SUMMARY OF ISSUES EMERGING IN COORDINATION BREAKDOWN FROM SECONDARY SOURCES (IN PARTICULAR INQUIRIES AND SIMILAR)

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Contents

Introduction

The secondary sources analysis is being conducted using the Human Factors Analysis and Classification System (HFACS) as a framework (Wiegmann & Shappell, 2003). This classification system draws off Reason's "Latent error" model of understanding organisational error as a combination of active and latent failures, as indicated by Figure 1.

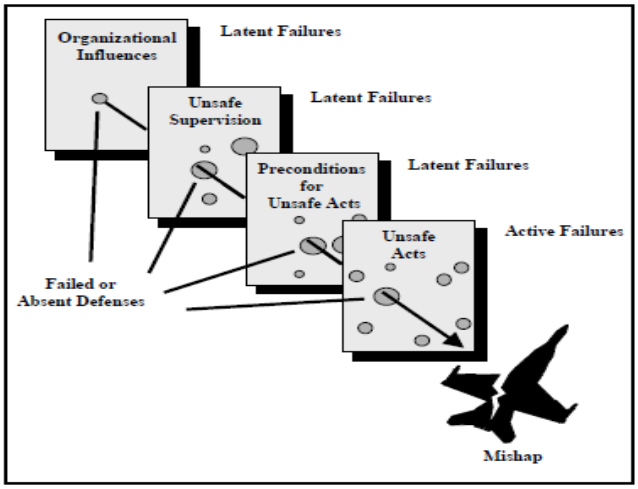

Figure 1. *The "Swiss cheese" model of human error causation (adapted from Reason, 1990).*

While the Reason model has strengths in acknowledging that errors occur due to a range of organisational factors or failures of other organisational defenses, Reason's model is necessarily descriptive. The Human Factors Analysis and Classification System (HFACS) provides an explanatory framework to better understand the trajectory of an error.

The Human Factors Analysis and Classification System

With respect to HFACS, "the original framework (called the *Taxonomy of Unsafe Operations*) was developed using over 300 Naval aviation accidents obtained from the U.S. Naval Safety Center" (Shappell & Wiegmann, 1997a). The original taxonomy has since been refined using input and data from other military and civilian aviation organisations to develop the current system.

The classification system includes nano-codes to be used to assess levels of failure. The layers include:

- Unsafe acts
- Preconditions for unsafe acts
- Unsafe supervision
- Organisational influences

As can be seen from Figure 1, the analysis drills backwards from an active (operational) error to review the latent preconditions and organisational influences that were also implicated. The research team have been trialling HFACS on transcripts from the 2009 Victorian Bushfires Royal Commission and early results indicate it is a useful classification system for this purpose. It is anticipated that some of the nano-codes will need to be adjusted to adapt the classification system from a largely aviation-based context to one more suited to fire and emergency services management.

There is also an opportunity to trial the classification system with agencies to analyse their own databases of incidents. The research team has canvassed this prospect with agencies who may be interested.

An appendix of categories and their definitions and examples of their potential application in fire and emergency events is attached as Appendix 1.

Use of the framework

A key element of the analysis has been to develop a robust method as well as identify patterns of human factors issues emerging from the secondary sources. Based on this, issues emerging are both methodological and outcome oriented.

Emerging Issues

One of the issues emerging suggests that the use of the terms 'accident' and 'error' may be inappropriate within the current domain. Therefore we have referred to the current analysis as Human Factors Issue Classification System (HFICS)

Initial use of that coding scheme (see Appendix 1) proved problematic, partly because of the need to code both at the IMT but also at the Regional and State coordination levels. This led us towards a layered approach where we were coding at all three levels (where possible) based on a synopsis of an individual 'issue'. This is consistent with the concept of 'error chains' – or that multiple errors at multiple different levels of an organisation are usually associated with accidents or incidents or even just sub-optimal outcomes.

For example, the following synopsis is drawn from Smith's (2005) review of the Wangary fire in South Australia:

> "During the Wangary Bushfire there are a number of indicators that there is not a common understanding of the operational control, command and coordination roles and responsibilities of personnel operating at the three levels. Failure to comprehensively and consistently apply and resource the ICS".

At the IMT level, such a statement is evidence of a routine violation. These are defined as tending to be habitual by nature and often tolerated by governing authority (Reason, 1990). Within both Smiths (2005) report and the associated

Inquest, it is clear that this situation was also strongly influenced by a Crew Resource Management (CRM) precondition within the IMT – (This includes teamwork and coordination and the communication practices needed to operate). At both the Regional and SCC levels we also code this example as including routine violations, however given the supervisory roles of both these levels of the CFS, we suggest that there was both inadequate supervision and, in some instances, failures to correct known problems. Finally, we can take a broader perspective and identify deficiencies at the organisational level (coded to the SCC) in:

- organisational process - which refers to corporate decisions and rules that govern the everyday activities within an organisation, including the establishment and use of standardised operating procedures and formal methods for maintaining checks and balances (oversight) between the workforce and management,

and;

- resource management - regarding the allocation and maintenance of organisational assets such as human resources (personnel), the support of training programs and the maintenance and improvement of equipment and facilities.

As a trial of the modified, multi-layered, HFICS, we coded 18 discrete human factors issues associated with the Wangary Fire at the IMT, Regional and SCC level. UTAS and UniSA each allocated one coder to the task and the results were compiled and analysed for inter-rater reliability. Initial results indicated a Cohen's Kappa of 0.28, well below the minimum acceptable level of 0.70. The coders met to review the coding scheme and via a modified Delphi (using disagreement in coding to discuss and modify the coding scheme) we revised our codings. Analysis of the revised codings indicated a Kappa of 0.80. On this basis we believe that we now have a robust methodology to proceed with coding further secondary sources. However the use of the HFICS coding scheme must include both the coding and the follow-up Delphi because the Delphi adds value to the description and understanding of the human factors issues. We come to a richer perspective on the issues by considering them from the perspectives of different people. In this respect the process is similar to the collaborative approaches such as Root Cause Analysis.

We will proceed over throughout July to code issues that have emerged from the Black Saturday Fires and Canberra Fire Storm using this methodology.

Preliminary findings in relation to issues emerging

Findings emerging from the secondary sources are outlined in Figure 2 and raise the following operational/applied issues:

- At the IMT level decision problems and violations predominate. Decision problems include procedural errors, poor choices and problem solving errors. These are sometimes referred to as procedural decision errors (Orasanu,

1993), or rule-based mistakes, as described by Rasmussen (1982). Violations are those actions that occur when the person knows the procedure but intentionally does not follow that procedure or policy. Sometimes there are good reasons for this, but often such actions can lead the system to a lower state of safety.

- The Regional level is dominated by problems associated with inadequate supervision of the IMT demonstrating problems associated with not being fully aware of the operational control, command and coordination roles and responsibilities of personnel. Other problems have included accepting information that flows from the IMT at face value without critiquing or querying information and recognising a problem but either failing to act, or acting in a way that makes the problem worse (such as confusing the chain of command).
- At the State Control level inadequate supervision of other levels of the organisation is also an issue, however the focus at this level indicates that resource management and organisational processes are broader, temporally more stable issues that influence actions at the IMT level.

Conclusion

The HFACS system has been renamed and re-focused to deliver a robust tool for driving the discussion of human factors issues in secondary sources for the BCRC project. HFICS should be combined with a Delphi to identify sources of agreement and disagreement around the coding and develop a richer understanding of the issue. Preliminary issues at the different levels of fire organisations are identified above and include a range of issues temporally constrained to specific fires as well as broader issues associated with the management of these organisations over time.

A full report on the human factors implications from the analysis of secondary sources will be submitted on 31st July 2011.

Figure 2. Wangary Fire HFICS diagram

Appendix 1

Level 1: Unsafe acts

According to Reason (1990), unsafe acts can be loosely classified into two categories: errors and violations. In general, errors represent the mental or physical activities of individuals that fail to achieve their intended outcome. Violations, on the other hand, refer to the wilful disregard for the rules and regulations. Wiegmann and Shappell (2003) added a further level of granularity to expand errors and violations.

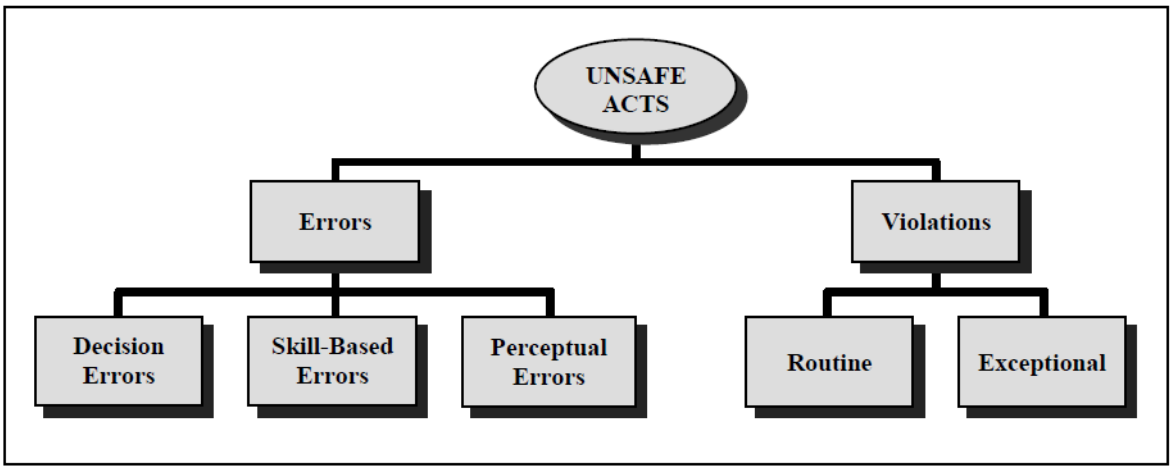

Figure 2. *Categories of unsafe acts committed by aircrews.*

Decision errors include procedural errors, poor choices and problem solving errors. These are sometimes referred to as procedural decision errors (Orasanu, 1993), or rule-based mistakes, as described by Rasmussen (1982).

Skill-based errors include applying a skill without much thought, due to task fixation; attention or memory loss (e.g., forgetting to do something).

Perceptual errors occur when sensory input is degraded or "unusual," (e.g., spatial disorientation).

As Shappell and Weigmann (2000, p. 5) note, "by definition, errors occur within the rules and regulations espoused by an organization; typically dominating most accident databases. In contrast, violations represent a wilful disregard for the rules and regulations" and these impact on safety.

Routine violations, tend to be habitual by nature and often tolerated by governing authority (Reason, 1990). Therefore, by definition, if a routine violation is identified, one must look further up the supervisory chain to identify either why those individuals

in authority who are not enforcing the rules (Shappell &Weigmann, 2000, p. 6) or whether the rules themselves need to change.

Exceptional violations appear as isolated departures from authority, not necessarily indicative of individual's typical behaviour pattern nor condoned by management (Reason, 1990). In this context they are considered "exceptional because they are neither typical of the individual nor condoned by authority" (Shappell & Weigmann, 2000, p. 6).

Examples of the applications of these HFACS categories pertinent to this research project are found in Table 1.

Table 1: Examples of Unsafe Acts above the IMT

Category		**Fire and Emergency Management Example**
Errors	Decisions	- The wrong level of warning is provided for the conditions - Underestimate the fire spread
	Skill-based	- Forgetting to update the warning - Not being able to upload a warning to the Web
	Perceptual	- Misreading a map or terrain (transposing north/south)
Violations	Routine	- Not completing an IAP on the first shift
	Exceptional	- Not confirming that there are pre-planned IMTs in place on high fire days

Level 2: Preconditions for unsafe acts

It is important to dig deeper as to why the unsafe acts occurred in the first place. Two major sub-divisions exist in this category (*of Preconditions for Unsafe Acts*)- "*substandard conditions of operators* and the *substandard practices they commit*." (Shappell & Weigmann, 2000, p. 6). These preconditions are identified in Figure 3 below.

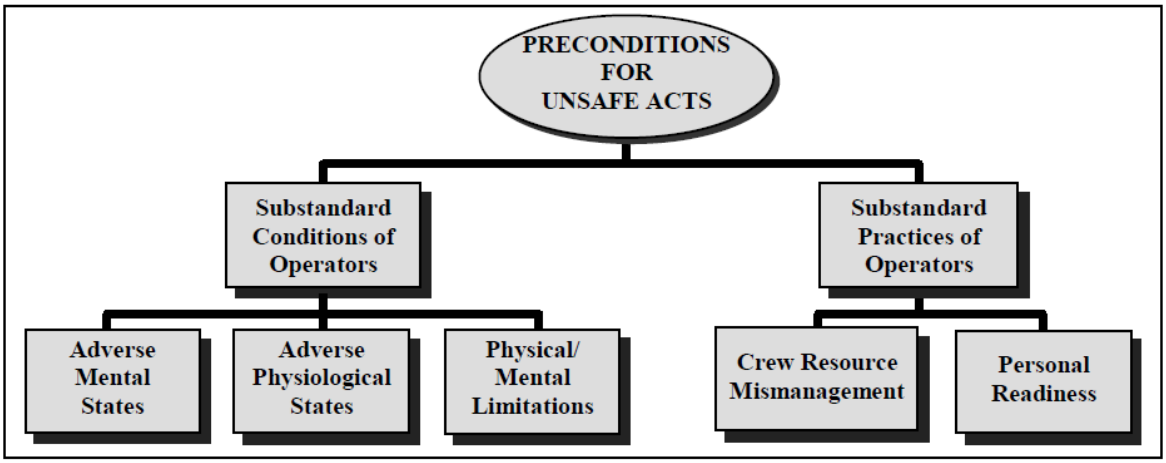

Figure 3. *Categories of preconditions of unsafe acts.*

Substandard Conditions of Operators relates to *adverse mental states* and was created to account for those mental conditions that affect performance. Principal among these are the loss of situational awareness, task fixation, distraction, and *mental* fatigue due to sleep loss or other stressors.

Adverse physiological states. The second category, adverse physiological states, refers to those medical or physiological conditions that preclude safe operations.

Physical/Mental Limitations. The third and final, substandard condition involves individual physical/mental limitations. Specifically, this category refers to those instances when mission requirements exceed the capabilities of the individual at the controls.

Substandard Practices of Operators. Generally speaking, the substandard practices of operators can be summed up in two categories: crew resource mismanagement and personal readiness.

Crew resource management. This includes teamwork and coordination and the communication practices needed to operate.

Personal Readiness. In aviation, or for that matter in any occupational setting, individuals are expected to show up for work ready to perform at optimal levels.

Examples of the applications of these HFACS categories pertinent to this research project are found in Table 2.

Table 2: Examples of preconditions for unsafe acts above the IMT

Category		Fire and Emergency Management Example
Substandard conditions of operators	Adverse mental states	Tunnel vision – overly focussed on one problem at the expense of other emerging conditions
	Adverse physiological states	Working beyond the shift length and being fatigued
	Physical/mental limitations	Colour blindness; hearing loss
Substandard practices of operators	Crew resource mismanagement	Failure to bring a non-routine situation to the attention of other team members
	Personal readiness	- being at work when ill; having been up all night - hangover

Level 3: Unsafe supervision

With active errors it possible to trace chain of events back up the supervisory chain of command. In the context of unsafe supervision, Shappell and Weigmann, (2000, p. 9) have identified four categories: inadequate supervision, planned inappropriate operations, failure to correct a known problem and supervisory violations.

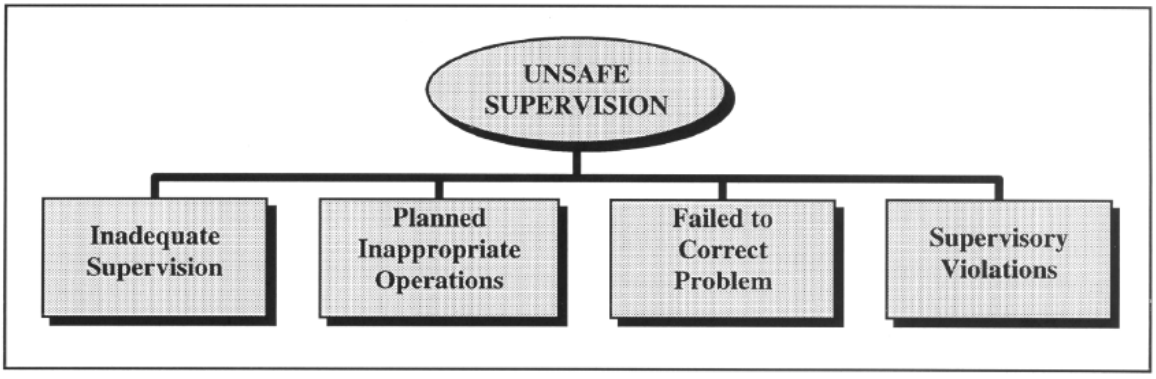

Figure 4. *Categories of unsafe supervision.*

Inadequate Supervision. Shappell and Weigmann, (2000, p. 9) note that it is the responsibility of the supervisor to provide guidance, training opportunities, leadership and motivation, as well as the proper role model to be emulated.

Planned Inappropriate Operations. Occasionally, the tempo of an operation results in increased risk such as crew rest is jeopardised, and ultimately performance is adversely affected.

Failure to Correct a Known Problem. The third category of known unsafe supervision, refers to those instances when deficiencies among individuals, equipment, training or other related safety areas are "known" to the supervisor, yet are allowed to continue unabated.

Supervisory Violations. These refer to those instances when existing rules and regulations are wilfully disregarded by supervisors.

Examples of the applications of these HFACS categories pertinent to this research project are found in Table 3

Table 3: Categories of unsafe supervision

Category	Fire and Emergency Management Example
Inadequate supervision	Allowing personnel to undertake roles not qualified for
Planned inappropriate operations	Providing a strategy inappropriate for the conditions
Failure to correct a known problem	Not addressing expressed concerns regarding establishing a line of control
Supervisory violations	Allowing personnel to continue to work under unsafe conditions

Level 4: Organisational influences

Shappell and Weigmann, (2000, p. 9) argue that supervisory practices, as well as the conditions and actions of operators can be linked to fallible decisions of upper-level management. This category tends to be rather broad but captures the key organisational influences involved in resource management, organisational climate and organisational processes.

Figure 5: Categories for Organizational Influences

Resource Management. This category encompasses the realm of corporate-level decision making regarding the allocation and maintenance of organisational assets such as human resources (personnel), the support of training programs and the maintenance and improvement of equipment and facilities.

Organizational Climate refers to a broad class of organisational variables that include organisational policies and organisational culture. These affect worker performance because of sanction and direct management's decisions about such things as selection and career progression, human resourcing and support policies (e.g., drugs and alcohol, overtime) as well as influencing the degree to which there is an incident investigation process.

Operational Process refers to corporate decisions and rules that govern the everyday activities within an organisation, including the establishment and use of standardised operating procedures and formal methods for maintaining checks and balances (oversight) between the workforce and management (Shappell & Weigmann, 2000, p. 13).

Examples of the applications of these HFACS categories pertinent to this research project are found in Table 4.

Table 4: Examples of organisational influences

Category	Fire and Emergency Management Example
Resource management	- not having in place the appropriate training program
Organisational climate	- cultural differences between units; levels or agencies - failure to develop the appropriate processes for risk assessment and monitoring
Organisational processes	- ill defined or too inflexible operating procedures

Beginning of Worked Example

The Kilmore East fire of 7 February 2009 burned across the Shires of Nillumbik, Mitchell and Yarra Ranges as well as the City of Whittlesea, about 85 kilometres north of Melbourne. The fire started at about 11:47, on top of a rocky hill between two gullies near Saunders Road in Kilmore East. The fire behaviour was extreme. Burning initially in a south-easterly direction, the fire crossed the Hume Highway and went on through Wandong on its way towards Mt Disappointment. The terrain and fuel where the fire burned promoted long-distance spotting: as the main fire front progressed across Mt Disappointment, fires were also reported at Wallaby Creek, Humevale, Strathewen, St Andrews, Steels Creek, Dixons Creek and Yarra Glen, and in the Healesville area.

After the south-westerly wind change, which passed through the fire ground between 17:40 and 19:00, the eastern flank of the fire became the front and the fire behaviour intensified. Almost immediately the head of the fire impinged on Kinglake, Kinglake West, Clonbinane, Steels Creek, Chum Creek and Strathewen, then it progressed towards Flowerdale, Hazeldene, Castella and Glenburn.

In all, 119 people died and 1,242 homes were destroyed. The combined area burnt by the Murrindindi and Kilmore East fires, which later merged, was 168,542 hectares. The Kilmore East fire alone burnt 125,383 hectares.

Collecting the Secondary Sources

The initial process of analysis includes establishing the coordination of the fire from the initial response, through the escalation within the relevant agencies and identifying the individuals responsible at various levels. In order to achieve this, we are producing 'mud-maps' of the coordination effort over time from (in this example) the 2009 Victorian Bushfires Royal Commission Interim and Final Reports. An example of a mud-map for the Kilmore East fire is shown in Figure 1.

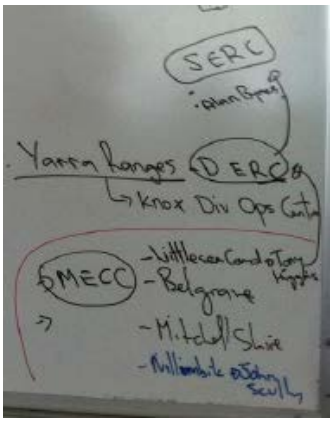

Figure 1: Kilmore schematic MECC to SERC

Once the scematics have been developed we identify the relevant testimonies and review these documents using the HFACS classification system described above. This involves a dual-triangulation approach

1. ***Triangulation of human factors issues from secondary sources.*** These sources include various testimonies of involved persons and commentary by the Commissioners. People within the Department of Sustainability and Environment (DSE), Country Fire Authority (CFA) and Victoria Police (VICPOL) may have differing perspectives on the human factors issues and those issues may change as they move through levels above the IMT. It is important we capture both competing and complimentary perspectives on these issues.
2. ***Triangulation of human factors issues by comparison of issue lists among research group.*** Conferences between Dr Christine Owen, Dr Chris Bearman and Dr Benjamin Brooks will occur having independently identified human factors issues in the secondary sources. Metrics for agreement is (% of issues identified by all three researchers). Issues will each be reviewed for relevance and either maintained or discarded.
3. ***HFACS Classification and assessment of inter-rater reliability.*** Each researcher will independently classify the issues using HFACS and these will be compared for reliability using standard metrics.

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