Management*, *22*(5), 1104–1123. https://doi.org/10.1108/JKM-05-2017-0172

Roberts, K. H. (1989a). New challenges in organizational research: High reliability organizations. *Industrial Crisis Quarterly*, *3*(2), 111–125. https://doi.org/10.1177/108602668900300202

Roberts, K. H. (1989b). New challenges in organizational research: High reliability organizations. *Industrial Crisis Quarterly*, *3*, 111–125.

Roberts, K. H., & Bea, R. (2001). Must accidents happen? Lessons from high-reliability organizations. *Academy of Management Perspectives*, *15*(3), 70–78. https://doi.org/10.5465/ame.2001.5229613

Roberts, K. H., & Rousseau, D. M. (1989). Research in nearly failure-free, high-reliability organizations: Having the bubble. *IEEE Transactions on Engineering Management*, *36*(2), 132–139. https://doi.org/10.1109/17.18830

Roberts, K. H., Rousseau, D. M., & La Porte, T. R. (1994). The culture of High Reliability: Quantitative and Qualitative assessment aboard nuclear-powered aircraft carriers. *The Journal of High Technology Management Research*, *5*(1), 141–161.

Roberts, Karlene H. (1990). Managing High Reliability Organizations. *California Management Review*, 101–113.

Robertson, M. M., & Endsley, M. R. (1994). The role of crew resource management (CRM) in achieving team situation awareness in aviation settings. *Western European Association for Aviation Psychology 21st Conference*.

Rochlin, G. I., La Porte, T. R., & Roberts, K. H. (1987). The self-designing High-Reliability Organization: Aircraft carrier flight operations at sea. *Naval War College Review*, *40*(4), 76–92. JSTOR.

Roeder, A. C., Bisel, R. S., & Howe, W. T. (2021). High-reliability organizing and communication during naturalistic decision making: U.S. National Weather Service (NWS) forecasting teams' use of 'floating.' *Journal of Applied Communication Research*, *49*(4), 441–459. https://doi.org/10.1080/00909882.2021.1907855

Roeder, A. C., Bisel, R. S., & Morrissey, B. S. (2021). Weathering the financial storm: A professional forecaster team's domain diffusion of resilience. *Communication Studies*, *72*(1), 1–16. https://doi.org/10.1080/10510974.2020.1807379

Rutten, W., Blaas-Franken, J., & Martin, H. (2016). The impact of (low) trust on knowledge sharing. *Journal of Knowledge Management*, *20*(2), 199–214. https://doi.org/10.1108/JKM-10-2015-0391

Salas, E., Burke, C. S., Bowers, C. A., & Wilson, K. A. (2001). Team training in the skies: Does crew resources management (CRM) training work? *Human Factors*, *43*(4), 641–674. https://doi.org/10.1518/001872001775870386

Salas, E., Prince, C., Baker, D. P., & Shrestha, L. (1995). Situation awareness in team performance: Implications for measurement and training. *Human Factors*, *37*(1), 123–136. https://doi.org/10.1518/001872095779049525

Schneider, M. (2002). A stakeholder model of organizational leadership. *Organization Science*, *13*(2), 209–220. https://doi.org/10.1287/orsc.13.2.209.531

Schulman, P. R. (1993). The negotiated order of organizational reliability. *Adminstration & Society*, *25*(3), 353–372. https://doi.org/10.1177/009539979302500305

Schwartz, D. (1990). *Training for situational awareness*. Flight Safety International.

Schwartz, J. (2020, September 15). How to fight a wildfire: Grueling work and managing risks. *The New York Times*. https://www.nytimes.com/2020/09/15/climate/firefighting-techniques.html

Scott, A. L., Howe, W. T., & Bisel, R. (2022). Reviewing High Reliability Team (HRT) scholarship: A 21st century approach to safety. *Small Group Research*, 38.

Seeley, M., Hede, H., Bylart, M., & Rodwell, J. (2023). Diagnosing the institutional forces impacting Australia's aerial firefighting capability. *Sustainability*, *15*(2), 1636. https://doi.org/10.3390/su15021636

Shafique, M. (2013). Thinking inside the box? Intellectual structure of the knowledge base of innovation research (1988–2008). *Strategic Management Journal*, *34*(1), 62–93. https://doi.org/10.1002/smj.2002

Sheehan, T. (2022, July 20). Yosemite declined offer for retardant air-drop in Washburn Fire's early hours. Here's why. *The Fresno Bee*. https://www.fresnobee.com/news/california/fires/article263622408.html

Shouhed, D., Gewertz, B., Wiegmann, D., & Catchpole, K. (2012). Integrating human factors research and surgery: A review. *Archives of Surgery*, *147*(12), 1141. https://doi.org/10.1001/jamasurg.2013.596

Shumate, M., Pilny, A., Catouba, Y., Kim, J., Pena-y-Lillo, M., Rcooper, K., Sahagun, A., & Yang, S. (2013). A taxonomy of communication networks. *Annals of the International Communication Association*, *37*(1), 95–123. https://doi.org/10.1080/23808985.2013.11679147

Singh, I. (2021, August 9). Judge questions drone's role as Dixie Fire grows to second-largest in California's history. *DroneDJ*. https://dronedj.com/2021/08/08/dixie-fire-drone-use/

State of California. (2021, July 23). *Newsom Administration Secures 12 Additional Firefighting Aircraft to Support Statewide Fire Response*. Office of Governor Gavin Newsom. https://www.gov.ca.gov/2021/07/22/newsom-administration-secures-12-additional-firefighting-aircraft-to-support-statewide-fire-response/

State of California. (2022, January 22). *Governor Newsom Joins Vice President Harris to Highlight State-Federal Investments and Action to Build Wildfire Resilience*. California Governor. https://www.gov.ca.gov/2022/01/21/governor-newsom-joins-vice-president-harris-to-highlight-state-federal-investments-and-action-to-build-wildfire-resilience/

Stonesifer, C. S., Calkin, D. E., Thompson, M. P., & Kaiden, J. D. (2014). Developing an aviation exposure index to inform risk-based fire management decisions. *Journal of Forestry*, *112*(6), 581–590. https://doi.org/10.5849/jof.13-096

Strauss, A. L., & Corbin, J. M. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed). Sage Publications.

Suppiah, V., & Singh Sandhu, M. (2011). Organisational culture's influence on tacit knowledge-sharing behaviour. *Journal of Knowledge Management*, *15*(3), 462–477. https://doi.org/10.1108/13673271111137439

Sutcliffe, K. M. (2011). High reliability organizations (HROs). *Best Practice & Research Clinical Anaesthesiology*, *25*(2), 133–144. https://doi.org/10.1016/j.bpa.2011.03.001

Sutcliffe, K. M. (2018). Mindful organizing. In R. Ramanujam & K. H. Roberts (Eds.), *Organizing for reliability: A guide for research and practice* (pp. 61–89). Stanford Business Books, an imprint of Stanford University Press.

Sutcliffe, K. M. (in press). Building cultures of high reliability. *Anesthesiology Clinics*. https://doi.org/10.1016/j.anclin.2023.03.012

Sutter, M., & Kieser, A. (2019). How consultants and their clients collaborate in spite of massive communication barriers. *International Journal of Business Communication*, *56*(2), 249–277. https://doi.org/10.1177/2329488415613340

Tracy, S. J. (2010). Qualitative quality: Eight “big-tent” criteria for excellent qualitative research. *Qualitative Inquiry*, *16*(10), 837–851. https://doi.org/10.1177/1077800410383121

Tracy, S. J. (2018). A phronetic iterative approach to data analysis in qualitative research. *Journal of Qualitative Research*, *19*(2), 61–76. https://doi.org/10.22284/QR.2018.19.2.61

Tracy, S. J. (2019). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact* (2nd Ed.). John Wiley & Sons.

Tracy, S. J., & Scott, C. (2006). Sexuality, masculinity, and taint management among firefighters and correctional officers: Getting down and dirty with “America’s heroes” and the “scum of law enforcement.” *Management Communication Quarterly*, *20*(1), 6–38. https://doi.org/10.1177/0893318906287898

United States Department of Agriculture. (2006, October 21). *Glossary of Wildland Fire Terminology*. USDA Forest Service. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fswdev3_009827.pdf

U.S. National Park Service. (2017, February 13). *Wildland Fire: Incident Command System (U.S. National Park Service)*. National Park Service. https://www.nps.gov/articles/wildland-fire-incident-command-system.htm

Useem, M. (2001). *Leading up: How to lead Your boss so you both win* (1st ed.). Three Rivers Press.

Vacar, T. (2022, May 20). *Cal Fire’s aerial defense more vital this fire season than ever before*. KTVU FOX 2; KTVU FOX 2. https://www.ktvu.com/news/cal-fires-aerial-defense-more-vital-this-fire-season-than-ever-before

Veazie, S., Peterson, K., & Bourne, D. (2019). *Evidence Brief: Implementation of High Reliability Organization Principles*. Department of Veterans Affairs (US). http://www.ncbi.nlm.nih.gov/books/NBK542883/

Veterans Health Administration. (2021, April 13). [General Information]. U.S. Department of Veteran Affairs. https://www.va.gov/health/aboutvha.asp

Vogus, T. J. (2004). *In search of mechanisms: How do HR practices affect organizational performance?* [Ph.D., University of Michigan]. https://www.proquest.com/docview/305181441/abstract/300FF85943774077PQ/1

Vogus, T. J., & Iacobucci, D. (2016). Creating highly reliable health care: How reliability-enhancing work practices affect patient safety in hospitals. *Industrial & Labor Relations Review*, *69*(4), 911–938. https://doi.org/10.1177/0019793916642759

Vogus, T. J., & Sutcliffe, K. M. (2007). The Safety Organizing Scale: Development and validation of a behavioral measure of safety culture in hospital nursing units. *Medical Care*, *45*(1), 46–54. https://doi.org/10.1097/01.mlr.0000244635.61178.7a

Vogus, T. J., & Sutcliffe, K. M. (2011). The impact of safety organizing, trusted leadership, and care pathways on reported medication errors in hospital nursing units. *Medical Care*, *41*(7), 6.

Vogus, T. J., Sutcliffe, K. M., & Weick, K. E. (2010). Doing no harm: Enabling, enacting, and elaborating a culture of safety in health care. *Academy of Management Perspectives*, *24*(4), 60–77. Scopus. https://doi.org/10.5465/amp.2010.55206385

Wear, D., & Varley, J. D. (2008). Rituals of verification: The role of simulation in developing and evaluating empathic communication. *Patient Education and Counseling*, *71*(2), 153–156. https://doi.org/10.1016/j.pec.2008.01.005

Webster, J., Brown, G., Zweig, D., Connelly, C. E., Brodt, S., & Sitkin, S. (2008). Beyond knowledge sharing: Withholding knowledge at work. In J. J. Martocchio (Ed.), *Research in Personnel and Human Resources Management* (Vol. 27, pp. 1–37). Emerald Group Publishing Limited. https://doi.org/10.1016/S0742-7301(08)27001-5

Wei, K. (2007). Sharing knowledge in global virtual teams. In K. Crowston, S. Sieber, & E. Wynn (Eds.), *Virtuality and Virtualization* (pp. 251–265). Springer US. https://doi.org/10.1007/978-0-387-73025-7_18

Weick, K. E. (1993). The collapse of sensemaking in organizations: The Mann Gulch disaster. *Administrative Science Quarterly*, *38*(4), 628. https://doi.org/10.2307/2393339

Weick, K. E. (2006). *The social psychology of organizing* (2nd ed.). McGraw-Hill.

Weick, K. E., & Roberts, K. H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative Science Quarterly*, *38*(3), 357. https://doi.org/10.2307/2393372

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the unexpected: Assuring high performance in an age of complexity*. San Francisco : Jossey-Bass. http://archive.org/details/managingunexpect0000weic

Weick, K. E., & Sutcliffe, K. M. (2006). Mindfulness and the quality of organizational attention. *Organization Science*, *17*(4), 514–524. https://doi.org/10.1287/orsc.1060.0196

Weick, K. E., & Sutcliffe, K. M. (2007). *Managing the unexpected: Resilient performance in an age of uncertainty* (2nd ed). Jossey-Bass.

Weick, K. E., & Sutcliffe, K. M. (2011). *Managing the unexpected: Resilient performance in an age of uncertainty*. John Wiley & Sons.

Weick, K. E., & Sutcliffe, K. M. (2015). *Managing the unexpected: Sustained performance in a complex world* (Third edition). Wiley.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (1999). Organizing for high reliability: Processes of collective mindfulness. In *Research in Organizational Behavior* (Vol. 1, pp. 81–123). Jai Press.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science*, *16*(4), 409–421.

Wiegmann, D. A., ElBardissi, A. W., Dearani, J. A., Daly, R. C., & Sundt, T. M. (2007). Disruptions in surgical flow and their relationship to surgical errors: An exploratory investigation. *Surgery*, *142*(5), 658–665. https://doi.org/10.1016/j.surg.2007.07.034

Williams, E. A., Donovan, J., Giles, L., & McKelfresh, D. (2022). High reliability organizing through an extended crisis: A case study of a U.S. university during COVID-19. *Journal of Applied Communication Research*, *50*(6), 655–672. https://doi.org/10.1080/00909882.2022.2141066

Williams, E. A., & Ishak, A. W. (2018). Discourses of an organizational tragedy: Emotion, sensemaking, and learning after the Yarnell Hill fire. *Western Journal of Communication*, *82*(3), 296–314. https://doi.org/10.1080/10570314.2017.1313446

Wilson, K. A., Burke, C. S., Priest, H. A., & Salas, E. (2005). Promoting health care safety through training high reliability teams. *Quality and Safety in Health Care*, *14*(4), 303–309. https://doi.org/10.1136/qshc.2004.010090

Witherspoon, C. L., Bergner, J., Cockrell, C., & Stone, D. N. (2013). Antecedents of organizational knowledge sharing: A meta-analysis and critique. *Journal of Knowledge Management*, *17*(2), 250–277. https://doi.org/10.1108/13673271311315204

Wittenbaum, G. M., Hollingshead, A. B., & Botero, I. C. (2004). From cooperative to motivated information sharing in groups: Moving beyond the hidden profile paradigm. *Communication Monographs*, *71*(3), 286–310. https://doi.org/10.1080/0363452042000299894

Xiao, Y., Moss, J., Mackenzie, C. F., Seagull, F. J., & Faraj, S. (2002). Transactive responsibility systems and high reliability teams: A tentative formulation. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *46*(16), 1428–1432. https://doi.org/10.1177/154193120204601605

Xu, Z., Frankwick, G. L., & Ramirez, E. (2016). Effects of big data analytics and traditional marketing analytics on new product success: A knowledge fusion perspective. *Journal of Business Research*, *69*(5), 1562–1566. https://doi.org/10.1016/j.jbusres.2015.10.017

Zhang, L., & He, J. (2016). Critical factors affecting tacit-knowledge sharing within the integrated project team. *Journal of Management in Engineering*, *32*(2), 04015045. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000402

Ziegler, J. A. (2007). The story behind an organizational list: A genealogy of wildland firefighters' 10 standard fire orders. *Communication Monographs*, *74*(4), 415–442. https://doi.org/10.1080/03637750701716594

Appendices

Appendix A

Map of California Department of Forestry and Fire Protection Regions and Units

Note. Image is adapted from the California Power Line Fire Prevention Field Guide (Porter et al., 2021).

Appendix B

List of Semi-structured and Informal Interview Participants

Pseudonym	Rank**	Experience Range***	Primary Position/Role	Location (Region)
Al	Contractor	Senior	Pilot	Southern
Alex*	Contractor	Senior	Air Tactical Group Supervisor Trainer	HQ
Bob*	Captain	Senior	Unit Operations	Northern
Brenton	Division Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Brian	Captain	Senior	Unit Operations	Southern
Carey	Battalion Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Christian	Division Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Cornell	Firefighter I	Junior	Unit Operations	Southern
Dallas	Battalion Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Danny	Contractor	Junior	Pilot	Southern
David*	Contractor	Senior	Pilot	HQ
Dominic	Captain	Senior	Air Tactical Group Supervisor Trainee	Northern
Doug	Battalion Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Dwight	Battalion Chief	Senior	Air Tactical Group Supervisor	Northern
Forrest*	Division Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Frank	Captain	Senior	Air Tactical Group Supervisor	Southern
Harold	Battalion Chief	Senior	Tactical Air Operations/Aviation	HQ

			Maintenance Unit Leadership	
Harvey	Captain	Junior	Air Tactical Group Supervisor Trainee	Southern
Hunter	Contractor	Senior	Pilot	Southern
Ike	Battalion Chief	Senior	Incident Commander	Northern
Jack	Engineer	Junior	Unit Operations	Southern
Jameson	Captain	Senior	Air Tactical Group Supervisor	Southern
Jared	Contractor	Senior	Pilot	Southern
Jeff	Captain	Senior	Air Tactical Group Supervisor Trainee	Southern
Jon	Contractor	Senior	Pilot	HQ
Kasey	Firefighter I	Junior	Unit Operations	Southern
Langley	Captain	Senior	Unit Operations	Southern
Mark*	Deputy Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Mike*	Battalion Chief	Senior	Air Tactical Group Supervisor Trainer	Northern
Morris	Firefighter I	Junior	Unit Operations	Southern
Norris	Battalion Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Oswald	Division Chief	Junior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Otto	Captain	Senior	Unit Operations	Southern
Pablo*	Contractor	Senior	Air Tactical Group Supervisor Trainer	HQ
Paul*	Battalion Chief	Senior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Robert*	Contractor	Senior	Pilot	HQ
Ryan	Battalion Chief	Senior	Air Tactical Group Supervisor	Southern
Shaun	Firefighter I	Junior	Unit Operations	Southern
Shelton*	Contractor	Senior	Pilot	HQ
Steve*	Division Chief	Junior	Tactical Air Operations/Aviation	HQ

			Maintenance Unit Leadership	
Thomas*	Contractor	Junior	Tactical Air Operations/Aviation Maintenance Unit Leadership	HQ
Tom*	Battalion Chief	Senior	Air Tactical Group Supervisor Trainer	Northern
Travis	Captain	Senior	Air Tactical Group Supervisor	Northern
Tyler	Contractor	Senior	Pilot	Southern
Walker	Firefighter I	Junior	Unit Operations	Southern
Walter	Engineer	Senior	Unit Operations	Southern
Will	Battalion Chief	Senior	TAO/AMU Leadership	HQ
Zach	Contractor	Senior	Pilot	Southern

Note. All listed names were randomly selected using an online name generator to protect participant identities.
* Participant names marked with a single asterisk (*) after their name conducted informal discussions with quotes captured in field notes.
** All non-California Department of Forestry and Fire Protection employee participants (e.g., contract partners and interagency partners) have been placed under the broad category of contractor to protect participant identities.
*** Individuals with less than 10 years working at California Department of Forestry and Fire Protection agency experience are listed as “junior.” Individuals with 10 or more years working at California Department of Forestry and Fire Protection agency experience are listed as “senior.” Contractors are classified as working at California Department of Forestry and Fire Protection only for time periods they are actively on a California Department of Forestry and Fire Protection contracts.

Appendix C

OV-10 Aircraft

Note. The image shows an OV-10 aircraft parked at a combined helitack and air attack base. The base operations staff and facilities where personnel reside during work hours are located in the buildings directly behind the OV-10. This image was captured during a familiarization tour provided by the state firefighting organization prior to entering the first research site for observations.

Appendix D

Panoramic View of Combined Helitack and Air Attack Base

Note. The image shows a panoramic view of a combined helitack and air attack base. Fixed wing aircraft used for aerial firefighting and training are observed in the lower left and right portions of the photo; helicopters used for firefighting are observed in the upper right portion of the photo. The base operations staff and facilities where personnel reside during work hours are located in the far left buildings. This image was captured from the air communication tower during a familiarization tour provided by the state firefighting organization prior to entering the first research site for observations.

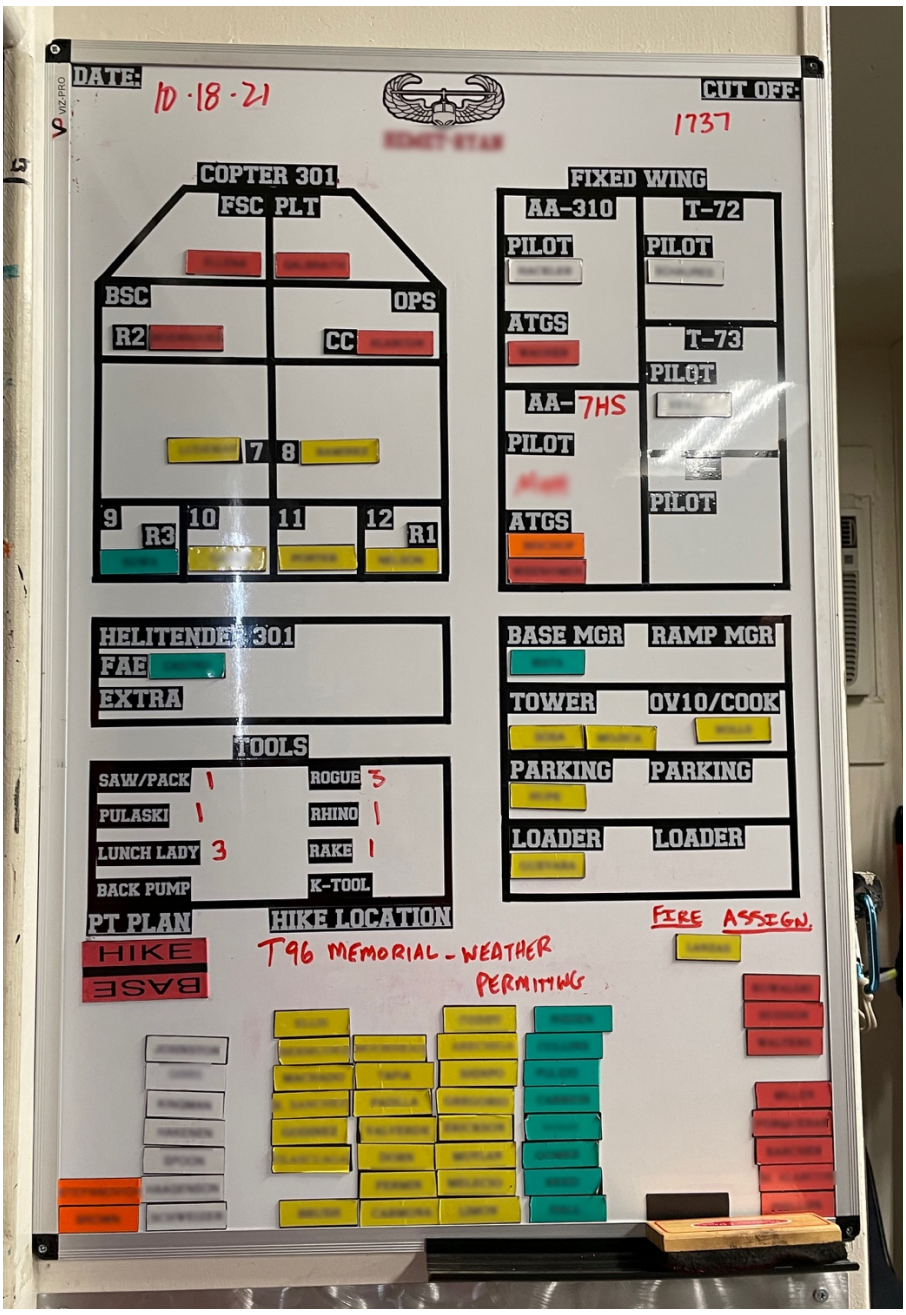
Appendix E

Sand Table Exercise Training Equipment

Note. The image shows a sand table utilized for aerial and ground firefighting training exercises. This image was captured during a familiarization tour provided by the state firefighting organization prior to entering the first research site for observations.

Appendix F

Daily Crew Assignment Board – Combined Helitack and Air Attack Base



Note. The image shows a white board with assignments for each position within the helitack and fixed wing unit at a combined helitack and air attack base. Names of team members have been obscured to protect participant identities. This image was captured during a familiarization tour provided by the state firefighting organization prior to entering the first research site for observations.

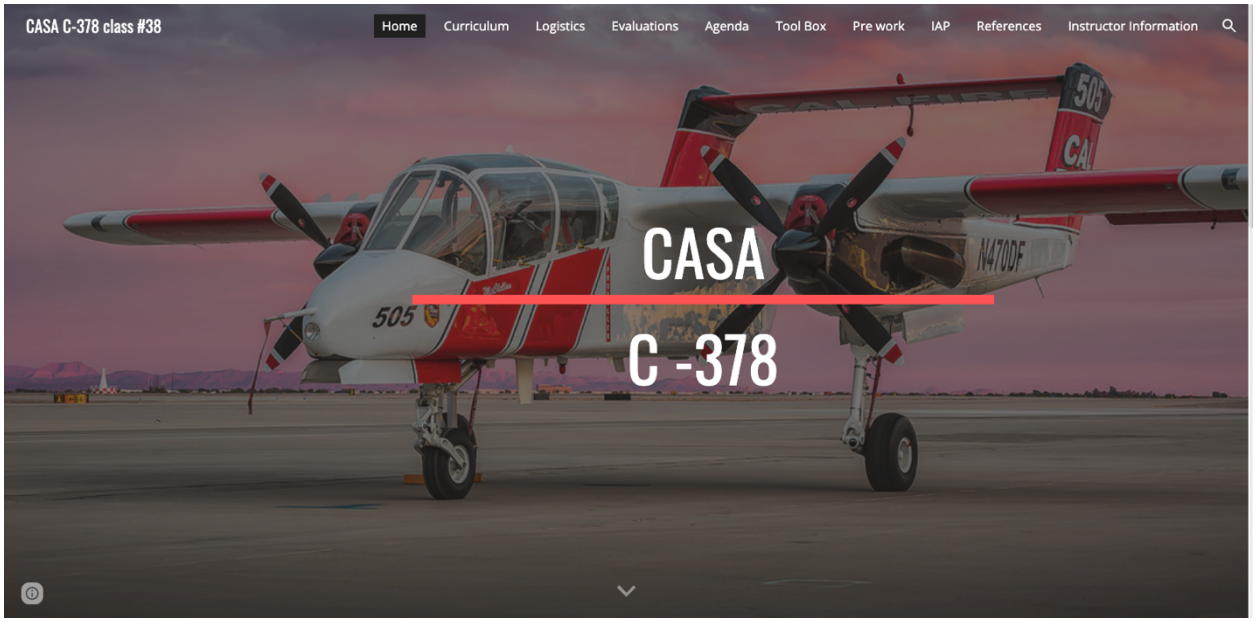
Appendix G

Non-Agency Familiarization Tour of Aircraft and Aircraft Support Facilities

Note. This image was captured during a familiarization tour facilitated by the state firefighting organization of a local agency (i.e., utility company) that works with the state firefighting agency on wildfire response. This tour was provided as a means of better understanding the complexities the state firefighting organization operated within during both its wildfire responses and daily operations.

Appendix H

Air Tactical Group Supervisor (ATGS) Training Course Materials Website



Note. The image shows the Air Tactical Group Supervisor (ATGS) trainee website home page.

Appendix I

Air Tactical Group Supervisor (ATGS) Training Course Materials

Note. The image shows the Air Tactical Group Supervisor (ATGS) trainee website home page and training materials included under the subheading “curriculum.”

Appendix J

Researcher Participant Observation of Aerial Tactical Group Supervisor "Buckhorn Incident" Training Exercise

Note. These images were captured during the Air Tactical Group Supervisor (ATGS) training exercise formally known as the "Buckhorn Incident." During this exercise, Air Tactical Group Supervisor (ATGS) trainers assisted in simulating a fire at a remote ranch location through the use of smoke devices. The researcher was invited to assist in this training endeavor.

Appendix K

In-Depth Interview Guide (60 minutes)
Topic: CAL FIRE Aviation Program (Tactical Air Operations and Aviation Maintenance Unit Leaders)
(5 minutes)

Hello, my name is Amber Lynn and I am a Ph.D. student at the University of Southern California. Thank you for participating in this interview today to discuss your experiences at CAL FIRE. Before we jump into our conversation, I wanted to share a few details and confirm once again that you are ok with participating in today's recorded interview.

1. As an employee at CAL FIRE, you are not required to participate in this interview. Today's interview is entirely voluntary, and you may choose to end this interview at any time;
2. I am recording our conversation to ensure that I accurately summarize your opinions, but no one outside of the research team will hear or watch the recording, including no one with the CAL FIRE organization;
3. There are no right or wrong answers when it comes to why you feel a certain way about something, so please share as much are you are comfortable discussing. You have been selected for this interview because of your expertise at CAL FIRE and I am looking forward to hearing your opinions and experiences;
4. Please feel free to ask me to repeat or clarify the question and take as long as you need to answer;
5. If there is a question you do not want to answer or a question that makes you uncomfortable, you do not have to answer it. Just let me know you do not wish to answer the question and I will move on to the next question.

Do you have any questions?
Do you still wish to participate in today's recorded interview?

Individual & Organizational Context/Background (10 minutes)

1. Can you share your name and your current position at CAL FIRE?
2. Can you tell me a little bit about your background and how you came to work at CAL FIRE?
3. Who are members of your team at CAL FIRE?
4. I assume your current role at CAL FIRE might be different during fire season that during the rest of the year - is that true?
    a. *If true*:
        i. Can you share an example of what a typical day looks like during the "off season"?
        ii. Can you share what a typical day looks like for you in your current role at CAL FIRE during fire season?
    b. *If not true*:

        i. Can you an example of what a typical day looks like for you?
5. Would you say it is accurate that firefighting is a risky job?
6. Would you say it is accurate that aviation is a risky job?
7. Can you give me an example of a risk that TAO deals with and how you manage that risk?
8. In relation to fighting fires and TAO, would it be accurate to say there are good outcomes and bad outcomes?
    a. Yes: What are good outcomes? Bad outcomes?
    b. No: Can you explain why that is?
9. With all the dangers and risks involved in fire aviation, what are some things CAL FIRE does that keeps bad outcomes from happening?
10. Can you give me an example of a bad outcome that happened within TAO and how that was dealt with?

Resource Scarcity (15 minutes)
Now, I'd like to talk about the resources at CAL FIRE for the aviation program.
I assume that like most state agencies in California, money and resources are always a bit tight.
Is this an accurate representation of the CAL FIRE aviation budget right now?

1. Can you share an example of how the current CAL FIRE budget and resources available have impacted your job?
    a. *Probe:* What have you done about it?
2. Can you describe how access to resources affects your job compared to another CAL FIRE department?
    a. *Probe:* What about compared to other agencies?
3. Can you describe an example of how access to resources has impacted the safety outcomes of your job and what you've done about it?
4. If a magic bag of money was available and CAL FIRE was given unlimited resources for one day (and one day only!), what would you get?
    a. Probe: Why would you get that?

Interagency Dependency (20 minutes)
As I understand it, CAL FIRE doesn't fight fires alone, but works with other agencies to help it fight fires in California…

1. Is this an accurate understanding of how wildland firefighting generally works in California?
2. *If true*:
    a. Can you share an example of another organization CAL FIRE aviation works with and what the <u>day-to-day relationship</u> looks like?
    b. Can you share an example of how this relationship works <u>when fighting a fire?</u>
    c. Can you tell me about a challenge or difficultly you've experienced when working with another organization?
        i. YES: What did you do about it?

        ii. NO: Why do you think this is the case [Probe: Why no difficulties - highly unusual!!]?
    d. Can you share an example of a relationship that has changed significantly in the past year between CAL FIRE aviation program and another organization?
        i. Probe: Why is that?
3. *If not true*:
    a. Can you describe what role other organizations (such as the U.S. Forest Service) play in fighting wildfires in California?
    b. Can you tell me how the CAL FIRE aviation program is impacted by other agencies (such as the U.S. Forest Service) when fighting wildfires?

Hard/Soft Power Laxity (10 minutes)
As I understand it, CAL FIRE is governed by state laws and can't really order people or agencies around in the same way the military can - is this true?

1. Can you tell me how you work around not being able to order people what to do, such as employees from other agencies, especially during a fire?
2. During a fire, are there ever situations where employees don't want to follow the rules set by CAL FIRE?
    a. YES: Can you share an example?
    b. NO: Why do you think this is not an issue?
3. Can you share an example of a policy or rule that you've seen someone ignore and how you handled the situation?

Final Organizational Questions (10 minutes - time permitting)

1. Can you share an example of teamwork you've experienced within the CAL FIRE aviation program?
2. Can you share an example of what you see as the biggest challenge facing the CAL FIRE aviation program?
3. Can you describe the biggest strength of the CAL FIRE aviation program?
4. Do you mind if I contact you after the fire season is over for a possible additional interview?

Appendix L

In-Depth Interview Guide (30 minutes)
Topic: CAL FIRE Aviation Program (Tactical Air Operations Teams) ATGS (Air Tactical Group Supervisor
(5 minutes)

Hello, my name is Amber Lynn and I am a Ph.D. student at the University of Southern California. Thank you for participating in this interview today to discuss your experiences at CAL FIRE. Before we jump into our conversation, I wanted to share a few details and confirm once again that you are ok with participating in today's recorded interview.

1. As an employee at CAL FIRE, you are not required to participate in this interview. Today's interview is entirely voluntary, and you may choose to end this interview at any time;
2. I am recording our conversation to ensure that I accurately summarize your opinions, but no one outside of the research team will hear or watch the recording, including no one with the CAL FIRE organization;
3. There are no right or wrong answers when it comes to why you feel a certain way about something, so please share as much are you are comfortable discussing. You have been selected for this interview because of your expertise at CAL FIRE and I am looking forward to hearing your opinions and experiences;
4. Please feel free to ask me to repeat or clarify the question and take as long as you need to answer;
5. If there is a question you do not want to answer or a question that makes you uncomfortable, you do not have to answer it. Just let me know you do not wish to answer the question and I will move on to the next question.

Do you have any questions?

Do you still wish to participate in today's recorded interview?

Individual & Organizational Context/Background (10 minutes)

1. Can you share your name and your current position at CAL FIRE?
2. Can you tell me a little bit about your background and how you came to work at CAL FIRE?
3. [If not discussed prior] Can you walk me through how you were selected for ATGS training?
    a. Did you WANT to be an ATGS?

ATGS Training (10-20 minutes)

1. Walk me through a training day during the second half of CASA, from wakeup to going to sleep. What did your day look like?
2. Tell me about the test at the end of the training – did you feel prepared, and how did it go?

3. Can you give me an example of what you thought the easiest element of the ATGS training was and why?
4. Can you give me an example of what you thought the hardest element of the ATGS training was and why?
5. How real were the simulations at the training, based on your experience?
6. In your opinion and based on your experience, how real was the Buckhorn exercise compared to an actual wildfire?
7. Thinking back to the Buckhorn exercise specifically, can you share an example from the training on how your coordination with the IC went?
8. Tell me about the feedback process – did most of your feedback come from CALFIRE instructors, USFS, or both?
    a. Can you share an example of specific feedback that you remember from the training?
9. The training includes a pairing with a Federal (USFS) partner – what are your thoughts on this pairing?
    a. Is it a useful part of the training?
    b. Did you like your partner?
    c. Can you give me an example from your recent training on how this partnership worked – or did not work?
    d. Can you tell me about a challenge or difficultly you've experienced when working with another organization?
10. Now that your CASA training is complete, what is next in your process for an ATGS role?

ATGS/TAO (10 minutes)

1. Is the aviation team at CALFIRE different than other CALFIRE teams (e.g. schedule 1 teams)? Can you give me an example?
2. What do you think is the biggest risk someone in the ATGS position will face?
    a. Can you give me an example of why you believe that?
3. If you could change anything at all about the ATGS position or the training, what would you change?

Final Organizational Questions (10 minutes - time permitting)

1. Can you share an example of teamwork you've experienced within the CAL FIRE aviation program?
2. Can you share an example of what you see as the biggest challenge facing the CAL FIRE aviation program?
3. Can you describe the biggest strength of the CAL FIRE aviation program?

Appendix M

In-Depth Interview Guide (30 minutes)
Topic: CAL FIRE Aviation Program (Tactical Air Operations Teams) ATGS (Air Tactical Group Supervisor) Post-Flight Interview Guide
(5 minutes)

Thank you for participating in this additional interview today to discuss your experiences at CAL FIRE. Before we jump into our conversation, I wanted to share a few details and confirm once again that you are ok with participating in today's recorded interview.

1. As an employee at CAL FIRE, you are not required to participate in this interview. Today's interview is entirely voluntary, and you may choose to end this interview at any time;
2. I am recording our conversation to ensure that I accurately summarize your opinions, but no one outside of the research team will hear or watch the recording, including no one with the CAL FIRE organization;
3. There are no right or wrong answers when it comes to why you feel a certain way about something, so please share as much are you are comfortable discussing. You have been selected for this interview because of your expertise at CAL FIRE and I am looking forward to hearing your opinions and experiences;
4. Please feel free to ask me to repeat or clarify the question and take as long as you need to answer;
5. If there is a question you do not want to answer or a question that makes you uncomfortable, you do not have to answer it. Just let me know you do not wish to answer the question and I will move on to the next question.

Do you have any questions? Do you still wish to participate in today's recorded interview?

(25 minutes)

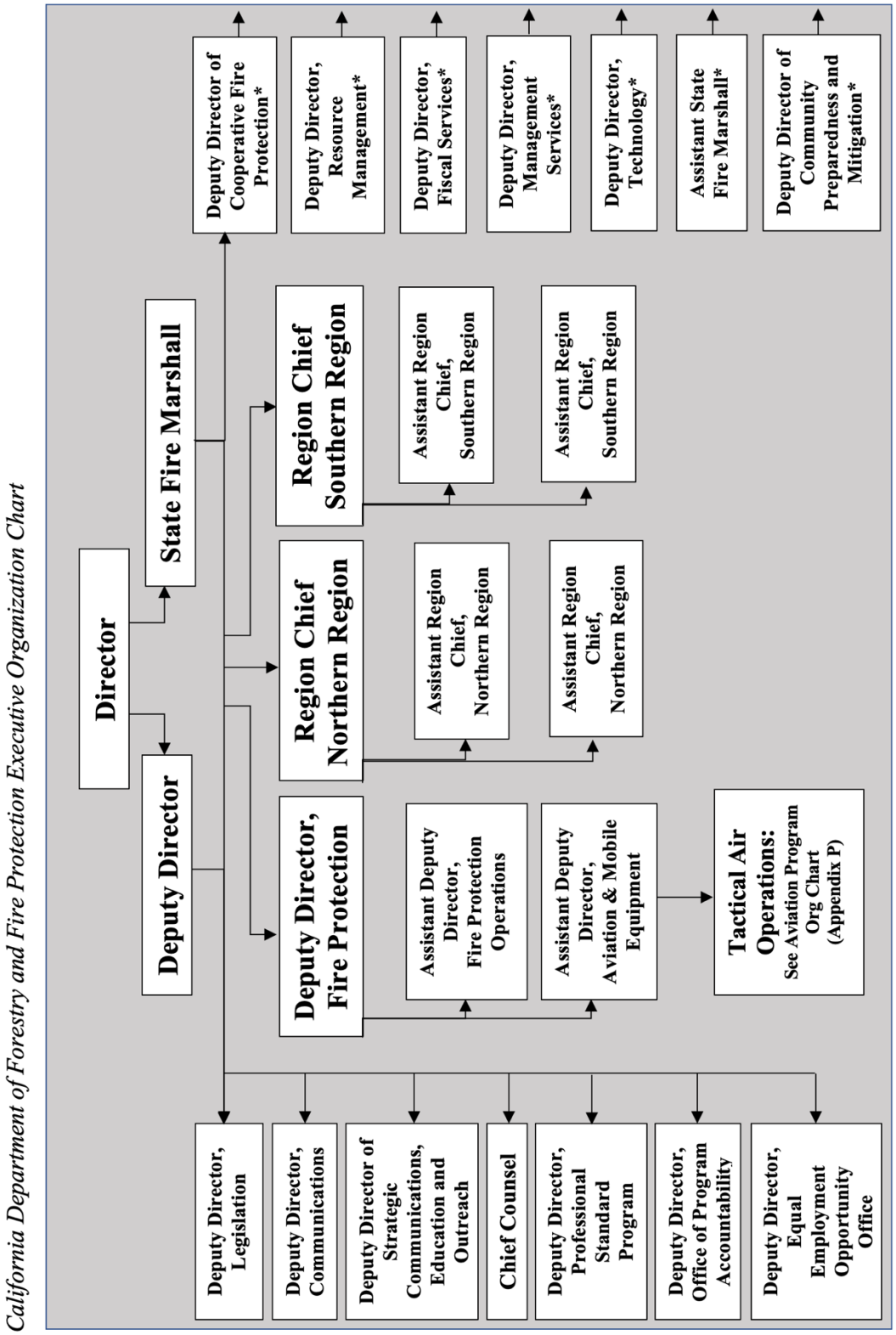
1. What was the qualification process like?
    a. Was any part easy for you?
    b. What did you struggle with most?
    c. Did any part of the qualification training surprise you?
    d. Who did you communicate with most?
2. Can you tell me the most memorable fire you had during your training?
    a. Can you tell me about the easiest fire you had during your training?
    b. Can you tell me the most difficult flight or fire you had during your training?
3. What makes an ATGS an expert at aerial firefighting compared to the IC?
4. How do you know how to direct the different types of aircraft to put out the fire most effectively? Where do you learn that?
5. After a fire is put out and you land, what happens next?
6. Besides the radios, did you ever use other technology to communicate with the IC, like your cell phone? How was that?
7. Based on your experience now, what do you think is the most important part of the ATGS job?

Appendix N

Meal Triangle

Note. The triangle was used to call team members to meals at a California Department of Forestry and Fire Protection southern region air attack base.

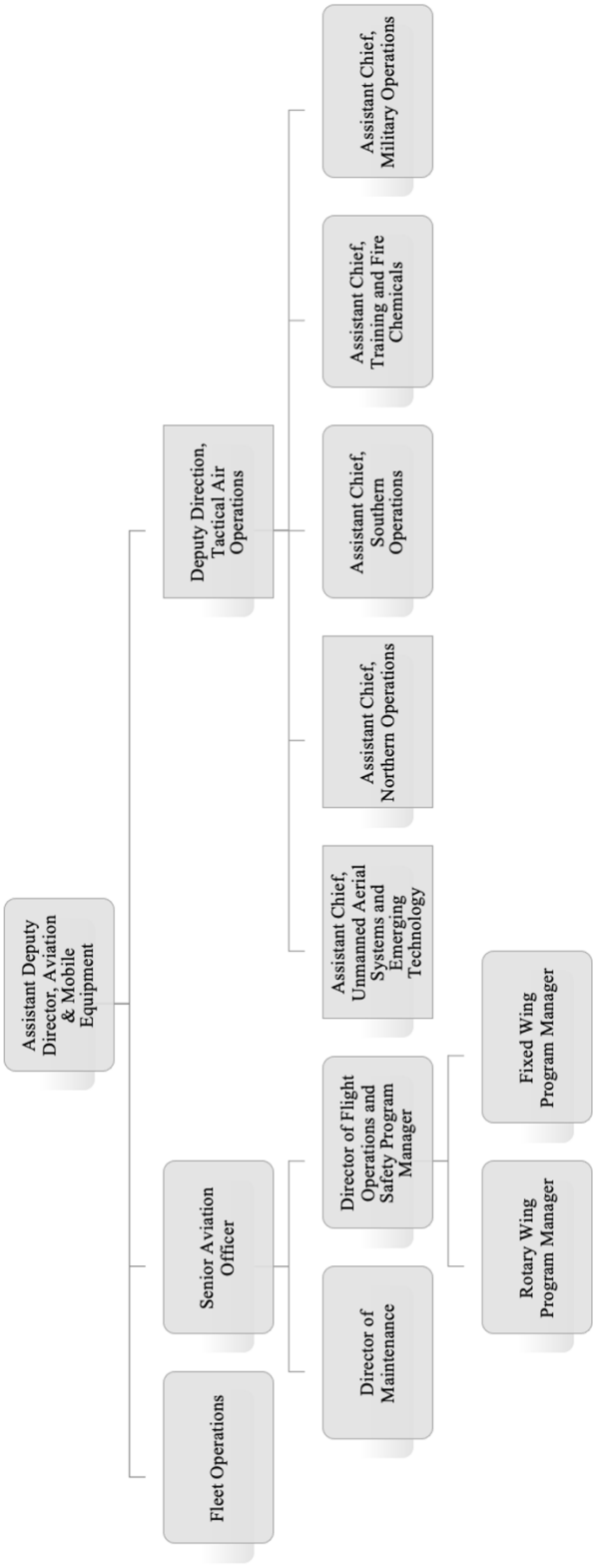
Appendix O



California Department of Forestry and Fire Protection Executive Organization Chart

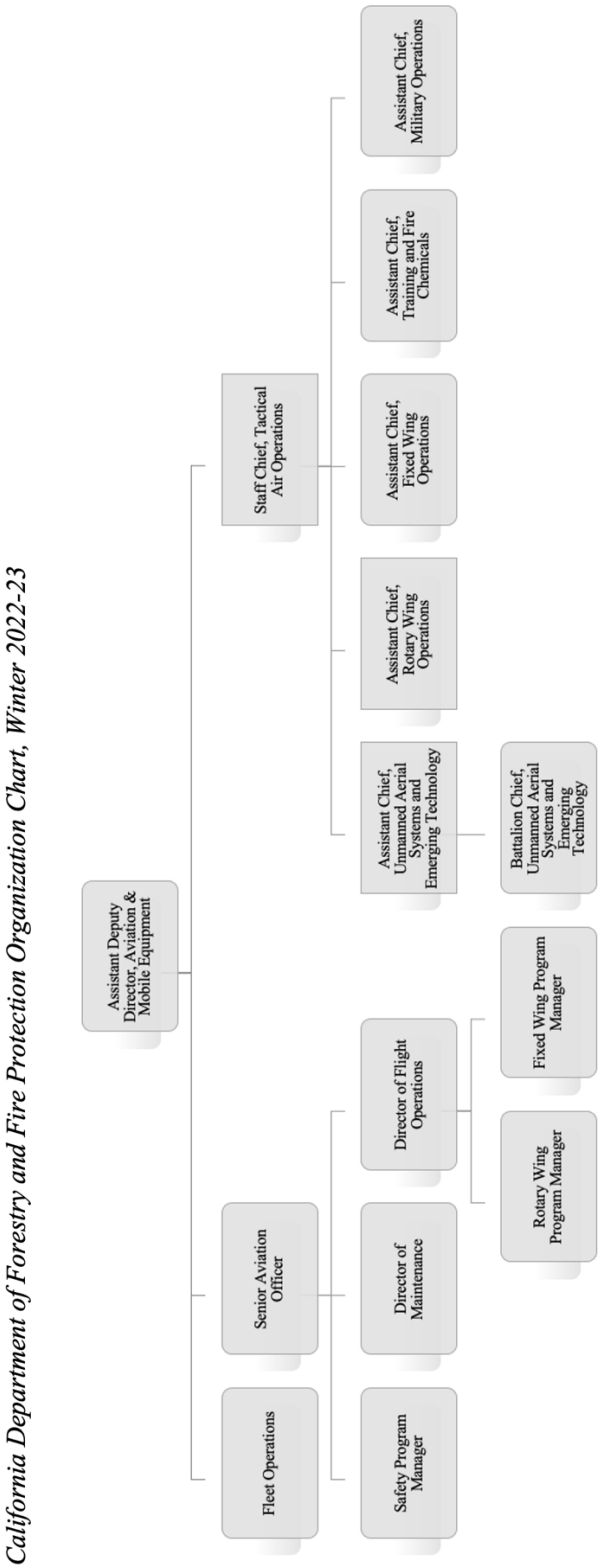
Appendix P

California Department of Forestry and Fire Protection Aviation Program Organization Chart, Spring 2022



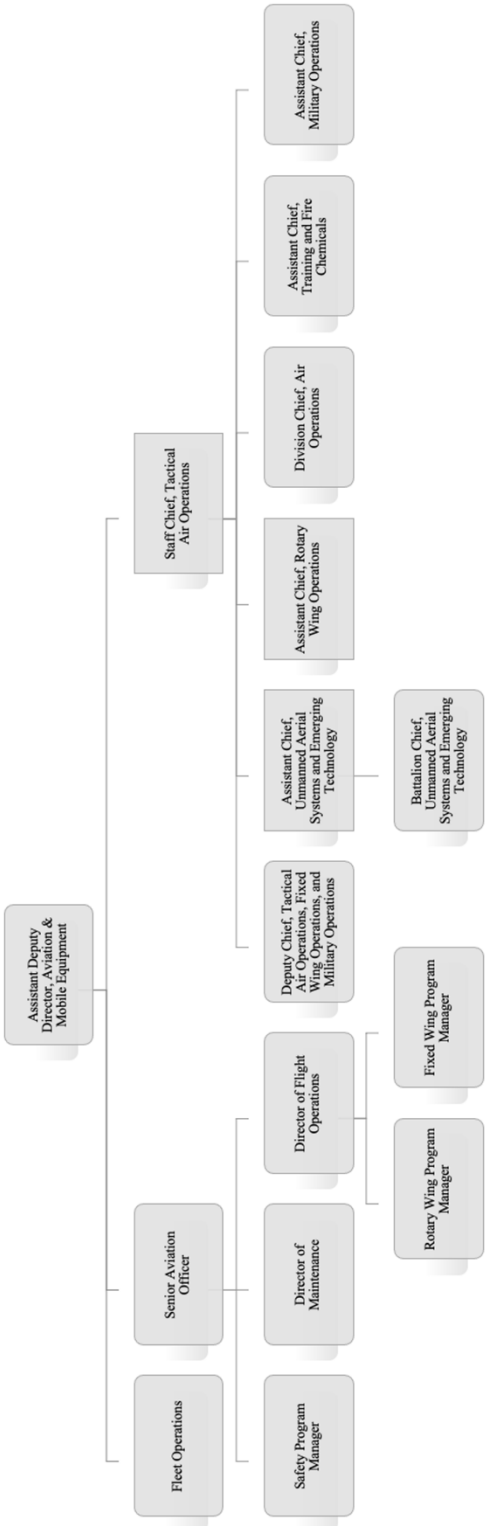
Appendix Q

California Department of Forestry and Fire Protection Organization Chart, Winter 2022-23



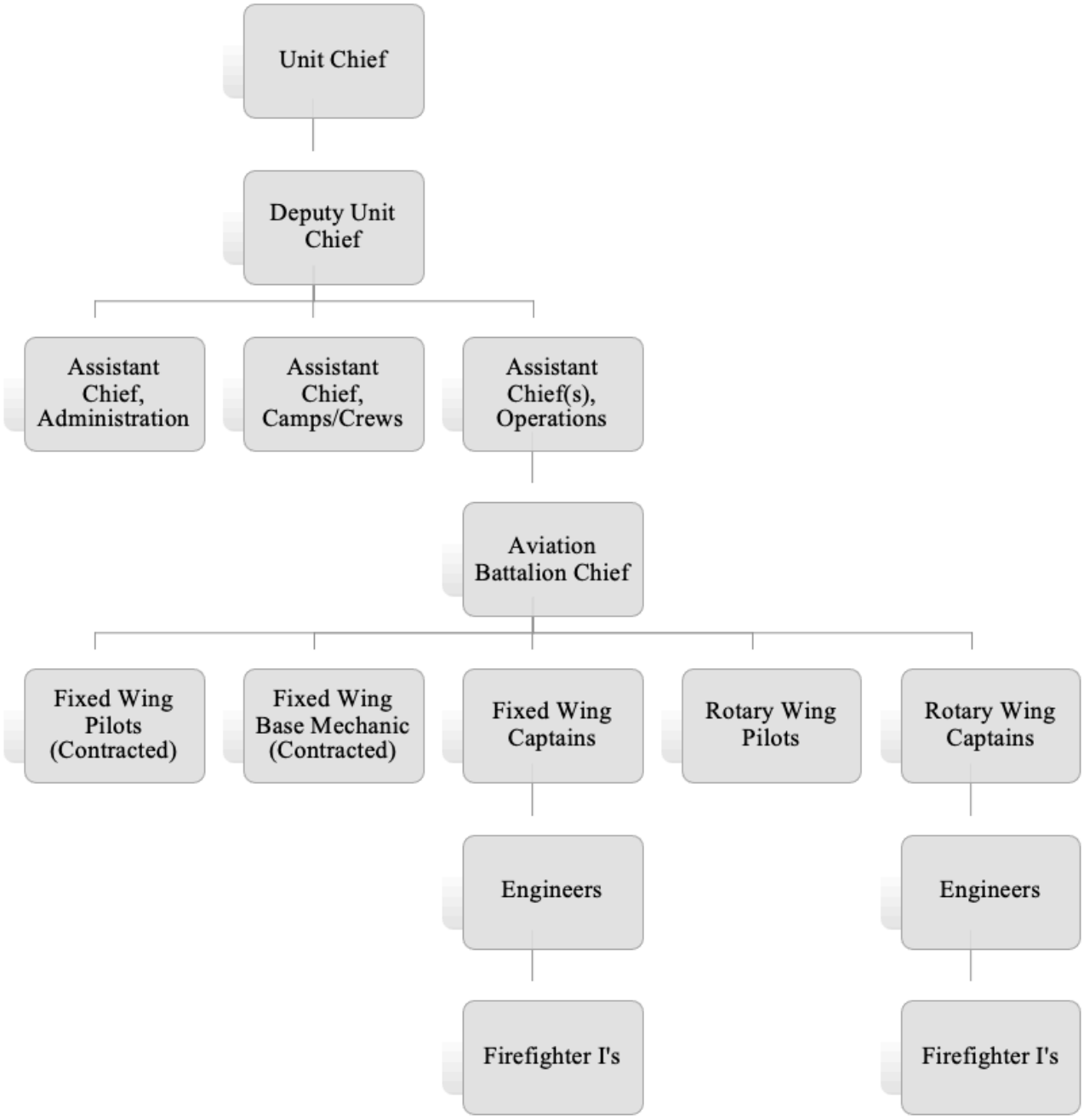
Appendix R

California Department of Forestry and Fire Protection Organization Chart, Spring 2023 (Pending as of 4/1/23)



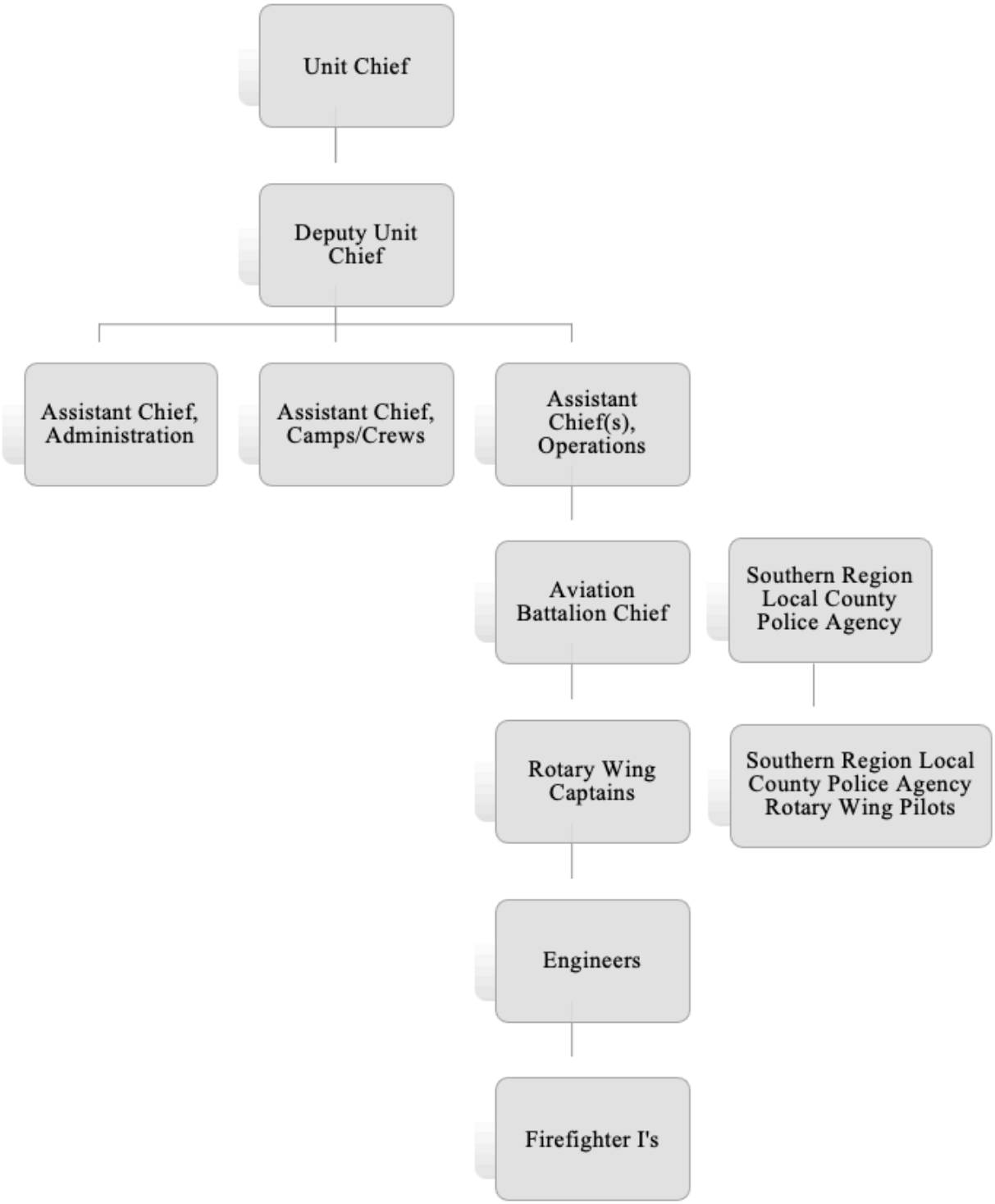
Appendix S

California Department of Forestry and Fire Protection Fixed Wing Unit Organization Chart



Appendix T

California Department of Forestry and Fire Protection Interagency Rotary Wing Organization Chart



Appendix U

Aerial Viewpoint From an Air Tactical Group Supervisor Training Flight Above the Buckhorn Incident Fire Simulation

Note. This view was captured from the King Air training aircraft, which is a different aircraft that the OV-10 that air tactical group supervisors traditionally utilize after obtaining their air tactical group supervisor qualification. However, the view represents the general overall perspective all air tactical group supervisors will have during an initial attack fire. This image was captured from video captured during the Buckhorn Incident, a training evolution, which predominantly utilized smoke machines and included only small incidental fires.