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Analysis of Australian aerial firefighting agency and operator interviews regarding aviation safety

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Acknowledgement of Country and Traditional Owners

The Australian Transport Safety Bureau acknowledges the traditional owners of country throughout Australia, and their continuing connection to land, sea and community. We pay our respects to them and their cultures, and to elders both past and present.

Executive summary

Why the ATSB conducted this study

Australian aerial firefighting is facing an escalating risk environment. Submissions from operators engaged in aerial firefighting operations to the 2020 Royal Commission into National Natural Disaster Arrangements (RCNNDA) highlighted several issues potentially affecting safety. The ATSB's statistical report AR-2020-022 found the number of occurrences per financial year had increased steadily since 2016–17 until March 2020. Since 2016, the ATSB has commenced 17 investigations involving aerial firefighting aircraft.

The ATSB is conducting a safety study to identify any systemic safety issues and other learning opportunities that could enhance the safety of aerial firefighting operations. As part of this safety study, the ATSB conducted in-depth interviews between May 2022 and February 2023 with 11 Australian fire agency representatives from all Australian states and territories, and 9 aircraft operators involved in firefighting operations. The aim of the interviews was to better understand the aviation hazards interviewees faced, how aviation safety was managed, and the opportunities they could see to improve the safety of aerial firefighting operations. This report presents the results of those interviews, and the key safety themes that emerged from interviewees' comments.

What the ATSB found

Eighteen key safety themes emerged from interviewees' comments. There was often wide variation in interviewees' perceptions of the fire agencies relating to each safety theme. Additionally, agency representatives and aircraft operators had opposing views on some of the safety themes such as safety culture and pressure to fly.

Several safety themes related to fire agencies' safety culture. Interviewees highlighted the need for fire agencies to develop a just, reporting, informed, learning and flexible culture. Additionally, most of the remaining safety themes also contribute to a positive safety culture.

The safety themes of standardisation and informal risk management contributed to several other safety themes. Interviewees raised these issues in relation to several areas of operation, including aircraft coordination, communication, training, pilot performance, risk identification and monitoring of changing risk conditions.

Interviewees perceived a need for fire agencies to play a greater role than they do currently in risk management and ongoing risk monitoring. Additionally, sustaining risk management practices during periods of increased intensity and complexity was reportedly a challenge for fire agencies, particularly during the 2019–20 fire season.

Contents

This report presents interviewees' perceptions on safety in Australian aerial firefighting operations. Interviewees' beliefs about potential safety concerns do not demonstrate that they are safety concerns and may not represent the views of other fire agency representatives and aerial firefighting operators.

Additionally, interviewees' perceptions represent a snapshot of their views at the time of the interviews. Interviewees' views, and the circumstances within aerial firefighting upon which they are commenting, may have changed since the time of the interviews. Further, since the interviews were conducted, fire agencies are at varying stages of reviewing or developing various aviation safety and risk management policies or practices that may address issues raised by interviewees.

This report does not contain findings and is part of the safety analysis for AS-2021-015 *Review of aviation safety aspects of aerial firefighting in Australia*. This report supports conclusions and findings for that safety study.

Introduction

Background

Australian aerial firefighting is facing an escalating risk environment (NAFC, 2021). Aerial firefighting activity has increased over recent bushfire seasons (ATSB, 2020a) and this increase is likely to continue. The Bureau of Meteorology (BoM) and CSIRO's 2024 *Annual State of the Climate* report continues to highlight the warming of Australia's climate and an associated increase in extreme fire weather and length of the fire season (BoM and CSIRO, 2024). Consequently, fire seasons are increasingly overlapping between the southern and northern hemispheres. This puts pressure on aircrew and aircraft resources, including large air tankers (LAT), the majority of which are currently sourced from Canada and the USA (Richardson and others, 2025). The human side of the risk equation for bushfires in Australia is also escalating, with rapidly expanding urban-rural interfaces around the major cities (Beringer, 2000). These changes not only mean the potential for increased firefighting activity and a greater need for personnel to support those operations, but also introduce new challenges and potential risks to Australian aerial firefighting. Other changes representing possible increased risk include the introduction of night firefighting operations and other evolving technologies or aircraft types, such as the use of remotely piloted aircraft systems (RPAS) to support firefighting operations (Binskin and others, 2020).

Following the 2019–20 fire season, a Royal Commission into National Natural Disaster Arrangements (RCNNDA) was held. Submissions from aerial firefighting operators highlighted several potential safety concerns. A common theme was the increasing complexity of the environment and the equipment used. This reportedly leads to change outpacing the capabilities and training of fire agency crew, a lack of standardisation and collaboration, a lack of a clear system for managing aviation risk, and communication problems. Additionally, aircraft operators cited commercial pressure, high accountability

for safety with low control, safety culture, and agency reporting and feedback processes.[1]

In 2020, as part of a response to the RCNNDA, the ATSB released the statistical report AR-2020-022*: A safety analysis of aerial firefighting occurrences in Australia, July 2000 to March 2020.* Some key results included:

- There were more occurrences involving aerial firefighting aircraft in Australia between July 2019 and March 2020 than any financial year in the study period (July 2000 to March 2020). Further, the number of occurrences per financial year had increased steadily since 2016–17.
- The average maximum take-off weight (MTOW) of aerial firefighting aircraft involved in a reported occurrence increased significantly over the study period. Foreign registered aircraft, which had an average MTOW around 10 times that of VH registered aircraft, contributed most to this increase.

The National Aerial Firefighting Centre (NAFC) reported that on the busiest day (31 December 2019) of the 2019–20 season alone, there were 1,350 flights involving 203 aircraft (Alder, 2020). Overall, the NAFC estimated that the 2019–20 fire season had around 4 times more aviation activity than the previous season, with 328 individual aircraft flying 79,705 hours (ATSB, 2020). The rapid increase of firefighting activity means increased density of aircraft over the fireground, putting a significantly higher demand on tasking, coordination and communication processes. Since 2016, the ATSB has commenced 17 investigations involving aerial firefighting aircraft, with 10 of those investigations occurring in the last 5 years. Additionally, the ATSB has received anecdotal reports from aerial firefighting pilots and operators concerned about the way activities are coordinated and unsafe tasking. These reports also indicated that many do not want to report occurrences to the ATSB as it may affect their potential to win contracts with firefighting agencies.

It is within the context of the aforementioned factors that the ATSB commenced safety study AS-2021-015 *Review of aviation safety aspects of aerial firefighting in Australia* to conduct a detailed examination of Australian aerial firefighting activities. As part of this safety study, the ATSB interviewed representatives from fire agencies from each Australian state and territory and key aerial firefighting operators.

Safety study goals

The goal of safety study AS-2021-015 *Review of aviation safety aspects of aerial firefighting in Australia* is to identify any systemic safety issues and other learning opportunities that could enhance the safety of aerial firefighting operations. The safety study is divided into 4 parts:

- Part A (this report), AS-2021-015a, presents the key safety themes reported by interviewees. It does not contain findings. The goal of Part A is to better understand the aviation hazards interviewees faced, and the opportunities they could see to improve the safety of aerial firefighting operations.

[1] Further details of submissions to the RCNNDA can be found at https://webarchive.nla.gov.au/awa/20211005051313/https://naturaldisaster.royalcommission.gov.au/.

- Part B, AS-2021-015b, will present the results from a survey of NAFC-registered aerial firefighting pilots.
- Part C, AS-2025-015c, will expand upon the ATSB statistical report AR-2020-022 and identify key trends in Australian aerial firefighting occurrences.
- The final report, AS-2025-015, will present a synthesis of the conclusions in Parts A to C to identify any systemic safety issues and other learning opportunities that could enhance the safety of aerial firefighting operations.

Aerial firefighting in Australia: an overview

Roles and types of aircraft

Aviation is an essential component of Australia's response to bushfires. Although aircraft alone cannot put out fires, they nevertheless play a significant role. A wide range of fixed-wing and rotary-wing aircraft are used to support fire operations. They are a mix of helicopters, Large Air Tankers (LAT), Single-Engine Air Tankers (SEAT), reconnaissance aircraft and special purpose aircraft. No single aircraft type is universally more effective than others in aerial firefighting. Their effectiveness depends on matching their capabilities with factors such as the task objectives, weather conditions, terrain, distance from a refilling source, and take-off and landing requirements. The aircraft engage in various support roles including fire detection, scanning and mapping, firebombing (where a suppressant is dropped on, or near, the fire to prevent the fire from spreading), aircraft coordination and tactical supervision, and transport and logistics roles.

Operational environment

Aerial firefighting operations occur in an inherently hazardous environment. The NAFC issues a contract that aircraft operators must accept to provide aerial firefighting services. The contract describes the 'operational environment' and creates a contractual obligation for operators to accept it. The operational environment is characterised by the following features, as outlined in the NAFC specimen contract (2025a):

- meteorological conditions at extremes with weather conditions generating extreme turbulence
- significantly reduced visibility cause by smoke, low cloud, dust or precipitation
- terrain that may be unfamiliar to personnel
- remote locations with limited or no facilities or supplies
- risk of dehydration and fatigue on personnel
- tasks required outside normal business hours
- multiple aircraft operating in close proximity
- implied or express pressure to "get the job done" given the nature of the tasks, fire or emergency operations, particularly when life or property or livelihoods are threatened
- stress associated with large scale fire and emergency operations
- operations occurring at low level with hazards including the terrain, smoke, wires, obstructions, locusts or birds

- requirements to fly over water
- prolonged periods where services are required to be provided.

Structure of industry

Fire agencies

In Australia, state and territory governments are primarily responsible for the management of bushfires within their borders. Each state or territory can have multiple agencies, all established by a separate Act of Parliament, with potentially overlapping responsibilities. For those states and territories with multiple fire agencies, separate agencies have responsibility for fires in metropolitan areas as opposed to bushfires or fires in state forests and national parks. Some agencies also have a central emergency management body and a state emergency management plan above them. This study only involved those fire agencies that use aerial firefighting assets to fight bushfires, and did not involve agencies responsible for metropolitan areas. The ATSB interviewed representatives from one fire agency in each state and territory except for NSW and WA, where there are 2 fire agencies engaged in aerial firefighting operations to fight bushfires. The fire agencies that participated in this safety study are:

- Australian Capital Territory Rural Fire Service (ACT RFS)
- Bushfires Northern Territory (Bushfires NT)
- Department of Biodiversity, Conservation and Attractions (DBCA), Western Australia
- Department of Energy, Environment and Climate Action (DEECA),[2] Victoria
- Department of Fire and Emergency Services (DFES), Western Australia
- New South Wales Rural Fire Service (NSW RFS)
- NSW National Parks and Wildlife Service (NPWS)
- Queensland Fire Department (QFD)[3]
- South Australian Country Fire Service (SA CFS)
- Tasmania Fire Service (TFS).

National Aerial Firefighting Centre and aircraft operators

Around 500 aircraft provided by over 150 operators are used in aerial firefighting operations across Australia (NAFC, 2024c). Many aerial firefighting aircraft are owned or contracted directly by the fire agencies in each state and territory. Fire agencies also use aircraft operators that have been procured by the NAFC.

The NAFC is a business unit of the National Council for Fire & Emergency Services (AFAC), which is the peak body responsible for representing fire, emergency services and land management agencies in Australia and New Zealand. The NAFC is a member based, non-profit organisation with membership drawn from the fire and emergency services agencies of the Australian states and territories. The NAFC procures the aircraft, along with their maintenance, fuelling, crew and insurance (Binskin and others, 2020). The NAFC contracts approximately 170 aircraft on behalf of the states and territories. These aircraft were provided by approximately 30 operators from all Australian

[2] DEECA was previously known as the Department of Environment, Land, Water and Planning (DELWP) until January 2023.
[3] QFD was previously known as Queensland Fire and Emergency Services (QFES) until July 2024.

states and territories for the 2024/2025 season (NAFC, 2024c). All operators are required to have either a Civil Aviation Safety Regulations 1998 (CASR) Part 137 air operator's certificate (AOC) or a CASR Part 138 Aerial Work Certificate (AWC) and must also meet certain standards for their aircraft and pilots that are contained in the NAFC contract.

The NAFC also coordinates the sharing of its fleet of contracted aircraft between fire agencies throughout Australia, alongside colleagues in the National Resource Sharing Centre (NRSC). Additionally, some state and territory agencies use a register of operators contracted by the NAFC on a call-when-needed (CWN) basis. Aerial firefighting pilots are employed by the aircraft operators who either supply aircraft services to the NAFC or directly to state and territory agencies under contract.

The NAFC has a Strategic Committee that has committed to facilitating several safety actions for the aerial firefighting industry, such as assisting in the development of nationally consistent standards and strategies that identify and manage risk in aerial firefighting (NAFC, 2023).

Method

Methodology

This study used a qualitative approach of in-depth, semi-structured interviews within an interpretive framework.[4] The emphasis was on understanding how risks are identified and managed in aerial firefighting from the perspective of those who operate within it, rather than the testing of any specific hypotheses.

Interview participants

Interviews were conducted between May 2022 and February 2023 with 11 Australian fire agency representatives from all Australian states and territories, and 9 operators involved in firefighting operations in different states and territories across Australia. Participants were selected using a purposive sampling technique.[5] Fire agency personnel were selected from all the fire agencies engaged in aerial firefighting operations in Australia, representing all states and territories.[6] They were either the head of aircraft operations or a similar position within their agency. Operators were selected to provide a cross-section of locations, size of operation and type of aircraft flown.

Interview process

The interviews were conducted using videoconferencing and ranged from at least 1 hour to 2.5 hours in length. Interviews were recorded and then transcribed verbatim.

Interview questions

The interviews were semi-structured. They combined a pre-determined set of open-ended questions to prompt discussion, with the flexibility to explore particular themes or responses further. Interviewees were asked broad, open-ended questions, such as ‘where do you think the biggest improvements to safety could be made?’ or ‘what do you consider the main threats to safety to be?’ Follow-up questions were asked about particular topics raised by the interviewee, which may not have been considered in the determination of topics prior to interview. The interviewee therefore partly controlled the direction of the interviews, so the same questions were not asked of all interviewees.

Resilience engineering

This study used the resilience engineering approach as a basis to structure the interview questions and prompt discussion with the interviewee. Resilience engineering is part of the ‘Safety II’ philosophy of safety management, which focuses on understanding why

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4 An interpretive framework reflects a belief that not all aspects of reality can be quantitatively measured or observed. Instead, understanding of a given situation (such as aerial firefighting operations) can be best achieved by asking the participants themselves, and analysing the themes that result (Neuman, 1997).

5 Purposive sampling is a non-randomized sampling technique where researchers select individuals or groups with particular knowledge, skills, or experiences relevant to the research question. The benefit of purposive sampling is that selecting participants most relevant to the research question improves the relevance, quality and accuracy of data collected (Neuman, 1997).

6 For some of the states and territories, 2 representatives were interviewed, resulting in a total of 11 interviewees for 9 fire agencies.

things go right by understanding everyday activities and treating safety as an emergent property of an organisational system (Hollnagel and others, 2015). According to Hollnagel (2015):

> Resilience engineering looks at how systems can sustain required operations under both expected and unexpected conditions by adjusting its functioning prior to, during, or following changes, disturbances, and opportunities.

It is this focus on sustaining operations under both expected and unexpected conditions that made resilience engineering a particularly suitable basis for examining aerial firefighting operations in interview.

The resilience engineering approach understands a system's resilience in terms of its ability to respond to, monitor, learn from and anticipate risk (see *Appendix A* for more details). The pre-determined questions to draw from during interview were primarily generated against these 4 main elements (see *Appendix B* for more details). An early peer review highlighted the need to add additional questions relating to topics such as tasking. Other concepts from safety management research such as safety culture were also used.

Limitations

A limitation of this study was the small sample size of fire agency representatives and aerial firefighting operators. Since the purpose of the interviews was to understand the aviation hazards interviewees faced, and the opportunities they could see to improve the safety of aerial firefighting operations, it was unnecessary to obtain a larger sample. The aim was not to canvas the views of the industry as a whole, but rather to gain insight into interviewees' perspectives via a smaller group of in-depth interviews. Nevertheless, it is important to emphasise that the interviewees' perspectives presented here cannot be said to be representative of all agency representatives and aerial firefighting operators. Additionally, a limitation of any interviewing is that there may be a difference between what interviewees say and what actually happens in practice.

Further, interviewees' beliefs about potential safety concerns do not demonstrate that they are safety concerns. At the time of publication, their perceptions have not been tested by the ATSB.

Interviewees' comments will be considered alongside the survey results in Part B (AS-2021-015b), occurrence data analysis in Part C (AS-2021-015c) and other evidence sources in the final report of the safety study (AS-2021-015).

Method of analysis

The interviews were transcribed in full and then coded[7] and analysed using the grounded theory analysis method (see *Appendix C* for a more detailed discussion of the grounded theory method). Grounded theory analysis is a systematic method for analysing

[7] Coding refers to 'categorising segments of data with a short name that simultaneously summarises and accounts for each piece of data' (Charmaz, 2005).

qualitative data.[8] It aims to produce an explanation that is 'grounded' in the data, rather than taking an already-held theory and testing or applying it.

Grounded theory analysis consists of 3 main stages. Stage one involved assigning a code[9] to each comment interviewees made. The codes assigned at this stage involved minimal analysis or interpretation and were akin to labelling. This stage produced a relatively long list of codes. In order to enhance inter-rater reliability, the first round of coding was validated by comparing the codes independently assigned by 3 ATSB investigators. Any discrepancies identified between investigators' codes were discussed and resolved.

In stage 2 of the coding process, the codes were refined using the constant comparative method, which involved comparing each new code with previous ones, to look for connections and create categories (Birks and Mills, 2023). At this stage, the focus of the codes was less about summarising the comments and more about what they represented. As the process continued, the number of codes reduced, and they became less descriptive and more abstract. Finally, in stage 3 of the coding process, core categories[10] were identified that pulled together and explained the earlier categories identified. These core categories form the key safety themes identified by this study.

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8 Qualitative data is descriptive information in the form of concepts or characteristics, that is, 'words' not 'numbers'. It focuses on 'how and why' rather than 'how many.'

9 A code within grounded theory is a descriptive phrase that the researcher has assigned to interview comments to summarise and account for what is being said. At first codes will be more akin to labels, but as the coding process progresses, they become more abstract and take the form of concepts.

10 A core category in grounded theory is also referred to as a central theme. It goes beyond description to integrate the categories identified and offer insight into why things are happening (Strauss and Corbin, 1990).

Results and discussion

Key safety themes identified by interviewees

Analysis of the interviews using the grounded theory method produced the following 18 key safety themes:

1. Safety culture – overview and leadership
2. Learning culture
3. Reporting culture
4. Informed culture
5. Just culture
6. Flexible culture
7. Standardisation
8. Informal risk management
9. Pressure to fly
10. Transfer of risk responsibility
11. Communication over the fireground
12. Aircraft coordination
13. Training and aviation proficiency of agency personnel
14. Pilot performance
15. Tasking and risk identification
16. Monitoring of changing risk conditions
17. High risk tolerance and risk normalisation
18. Commercial pressures

This section provides context for a theme where necessary and summarises what interviewees said about each key theme.

Safety theme: Safety culture – overview and leadership

Summary of what interviewees said about safety culture – overview and leadership

- Interviewees were almost equally divided as to whether fire agencies have a positive or negative safety culture.
- Most agency representatives spoke of a positive fire agency safety culture, while most operators spoke of a negative fire agency safety culture.
- Interviewees' perceptions of fire agency safety culture also varied between the fire agencies. Some fire agencies were perceived to have a positive safety culture while others were perceived to have a negative one.

- Two of the agencies had multiple comments from operators regarding safety culture:
  - The South Australia Country Fire Service (SA CFS) was identified as having a positive safety culture by 4 operators.
  - The New South Wales Rural Fire Service (NSW RFS) was identified as having a negative safety culture by 5 operators.
- Interviewees perceived a lack of understanding of aviation safety and risk management among senior fire agency personnel across states and territories.
- Interviewees' understanding of who was accountable for aerial firefighting safety varied, indicating a lack of clarity on this issue.

Context for safety theme: safety culture – overview and leadership

One of the key themes to emerge from the coding of the interview data was safety culture. 'Safety culture is arguably the single most important influence on the management of safety' (ICAO, 2018). It is the context within which individual safety-related attitudes and behaviours develop and persist. It is considered a subset of organisational culture (Kirwan and others 2018). There are numerous definitions of safety culture. There are also many debates in the literature concerning issues such as safety culture versus safety climate and how and to what extent safety culture can be measured or controlled.[11] Of primary importance is how the concept was understood in this study and applied to code and analyse the interview data, and it was considered unnecessary to explore most of these debates further in this report.

How safety culture is understood in this study

A definition of safety culture that reflects how it is understood in this study is by Edwards and others (2013), which draws on Schein's (1992) definition of organisational culture:

> The assembly of underlying assumptions, beliefs, values and attitudes shared by members of an organisation, which interact with an organisation's structures and systems and the broader contextual setting to result in those external, readily-visible, practices that influence safety.

This definition was chosen because it contains the 3 elements of:

1. organisational members' assumptions, beliefs, values and attitudes
2. structures and systems
3. behaviours.

It also accounts for the influence of broader structures (e.g. regulatory) and external context (e.g. political influence and public expectations). These are all elements that shape an organisation's culture with respect to safety.[12]

However, a more accessible way to think of safety culture is to use the now common phrase first used by Deal and Kennedy (1982) about organisational culture in general. Safety culture can be thought of as 'the way we do things around here' concerning

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[11] See, for example, Hale (2000), 'Culture's confusions'; Wiegmann and others, (2004) 'Safety culture: An integrative review' and Hopkins (2018), 'The use and abuse of culture'.

[12] Another commonly used and similar definition is by Uttal (1983): 'Shared values (what is important) and beliefs (how things work) that interact with an organisation's structures and control systems to produce behavioural norms (the way we do things around here)' (as cited in Reason, 1997).

safety. This deals with the ‘behaviours’ element only but is a useful way to think about safety culture because it is the more tangible element and the one that is more readily influenced and understood (Hopkins, 2018).

Safety culture – something all organisations have or an aspiration?

In Edwards and others’ (2013) definition of safety culture mentioned above, 'practices that influence safety' could be positive or negative, as could ‘how we do things around here’ with respect to safety. This leads to speaking of a 'good' or 'bad' and 'positive' or 'negative' safety culture. Alternatively, the concept of safety culture can be seen as synonymous with a positive safety culture or ‘a culture of safety’, for example as used by the FAA:

> The shared values, actions, and behaviours that demonstrate a commitment to safety over competing goals and demands’ (Worthington and others, 2024).

Reason (1997) also refers to safety culture as something aspirational for organisations, rather than as something that all organisations have. In this case, you either have a safety culture, or you do not (and perhaps are working towards it) (Hopkins, 2018). However, most aviation organisations[13] talk about a ‘positive safety culture’ and distinguish this from a negative or poor safety culture.[14] The interviewees also used the term in this way. Given this is how much of the aviation industry and the interviewees employ the concept, it made sense for this study to employ it in the same way.[15]

Multiple elements of safety culture

Safety culture consists of several inter-related elements or dimensions. There is still no definitive list of these dimensions. The coding used in this study to categorise safety culture in the interview transcripts was based primarily on Reason's (1997) model of safety culture as an informed, just, learning, reporting and flexible culture. Additional elements from other models of trust, accountability and management commitment, resourcing and compliance with a systematic safety management system have also been included.[16] Risk management also contributes to the concept of safety culture, given that safety culture is ‘both a product and a driver of risk-related practices’ (Tear and others, 2020).

When taken together, most of the themes arising out of the coding of the interview data could be categorised under the ‘safety culture’ concept. For the purposes of assessing safety culture, all these factors should be considered. However, for the purposes of

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[13] This includes the Federal Aviation Administration (FAA), despite its definition, which also highlights the confusion around this term and how it is frequently used in both these ways interchangeably. See for example, FAA (2024: 9) which uses safety culture in both ways, and also FAA (2013), which refers to a positive safety culture.

[14] See, for example, ICAO (2018: 3-2), and CASA (2019: 16-17). See also National Transportation Safety Board (NTSB) (2024: 57), which refers to an operator’s ‘poor’ safety culture.

[15] Despite this, the elements of safety culture of an informed, just, learning, reporting and flexible culture are treated in this report as something an organisation either does or does not have. This is consistent with Reason’s (1997) and others’ approach in the literature (although the elements of safety culture are also used in both ways). Thus, a ‘good’ or ‘positive’ safety culture is one that *is* informed, just, reporting, learning and flexible, that is, it has these elements. This is because although it makes sense to talk about, for example, a good or bad reporting culture, it makes less sense to talk about a good or bad ‘just’ culture or a good or bad ‘flexible’ culture. Rather, if an organisation has a just culture, this is synonymous with having a ‘good’ just culture, and if an organisation does not have a just culture, it is referred to as having an alternative culture, for example a ‘blame’ culture, not a ‘bad’ just culture.

[16] See, for example, Hudson (2007); Westrum and Adamski (2017); and the International Atomic Energy Agency (IAEA) (2020). Internal ATSB guidance on safety culture also informed these elements.

coding the interview data, only Reason's (1997) elements were explicitly grouped in this way as a foundation. The remaining themes were left separate so as not to simply code everything as 'safety culture' and obscure the detail of the themes arising from the interview data.

The use of 'safety culture' in interviews

The interviewees were asked about 'the dominant culture within the agency with respect to aviation safety' (see A9 of 'Anticipate' in *Appendix B* for details). Interviewees often responded to this question using the term 'safety culture'. They also used this term unprompted when answering broader, more open questions such as 'where do you believe the threats and opportunities are in aerial firefighting?' This is consistent with the general familiarity and use of the concept within aviation and any safety critical industry. Further, the grounded theory approach emphasises coding and analysing a given situation using – as much as possible – the phrases of the interviewees themselves. This ensures the analysis remains 'true' to the interviewees' intent and is an accurate representation (Birk and Mills, 2015). It was this widespread use and familiarity by interviewees that made it an appropriate term and concept to use in this context.[17]

Safety culture – leadership

The leadership element of safety culture (often referred to as management commitment) refers to:

> The ability of its upper level management to demonstrate an enduring, positive attitude toward safety, even in times of fiscal austerity, and to actively promote safety in a consistent manner across all levels within the organization (Wiegmann and others, 2004).

Interviewees' comments that related specifically to how management approached safety were therefore coded in this category, as well as any general comments on agencies' safety culture overall.

Details of interviewee comments on safety culture: overview and leadership

Most interviewees (7 of 9 operators and 10 of 11 agency representatives) commented directly on safety culture. Two of the 9 operators and 8 of the 11 agency representatives commented that their primary firefighting agency had a positive safety culture. In contrast, 6 operators[18] and 2 agency representatives commented that the agency they operated with had a negative safety culture.

Overall, therefore, of the 17 interviewees who commented on safety culture, 9 commented on a positive safety culture within fire agencies while 7 commented on a negative one, with 1 interviewee who commented on more than one fire agency providing both a negative and positive response. However, given that a greater number of agency representatives were interviewed and they were more likely to speak positively of a fire agency's safety culture, it is not possible to accurately conclude that there were

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[17] This is despite acknowledging the potential for confusion when using the term 'safety culture.' Hopkins (2018) argues that the term safety culture is so confusing it should be abandoned, and instead replaced with questions about the priority an organisation gives to safety, or its risk management practices.

[18] One operator who operated with more than one fire agency provided a positive response about one fire agency and a negative response about another fire agency, which resulted in a total of 8 responses from 7 operators.

more interviewee comments about a positive fire agency safety culture than a negative one.

When the positive and negative responses about fire agency safety culture are compared, it is evident that it was mostly operators who commented negatively on safety culture and fire agency representatives who commented positively. Operators and agency representatives therefore tended to have opposed perceptions of fire agency safety culture. As an example, a fire agency was perceived by some operators as having a negative safety culture but the agency representative reported that safety culture had 'always been very much at the forefront of our operations…'. This difference between operators' and agency representatives' responses is consistent with research on perceptions of safety culture, which has shown that those with less power are likely to view safety culture less positively than those who have more control over the situation (Tear, 2020).

The existence of both negative and positive comments by interviewees on fire agency safety culture alone suggests that the extent to which fire agencies have a positive safety culture varies between states and territories. This was also supported by 5 operators and one agency representative who explicitly commented on a wide difference in safety cultures between the states and territories. Four of these operators singled out the SA CFS as having a positive safety culture. In contrast, 5 operators singled out the NSW RFS as having a negative safety culture. Additionally, 2 agency representatives singled out the NSW RFS as having a negative culture that impacted operations, but without referring specifically to safety culture.

Some interviewees (5 agency representatives and 4 operators) also perceived a lack of understanding of aviation safety and risk management by senior agency personnel. Interviewees commented that this contributed to the perceived lack of a positive safety culture in some fire agencies.

Finally, perceptions of who is accountable for aerial firefighting safety varied among the 8 agency representatives and 4 operators who commented on this issue. It was widely acknowledged that 'obviously safety is everyone's concern', but beyond that there was variation and a degree of uncertainty about who is accountable for the safety of aerial operations above the fireground. Five of the 8 agency representatives who commented on this issue perceived accountability to lie with various senior fire agency personnel, particularly the Commissioner of each fire agency. Other interviewees (1 agency representative and 2 operators) highlighted a shared responsibility for safety between the fire agency and the pilots. Two interviewees (one agency representative and one operator) reflected a more localised understanding of accountability for safety as being 'pilot to pilot'. Similarly, 2 operators believed that fire agencies *should* have overall responsibility but shifted it to operators and pilots instead. Uncertainty about who is ultimately responsible for aerial firefighting safety was expressed by 2 agency representatives concerning fire incidents involving more than one fire agency. Interviewees commented that having more than one agency involved meant it was sometimes unclear who was accountable. This variation and degree of uncertainty about accountability is consistent with the diffuse nature of regulatory responsibility for aerial firefighting safety, as outlined in the *Context* section for *Safety theme: Transfer of risk responsibility.*

Safety theme: Learning culture

Summary of what interviewees said about learning culture

- Overall, a degree of learning was occurring in some fire agencies, but it was still limited in its scope and application.
- Some fire agencies did not have a learning culture, although many fire agency representatives expressed a commitment to organisational learning.
- Interviewees highlighted that those fire agencies perceived not to have a learning culture had:
  - an unwillingness to learn
  - a focus on individual-level rather than systemic analysis
  - a lack of capacity to undertake learning.
- While fire agencies conducted post-incident reviews, and some reported a degree of trend analysis, these learning actions were limited in scope and had a short-term focus.
- Agencies' systems and procedures had not kept pace with the expansion of aerial firefighting and in some cases still reflected a focus on ground rather than aerial firefighting operations.
- Some fire agencies did not consult sufficiently or effectively with operators and pilots.

Context for safety theme: learning culture

Learning plays a significant role in mitigating future risks and is a fundamental part of most if not all descriptions of safety culture. Reason's (1997) definition of a learning culture used by the Civil Aviation Safety Authority (CASA) and others is:

> The willingness and the competence to draw the right conclusions from its safety information system, and the will to implement major reforms when the need is indicated.

Drawing on this definition and others,[19] the following key points represent how learning culture was understood in this study to code the interview data:

- a willingness and capability to learn and adapt from own and others' experiences
- learning opportunities actively sought
- an openness to feedback
- a systemic approach to managing and understanding risk
- formalised systems to support continuous improvement.

The public expectation for learning in fire agencies is well-established. Fire agencies' operations are regularly scrutinised, with over 60 federal or state and territory-based inquiries and reviews into Australia's bushfire response since 2006.[20] Many recommendations have not been implemented by fire agencies, nor are the lessons from state- and territory-based inquiries shared across jurisdictions (Dwyer, 2022). Two Australian states now have dedicated institutional arrangements to monitor whether

[19] See, for example, Morrow and Coplen (2017), Wiegmann and others (2004) and ICAO (2018).

[20] Refer to the Bushfire and Natural Hazards CRC online database of Australian emergency inquiries and reviews, 2025. The total includes all types of reviews and inquiries for bushfires listed in the database except for audits.

recommendations have been implemented. The RCNNDA recommended other states and territories do the same (Binskin and others, 2020). A challenge for fire agencies is having the time and the resources to reflect on experiences and put any learning into action (Owen and others, 2018). Fire agencies' ability to learn is also dependent on whether they have the elements of a learning culture outlined above, as well as a strong reporting culture.

Details of interviewee comments on learning culture

Six of 11 agency representatives and 5 of 9 operators commented on a lack of a learning culture within fire agencies. Interviewees highlighted factors such as an unwillingness to learn from inquiries or reports or implement associated actions and a focus on individual-level rather than systemic analysis. In contrast, one operator commented positively on the willingness to learn and accept feedback by a fire agency. Seven of 11 agency representatives also provided responses that reflected a commitment to organisational learning and some explicitly welcomed the ATSB study as a chance to improve. However, at least 4 of these were expressed as intentions and may not be associated with demonstrable action in the form of formalised policies and practices implemented. Three agency representatives also observed that organisational learning tended to arise reactively from fatal accidents, rather than emerging proactively from a learning culture. Further, 4 agency representatives observed that they had limited capacity to undertake organisational safety learning and review.

Most agency representatives (8 of 11) and 3 operators reported some form of debrief or after-action review by fire agencies. They also reported a degree of action following an incident report, in the form of a formal investigation process for near misses[21] and serious incidents. However, interviewee comments suggest actions after this point in terms of what fire agencies did with the information from debriefs or incident reports were limited. According to 2 of the 3 operators who commented on after-action reviews, the reviews were not broad enough to include agency actions or were not sufficiently safety focused. Five agency representatives and 3 operators commented that they did not receive feedback from the agency on incident reports. They also observed that the development and formalisation of any review process was still nascent, with 'not a lot' happening after the reviews.

In addition, although 4 agency representatives reported that they undertook trend analysis it was discussed only in relation to the most recent fire season and did not

[21] The term 'near miss' is used in the safety culture and systems safety literature to be synonymous with 'close call'. For example, Reason (1997) defines near miss as 'any event that could have had bad consequences, but did not'. The term near miss is also used in this way in relation to work health and safety (WHS). For example, near miss is defined in *ISO 45001:2018, Occupational health and safety management systems,* as 'an incident where no injury and ill health occurs, but has the potential to do so' and notes that it also may be referred to as a 'near-hit' or 'close call' (ISO, 2018). This is in contrast with the use of the term by survey respondents and other aviation industry members, who use near miss as synonymous with the ATSB term of 'near collision', which is defined in the *ATSB Occurrence Category Taxonomy* as 'an aircraft that is airborne, taking off or landing comes into such close proximity with another aircraft, terrain, person or object where immediate evasive action was required or should have been taken' (ATSB, 2026). The ATSB does not have an equivalent term for the more generalised understanding of near miss in the systems safety and WHS literatures, because the ATSB uses the ICAO definition of an incident as 'an occurrence, other than an accident, associated with the operation of an aircraft which affects *or could affect* the safety of operation' (emphasis added, ATSB, 2026).

involve long-term analysis or monitoring of trends across fire seasons. Four other agency representatives commented that trend analysis needed improvement because of a lack of focus on long-term trends and systemic issues. An additional agency representative observed that while their work health and safety (WHS) incident management system should have also been doing trend analysis for aviation, it had apparently 'missed' some recent aviation incidents.

Two agency representatives and 2 operators commented that agencies' systems and procedures to support aerial firefighting operations had not kept pace with the expansion of the industry. Five agency representatives also commented that some safety systems still reflected a focus on ground rather than aerial firefighting operations.

Regarding consultation by fire agencies on safety matters, 5 of 9 operators and 4 of 11 agency representatives commented on this issue. Four operators and one agency representative commented that agencies did not consult sufficiently or effectively with operators and pilots. In contrast, 2 agency representatives believed they had a positive consultative relationship with their operators.[22] One operator had experienced good consultation with 2 fire agencies, but attributed that to the small, close-knit nature of their communities. They also perceived other agencies to be different.

Safety theme: Reporting culture

Summary of what interviewees said about reporting culture

- All agency representatives described an incident reporting system within their agency.
- There was a perceived lack of a reporting culture within some fire agencies.
- Interviewees highlighted in relation to some fire agencies:
  - a lack of response or action to reports
  - agency documentation discouraging reporting
  - under-reporting of occurrences to fire agencies
  - a fear of retribution or blame for reporting.
- The reasons given for under-reporting were:
  - whether the incident was witnessed
  - whether they could identify the individuals involved
  - not reaching the 'threshold' for reporting
  - the normalisation of risk
  - a fear of blame or retribution.
- Interviewees noted barriers to operators' or pilots' reporting certain incidents to the ATSB. The ATSB was sometimes conflated with CASA (the regulator), and intense, long days during busy fire seasons reportedly acted as disincentives to reporting.
- To encourage greater reporting from aircrew, the systems for reporting aviation occurrences or safety concerns to fire agencies could be more aviation specific.

[22] The fourth agency representative who commented on this issue emphasised the importance of consultation without stating whether it existed.

Context for safety theme: reporting culture

A reporting culture is one in which personnel are willing to report hazards, errors, near misses and concerns, as well as suggest improvements (Reason, 1997). It is underpinned by accessible reporting procedures and enabled by a just culture. Within a reporting culture, management regard employees as a vital source of information to manage risk (Patankar and others, 2012).

The voluntary sharing of information is essential in any safety-critical organisation such as firefighting agencies. It enables them to detect emerging risks, investigate and explain serious incidents, and understand and improve their practices and systems (McCrae, 2016). All fire agencies are required to have a WHS hazard and incident reporting system, as required under various state- or territory-based legislation. However, a reporting culture goes beyond this requirement to capture 'anything that they think is affecting safety…' (Lee, 1999, cited in ATSB, 1999). Further, CASA has emphasised the distinction between meeting OHS requirements and having safety management functions tailored to support the safe operation of aircraft.[23]

Details of interviewee comments on reporting culture

All agency representatives described some degree of incident reporting methods outlined in their standard operating procedures (SOP). Two operators also mentioned a formal procedure for reporting incidents, although one of the operators was not sure it was written down. Nevertheless, overall, interviewees' comments suggested a lack of a reporting culture within some fire agencies. Of the 6 operators who commented on this issue, 5 believed that the fire agency with which they primarily operated did not have a reporting culture. Fire agency representatives were divided on whether their agency had a reporting culture. Six of 11 agency representatives commented that their agency had a reporting culture. In contrast, 8 of 11 agency representatives described how their agency did not have a reporting culture. Five agency representatives who believed they had a reporting culture also commented on incidents of under-reporting and a fear of retribution or blame inhibiting reporting. Given that a willingness for individuals to report is a key aspect of a reporting culture, these qualifying statements were given more weight. Two of 11 agency representatives did not comment on this issue.[24]

Interviewees provided several reasons for believing their agency did not have a reporting culture. Four interviewees (3 operators and 1 agency representative) reported that their concerns or incident reports were not acknowledged or actioned. Five agency representatives and 5 operators commented on a fear of retribution and a blame culture in relation to reporting. Two operators believed that clauses in their contracts or agency operations manual actively discouraged them from reporting incidents or concerns.

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[23] Refer to CASA (2022a) SMS guidance documentation *SMS 1 Safety management system basics*, under the heading 'Aviation safety verses people safety', pp 6.

[24] The 6 positive comments by agency representatives and the 8 negative comments sum to more than the total number of agency representatives who commented (9 of 11), because 5 agency representatives made both positive and negative comments on reporting culture.

Under-reporting was highlighted by 7 agency representatives and 4 operators who referred to incidents routinely not being reported, but for different reasons. The reasons given for under-reporting were:

- whether someone else had witnessed the incident and would therefore know that a report needed to be made
- the normalisation of risk[25]
- not reaching the 'threshold' for reporting
- a belief that there was no point reporting if there were insufficient details to identify the pilots and aircraft involved
- a fear of blame or retribution.

Interviewees' comments on under-reporting are consistent with CASA's aerial firefighting sector safety analysis, which showed lower reporting rates for this sector (CASA, 2023). An operation that is characterised by routine under-reporting cannot be said to have a reporting culture.

The reasons for under-reporting provide further evidence for a lack of a reporting culture. Believing that an incident should be reported only if it was witnessed by others reflects an understanding of reporting for compliance only. Similarly, focusing on whether individuals can be identified reflects an understanding of reporting for punitive or bureaucratic purposes. This approach perceives the value of reporting to be identifying the individuals and aircraft involved, not sharing details of the incident to enable learning. Believing that there is a threshold so that only 'serious' or unusual events are reported also indicates a lack of reporting culture. A reporting culture goes beyond when an incident has occurred to include safety concerns that may detect emerging risks (Wiegmann and others, 2004). All these reasons for under-reporting fail to recognise the primary purpose of reporting as enabling learning about operations to enhance safety.

Three agency representatives and one operator commented on incidents that are required to be reported to the ATSB under the Transport Safety Investigation Regulations 2003. All 4 interviewees stated that reporting these incidents to the ATSB was the operator's responsibility.[26] They did highlight, however, that some operators and pilots conflated the ATSB with CASA the regulator and were consequently fearful of the consequences arising from reporting. Additionally, an agency representative highlighted that days during busy fire incidents were often long and intense, meaning reporting could not occur until pilots were back at their accommodation, fatigued at the end of a long day, and with a succession of other long days to follow. The agency representative suggested these circumstances might discourage reporting.

Finally, 4 agency representatives observed that the reporting of aviation incidents or safety concerns was done through their OHS system for ground firefighting operations. They believed it should be made more aviation-specific to encourage greater reporting from aircrew.

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[25] The normalisation of risk occurs in relation to incident reporting when a reportable event occurs so frequently that it becomes 'normal' under the current, high-tempo circumstances and no longer appears worthy or necessary to report.

[26] Subsection 3(1) of the *Transport Safety Investigation Act 2003* requires a 'responsible person' to report certain matters to a nominated official. The *Transport Safety Investigation Regulations 2003* defines the kinds of matters that must be reported to the ATSB and the kinds of responsible persons who are required to make a report, which include crew members, owners and operators, people performing an air traffic control service, maintenance personnel, and ground crews.

Safety theme: Informed culture

Summary of what interviewees said about informed culture

- The NAFC was facilitating some sharing of safety information at a national level via avenues such as the Fire Emergency Aviation Technical (FEAT) group.[27]
- The sharing of information needed a greater focus on safety and risk information at the operational level.
- Overall, most agency representatives and more than half the operators believed that more is needed to share safety information consistently and routinely across the agencies and with industry.

Context for safety theme: informed culture

An informed culture is 'one in which those who manage and operate the system have current knowledge about the human, technical, organisational and environmental factors that determine the safety of the system' (Reason, 1997). In an informed culture, management and employees are aware of the risks facing their operations at any given time (ICAO, 2018). This awareness is dependent on the organisation having a reporting, learning and just culture and helps explain why Reason states that 'in most important respects, an informed culture is a safety culture' (Reason, 1997).

Individuals in a positive safety culture are not just informed, they also value informing others about safety (ICAO, 2018). Researchers examining safety culture, high reliability organisations and resilience engineering have all emphasised the importance of free-flowing information for managing risk.[28] Sharing safety information enables fire agencies to learn from others' incidents and hazards, not just their own. This study therefore also coded the extent to which fire agencies shared safety information as part of an informed culture. The interviewee comments addressing the sharing of safety information internally via reporting or consultation have been addressed under reporting and learning.

Fire agencies share safety information via national forums such as the NAFC ASG,[29] as well as at a state level.

Details of interviewee comments on informed culture

Eight of 11 agency representatives and 3 operators commented that the sharing of information between agencies was not working very well and needed improvement. Of these 8 agency representatives, 2 also commented that the sharing of safety information was just in response to major accidents or events, and 2 others commented that any sharing of information was not formalised. Further, 3 agency representatives and

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[27] This group was called the Fire Emergency Aviation Technical (FEAT) group at the time of the interviews, and it is this group to which interviewees referred. In 2023 following a review of their groups, the NAFC established the ASG to reflect a stronger focus on aviation safety. The other aviation functions of the FEAT group were separated from aviation safety and included in the workplans of other groups, such as the Aviation Research and Innovation Group (which commenced in 2025). The NAFC Aviation Safety Group (ASG) is now the primary forum for inter-jurisdictional safety information sharing, development of standards and doctrine, and progression of safety culture in the sector.

[28] See, for example, safety culture: Westrum (2004); high reliability organisations: Weick (1993); and resilience engineering: Dekker (2011).

[29] As noted at footnote no. 25, the functions of this group were formerly part of the functions of the FEAT group.

2 operators commented on the competitive culture that existed between agencies from different states and territories. They believed that this can be a barrier to the sharing of safety information, particularly 'lessons learned' from incidents or near misses. In contrast, 3 agency representatives and 1 operator reported that the sharing of information between agencies was beneficial and worked well at times.

The 3 agency representatives and 1 operator who commented positively on information sharing reported that sharing of information occurred across the states/territories through the NAFC and the FEAT group. In contrast to these positive comments, 7 agency representatives commented that for information sharing to be effective, the content of these meetings needed to focus more on safety and risk information at the operational level.

Regarding the sharing of safety information by fire agencies with operators and pilots, agency representatives were more likely than operators to perceive that this sharing occurred. Four of 11 agency representatives stated that safety information was shared with industry. In contrast, 5 operators and 2 agency representatives commented on a lack of sharing of information between agencies and industry.

Just over half of the operators interviewed (5 of 9) commented positively on the sharing of safety information with other operators, but one operator noted that the degree of sharing of information would always be limited by commercial concerns. Three agency representatives also commented on the commercial competitiveness between operators and pilots. Night firefighting was provided as an example of where the experiences of one operator could benefit others, but its learning value was limited because of commercial competitiveness.

Safety theme: Just culture

Summary of what interviewees said about just culture

- Interviewee comments suggested some fire agencies do not have a just culture.
- Some interviewees reported a fear of retribution for reporting incidents or safety concerns and a blame culture.
- Some pilots and operators fear financial repercussions for speaking up, a situation reportedly exacerbated in some instances by agencies building their own fleets.
- A blame culture was identified by more agency representatives than operators. It was linked to a lack of understanding of the systems safety approach in aviation.

Context for safety theme: just culture

This study used the Civil Air Navigation Services Organisation (CANSO) definition to understand just culture, which in turn was based on Reason's (1997) definition, as:

> An atmosphere of trust in which people are encouraged for providing essential safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behaviour (CANSO, 2008).

The elements of Reason's model are closely intertwined, such that each is very dependent upon the other. A just culture enables a reporting culture by promoting an environment of openness that encourages reporting of incidents and concerns without fear of retribution or blame. This in turn fosters an informed culture because it enables

the organisation to have a more realistic understanding of how things are actually done, not just should be done. A just culture is therefore critical to managing risk in safety-critical operations such as firefighting.

Details of interviewee comments on just culture

Just over half of the operators interviewed (5 of 9) and 2 of 11 agency representatives spoke of a fear of retribution when it came to reporting incidents or safety concerns. Operators and pilots feared financial repercussions such as losing tasking or future contracts. An agency representative suggested this fear of lost contracts was not unreasonable in the circumstances, given the people overseeing the operation on the fireground were often the same people who make decisions about future contracts. The fear of retribution was also reportedly magnified because operators were competing with some agencies for business due to these agencies developing their own aircraft fleet.

Three operators and 5 agency representatives also spoke of a blame culture. One agency representative, reflecting on the review of incidents by fire agencies, linked the tendency to blame to a lack of understanding of systems safety in aviation. This is consistent with interviewee comments on learning culture (above) that highlighted a focus on individual actions rather than a systemic approach to understanding the causes of accidents. This approach was also evident in an agency representative's comment that attributed the causes of occurrences in aerial firefighting to 2 factors only: 'human error and mechanical failure'. In contrast to the 8 interviewees who spoke of a blame culture, 1 agency representative commented that they have a just culture where people feel safe to speak up. Another agency representative spoke about personally trying to create a just culture, even though they are not there yet.

Safety theme: Flexible culture

Summary of what interviewees said about flexible culture

- The system sometimes struggled to maintain safety standards and SOPs when it was under pressure from a busy season or incident.
- Most examples were from the 2019–20 season. They concerned:
  - SOPs not followed
  - risks taken and normalised
  - under-reporting of incidents
  - airspace management
  - standards compromised to fulfil personnel resourcing demands.

Context for safety theme: flexible culture

The 'flexible' element of Reason's safety culture model is the least used and most misunderstood. Reason defines a flexible culture as one that can adapt effectively to changing demands (Reason, 1997). A flexible culture is relevant to high-tempo situations where there may be no precedent and therefore no SOP to cover all eventualities. Reason's concept of a flexible culture is based on the examination of high-reliability organisations, so-called because they maintain safe and effective operations despite a complex and dynamic work environment with hazardous technologies. They also successfully manage intermittent, somewhat unpredictable periods of peak intensity

under considerable time pressure (Reason, 2000). This may explain why many approaches to measuring safety culture do not include 'flexible' as a specific element,[30] because not all organisations that have a safety culture fit the criteria for a so-called high reliability organisation. High reliability theory is based on the operations of aircraft carriers, nuclear power plants and air traffic controllers, and is not always applicable to every organisation. It is, however, directly comparable to aerial firefighting which also has periods of high intensity, often under considerable time pressure to save lives and properties, using hazardous technology in a complex and dynamic operating environment. For this reason, the 'flexible' safety culture element was relevant to code interviewee responses of how risk was managed during high-tempo fire incidents or fire seasons.

The unprecedented intensity and length of the Australian 2019–20 fire season was an example of the types of challenges and risks introduced when the firefighting system is put under sudden, intense and prolonged pressure (Binskin and others, 2020). Additional risk is introduced as a result of factors that include increased density of aircraft operating in close proximity, communication challenges, personnel shortages, additional aircrew unfamiliar with local terrain or operating procedures, community pressure, and extended operating hours resulting in increased likelihood of fatigue and stress.

Details of interviewee comments on flexible culture

Eight of 11 agency representatives and 4 of 9 operators commented on occasions when the system was unable to adapt effectively to changing demands without compromising safety. Most of these comments concerned the 2019–20 fire season. One agency representative and one operator described how during that season, risks were taken and normalised. They described accepting lower levels of visibility because what were normally exceptional circumstances became the norm. Two agency representatives and one operator commented that the reporting of incidents was compromised during the 2019–20 season, because they were simply too busy to report them or events that were usually rare had become too commonplace to report. Three agency representatives also highlighted the rapidly increasing tempo of operations putting pressure on airspace management. They commented that it resulted in a period of increased risk from such a high concentration of aircraft over a fire without any associated risk mitigation. Finally, 2 agency representatives and 2 operators commented that standards are compromised, and risks are introduced to have sufficient pilots and aircraft. They described how busy seasons or fire incidents resulted in a greater reliance on CWN aircraft unfamiliar with the terrain, the SOPs and other operators, and inexperienced volunteers or pilots.

[30] See, for example, the list of features of a positive safety culture provided by ICAO (2018).

Safety theme: Standardisation

Summary of what interviewees said about standardisation

- A lack of standardisation between fire agencies both *across* states and territories and *within* states and territories was one of the key issues raised during interviews.
- The lack of standardisation was raised in relation to various operational matters. These included:
  - communication on the fireground
  - SOPs
  - training
  - flight following
  - separation protocols and aircraft coordination
  - tolerance for risk
  - safety standards
  - contract management.

Context for safety theme: standardisation

As mentioned in the introduction of this report, each state and territory had one or more fire agencies that manage aerial firefighting operations. Most of these fire agencies have their own SOPs, although some like the Australian Capital Territory and New South Wales (NSW) also share SOPs.[31] Consequently, pilots who operate in more than one state or territory can operate under more than one set of SOPs when switching between fire incidents. This introduces risk because safe and effective operations depend on aircrew having a shared mental model of a task, which in turn is founded on SOPs (FAA, 2017). A lack of standardisation in operations is considered one of the key issues influencing Australian aerial firefighting (Seeley and others, 2023). A need for standardisation of SOPs across states and territories was raised in operators' submissions to the RCNNDA. Further, ATSB investigation AO-2023-008 into a 737 air tanker accident in Western Australia in 2023 found the absence of national LAT SOPs to be a safety issue (ATSB, 2024). CASA has also identified the lack of standardisation in fire agency aviation SOPs to be one of 5 'significant issues facing the sector' in its sector safety risk profile (SSRP) for aerial firefighting operations (CASA, 2023). In recognition of this issue, the fire agencies from each Australian state and territory have begun developing national standards for aerial firefighting, assisted by the NAFC.[32]

Details of interviewee comments on standardisation

Seven of 11 agency representatives and 4 of 9 operators raised the issue of a lack of standardisation in firefighting operations across states and territories. Further evidence of a lack of standardisation can be drawn from interviewees' descriptions of various operational processes. Interviewee descriptions of incident reporting methods, communication, training strategies, air traffic management and risk management demonstrated differences in their operations. Three agency representatives also raised the issue of a lack of standardisation between agencies within a state or territory.

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[31] Refer to the NSW RFS (2022) *Interagency Aviation Standard Operating Procedures*, version 4.2, for details.

[32] Refer to NAFC (2025b*) Standards and Guidance Notes,* for details.

Safety theme: Informal risk management

Summary of what interviewees said about informal risk management

- There is a perceived lack of formalisation and documentation of risk management practices.
- The success of informal risk management practices is often dependent on the individuals and relationships involved.

Context for safety theme: informal risk management

Recent studies have identified the use of informal risk management practices by Australian firefighters in firefighting organisations.[33] Informal risk management is understood in this study as those practices that employees use either in the absence of, or as a deviation from, formal procedures or guidance. They are:

> Typically adaptive, task-relevant, and easily implemented in the workplace, helping to minimise the chance that an accident or error occurs despite conditions of increased risk (Patterson and others, 2022).

The concept of informal risk management is similar to the concepts from systems safety literature of work-as-imagined (WAI) versus work-as-done (WAD). WAI represents how management think work should be done to achieve intended outcomes, whereas WAD represents the direct experience of those who do the work (Hollnagel and Clay-Williams, 2022). These concepts recognise that the SOPs or guidance for responding to risk in organisations that deal with emergency situations may not always meet requirements at the time. Sometimes things go well only because people adjust their behaviour to changing circumstances and the demands of the particular situation (Hollnagel and others, 2015). Thus, informal risk management practices often represent deviations from procedure based on frontline experience and knowledge being applied to unanticipated situations. Indeed, as discussed above, an organisational ability to enable those with the expertise to make these types of decisions is what the ‘flexible’ element of safety culture entails. However, informal risk management practices may also occur because of a lack of guidance from an organisation as to how risk should be managed. This lack of guidance introduces risk due to the haphazard use of informal practices across the organisation and failure to identify dysfunctional strategies (Dawson and others, 2012).

Details of interviewee comments on informal risk management

Nine of 11 agency representatives and 4 of 9 operators commented on a lack of formalisation and documentation of risk management practices in relation to various aspects of operations. These included:

- aircraft coordination
- incident reporting
- tasking
- task refusal

[33] See, for example, Dawson and others (2015) and Paterson and others (2022).

- information sharing
- mentoring
- management of pilot performance.

Additionally, 7 of 9 agency representatives and 2 operators commented on the lack of guidance for assessing risk in changing conditions and deciding whether it was safe to fly.

In contrast, 3 agency representatives reported that they had extensive risk management documentation. A further 3 agency representatives emphasised that certain operational aspects were formalised in their SOPs, including a risk assessment and a pilot's right to decide not to fly.

Interviewee comments suggest that the lack of formalisation often succeeds because of a small community and good interpersonal relationships. Seven of 11 agency representatives and 5 operators commented on the reliance on a small community and/or good agency-operator interpersonal relationships, for various aspects of managing risk. Communication around task rejection, sharing of risk information, reporting incidents or raising concerns and pre-flight risk assessments were all highlighted as relying on a small community/good interpersonal relations for their effectiveness. Interviewees' comments suggest that a small community and good interpersonal relationships were protecting the operation against the risks that arise from a lack of formalised risk management practices. Individualised practices and a lack of documentation are still effective when an operation is small, personnel are working with people they know well, and a shared understanding of operational practices exists without it needing to be written down. However, as an organisation increases in size and complexity, these protective measures are no longer effective and risk is introduced.

Safety theme: Pressure to fly

Summary of what interviewees said about pressure to fly

- All interviewees spoke of feeling some form of pressure for pilots to fly.
- The biggest perceived sources of pressure were from agency to aircrew and public or political pressure.
- Most operators reported feeling pressured to fly by agency personnel. In contrast, almost two thirds of fire agency representatives commented there was no pressure to fly.
- Some agency representatives reported pressure on them applied by more senior agency personnel.
- Interviewees identified public and political pressure for aircraft to be flown, particularly LATs, even when they were considered to be ineffective.
- Interviewees also reported financial and situational pressure on pilots to fly.
- Interviewees commented that the primary method for mitigating the pressure to fly was that pilots could always refuse to fly.
- Some fire agencies used additional methods to mitigate the pressure to fly, such as the air attack supervisor (AAS) acting as a filter.

- Just over half of the agency representatives and some operators believed that the decision of whether it was safe to fly came down to the individual pilot's appetite for risk.
- Action after a task refusal varied across fire agencies, ranging from a documented task refusal process to various informal processes or no agreed process.

Context for safety theme: pressure to fly

The safety theme 'pressure to fly' refers to pilots feeling pressured to fly in potentially unsafe conditions or when aircraft would provide little benefit.[34] There are significant public and political expectations of aerial firefighting, with people expecting to see an aircraft over 'their' fire, if not every fire (NAFC, 2021). Aerial firefighting attracts significant media attention, which can create the impression that it is the aircraft that will save lives and houses. Aircraft also provide a highly visible way for governments to demonstrate that they are taking action. All these factors may result in a pressure for pilots to fly. These pressures can be explicit in the form of threats, references to lives and houses at risk or repeated requests to fly. They may also be implicit, such as asking a pilot to go and see if conditions are suitable for firebombing. Once airborne, pilots may be more likely to complete the task. This is known as the 'foot in the door' technique, where once a person has agreed to small request, they are more likely to agree to a bigger one. It has been identified as one of the social psychological pressures on pilots to take risks in challenging weather situations (Paletz and others, 2009). Other studies have also shown that the pressure to fly could result in pilots or fire agency personnel accepting higher levels of risk. A study of US firefighters revealed how the perceived social, political and economic pressures resulted in situations of unnecessary exposure to risk (Flores and Haire, 2022).

Details of interviewee comments on pressure to fly

Pressure to fly

All interviewees (9 operators and 11 agency representatives) spoke of feeling some form of pressure for pilots to fly. The biggest perceived sources of pressure were from agency to aircrew and public or political pressure. Eight of 9 operators and 3 agency representatives spoke of a pressure to fly applied by agency personnel on pilots. The interviewees primarily described an overt pressure to fly, but some described the more implicit pressure of being asked just to 'take a look' to see if conditions were suitable. In contrast, 7 of 11 agency representatives reported that there was no pressure to fly from the fire agency placed on pilots.

Five of the 11 agency representatives spoke of a pressure for pilots to fly being applied to them by more senior agency personnel. In contrast, 1 agency representative commented that they did not get pressured by senior personnel, while the remaining 5 agency representatives did not comment on this issue.

Interviewees also reported public and political pressure for pilots to fly. Nine of 11 agency representatives and 4 of 9 operators described public or political pressure for aircraft to be flown over fires. This occurred even when aircraft were considered ineffective in the

[34] A pressure to fly was raised by 2 aerial firefighters during the NSW Coroner's inquiry into the 2019–20 NSW bushfire season. However, the Coroner concluded that there was no 'undue influence (financial or otherwise) placed on pilots or aviation operators to accept or continue with unsafe taskings' (refer to O'Sullivan (2024), pp 168, for details).

prevailing conditions. Interviewees believed this was because aircraft, especially LATs, are a very powerful visual representation of agencies' and governments' response to bushfires. Three of these interviewees specifically mentioned public or political pressure to fly relating to LATs.

Four agency representatives and 4 operators also identified financial pressure on pilots to fly. The financial pressure was perceived as primarily coming from whether a pilot was on contract, or whether they were paid by hours flown. The interviewees believed that pilots and operators paid by hours flown would be less likely to refuse a task in marginal conditions. Three of these interviewees also perceived the financial pressure as coming from fire agencies to operators, because they were contracted to provide a service. In contrast, 2 agency representatives commented that pilots do not feel financial pressure to fly. For one agency representative, this was because pilots were on contract and still paid whether they flew or not (which does not apply to those getting paid by the hour). For the other agency representative, it was because they did not believe that the financial incentive to fly and get paid was enough to take undue risks.

Some interviewees also reported that the situation itself can generate a pressure to fly. Five agency representatives and 2 operators described feeling a pressure for pilots to fly from their awareness that lives and houses were at risk. Pilots are often based locally, and this exacerbates that pressure to fly and may affect their ability to conduct an effective risk assessment.

Risk mitigation of pressure to fly

The primary method for mitigating the pressure for pilots to fly was reported by interviewees to be that pilots can always refuse to fly. Nine of 11 agency representatives reported firmly that if a pilot says it is not safe to fly, then their word is final. This is consistent with a transfer of the responsibility for managing risk from the fire agency to the pilot in command (PIC) (see *Safety theme: Transfer of risk responsibility* for details).

Interviewees described other ways that fire agencies mitigated the pressure to fly. Five agency representatives and 2 operators reported fire agencies using pre-season training or crew resource management (CRM) training to emphasise that the pilot can and should always speak up and say no when they felt it was unsafe to fly or continue to fly. They also described using the air operations manager (AOM), or similar, to lessen the workload of aircrew and including the pilot's right to refuse a flight based on safety within their SOPs.

Further, 6 agency representatives and 2 operators commented that the AAS could act as a type of filter between the demands of the tasking individuals and the pilot. Interviewees reported that some AASs filtered the sense of urgency arising from emergency situations. They made decisions about whether to stop flying depending on the conditions. They also made decisions about tasking effectiveness depending on factors such as pilot experience and type or number of aircraft involved. However, consistent with interviewee comments on a lack of formalisation of other risk mitigation processes (see *Safety theme: Informal risk management*), these measures are dependent on individuals. It is not assured that they would occur to mitigate any pressure to fly. In contrast, one agency representative commented that they do not mitigate the pressure to fly, using the AAS or otherwise.

Interviewee comments suggest that telling pilots they can always say no is insufficient risk mitigation against undue pressure for pilots to fly. Eight of 9 operators describing

having experienced mostly overt pressure demonstrates this. Additionally, 6 agency representatives and 2 operators commented that the decision to fly comes down to the individual pilot's appetite for risk. This in turn is determined by their experience level or degree of local knowledge. Additionally, 4 operators and 3 agency representatives reported that the decision to fly in marginal conditions came down to the operator's culture and the pilot.

Fire agency actions when a pilot refuses a task can also generate pressure on pilots to fly. Factors such as not having a procedure to legitimate and streamline task refusals or asking other pilots to fly after a task refusal can generate implicit pressure on pilots to fly. The ATSB investigation AO-2020-007 into the fatal LAT accident in NSW found a contributing factor was:

> The Rural Fire Service continued the B134 tasking to Adaminaby when they learned that no other aircraft would continue to operate due to the environmental conditions. In addition, they relied on the pilot in command to assess the appropriateness of the tasking to Adaminaby without providing them all the available information to make an informed decision on flight safety.

Four agency representatives described what happened in their operation when a pilot refused a task. Two reported that they used criteria like type of aircraft and/or pilot experience to re-task another pilot, but acknowledged that this was informal only, and subjective. A third agency representative acknowledged that they could improve safety by letting the pilot who is being re-tasked know that someone else had said no. The fourth agency representative highlighted the tasking rejection process that they have developed in response to an ATSB accident investigation report. In addition, 4 operators and 4 agency representatives commented on the lack of a formal process for task refusal, while another agency representative was not sure if there was one or not. Three agency representatives reported that a record was kept of task refusals. Two operators and 2 agency representatives commented on 'pilot shopping'.[35]

Safety theme: Transfer of risk responsibility

Summary of what interviewees said about transfer of risk responsibility

- Most interviewees' comments reflected a transfer of risk responsibility away from fire agencies onto pilots, operators or the AOC and CASA's oversight.
- The transfer of risk responsibility concerned the decision to fly in marginal conditions, operational risk identification and management, and managing aircraft separation.
- Some interviewees perceived a lack of regulatory oversight of aerial firefighting operations by CASA. In contrast, some agencies reported regular interactions between agencies and CASA.
- Some agencies described a program of oversight by agencies involving compliance checks of operators. However, these audits functioned more as 'contract compliance checks' rather than as safety audits.

[35] Pilot shopping refers to the practice of 'shopping around' for a pilot to accept a task when others have previously refused.

Context for safety theme: transfer of risk responsibility

How transfer of risk responsibility is understood in this study

The concept of a transfer of risk responsibility is understood in this study as the responsibility for managing risk being transferred from one party to another. The transfer of risk can be intentional or unintentional. It also may occur simply by default, resulting from a lack of formal regulatory responsibility for managing risk and/or a lack of formalised risk management practices. It results in a concentration of the responsibility for managing risk with the 'risk-exposed' (Hermansson and Hanson, 2007).[36]

Responsibility for managing risk in aerial firefighting operations

The responsibility for managing risk in aerial firefighting operations is unclear. Fire agencies contract, task and coordinate the aircraft and control the aerial firefighting operations. Operators provide the aircraft and pilot to the required standards. CASA regulates the aerial firefighting sector with regulation that applies to operators and pilots only, not fire agencies. Operators are regulated under CASR Part 137 - *Aerial Application Operations other than Rotorcraft* or CASR Part 138 - *Aerial Work Operations*.

Safety management systems (SMS) in aerial firefighting operations

CASR Part 138 requires operators to have an SMS scaled to the size and complexity of their operation. An SMS is a systematic approach to managing safety. Risk management is central to an SMS, along with safety policy, documented procedures and other components. The NAFC also requires all operators contracted with them to have an SMS (NAFC, 2025a) but fire agencies are not required to have one for their aviation operations. The United States Department of Agriculture Forest Service (USFS) manages wildland fires on national forests and grasslands. In contrast with Australian fire agencies, the USFS has an SMS for its own aviation program as well as a requirement for its aviation service providers, consisting of (USFS, 2020):

- safety management policy
- safety risk management
- safety assurance
- safety promotion.

The USFS states that the SMS 'provides the agency with a systematic approach to managing safety risks in aviation' (USFS, 2023).

However, Australian fire agencies are required to manage risks in the workplace under the relevant WHS legislation. They are also responsible for the training and capability of agency personnel to support agencies' use of aerial firefighting.

Following ATSB investigations into fatal aerial firefighting accidents such as AO-2020-007, AO-2023-008 and AO-2023-053, as well as the ATSB investigation AO-2023-054 into multiple reports of unsafe aircraft proximity occurrences, fire agencies have begun developing enhanced safety and risk management policy. For example, NSW RFS implemented an Aviation Safety Management System in October 2025 and fire agencies established the multi-agency ASG in 2023, assisted by NAFC.

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[36] Hermansson and Hanson (2007) propose a three-party model for understanding risk-related decisions, consisting of the risk-exposed, the beneficiary (of the risk being taken) and the decision-maker.

Responsibilities of the pilot in command (PIC)

All operators and pilots must also comply with Part 91 of CASR - *General operating and flight rules.* These rules cover several areas of operation including communication and preventing collision. Part 91 also contains the responsibilities of the PIC of the aircraft. The PIC has final authority over the operation of the aircraft and must ensure the safe operation of the aircraft during a flight.

Regardless of who is legally responsible for managing risk in aerial firefighting operations, interviewees' comments reflected where they thought responsibility *could* or *should* lie, not just where it was currently legally assigned. In other words, interviewees made comments that reflected a transfer of risk responsibility away from agencies to other parties. This is the case whether agencies are legally required to manage risk or not.

Complex nature of risk responsibility in firefighting operations

The complex nature of who has responsibility for managing risk in aerial firefighting is demonstrated by examining CASA's top 5 'significant issues' identified in the aerial firefighting safety sector risk profile (CASA, 2023). Two of the 5 risks identified such as 'standard operating procedures' and 'communication equipment and procedures' are controlled and determined by fire agencies, not operators or pilots. The NAFC Strategic Committee has committed to assisting Australian fire agencies in developing national standards in these areas.

The transfer of responsibility for managing risk can result in the concentration of this responsibility on individual pilots as they operate in a complex and dynamic environment. Although fire agencies are not regulated by CASA, ATSB investigation AO-2020-007 into the fatal LAT accident in NSW determined that agencies should define the acceptable level of risk for the operation (ATSB, 2020b). This would provide an effective additional layer of defence above that of the PIC's dynamic risk decision-making.

Details of interviewee comments on transfer of risk responsibility

Overall, 9 of 11 agency representatives and 5 of 9 operators made comments that reflected a transfer of risk responsibility away from the fire agencies and onto pilots, operators or the AOC and CASA's oversight.

Seven agency representatives and 3 operators commented directly on the transfer of risk responsibility to pilots. The comments by 4 of these agency representatives and 1 operator concerned the responsibility for deciding whether it was safe to fly, particularly in marginal conditions. These interviewees believed it was 'the pilot's responsibility' to assess risk and make decisions in these circumstances. One of these agency representatives did note, however, that this issue is 'one of the biggest conundrums' because they believed that agencies put pilots in marginal conditions and then say it's their responsibility to manage risk. Five agency representatives and 2 operators reported the transfer of risk responsibility in relation to risk identification and risk management more generally. One of the 5 agency representatives believed there was a 'massive disconnect' because the responsibility for risk identification and management was essentially the personal responsibility of the pilot. Finally, 2 agency representatives commented on the transfer of risk responsibility in relation to managing aircraft separation. One of the agency representatives called it 'one of the main threats', while the other pointed out that agencies have no legal authority to manage aircraft separation.

In contrast to the interviewees' comments reflecting a transfer of risk responsibility to pilots, an agency representative commented that they now understand that agencies also have a responsibility to manage risk, because the ATSB 'made that clear' in the C130 accident investigation.

Five agency representatives and 2 operators also made comments that reflected a transfer of risk responsibility to operators and their AOC and CASA oversight. One operator commented that apart from managing the risk of fatigue, risk management is left to them, with agencies having 'no idea' how risk is managed. The other operator (and one agency representative) believed that operators and pilots had more aviation expertise to manage risk than did fire agency personnel. Five agency representatives commented that they rely on operators' SMSs and processes to manage the operational risks. Of these 5 agency representatives, 1 observed that operators are 'very good at self-regulation' and another pointed out that managing aviation operational risk is the legal responsibility of operators and CASA, not fire agencies. An agency representative also commented that they just had to 'have faith' in CASA. However, although operators are required to have an SMS and are regulated by CASA, they do not control operations during a fire incident.

Further, despite some interviewees expressing a reliance on operators' AOC requirements and CASA's associated oversight to manage safety risk in their aerial firefighting operations, comments by interviewees were mixed concerning the effectiveness of CASA's oversight. The operators who commented on this issue spoke of a lack of regulatory oversight, while the agency representatives (with one exception) spoke of regular interaction with CASA. Although no interview questions addressed regulatory oversight, 4 operators and 1 agency representative commented on a lack of regulatory oversight of aerial firefighting operations by CASA. In contrast, 4 agency representatives spoke of their agency's regular interactions with CASA, although the examples given of interactions with CASA concerned specific issues such as fatigue management, and agency use of temporary restricted airspace (TRA) and notices to airmen (NOTAMs), rather than managing operational risk overall. One agency representative also commented that they interact with CASA about potential safety concerns relating to individual operators.

Five agency representatives described a program of oversight by agencies that involved compliance checks of operators against the conditions in their contract, usually by an external auditor. However, these audits reportedly functioned more as 'contract compliance checks' in terms of checking mandatory equipment requirements and similar issues, rather than functioning as safety audits where risk identification and mitigation was central.

Interviewees' comments on the pressure for pilots to fly and the lack of any formalised risk mitigation other than that the pilot can always refuse a task, as discussed above, also reflect a transfer of risk responsibility away from the fire agency onto the pilot. Together, these comments suggest a concentration of the responsibility for managing risk on the pilot.

Safety theme: Aircraft coordination

Summary of what interviewees said about aircraft coordination

- There was a lack of standardisation of aircraft coordination procedures between fire agencies.
- In some instances, there was also a lack of formalisation of the procedures AASs used. This resulted in procedures varying between AASs.
- Over half of all interviewees expressed concern about the risk of collision.
- The degree of intervention and management of aircraft separation by AASs varied among fire agencies.
- The 'span of control' for an AAS and when an AAS was deployed varied between fire agencies and was not always formalised.
- Some agency representatives believed TRA designations should be used more frequently.

Context for safety theme: aircraft coordination

There are specific challenges associated with aircraft coordination in aerial firefighting. Pilots must maintain separation while managing the convergence of aircraft at low level, poor conditions including smoke and turbulence, potentially steep terrain, and multiple aircraft all operating over a fire in uncontrolled airspace.[37] Fire agencies in each state and territory have their own airspace procedures, which can lead to difficulties for operators working across borders and in different jurisdictions. However, fire agencies recently developed a national *Airspace Management Guideline* that sets out minimum requirements for ensuring aircraft separation, assisted by the NAFC (NAFC, 2024a). As mentioned earlier as part of the *Context for safety theme: communication on the fireground*, fire agencies have also produced national guidelines for cross-border airspace management, assisted by the NAFC (NAFC, 2024b).

Additionally, the AAS plays a key role in coordinating aircraft. An AAS is responsible for 'supervising aerial fire suppression activities and other tactical missions from the air' (AFAC, 2021a), which includes '…directing other aircraft and any other resources assigned to the fire' (NAFC, 2025a). Some operators also use automatic dependent surveillance broadcast (ADS-B) equipment to aid situational awareness, although this is not currently a regulatory requirement on firefighting aircraft.

Details of interviewee comments on aircraft coordination

Interviewees described the methods fire agencies used to coordinate aircraft over the fireground. Their comments suggest that while there were processes in common across fire agencies, there were also differences and sometimes a lack of formalisation of certain procedures. Four agency representatives and 2 operators commented on the lack of standardisation between fire agencies for aircraft coordination. Two of these 4 agency representatives highlighted the lack of standardisation for coordinating aircraft between different agencies within one state. Two operators and 3 agency representatives also

[37] Uncontrolled airspace is not actively managed by air traffic controllers. Authorisation to provide air traffic control functions requires a valid and current licence, rating and endorsement under CASR Part 65 (CASA, 2022b).

described a lack of formalised procedures for managing traffic and aircraft separation. This reportedly led to different procedures being followed depending on the individual AASs involved.

Just over half (6 of 11) of the agency representatives and operators (5 of 9) interviewed spoke of the risk of collision between aircraft over the fireground. One agency representative and one operator mentioned experiencing a near collision. The risk of collision was highlighted in relation to the following issues:

- pilots organising their own separation in poor environmental conditions
- inexperience and inappropriate tasking
- media aircraft operating outside of radio frequencies or SOPs
- differences in communication SOPs between military[38] and civilian aircraft
- communication breakdowns
- high traffic density with various aircraft types.

Seven agency representatives and 3 operators commented on the role of the AAS in coordinating aircraft on the fireground. It is evident from these comments that while the AAS played an important role coordinating aircraft, the degree of control and involvement by the AAS varied. Some interviewees emphasised that the AAS did not control aircraft separation and did not function as an air traffic controller. Instead, the AAS discussed operational requirements and how they related to aircraft separation stacks. Other interviewees described AASs as directing aircraft and perceived that they were responsible for ensuring aircraft separation, together with pilots. There were also reported differences regarding when an AAS is dispatched to supervise aircraft. Two agency representatives and one operator reported that an AAS is deployed for 3 or more aircraft over a fireground. A further 2 agency representatives commented that they differ from the other states and territories because they endeavour to send an AAS out with aircraft to every fire. These comments highlight a lack of standardisation between fire agencies in the use of AASs to coordinate aircraft. Additionally, they highlight the ambiguity surrounding the degree of responsibility an AAS has for managing aircraft separation.

Six agency representatives commented on the use of an AAS ‘span of control’.[39] These comments also highlight differences between states/territories regarding the ‘span of control’ for aircraft. Of these interviewees, 3 agency representatives mentioned a span of control of ‘5–7’, ‘1 in 5’ and ‘about 6.’ Two agency representatives observed that the notion of a span of control is ingrained in all firefighters for fire trucks but is not formalised in the same way for aircraft. Another agency representative commented in relation to an AAS span of control that they’re not good at encouraging people to ask for help.

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[38] Although the Australian Defence Force (ADF) does not have the capability or resources to fight bushfires, if requested it provides assistance to states and territories during bushfires. This assistance includes the use of ADF bases and refuelling equipment for aerial firefighting aircraft as well as the provision of aircraft for tasks such as transporting fire crews, air observation, and search and rescue operations. For example, during the 2019–2020 bushfire season, the ADF provided 67 fixed-wing and rotary-wing aircraft in support of firefighting operations (Binskin and others, 2020).

[39] Span of control is a term traditionally used in ground firefighting operations and other emergency services, and refers to the number of crews, officers or, in this case, aircraft, that can be controlled safely and effectively by one person.

Lastly, 3 agency representatives commented on the growing need to use TRA designations over fire incidents more frequently, due to drones and other aircraft coming near out of curiosity.

Safety theme: Communication over the fireground

Summary of what interviewees said about communication over the fireground

- Most operators and some agency representatives reported safety concerns with aircraft communication over the fireground.
- A key concern was the use of multiple radios and frequencies.
- Communication issues reportedly led to breakdowns in communication and an associated risk of collision.

Context for safety theme: communication over the fireground

Aerial firefighting often involves multiple aircraft operating in a relatively small airspace in challenging conditions. These factors mean effective communication is essential for maintaining situational awareness and managing the risk of collision. Communication in aerial firefighting has the added challenge of the use of multiple radio frequencies over the fireground, with pilots reportedly monitoring up to 5 frequencies at a time. Pilots are also required to manage different types of communication devices fitted to aircraft to enable communication with ground crew and other aircraft or air traffic control (CASA, 2023). These challenges are magnified by a lack of standardisation across state and territory borders. Aircraft operating on a state or territory border must be able to communicate with fire agencies from both sides. However, the tactical radio systems from different states and territories are reportedly sometimes incompatible and different common traffic advisory frequencies (CTAFs)[40] may be in use by different fire agencies. Fire agencies, assisted by the NAFC, have developed a national cross-border airspace management guideline to address communication across borders (NAFC, 2004b). CASA has also identified communication as one of 5 ‘significant issues’ facing aerial firefighting.

Details of interviewee comments on communication over the fireground

Overall, 5 agency representatives and 7 of 9 operators raised communication with aircraft over the fireground either by other aircraft or by ground-crew as a safety concern. A key concern for the 7 operators and 2 of the 5 agency representatives was having too many radios and frequencies in use. Five agency representatives and 2 operators spoke of communication breakdowns, primarily between pilots in different aircraft. Two of these interviewees (one agency representative and one operator) commented on communication breakdowns resulting from LATs having their own frequencies. Two agency representatives also reported breakdowns in communication occurring between pilots and groundcrew. Three agency representatives and 2 operators were concerned about the risk of collision arising from communication breakdowns.

[40] CTAF refers to the designated frequency on which pilots make positional broadcasts.

Safety theme: Training and aviation proficiency of agency personnel

Summary of what interviewees said about training and aviation proficiency of agency personnel

- Most interviewees considered some fire agency personnel to be lacking in aviation expertise.
- Some interviewees believed it was difficult to maintain currency for fire agency personnel.
- Some interviewees were concerned about the use of volunteers for aviation-related roles.
- Training was perceived to be at times haphazard in its delivery, non-standardised in its content, and may not address risk assessment sufficiently.

Context for safety theme: training and aviation proficiency of agency personnel

Fire agencies are responsible for providing trained personnel to fill several specialist aviation-related firefighting roles. AFAC has a *Fire and Emergency Aviation Training and Assessment Framework* that sets out a national approach to the training of these personnel (AFAC, 2021b). The NAFC also has an aviation simulation project underway into the use of simulation techniques to train fire agency personnel in aviation roles (NAFC, 2025c). At a state level, in 2023 the NSW RFS opened an $8.3 million aerial firefighting training centre called the Aviation Centre of Excellence, which includes 4 aerial training simulators (Dib, NSW Minister for Emergency Services, 2023). The issues of standardisation of training, and fire agencies having enough appropriately qualified personnel in aviation roles, have been highlighted in several inquiries.[41]

Details of interviewee comments on training and aviation proficiency of agency personnel

Seven of 11 agency representatives and all 9 operators commented on a lack of aviation expertise of fire agency personnel, from operational to senior management level. Three operators and 4 agency representatives specifically referred to a lack of aviation knowledge and experience of fire agency senior management. The lack of aviation expertise was perceived as resulting in unrealistic expectations of pilot and aircraft capabilities.

Four agency representatives and one operator commented on the difficulty of maintaining currency for agency employees. They highlighted that for many agency personnel, aerial firefighting was not their full-time or ‘core’ business. In contrast, 2 agency representatives reported that a lack of currency was not an issue for them, because they were a small enough group that everyone gets some experience. This is another example of how a smaller, interconnected community can insulate some

[41] See, for example, the RCNNDA report (Binskin and others, 2020) and submissions by aviation organisations. See also Owens and O’Kane (2020), *Final Report of the NSW Bushfire Inquiry*.

agencies from factors that have reportedly become problems in other larger agencies (see *Safety theme: Informal risk management*).

Two agency representatives and 4 operators also voiced concerns about the reliance on volunteers to perform aviation-related roles. The reasons for concern varied across the interviewees. Key concerns included that the volunteer workforce was aging and declining, the lack of continuity with volunteers in aviation-related roles, and the wide variation in the quality of volunteers.

Lastly, all 11 agency representatives and 4 of 9 operators commented on the training provided to agency personnel in aviation-related roles. The operators reported the need for agency personnel to receive more training to follow SOPs and highlighted the wide variation in training standards. They also commented on the need for multi-disciplinary training and ensuring CWN pilots were included. Two operators also believed that the fire agencies should consult with operators and pilots about training content. The agency representatives' comments were more varied and did not have a central theme. Overall, their comments suggest that training was sometimes haphazard in its delivery, unstandardised in its content across fire agencies, and may not address risk assessment sufficiently. Three agency representatives observed, however, that training was improving, especially with the development of national standards.

Safety theme: Pilot performance

Summary of what interviewees said about pilot performance

- Some interviewees believed it was difficult for pilots to achieve the minimum hours required or maintain currency.
- There was minimal formal monitoring of pilot performance. Where monitoring did occur, the emphasis was on improving efficiency and effectiveness, rather than on safety.
- The NAFC contract required operators to have an SMS and contained minimum requirements for pilots' capabilities.

Context for safety theme: pilot performance

This safety theme addresses interviewee comments on minimum requirements for pilots' experience and maintaining currency, as well as how pilot performance and operational safety are monitored. Minimum requirements for pilots' experience and currency in terms of hours flown are contained in the NAFC contract. CASA's sector safety risk profile workshop for aerial firefighting held in 2023 identified pilot experience as one of the top threats within the sector. Operators raised concerns about the limited pathways to bring someone into the industry (CASA, 2023).

Details of interviewee comments on pilot performance

Five of 11 agency representatives and 3 of 9 operators commented on the difficulty for pilots to achieve the minimum hours required or maintain the required currency. Two agency representatives and one operator believed that agencies needed to facilitate the process through mentoring or budgeting for new pilots to observe others.

Interviewees were asked whether they used safety performance indicators (SPIs) for aerial operations. The intent was to examine if agencies used them to highlight aerial

operations trending in a potentially hazardous way. However, interviewee responses reflected a focus on monitoring pilot performance in terms of efficiency and accuracy, rather than the safety of operations overall.

Six agency representatives and 3 operators gave varied responses to questions of how they monitored safety performance and if they used SPIs. A common theme, however, was that there was minimal formal measuring of safety performance. Further, when monitoring of performance occurred, the emphasis was on efficiency and effectiveness, not safety.

None of the 6 agency representatives reportedly used SPIs. One agency representative observed that 'we are starting to get there but we've got a way to go.' Only 2 of the 6 agency representatives who commented on this issue reported using some degree of formal performance monitoring, neither of which were directly related to safety. One of these agency representatives reported using ARENA[42] data to monitor the cost per litre of suppressant between different aircraft. They also reported that the State Air Desk[43] ran a spreadsheet of performance statistics that was periodically examined to improve efficiency. The other agency representative reported monitoring turnaround times to improve response times. Two operators also commented that pilot performance was monitored but believed the focus for doing so was on billing and saving money, not safety.

Four agency representatives and one operator reported that any performance monitoring that occurred was not formalised and instead was through informal observation and feedback only. Of these interviewees, one agency representative and one operator reported that the AAS and ground crew monitored pilots' performance. Additionally, an agency representative reported that it was the job of air base managers (ABM) to check on pilots' performance over the fireground but noted that this would be 'unusual.'

Two agency representatives pointed out that while they did not monitor safety performance, the NAFC contract required operators to have an SMS. However, the influence of an operator's SMS on safety performance over the fireground is limited because it is the fire agencies who task and coordinate aircraft. All 6 agency representatives who commented on this issue also mentioned the minimum requirements for pilots' capabilities contained within the NAFC contract, which ensured a minimum level of competency.

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[42] ARENA is a web-based national management support system maintained by the NAFC for the tracking and tasking of aerial firefighting resources. The NAFC has emphasised that ARENA should never be used as a *real-time* aircraft tracking tool.

[43] States and territories usually manage the use of aerial assets through a central mechanism, such as a State Air Desk. A State Air Desk manages the dispatch and coordination of firefighting aircraft around the state.

Safety theme: Tasking and risk identification

Summary of what interviewees said about tasking and risk identification

- Interviewees voiced concerns about tasking. However, there was no single theme characterising interviewees' concerns.
- Interviewees highlighted tasking issues such as:
  - a lack of clarity of objectives
  - aircraft tasked prior to tasking viability being established
  - a lack of aviation experience of fire agency personnel leading to unrealistic tasking
  - aircraft tasked based on cheapest option
  - bias in operator selection
  - unsuitable tasking for conditions and aircraft type.
- Some risk identification and assessment by fire agencies is occurring as part of the tasking process. However, this is occurring to varying degrees and with varying levels of formalisation.

Context for safety theme: tasking and risk identification

The tasking and dispatch of aircraft is generally coordinated by the states and territories through a central mechanism such as an Air Desk. Air desks manage the requests for aircraft and arrange their dispatch (Binskin and others, 2020).

Details of interviewee comments on tasking and risk identification

Five agency representatives and 4 operators commented on a variety of concerns relating to tasking, with no overarching theme emerging. Two agency representatives and one operator highlighted a lack of clarity about tasking objectives. Two interviewees (one operator and one agency representative) stated that aircraft should not be tasked before the agencies have investigated whether the tasking is safe and likely to be effective. This point was also made by interviewees in *Safety theme: Pressure to fly* concerning pilots being dispatched and asked to 'take a look' to see if tasking was suitable. One operator and 2 agency representatives believed that a lack of aviation experience by fire agency personnel influenced tasking. According to these interviewees, a lack of aviation experience led to unrealistic expectations and an inability to judge the appropriateness of tasks and conditions for different aircraft. One agency representative and 2 operators commented on aircraft being tasked based on the cheapest option. Other concerns reported by interviewees included:

- A bias in operator and aircraft selection. For example, an agency representative described 'a blatant use of one company over another', reportedly despite other aircraft being more suitable and the tasking putting those pilots to the limits of their flight and duty times.
- Tasking in unsuitable conditions.
- Tasking of unsuitable aircraft for the task to be performed.

In contrast to these concerns about tasking, one agency representative spoke positively of their agency's tasking process and reported that they have defined tasking procedures and well-trained personnel.

Overall, interviewee comments suggest some risk identification and assessment is occurring as part of the tasking process to varying degrees within the fire agencies, and with varying levels of formalisation. Interviewee comments on this topic varied, with no central theme.

Eight agency representatives and 3 operators described how agencies identified and assessed aviation operational risk for tasking. There were different interpretations of the question reflecting different levels of operational focus.

Two interviewees (one operator and one agency representative) described the AAS and the pilots assessing risk before a suppressant drop. Another agency representative described how pilots found and risk assessed their own water source. Two agency representatives described daily morning safety briefs where risks are discussed and one agency representative described the AOM as identifying and assessing risk and reporting to the incident management team throughout the day. Two agency representatives referred to a meteorologist at state level to assist with weather- and fire activity-related risk, while another spoke of a high-level daily risk assessment concerning factors such as weather, degree of fire activity and available assets. One agency representative also reported a pre-flight risk assessment contained in their SOPs.

Finally, one agency representative reported no formal risk assessment occurring, while another acknowledged in response to an ATSB investigation that fire agencies needed to do more risk assessment of tasks.

Safety theme: Monitoring of changing risk conditions

Summary of what interviewees said about monitoring of changing risk conditions

- Most fire agencies used a dynamic risk assessment to identify periods of increased risk during firefighting operations.
- The process could be consultative, involving agency personnel and aircrew in equal measure, pilot to pilot, or undertaken by the AAS.
- Minimal guidance or criteria was provided by fire agencies for the dynamic risk assessment.
- Some interviewees used the 'safe-effective-efficient' criteria for tasking aircraft or deciding to continue with a task.
- The process for flying again after being grounded due to poor weather conditions was undocumented. However, it involved consultation with pilots and possibly sending the AAS to have a look to reassess.
- Some interviewees believed fire agencies did not monitor risk sufficiently.
- Interviewees' comments suggest that the dynamic risk assessments were largely informal and undocumented and dependent on the individuals involved.

Context for safety theme: monitoring of changing risk conditions

The dynamic nature of firefighting operations requires changing risk levels to be monitored and assessed throughout the operation. While a rigid application of SOPs in high-tempo, emergency situations can be problematic, relying entirely on individuals' ability to do a dynamic risk assessment can be too. Even during the most rapidly changing emergency situations, individuals need to understand the nature and severity of risk and make a judgement about likelihood and consequence (Penney, 2019). The expectation that pilots are doing this even under the time-pressured, complex conditions and high workload that characterise serious fire incidents may be unrealistic.

Further, aircrews need guidance for determining what is an acceptable level of risk in certain situations. However, fire agencies cannot be expected to prescribe every element of a dynamic risk process. A dynamic risk assessment should be responsive to circumstances and to some extent will depend on the individuals involved. Nevertheless, safety is relative, and what one person considers safe might not be safe for another. Assuming pilots will conduct a dynamic risk assessment without providing specific guidance or training can lead to ambiguity and confusion about when the level of risk becomes unacceptable (Hopkins, 2011). The need for guidance from fire agencies and operators for assessing risk was highlighted by the ATSB investigation into the C130 LAT accident in NSW on 23 January 2020 (AO-2020-007).

Details of interviewee comments on monitoring of changing risk conditions

Nine of 11 agency representatives and 1 operator reported that they used a dynamic risk assessment to identify periods of changing or increased risk during firefighting operations. Of these interviewees, 6 agency representatives described a process involving regular discussion and feedback between the ABM, AASs and aircrew. This included reports of changing conditions being passed from the incident management team to aircrew via the AAS. Interviewees also reported that the dynamic risk assessment occurred by pilots. One agency representative commented that the dynamic risk assessment by the pilot was supported by their SOPs relating to, for example, fatigue management. Another agency representative identified that pilots needed sufficient time and space to make decisions over the fireground. Lastly, one agency representative reported that they relied on the experience and training of the AASs to assess risk and that they often did risk assessments on the way to a fire.

Interviewees also described the degree of guidance provided to aircrew to conduct dynamic risk assessments. One agency representative observed that while the agency's SOPs contained a pre-flight risk assessment, the dynamic risk assessment criteria or process used during a fire was undocumented. Another agency representative assumed that all aircrew were already trained to do dynamic risk assessments because of their aviation backgrounds. Only one agency representative reported using some form of risk matrices or limits to guide risk decision-making over the fireground, but these were informal only. Two operators and 2 agency representatives believed that the firefighting situation was too varied to be able to set limits or create a risk matrix.

Three operators and 4 agency representatives made comments that reflected the use of a ‘safe, effective, efficient’ approach when tasking aircraft or deciding to continue with a task. This approach asks if these 3 criteria are met when assessing a task. However, 3 agency representatives observed that there was no accompanying guidance for assessing these criteria. It was an uncertain and informal process and therefore dependent on individual interpretations.

Five agency representatives and one operator commented on the process for flying again after being grounded due to poor weather conditions. All interviewees described a process of consultation with pilots before deciding to fly again. Two interviewees also reported sending the AAS to have a look to reassess. No interviewees mentioned documented guidance or procedure.

Four interviewees (3 agency representatives and 1 operator) commented that they believed there was insufficient risk monitoring by fire agencies.

Safety theme: High risk tolerance and risk normalisation

Summary of what interviewees said about high risk tolerance and risk normalisation

- Most agency representatives and some operators reported a high tolerance for risk.
- Interviewees commented on the high risk tolerance in relation to the general culture of firefighting, reporting of incidents and night firefighting.
- Some interviewees also described instances of risk normalisation in relation to incident reporting and high-tempo fire incidents and busy fire seasons.

Context for safety theme: high risk tolerance and risk normalisation

Research by Martínez-Fiestas and others (2020) and other researchers have highlighted a higher tolerance for risk among firefighters. This is particularly the case when there is a perceived threat to life or homes (Ash and Smallman, 2010). Firefighters’ risk tolerance is shaped by the fire agencies’ safety culture (Mearns and others, 1998). Fire agencies’ response to firefighting also attracts significant political and community expectation (NAFC, 2021).[44] Expectation can create pressure to accept higher risk (Martínez-Fiestas and others, 2020). However, at the same time, fire agencies have requirements under Australian workplace health and safety legislation to create a safe workplace. Fire agencies must implement a risk-based approach to ensure that risks are ‘as low as reasonably practicable’ (ALARP) (Penney, 2022).

The normalisation of risk is another factor that results in a higher risk tolerance. Risk normalisation occurs when risky practices or situations do not result in an accident and over time become accepted as normal (Hopkins, 2011). It is the process of becoming desensitised to risks in your environment (Sedlar and others, 2023). Risk normalisation is

[44] See also the NAFC (2020) *Strategic Framework: 2020-2025*, which states ‘Aviation is a highly visible asset with strong political influences. …Best use of limited resources and conveying realistic limitations and shaping expectations to governments and the community in general is important.’

more common in situations where individuals have a high level of personal responsibility despite only having low control over the operation. It is also more likely when there is a gap between formal procedures and informal practice (Stave and Torner, 2007). According to interviewees, both situations exist in aerial firefighting.[45] Higher risk tolerance and the normalisation of risk in aerial firefighting may lead to individuals and organisations losing their ability to accurately perceive vulnerabilities in their operational environment.

Details of interviewee comments on high risk tolerance and risk normalisation

Eight of 11 agency representatives and 4 operators spoke of a high tolerance for risk or a normalisation of risk by agency personnel and pilots. Of these, 6 agency representatives and 2 operators highlighted a high tolerance for risk within aerial firefighting operations by both agency personnel and pilots. Interviewees commented on a higher risk tolerance in relation to a variety of areas of operation. These included the general culture of firefighting, reporting of incidents and night firefighting. However, an agency representative did emphasise that the higher tolerance for risk was accompanied by risk management practices. Two agency representatives and one operator also highlighted the normalisation of risk in relation to incident reporting and high tempo, busy situations. Incidents occurred so frequently they were not considered worth reporting or they were dealt with and then overlooked because aircraft were needed back over the fire.

Safety theme: Commercial pressures

Summary of what interviewees said about commercial pressures

- Interviewees reported commercial pressures were at times negatively affecting operations and creating risk.
- Over half of the agency representatives reported that insufficient resources affected learning, implementing change, mentoring or training.
- Ageing airframes were a concern.

Context for safety theme: commercial pressures

Aerial firefighting operations are part of Australia's general aviation industry. Estimates of overall income and expenses for general aviation suggest that the average general aviation business operates with a very narrow profit margin (BITRE, 2017). An ageing aircraft fleet and associated rising maintenance costs, rising avgas fuel and infrastructure costs, and difficulty attracting and retaining pilots are just some of the challenges facing all general aviation. According to the General Aviation Advisory Network (GAAN), the commercial pressures facing Australian general aviation also include high sensitivity to market pressures, lack of incentives to investment, over-regulation and limited political influence (GAAN, 2023). Most firefighting operator submissions to the RCNNDA highlighted that current contract lengths and minimal work during the off season discourage investment and make it difficult to secure long-term finance (Binskin and others, 2020).

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[45] See *Safety theme: Informal risk management* and *Safety theme: Transfer of risk responsibility*.

Details of interviewee comments on commercial pressures

Overall, 9 of 11 agency representatives and 4 of 9 operators perceived fire agencies' firefighting operations and capabilities to be unduly influenced by commercial pressures and limited resourcing. Three agency representatives and 4 operators provided examples of where they believed commercial pressures on fire agencies negatively influenced operations and introduced risk. Of these interviewees, 2 operators and 1 agency representative commented that aircraft were tasked based on the most economical option. Two operators believed some agencies were excessively focused on media attention to attract funding. One operator and one agency representative believed that the focus of flight tracking was on billing, not safety. As stated under *Safety theme: Informed culture*, one operator observed that the degree of sharing of safety information would always be limited by commercial concerns. Other interviewees highlighted:

- night firefighting, where a reported focus on efficiency and effectiveness was eroding risk management practices
- fire agencies' evaluation of performance, with a focus on litres of retardant capacity/aircraft without accounting for aircraft capabilities or accuracy.

Further, 6 of 11 agency representatives commented on insufficient resources limiting fire agency capacity for learning, implementing change, mentoring and training.

Interviewees also reported commercial pressures on operators. Two agency representatives and 2 operators commented on the commercial pressures arising from the seasonal nature of firefighting. Interviewees' comments included that it made it difficult to invest in aircraft, retain qualified pilots and 'stay afloat' during the off-season. Two agency representatives and 2 operators highlighted that some operators are now in direct competition with fire agencies for work, with fire agencies building their own aircraft fleets.

Seven agency representatives and 3 operators also believed that the use of CWN contracts resulted in commercial pressure on pilots and operators. According to these interviewees, CWN contracts limited an operator's ability to invest in aircraft and training. They also made it more likely that the operator and pilot would fly in marginal conditions, since they would not be paid otherwise. Interviewees also believed the use of CWN contracts introduced risk because of pilots' unfamiliarity with procedures and operators reportedly not always being required to meet NAFC contract standards. Finally, one agency representative and 3 operators commented on the length of contracts, which were considered too short to enable investment.

Only 2 interviewees (1 agency representative and 1 operator) commented on commercial pressure on operators resulting in 'tow-trucking'. Tow-trucking is when operators without a contract position their aircraft close to a fire to increase their chances of being tasked.

Five of 11 agency representatives and 4 of 9 operators expressed concern about ageing airframes. Interviewees reported that contract lengths were not long enough to enable investment in new aircraft. They also perceived that the situation was exacerbated by fire agencies investing in their own fleets rather than contracting operators.

Conclusions

Analysis of the interviewees' comments identified 18 key safety themes. The primary conclusions from these are:

- There was wide variation in interviewees' perceptions of fire agencies in the safety themes identified. For any safety theme, therefore, it was not possible to characterise all fire agencies in the same way.
- Agency representatives and operators sometimes had opposing views on the extent to which a safety aspect was being achieved, for example regarding safety culture and a pressure to fly.
- Several safety themes were identified that suggest that some fire agencies may not have a positive safety culture:
  - Interviewees believed that fire agencies could enhance their management of safety by developing a just, learning, reporting, informed and flexible culture.
  - The remaining safety themes interviewees identified also support the perceived need for fire agencies to have a positive safety culture.
- Issues relating to standardisation and formalisation were identified as key safety themes but were also present in several of the other safety themes including:
  - aircraft coordination
  - communication
  - training
  - pilot performance
  - risk identification and monitoring of changing conditions.
- Several key safety themes relating to risk management were identified including:
  - transfer of risk responsibility
  - pressure to fly
  - risk identification and monitoring of changing conditions
  - high risk tolerance and risk normalisation.

  These safety themes suggest that interviewees perceived a need for fire agencies to play a greater role in risk management and ongoing risk monitoring.
- Sustaining risk management practices during periods of increased intensity and complexity was reportedly a challenge for fire agencies, particularly during the 2019–20 fire season.

Glossary

AAS	Air attack supervisor
ABM	Air base manager
ACT RFS	Australian Capital Territory Rural Fire Service
ADF	Australian Defence Force
ADS-B	Automatic dependent surveillance broadcast
AFAC	National Council for Fire & Emergency Services
ALARP	As low as reasonably practicable
AOC	Air operator certificate
AOM	Air operations manager
ASG	Aviation Safety Group
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BoM	Bureau of Meteorology
Bushfires NT	Bushfires Northern Territory
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations 1998
CRM	Crew resource management
CTAF	Common traffic advisory frequency
CWN	Call-when-needed
DBCA	Department of Biodiversity, Conservation and Attractions
DEECA	Department of Energy, Environment and Climate Action
DFES	Department of Fire and Emergency Services
FAA	Federal Aviation Administration (US)
FEAT	Fire Emergency Aviation Technical group
GAAN	General Aviation Advisory Network
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Organization
LAT	Large air tanker
MTOW	Maximum take-off weight
NAFC	National Aerial Firefighting Centre
NOTAM	Notice to airmen
NPWS	NSW National Parks and Wildlife Service
NRSC	National Resource Sharing Centre

NSW RFS	New South Wales Rural Fire Service
NTSB	National Transportation Safety Board (US)
PIC	Pilot in command
QFD	Queensland Fire Department
RCNNDA	Royal Commission into National Natural Disaster Arrangements
RPAS	Remotely piloted aircraft systems
SA CFS	South Australia Country Fire Service
SEAT	Single engine air tanker
SMS	Safety management system. A systematic approach to organisational safety encompassing safety policy and objectives, risk management, safety assurance, safety promotion, third party interfaces, internal investigation and SMS implementation.
SOP	Standard operating procedure
SPI	Safety performance indicator
SSRP	Safety sector risk profile
TFS	Tasmania Fire Service
TRA	Temporary restricted airspace
USFS	United States Forest Service
WHS	Work health and safety

Sources and submissions

Sources of information

See *Method* section for details.

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Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- National Aerial Firefighting Centre
- Civil Aviation Safety Authority
- Australian Capital Territory Rural Fire Service
- Bushfires Northern Territory
- Department of Biodiversity, Conservation and Attractions, Western Australia
- Department of Fire and Emergency Services, Western Australia
- Department of Energy, Environment and Climate Action, Victoria
- New South Wales Rural Fire Service
- New South Wales National Parks and Wildlife Service
- Queensland Fire Department
- South Australian Country Fire Service
- Tasmania Fire Service
- Operators interviewed for the study.

Submissions were received from:

- National Aerial Firefighting Centre
- Civil Aviation Safety Authority
- New South Wales Rural Fire Service
- Department of Fire and Emergency Services, Western Australia
- Department of Energy, Environment and Climate Action, Victoria
- Two operators interviewed for the study.

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix A – Hollnagel's resilience engineering approach

The Resilience engineering approach understands a system's resilience in terms of its ability to respond to, monitor, learn from and anticipate risk. Hollnagel (2010) defines these abilities as:

The potential to respond: Knowing what to do or being able to respond to the irregular and regular. Responding to changes, opportunities and disturbances by activating prepared actions or by adjusting current actions to suit the new conditions and changes to the environment in which it operates.

The potential to monitor: Knowing what to look for or being able to monitor that which is or could seriously affect the organisation's performance in the immediate future either positively (Safety II) or negatively (Safety I). Monitoring must cover the organisation's own performance as well as what happens in the environment in which it operates.

The potential to learn: Knowing what has happened, being able to learn from all experiences and to learn the right lessons from the expected conditions and unexpected conditions by understanding both what goes right, as well as the right (Safety II) lessons from unexpected conditions and what goes wrong (Safety I).

The potential to anticipate: Determining or predicting what to expect or being able to anticipate conditions/environment further into the future, such as possible disruptions, unusual demands or constraints, new opportunities, or changing operating conditions.

Appendix B – Interview question framework

These questions are based on Hollnagel's (2010) list of Resilience Analysis Grid questions.

Anticipate (Risk analysis)

A1 Expertise

- **A1.1** Whose input is used at what stage to look ahead and identify potential risks?
- **A1.2** What training and resources do the units or people tasking aircraft have for assessing future threats or opportunities to do the job accurately and is it sufficient?

A2 Frequency

- **A2.1** How often is the scenario reassessed and how often you get updates? Are they push or pull? How many sources do they come from?

A3 Communication

- **A3.1** How is assessment of anticipated threats and opportunities passed to the pilot? How do pilots stay up to date with the operational conditions?

A4 Strategy

- **A4.1** How do you determine what the future is likely to look like with respect to pressures on aviation safety?
- **A4.2** What planning takes place to alleviate known risks to aviation safety?

A5 Model

- **A5.1** What measurements, events or changes will alert you to a change in aviation safety risk?

A6 Time Horizon

- **A6.1** How far ahead are you planning when tasking aircraft? (Do you know for example when that crew's hours will be up before they are tasked?)

A7 Acceptability of risks

- **A7.1** How is tolerability of aviation risk set and communicated?
- **A7.2** Who is accountable for aviation safety on a fireground? How can that change tolerability to risk?

A8 Aetiology

- **A8.1** Where are threats to aviation safety expected to arise from on the fireground? (Adaptive capacity v demand, buffers failing, manoeuvring space).
- **A8.2** Where are the opportunities for safer operation?

A9 Culture

- **A9.1** What is the dominant culture within the agency with respect to aviation safety?

Monitor

M1 Indicator list

- **M1.1** What safety performance indicators have been identified and applied to aviation safety risk?

M2 Relevance

- **M2.1** Who ensures performance indicators remain relevant?

M3 Indicator type

M3.1 What are the most important elements in your operation to monitor for potential impact on safe operation of aircraft?

M4 Validity

M4.1 Which indicators have proven to be most useful to maintain safe margins of aviation operation?

M5 Delay

M5.1 With respect to any lagging indicators (reducing availability of crew or increased maintenance for example) how long before impact to safe operations is noted?

M6 Measurement type

M6.1 What comes back from the field? (Hazard reports? From who? Do AAS log 'red flags' during normal ops?)

M7 Measurement frequency

M7.1 How often does info come back from field with respect to monitoring daily ops?

M8 Analysis / interpretation

M8.1 With information that is fed back, how much of it can be used straight away and what requires analysis?

M8.2 How are flight crew assessed with respect to performing services to a satisfactory standard?

M8.3 How are flight crew assessed with respect to maintaining appropriate safety standards?

M9 Stability

M9.1 How changeable is the list of things that those with an impact on aviation safety need to monitor or measure?

M10 Organisational support

M10.1 What support is provided to the people who monitor and make decisions which impact aviation safety risk?

M10.2 What time and resources are available to refine and enact the monitoring strategy?

Respond

R1 Event list

R1.1 Which events (in the context of aviation safety) does the agency have prepared responses for, and are the conditions for calling a stop to aviation operations clear?

R2 Background

R2.1 What guidelines and protocols exist to support decision making in the circumstances where aviation operations need to be stopped and restarted?

R3 Relevance

R3.1 Who is responsible for evaluating and determining what agencies should do in response to worsening conditions, near miss or accident?

R4 Threshold

R4.1 What is the process and framework for a PIC to refuse a task on grounds of safety?

R4.2 Where are these decisions recorded and what analysis of the reasons or conditions that existed at the time is undertaken?

R4.3 What is the criteria for tasking another or the same aircraft? What considerations are made in doing so?

R5 Response list

R5.1 What does the agency do following suspension of operations by a pilot or an occurrence (such as a near miss)?

R5.2 Where conditions are deteriorating, what is in place for identifying that, and changing mode of operation to maintain safe margins? (IFR only stipulated in deteriorating visibility, for example).

R6 Speed

R6.1 When a situation looks to be becoming fraught, how quickly can changes be made to restore safe margins?

R7 Duration

R7.1 Who measures the amount of time the fleet is operated in a stressed condition and how long is it expected to go for?

R8 Resources

R8.1 Do you have pre-prepared responses plans or temporary adaptive procedures to deal with the varied situations of task demand exceeding capability?

R8.2 What examples are there of them being used and how effective have they proven to be?

R9 Stop rule

R9.1 What would a decision to start again be predicated on?

R9.2 What pressure to restart would exist and where is it likely to come from?

R10 Verification

R10.1 How are response plans or temporary adaptive measures assessed and maintained to be appropriate?

Learn

L1 Selection criteria

L1.1 How does the organisation decide on which events to investigate or escalate?

L2 Learning basis

L2.1 Which elements of operation does the organisation target for use in its training programs?

L3 Data collection

L3.1 What mechanisms are there for collection of hazard reports and improvement opportunities? (This includes from pilots and operators.)

L3.2 Is anyone trained in collection and analysis of data?

L3.3 How do you work with other agencies to identify common issues and discover solutions?

L4 Classification

L4.1 How are reports relating to aviation safety classified?

L4.2 Is there a common language with other departments or agencies?

L5 Frequency

L5.1 How often are changes due to identified hazards built in?

L6 Resources

L6.1 What resources are available for hazard identification / analysis / management and investigation?

L7 Delay

L7.1 When someone reports an event, how long does it take to be analysed, provided to an accountable manager, resolved, and built back into system?

L8 Learning target

L8.1 With lessons distilled from events, at what level are they built back in to the system? (Who is the target of learning? Individual, collective, agency, external parties.)

L9 Implementation

L9.1 Can you provide examples of lessons learned being absorbed through the system? Procedures, training, guidance, redesign of tasks etc…

L10 Verification and maintenance

L10.1 Where an occurrence has prompted a change, how does the agency test that the change had the desired effect?

Contract

C1 Operating environment

C1.1 A number of elements in the operating environment carry risk of LOC-I, midair collision and CFIT, how does the agency manage these risks?

C1.2 How does the agency manage the risk of pilots pushing too far due to implied or express pressure?

C1.3 How does the agency manage the risk of operators taking on more risk due to drift caused by pressure?

C2 Required courses

C2.1 What standards exist for FRMS, CRM/HF courses?

C2.2 How do the agencies satisfy themselves that a course covers the right info for the risks they face?

C3 Tasking

C3.1 What is the risk analysis process for tasking aircraft?

C3.2 What examples do you have of the agency requiring the removal or replacement of flight crew for reasons of task performance?

C3.3 What examples do you have of the agency requiring the removal or replacement of flight crew for reasons of safety?

C3.4 Are there examples of standing down a contractor for any instances of non-compliance in delivery of the service?

Appendix C – Grounded theory analysis

Grounded theory analysis is a systematic approach to analysing qualitative data. It was designed to handle qualitative data in a more structured and objective way. It was first developed by Glaser and Strauss in 1967 and has been elaborated upon over the years, by Strauss and Corbin (1990), Charmaz (2025) and others.

Purpose of grounded theory

Grounded theory has the explicit purpose of generating theory from data. It is an inductive approach, which means it works from the 'ground up' to produce theory and explanation arising from the evidence. It contrasts with the traditional, deductive theory verification model where an existing theory or hypothesis about a research subject is applied and tested (from the 'top down') (Punch, 1998). Researchers using grounded theory aim to start with an open mind instead. Grounded theory finds concepts and categories within the data, rather than bringing pre-existing ideas to the data from literature or prior experience. Thus, the whole premise of grounded theory is that the theory will be 'grounded' in the data. The benefit of using this approach is that it is possible to discover new theoretical insights about the subject being studied. How grounded theory was used

Grounded theory was used in this study only to inform the analysis of interview data stage. However, grounded theory constitutes a whole approach to conducting research, including how data is collected (Birks and Mills, 2023). In the pure interpretation of grounded theory, interview questions would not be guided by pre-existing theories such as resilience engineering, as they were in this study. Instead, they would begin with very open questions aimed at gaining an understanding of a situation, before more narrow questions 'emerged' naturally from responses given. Additionally, data collection would unfold and continue with the aim of achieving 'theoretical saturation', which occurs when new themes or categories are no longer being created. Theoretical saturation is also achieved when there are no patterns in the data left unexplained by current themes or categories (Charmaz, 2025). For this to occur, data collection and analysis must occur concurrently.

The coding stage in a pure grounded theory approach should also start with an 'open mind' without explicitly applying a theory. However, all researchers have to some extent been exposed to prior theories or explanations of the area under study. Hence investigators automatically accessed schemas in their minds when coding the interviews to produce categories, for example 'safety culture'. Strauss and Corbin (1990) recognise that a degree of pre-existing knowledge of a subject will exist. Nevertheless, not applying a particular theory helps defend against forcing the evidence to fit a pre-determined understanding of the situation. It also prevents other evidence being overlooked because it does not fit with current theory.

The coding process

The essential idea in analysing data using grounded theory is to produce a core category (or categories) that accounts for what is central in the data. The categories will be at a higher level of abstraction but still grounded in the data. There are 3 main stages in this process. All stages involve the constant comparative method, where any incoming data is compared to existing data and categories are reconsidered, merged or reformed (Charmaz, 2025).

Stage 1: Open coding

The first stage is called ‘open coding’. This involves the researcher assigning a code to each comment made by interviewees. At this stage the codes are very broad and are only one step up from labelling. There is minimal analysis or interpretation and the aim at this first stage is simply to summarise and account for each comment. Everything is coded too. This is to ensure that the process remains open to all possible theoretical categories, rather than the researcher inadvertently coding only the comments that make sense to them and fit with their understanding of the situation (Punch, 1998). It also means that the researcher is less likely to interpret the evidence based only on preconceived ideas or assumptions about a situation. Each comment in the interview transcripts was assigned a code in this way. This produces a fairly long list of first-order ‘codes’ or categories. The codes are already raised to a higher level of abstraction, but at this stage are still more descriptive than theoretical in nature.

Stage 2: Axial coding

The second stage is called ‘axial coding’. Axial coding is defined by Strauss and Corbin (1990) as:

> A set of procedures whereby data are put back together in new ways after open coding, by making connections between (and within) categories.

At this stage connections are made between the first-order codes, so that the main categories that have emerged from open coding of the data are interconnected with each other. At the same time, the level of conceptual analysis is elevated again (Birks and Mills, 2023). The process is guided by making comparisons and asking questions such as ‘what is this an example of?’ Or, ‘what does this represent?’ As a result, the codes become less descriptive and move closer to theory. This process produces a much smaller set of categories raised to a higher level of abstraction.

Stage 3: Selective coding

The third stage of grounded theory analysis is called ‘selective coding’. This stage involves systematically relating categories under ‘core’ categories (Strauss and Corbin, 1990). A core category is the overarching concept that links each of the categories that are produced during axial coding. Core categories provide the researcher with a way to link most or sometimes all of the categories identified during the axial coding stage (Birks and Mills, 2023). The category of safety culture from this study is a good example. Ultimately, the goal of the grounded theory coding process is to build an explanation of a situation like aerial firefighting that is faithful to the evidence.

About the ATSB

The **Australian Transport Safety Bureau** is the national transport safety investigator. Established by the *Transport Safety Investigation Act 2003* (TSI Act), the ATSB is an independent statutory agency of the Australian Government and is governed by a Commission. The ATSB is entirely separate from transport regulators, policy makers and service providers.

The ATSB's function is to improve transport safety in aviation, rail and shipping through:

- the independent investigation of transport accidents and other safety occurrences
- safety data recording, analysis, and research
- influencing safety action.

The ATSB prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, international agreements.

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings.

At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

About ATSB reports

ATSB investigation final reports are organised with regard to international standards or instruments, as applicable, and with ATSB procedures and guidelines.

Reports must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

An explanation of ATSB terminology used in this report is available on the ATSB website.