

# Report of visit to France, Canada and USA

## August – September 2006

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## Acknowledgement

The participants of the Best Practice Visit would like to acknowledge and express their gratitude to the various international agencies and organisations who undertook to host the group. The hospitality shown was unfailingly generous and the group would particularly like to thank those individuals who took time from their busy schedules to make arrangements, prepare and deliver presentations, demonstrate equipment and practices, and conduct detailed discussions. In many locations, visits were at times of particularly high fire activity which, although useful in many respects from the perspective of the group, placed considerable additional workload on hosts.



## Glossary of terms

AAO	Air Attack Officer; see also ATGS
AAS	Air Attack Supervisor; see also ATGS
AFAC	Australasian Fire Authorities Council
ATGS	Air Tactical Group Supervisor
BC	British Columbia, Canada
BCFS	British Columbia Forest Service
BIA	Bureau of Indian Affairs, U.S.A.
BLM	Bureau of Land Management, U.S.A.
BUI	Build Up Index - a measure in the Canadian fire danger rating system
CDF	California Department of Forestry and Fire Protection
CEREN	Cooperative Forest Research Facility, France
CRC	Cooperative Research Centre
CWN	Call When Needed (contract type)
EMS	Emergency Medical Service
EU	Exclusive Use (contract type)
FFMS	Forest Fire Management System, BC Canada
FPA	Fire Program Analysis, U.S.A.
FWI	Fire Weather Index
FWS	Fish and Wildlife Service, U.S.A.
ISI	Initial Spread Index - a measure in the Canadian fire danger rating system
NAFC	National Aerial Firefighting Centre, Australia
NFDRS	National Fire Danger Rating System, U.S.A.
NICC	National Incident Coordination Centre, U.S.A.
NIFC	National Interagency Fire Centre, U.S.A.
NPS	National Parks Service, U.S.A.
PATC	Provincial Air Tanker Centre, BC Canada
RAMP	Response Analysis Management Program, BC Canada
SEAT	Single-Engine Air Tanker
TRK	Training Resource Kit
UAV	Unmanned Aerial Vehicle
US	United States (of America)
USDA	United States Department of Agriculture
USFS	United States Forest Service - a branch of USDA
WATG	Wildfire Aviation Technical Group, Australia

1 acre = 0.4 hectares

1 us gallon = 3.78 litres



## SUMMARY of FINDINGS & RECOMMENDATIONS

In August and September 2006, a small group of Australian fire agency personnel visited France, Canada and the U.S.A. to study aspects of the aerial suppression of landscape fires. The visit was principally aimed at identifying opportunities for improving the operational safety, efficiency, and effectiveness of Australian aerial fire suppression.

The group concluded that the majority of practices currently applied in Australia are relevant and appropriate, and generally reflect international best practice. However, a number of potential refinements and improvements were identified. It was also concluded that continuing to share information and strengthen ties with international colleagues was advantageous.

The principal findings and recommendations outlined below have arisen from prioritising and synthesising important themes arising through the course of the visit. These form the “take-home messages” from the visit. More detailed findings and recommendations pertaining to each separate theme are contained in the body of this report as well as the rationale underpinning the principal findings and recommendations.

### Principal Findings

- PF1.** Aerial fire suppression in Australia is generally conducted using aircraft types with capabilities that are appropriate to the range of situations encountered. This may change in response to pricing and as technology continues to be developed, refined and proven. It is important to regularly monitor developments around the world.
- PF2.** Australian aerial firefighting practices are generally conducted to standards that are aligned with international best practice, although a number of areas could be improved.
- PF3.** Practices around the world have, at times, evolved without necessarily being based on verifiable evidence. Targeted research and operational analysis is a key to effective aerial fire operations and to ensure optimal resource allocation.
- PF4.** Effective measurement of aerial suppression performance continues to pose a challenge to most fire management agencies.
- PF5.** Although there are a number of risk-based decision support tools in place worldwide, the development and implementation of systems that effectively assess risk and support resource allocation decisions also continues to pose a challenge.
- PF6.** The use of short to medium term (0 to 7 days, and 0 to ~30 days) standard weather forecasting products and derivative products (such as BUI, ISI, fuel dryness) is well advanced in other countries. This style of product has potential to provide considerable benefit in the Australasian context.
- PF7.** Considerable benefits flow from standardisation of systems and operating practices across jurisdictions.
- PF8.** Considerable benefits flow from comprehensive training and skills maintenance for personnel involved in supervision, support, utilisation and operation of aerial resources.
- PF9.** Australia is likely to benefit considerably in the areas of training and skills maintenance from the further development and application of simulator technology.
- PF10.** Australia would benefit from the implementation of a national approach to electronic tracking of aerial resources, and ultimately from inclusion of this information into a wider, integrated information and management system.



## Principal Recommendations

- PR1. Continue to actively develop relationships and associations with international colleagues and organisations in order to share information, reduce duplication and develop collaborative synergies; and to remain up-to-date with advances in research, technology and operating practices.
- PR2. Continue to actively foster cooperation and collaboration between Australian states and territories including the development of common standards and operating practices, and improved mutual-aid arrangements to share resources according to risk.
- PR3. That NAFC and AFAC cooperate to develop a range of projects and programs to further develop best practice in aerial operations, including for example: the production of practice guides and the nomination of jurisdictions to lead or champion national approaches.
- PR4. (a) Reinforce and maintain whole-of-service contracted outsourcing as the preferred service delivery model for Australia;
- (b) continue to review preferred models as costs change and technology advances;
- (c) direct the Wildfire Aviation Technical Group to further develop and refine sophisticated contract management practices to ensure optimal delivery.
- PR5. (a) Reinforce through position papers, practice guides, and other means that worldwide experience and research has demonstrated that the most efficient application of aerial resources is in rapid initial attack of incipient fires; and
- (b) develop models to guide the appropriate weight-of-attack during the initial fire response.
- PR6. Recommend to AFAC/NAFC members that:
- (a) each state/territory take a centralised approach to dispatch and strategic coordination of aircraft for fire suppression within jurisdictions; and
- (b) that NAFC, or similar national entity, provides a strategic coordination and information service to facilitate sharing between jurisdictions.
- PR7. Identify, develop and implement standard Australia-wide weather and derivative fire risk outlook products that enable consistent understanding and comparison of forecast risk within and between jurisdictions.
- PR8. Finalise the current AFAC Aviation Training Resource Kit (TRK) project for implementation of a high quality national, standardised approach to competency-base training and certification for aviation supervision and support (i.e. specialist) personnel.
- PR9. Extend the TRK or similar project to ensure a national, standardised approach to delivering high-quality training to personnel utilising aviation resources (i.e. non-specialists) in fire operations.
- PR10. That AFAC/NAFC implement a major project to further research and develop the use of computer-based simulator technology for training and skills maintenance.
- PR11. Continue and expand Bushfire CRC research into the effectiveness of aerial fire suppression. This should include detailed research into the effectiveness of different aircraft types, bombing systems, and fire retardants/suppressants.
- PR12. Continue and expand Bushfire CRC research into the development of risk-based resource allocation optimisation tools. This should be informed by experiences with developing similar tools in other countries.

- PR13.(a) That AFAC/NAFC develop a standard national aircraft and delivery system rating and approval system (along the lines of the U.S. Air Tanker Board) and
- (b) in the interim, establish a collective network of shared information to enable effective evaluation of delivery systems.
- PR14. That AFAC/NAFC/Bushfire CRC cooperate to develop and implement a standard “after action” reporting and data collection system (as far as practicable using automatically acquired data) for aerial suppression.
- PR15. Closely monitor the outcomes of operations of the new generation of large fixed-wing air-tankers, and where appropriate, monitor and participate in any associated evaluation programs.





## **BACKGROUND**

The Directors of the Australian National Aerial Firefighting Centre (NAFC) identified a need to examine international aerial firefighting operations in order to benchmark Australian practices and identify opportunities for improvement.

Accordingly, the Aerial Firefighting International Best Practice Visit was organised by NAFC in conjunction with the Australasian Fire Authorities Council (AFAC). Over 18 days during August and September 2006, fifteen participants from Australian states and territories, the Australian Government, NAFC and the Bushfire Cooperative Research Centre (CRC), visited France, Canada, and the USA. See **Appendix 1** for a list of participants.

The visit was funded jointly by NAFC, AFAC, the Australian Government, state and territory governments, and the Bushfire CRC.

The specific locations chosen for the visit were thought to be most analogous to the types of fuels, climate and organisational arrangements likely to be encountered in Australia. The visit was timed to coincide with the likely fire season at these destinations and at many locations significantly above-normal fire activity was being experienced or had just been experienced. Although somewhat stressful for the hosts, the high levels of activity provided invaluable opportunities to fully examine systems and practices.

During the course of the visit, a total of 31 private and public sector organisations were examined. **Appendix 2** lists the locations and organisations that were visited.

The primary objectives of the visit, as communicated to host organisations, were:

- To examine aspects of best practice in aerial fire suppression, with a view to improving aerial fire suppression in Australia.
- To foster international cooperation and collaboration to improve the effectiveness and safety of aerial fire suppression throughout the world.

A secondary objective was to provide development opportunities for personnel who are likely to manage aerial firefighting activities in the future.

Hosts were also informed that the group had a particular interest in:

- approaches to collaboration, cooperation between jurisdictions;
- decision support for resource allocation, and matching resources to risk;
- systems for coordination of specialised aircraft assets;
- technological developments to aid effectiveness, efficiency and safety;
- contracting systems, including performance management; and
- systems for training of aircrew and specialist supervisory and support personnel.

This report summarises the key findings, observations and recommendations of the visit. The report groups the findings and recommendations into six main subject areas. Principal findings and recommendations have then been synthesised from the common themes. A vast amount of additional material was also collected and readers wishing to pursue particular topics in more detail should contact the NAFC office.

## **AERIAL SERVICE PROCUREMENT ARRANGEMENTS**

### **FRANCE - Sécurité Civile**

Sécurité Civile is a federal agency overseen by the French National Minister for the Interior. It manages all fixed-wing fire bombing aircraft utilised in France and as part of its federal charter, has responsibility for the supply of fixed-wing fire tankers in support of forest firefighting operations.

At the provincial level Sécurité Civile supports and is supported by local fire departments. Sécurité Civile coordinates with provincial fire departments, and on behalf of them conducts initial aerial attack on fires.

Sécurité Civile owns the following aircraft:

- 11x Canadair Air CL-415
- 10x Grumman Tracker S-2F
- 2x Dash 8 Q400
- 3x Beechcraft King Air 200



Photo: Converted Dash 8 Q400 on the ramp at Marignane

#### ***Contractual arrangements***

Sécurité Civile does not generally contract additional aircraft. Fire bombers are all purchased outright and owned by the Federal Government.

Maintenance is contracted to a third-party commercial organisation, and aircraft crewing is managed in-house, primarily using employed pilots.

In recent years Sécurité Civile has contracted the services of Type 1 helicopters (Erickson Air-crane) for the fire season, with crewing partly provided by the contractor and partly by Sécurité Civile.

At the provincial level, local fire departments hire helicopters for aerial observation, command and water bucketing.

#### ***Funding model***

Sécurité Civile's funding for the procurement of aircraft is obtained through the National Minister for the Interior. Funding includes fixed-wing aircraft maintenance and procurement, pilot salaries and aviation fuel. Provincial governments fund the hire/purchase of helicopters for their fire departments directly.

Sécurité Civile receives an annual budget of:

- € 45 million for functioning of six fixed-wing airbases that operate Sécurité Civile's firebombers.

- € 15 million for capital infrastructure and asset depreciation of Marignane airbase (main airbase for Sécurité Civile). If this particular funding is not expended at the end of the financial year the money can be rolled over and used for capital procurement in future years. Such funding has been utilised to purchase and outfitting of new aircraft, such as the Dash 8 Q400's.
- Total € 60 million annual funding. This funding total currently equates to \$120 million AU per annum.

### **CANADA – British Columbia Forest Service (BCFS)**

The British Columbia Forest Service is the provincial (state) agency responsible for forest fire management within the province of British Columbia. It manages all fixed-wing and rotary aircraft operations that support forest fire management/suppression within the province.

#### ***Contractual arrangements***

The BCFS Protection Program contracts virtually all of its aerial fire suppression resources from the private sector and principally relies on the contractors to provide pilot training and certification.

The Program maintains a strong emphasis on rapid 'first strike' initial attack – the concept of attacking a fire immediately upon detection and containing it so that it does not spread and require further resources and expenses to extinguish. Methodology is to hit the fire fast with a heavy initial attack then allow ground crews to contain the fire. Aircraft will do only a few sorties on the fire before heading back to designated base to await further deployments to new fires. This has produced, on average, 97% efficiency in initial attack success on fires where aerial tanker support was requested and actioned.

*[NOTE: One of the BCFS performance indicators is that 90% of all forest fires occurring in British Columbia must be suppressed during initial attack. Initial Attack is defined as “any fire burning within 24hrs upon first detection of that fire”.]*

BCFS contracts are:

- Non-prescriptive and seek to glean from the aviation industry the services that an operator can supply. Contracts tend towards describing what BCFS wants to achieve in its operations rather than being a prescriptive document.
- For set time periods, either 5yrs or 10yrs.
- No longer awarded solely based on cheapest price.
- Now awarded on a 60/40 weighted split between Service Delivery/Value for Money. Cost per litres delivered is not the only consideration in the Value for Money component of the contract evaluation process.

Fixed-wing fire bombing operations for all of British Columbia are managed from the BCFS Provincial Air Tanker Centre (PATC) at Kamloops in southern British Columbia. Kamloops is responsible for dispatch, strategic planning (daily/hourly alert status, aircraft group configurations), and logistical support for fixed-wing operations.



Photo: Aircraft on the ramp at BC Provincial AirTanker Centre in Kamloops

Helicopter operations are managed from the various “Rapattack” bases located throughout British Columbia (Rapattack are helicopter rappelling crews). These bases manage the day-to-day strategic planning and logistical support for the helicopters assigned to them. Rapattack base managers work with the BCFS Head Office in the contracting of desired helicopters for rapattack operations.

BCFS have contracted 31 aircraft for the 2006 fire season. These are:

- Fixed-wing Airtankers (15 total):
  - 6x Firecat Grumman Tracker S-2F
  - 3x L188 Lockheed Electra
  - 2x Air Tractor 802F
  - 4x CV580 Convair
- Fixed-wing Bird-dogs (8 total):
  - 4x Aerostars (A600)
  - 4x Turbo Commander (TC690)
- Fixed-wing Transporters (2 total):
  - 1x King Air 200
  - 1x Twin Otter DHC6
- Rotary-wings (6 total):
  - 3x Bell 212
  - 1x AStar BA
  - 2x Bell 206B Jetranger

In addition BCFS also have a mutual aid agreement with other Canadian provincial fire agencies for the supply of additional rotary and fixed-wing aircraft including CL-415's. Two Martin Mars fixed-wing bombers are also available in British Columbia on a casual hire basis.

Two contractors (one fixed-wing and one rotary-wing) were interviewed by the study tour group and provided the following comments with regard to contractual arrangements undertaken by BCFS:

- *“Contracts in British Columbia are very simple. BCFS and Contractors prefer it that way. Once contracts are signed, they're put in the draw and BCFS personnel and Contractor then works closely together to ensure compliance, efficiency and safety.”*
- *“The 5 or 10 year contracts were essential to allow a company to set up its operation, acquire suitable aircraft and plan ahead. Therefore this allows an operator to attract better pilots, and that means better safety and efficiency of operations.”*
- *“Contractor would rather receive a 5 to 10 year contract that is open for them to say what they can do for BCFS, rather than a contract that is based on cost alone. Better for the contractor to build on their company. Good pilots cost money. Innovation costs money. Running an aviation operation costs money. Longer contracts guarantee that funding source will be there over time.”*
- *Comment from the BCFS: “The longer the contract they offered, the more innovation and better aircraft offered by the aviation industry. Longer contracts are better for BCFS also as it guarantees that the desired aircraft remain available for their use. Airtanker contracts are for 5 or 10 years. Helicopter fleet contracts used to be from 2 to 3 years but have now also gone to 5 years with + 1 year extensions.”*
- *One helicopter provider stated: “We can't work on short term contracts. These don't allow us to invest in our operation. Basically you get what you pay for! A 2,000hr experienced Pilot-in-Command attracts a higher salary than a 200hr Pilot-in-Command. New aircraft cost money!”*

### ***Funding model***

Fixed-wing airtanker contracts are all administered from Kamloops and amount to \$43 million CA per annum. Helicopter contract amounts were not able to be defined.

Funding for fire aviation contractual arrangements (and for other fire management undertaken by the BCFS) is derived through a levy system brought into effect through Part 3, Division 2 of the British Columbia Wildfire Act 2004.

## **UNITED STATES OF AMERICA**

Approximately 280 million hectares of federal lands are managed by the five federal land management agencies: the US Forests Service (USFS), US Bureau of Land Management (BLM), US National Parks Service, Bureau of Indian Affairs and the Fish and Wildlife Service.

All five agencies have responsibility for fire suppression on federal lands and work cooperatively through the National Interagency Fire Centre (NIFC). The US Forest Service and the US Bureau of Land Management administer all federal fire aviation contracts on behalf of the five US federal land management agencies. The US Forest Service administers the federal fire aviation contracts for the large multi-engine airtanker fleet. The US Bureau of Land Management administers the federal fire aviation contracts for the single engine airtanker (SEAT) fleet.

An average of 2.4 million hectares of federal lands is affected by wildland fire per annum. Approximately 80,000 fires occur each year on federal land in the US.

### **US Forest Service, US Department of Agriculture**

#### ***Contractual arrangements***

According to the USFS, aviation is the most expensive component of their fire suppression operations. Ninety six per cent of aircraft utilised on fire operations are contracted and these contracts consume 98% of the USFS's aviation budget. The USFS contract around 800 aircraft each fire season.

USFS Aviation Contract Management website is at: <http://www.fs.fed.us/fire/contracting/>

US federal contracts are either for 90 or 120 days per annum and the operator must be able to move from state to state to support fire suppression operations nation wide. Contracts are for 1 year with 2 x'+1' year options for a maximum of 3 years.

The USFS believe that contractors prefer shorter contracts and so set their contracts for this time length. However the study tour received mixed responses to this from operators they visited. One operator said they preferred the shorter contract period so they could price factor in changes to insurance premiums (US aviation insurance premiums have risen threefold since the 11<sup>th</sup> September 2001). Other contractors stated the opposite saying that longer contracts were better (preferring 3 year, 5 year, or even 10 year contracts).

The USFS would prefer to issue a 5 year contract but have encountered some resistance from operators who are concerned at being locked into contracts without adequate rise-and-fall provisions.

USFS contracts have variable cost structures built into them to cover such things as wages and fuel. Contracts do not have the capacity to cover changes to items such as insurance premiums.

The USFS employs 70 to 80 pilots on a full time basis. Most of these are fixed-wing pilots (only 9 are helicopter pilots). These pilots perform the check and training rides for contract pilots utilised on USFS contracts. They are responsible for the carding system employed by the USFS to identify approved contract pilots and their capabilities. These pilots also fly fire operations during the fire season.

All pilots contracted to the USFS must meet the agency's minimum pilot standards, pass a check-ride and be monitored for their performance during the fire season. There is a three year rotation process to review all contract pilots that fly for the USFS.

USFS contracts spell out the minimum aircraft requirements and minimum pilot standards and any special requirements expected by the USFS. Contract pilots must also attend a CRM (Crew

Resource Management) course conducted by the USFS. The USFS also expects that any prospective contractor meet FAA requirements prior to any approval of contracts.

*[NOTE: As aerial fire suppression operations falls under the 'Private' or 'State Aircraft' category of aircraft operations within the United States, the FAA is less directly involved in the regulation of aerial fire suppression. For safety reasons however, the USFS has mandated that the industry adhere to certain FAA standards].*

In addition to checking and training pilots, the USFS also employs full time aircraft maintenance personnel. These personnel undertake site inspections of contract operators and audits of their records.

The USFS have moved away from having the majority of their aircraft procured through CWN contracts. Now the majority of contracted aircraft are procured through Exclusive Use contracts. This guarantees that the larger aircraft (in particular the Type 1 helicopters) are available for fire operations. Over the last few years the numbers of Type 1 helicopters available for CWN has been dwindling due to the fact that these aircraft are being contracted by other industries (in particular the oil industry). USFS believes that the issuing of Exclusive Use contracts guarantees aircraft availability for the fire season.

Additional aircraft may be sourced from the military. Generally this option is only available when it can be demonstrated that civilian sources are not available. The visit observed several National Guard C-130s fitted with 1st generation Modular Airborne Fighting systems operating from Boise.

### ***Funding model***

The USFS's funding is derived as follows:

- Each region funds the contracting of fire suppression aircraft. There is no centralised Head Office budget for aircraft acquisition.
- With the exception of large airtankers, fire suppression aircraft are contracted at the USFS regional level. NOTE: All USFS regions adhere to a national set of standards, training qualifications, policy and SOPs.
- During the 2003 fire season, aviation expenditure was approximately (US) \$135 million, predominantly on Call-When-Needed resources.
- During the 2004 fire season, expenditure was approximately (US) \$87 million. This was predominantly spent on exclusive contractual aircraft and much less on CWN.
- During the 2005 fire season, aviation expenditure was also approximately (US) \$87 million. Again this was predominantly spent on exclusive contractual aircraft and much less on CWN.
- The 2006 fire season expenditure had not been finalised at the time of the study tour due to the US fire season not having ended.



Photo: National Guard C-130s equipped with 1<sup>st</sup> generation Modular Airborne FireFighting Systems operating from Boise



## **US Bureau of Land Management (BLM), Federal Department of Interior (DoI)**

Each region within the four Bureaus responsible for wildland fire suppression bids for their aircraft service requirements for the upcoming period. The DoI's Acquisition Section manages contractual processes and acts as a broker for what the regions get (they rarely get all that they want.)

### ***Contractual arrangements***

Contracts are awarded on the basis of:

- contractor experience;
- contractors past performance;
- aircraft capability; and
- price.

Comment from the Acquisition Manager regarding the weighting used in awarding contracts: "Due to increased Congressional pressure to contain costs in fire suppression, value for price offered by potential contractors is starting to overly influence the decision as to which companies receive a contract."

Once contracts are awarded, the DoI's services (i.e. BLM, NPS, BIA, FWS) manage and ensure contract compliance.

BLM employs 8 fixed-wing pilots on a full time basis. These pilots conduct the check and training rides for BLM's contracted pilots. BLM contract 87 SEAT's each fire season. Contracts last a minimum 60 to 90 days per annum.

### ***Funding model***

Funding for fire suppression aircraft comes centrally from the Dept. of Interior's Acquisition Section. The Department of the Interior's Aviation Contract Management website is at: <http://amd.nbc.gov/apmd/seat/seat.htm>

## **California Department of Forestry and Fire Protection (CDF) - a state perspective**

The CDF is California's only state level agency that engages in wildland fire suppression. CDF manages its fire and aviation responsibilities through its Fire Protection Division. Despite being a state-based land manager, the CDF is also a fire and emergency service agency with responsibilities over many areas of California for the provision of wildland fire protection, structural fire protection, EMS, HAZMAT and paramedic services.

In support of its ground forces, the CDF emergency response air program includes:

- 23x Grumman S-2T 1,200 gallon airtankers (*one is kept as maintenance relief*);
- 11x UH-1H Super Huey helicopters (*two are kept as maintenance relief*); and
- 14x OV-10A airtactical aircraft (*one is kept as maintenance relief*).

These operate from 13 air attack and nine helitack bases located state-wide. This enables aircraft to reach most fires within 20 minutes.



Photo: CDF owned OV-10 used for Air Attack Supervision



### ***Contractual arrangements***

Most aircraft were acquired at nominal cost through the Federal Excess property Program. Other Airtankers utilised by the CDF are acquired through federal contracts administered by the USFS and provided to CDF. CDF manages and pays for these aircraft through their own budget and they work in partnership with the USFS for operational interoperability between the state and the federal services.

A total of 18 CDF personnel oversee the program with an additional 130 contract employees providing mechanical, pilot and management services to the program. The CDF works in partnership with two private sector companies to provide aircraft and pilots as well as maintenance and logistical support.

The CDF's current support contractors are DynCorp and Logistics Specialties Incorporated (LSI). DynCorp provides airtanker and airtactical plane pilot services, and all aircraft maintenance services. (All CDF helicopters are flown by CDF pilots.) LSI provides procurement and parts management services.

### ***Funding model***

The average annual budget of the CDF Aviation Management Program is nearly \$20 million. This includes all 48 aircraft (fixed and rotary-wing) operated by CDF.

## **LA County Fire Department– A US County (local government) perspective**

The LA County Fire Department has responsibility over some 4081 square miles and for providing first response to 56 of the 80 cities in the county.

The LA County Fire Department own and operate:

- 4x B412's,
- 3x S70 Blackhawks ("FireHawk") and
- 1x 206B Jetranger as an air attack platform.

With the exception of the Jetranger, all helicopters are multi-mission capable, being fitted out for fire suppression, paramedic heli-vac, and EMS work. All aircraft work on a 24/7 basis with night flying being undertaken with the assistance of night vision goggles.

The LA County charges out its aviation services at a cost of (US) \$4,000/hr to cover fuel, maintenance, and personnel. Equivalent commercial hire costs would be around US \$7,000/hr.

All aircraft have either been bought outright or are currently under a leasehold arrangement, pending full purchase by LA County Fire Department. All 18 pilots and maintenance staff (aviation mechanics) that work for LA County Fire Department are full time employees. All maintenance is done on-site at the Department's Headquarters.

LA County Fire Department also has on contract over the summer period 2x CL-415's. These are contracted from Quebec, Canada for a 90 day period. The LA County Fire Department also intends to contract directly with 10-Tanker for the DC-10. They plan to support the operation through CDF's airbases. Contractual arrangements are pending.

### ***Funding model***

LA County expends US\$7.7 million annually to keep all ten helicopters flying (excluding capital and acquisition). This is funded by LA Country Local Government. This cost includes fuel, maintenance and training for pilots, air crew and two specialised 10-person wildland fire crews in the LA Country Fire Department.

Aircraft are insured to the value of (US) \$100 million. The LA County Fire Department has an overall budget of (US) \$770 million.



Photo: LA County Fire Department owned S70 FireHawk

## Findings

- F1.** Countries with similar climate and fire issues to those encountered in Australia generally invest more in aerial fire suppression in total as well as on a per capita basis for population living in high risk areas.
- F2.** Supply models for aerial services vary from country to country according to structure of government, financial arrangements, history and culture. There were no compelling reasons identified to depart from the procurement model currently used in Australia, where most aerial firefighting services are acquired on a contract whole-of-service provision basis from third party suppliers (although this should continue to be reviewed).
- F3.** Where contracts are let for any aerial service provision, there is a strong trend to award on the basis of value-for-money rather than lowest price.
- F4.** There is a strong trend towards “exclusive-use” (EU) contracts, rather than Call-When-Needed (CWN) arrangements. Although more expensive in some years, EU has been found to be more cost-effective in the long run, is better for continuity of supply, generates other capacity and capability benefits in the industry, and offers safety and risk management benefits.
- F5.** The greatest value is obtained from contract service provision arrangements when a close, professional working relationship with the contractor is maintained, and sophisticated (but not necessarily complex) contract management techniques are employed to monitor and develop contractor performance.
- F6.** Longer term contracts result in better equipment, better aircraft and better quality pilots. Cost savings are often marginal, but value-for-money is significantly increased through longer term contract arrangements. Longer term contracts are strongly preferred by both contracting agencies and suppliers, provided appropriate rise-and-fall provisions are employed.

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| <p><b>F7.</b> Contract requirements and operating procedures that are common across jurisdictions generate significant costs savings, and considerably improve the efficiency of resource sharing.</p> |
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## Recommendations

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| <p><b>R1.</b> Maintain the current procurement model of outsourced whole-of-service provision to third party contractors (and continue to review).</p> <p><b>R2.</b> Continue to reinforce “value-for-money” as the primary determinant of contract award.</p> <p><b>R3.</b> Where practical, implement service provision contracts for periods of five or more years (incorporating appropriate rise and fall provisions).</p> <p><b>R4.</b> As far as practical, provide contract services sufficient for a normal situation on an Exclusive Use (dedicated) basis, and only utilise Call-When-Needed resources when above-normal situations are encountered.</p> <p><b>R5.</b> Task the Wildfire Aviation Technical Group to further investigate and develop sophisticated contract management practices, based on the collaborative models observed, that will enhance efficiency, effectiveness and safety.</p> <p><b>R6.</b> Continue to strongly pursue and support the development of commonality of standards (i.e. policy, standard operating procedures, contracts, call-when-needed arrangements, resource sharing) and aviation training across all member agencies.</p> |
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## **AERIAL RESOURCE PROCUREMENT**

All agencies visited recognise the challenges they face in managing increasing numbers of aerial resources in a more demanding and complex fire-fighting environment. As in Australia, most have grown from a largely regionally or district-based and managed resource deployment approach, to a more co-ordinated regional and even national approach. This has occurred through necessity relating to safety requirements, cost drivers in agencies, and demands for increased efficiency.

Their approach to national or regional coordination applies mainly to the use of large fixed-wing and Type 1 rotary-wing aircraft which were limited in number and represented a significant component of suppression costs. There did not appear to be obvious efficiency or effectiveness gains to be made by regionalising the management of smaller (Type 3) or non-specialised Type 2 rotary-wing aircraft.

A common theme in all jurisdictions is recognition of the importance of effective first attack capability which is considered to be critical to the successful use of aerial resources in wildfire suppression.

### **France - Sécurité Civile**

The importance attached to having aerial resources quickly available is such that during periods of high fire danger in the Provence region, aircraft are on airborne patrol and so are able to respond to any incident within this large area within just 10 minutes of notification.

This is achievable by having two pairs of aircraft (Firecats - a ConAir supplied converted Grumman S-2T), flying pre-determined patrol routes during daylight hours (1000hrs – 1800hrs). These aircraft and all initial attack aircraft fly with full loads of retardant. With large multi-engined aircraft such as this, it is possible to sustain patrol for significant periods. Because the aircraft are owned and pilots employed full time, the additional costs are limited to fuel, increased maintenance and a pilot flight time management cost. The annual budget of € 45 million for operating 6 fixed-wing bomber bases and € 15 million for capital and infrastructure highlights the importance placed on aerial firefighting capability in Europe.



Photo: Sécurité Civile dispatch centre at Marignane

The Sécurité Civile base at Marignane is one of six such bases and employs a manual dispatch strategy based upon radio contact. Upon detection or notification of a fire, the patrol aircraft conduct initial attack and provide a situation report on the fire. The success level of this first attack triggers an automatic response of additional Canadair CL 415 or CL 215 aircraft to the incident by the Sécurité Civile co-ordinator. The water scooping aircraft are able to remain on the scene and can use local water sources to continue attack if required. The initial patrol aircraft return to base to reload and to continue the patrol route.

This approach maximises the initial weight of attack with a strong emphasis on direct attack of small fires but does not appear to utilise a scaled response based on potential loss or eventual suppression costs. This probably reflects the value of infrastructure and the closely settled nature of these fire prone areas of southern France. A drawback of this approach is that often the aircraft return from patrol without having deployed their retardant load therefore a suitable dump site must be available for them to reduce weight prior to landing. This obviously incurs a cost for the unused load of retardant and an environmental cost for the maintenance of a retardant dump site.

### **Canada - British Columbia Forests**

A similarly rapid initial attack and significant weight-of-response approach is used by BC Forests, with District Fire Control Centres generating an Airtanker Request to the Provincial Bomber Base in Kamloops. Initial incident information taken through the fire reporting call centre on a 1800 number is available to the local fire control centre within two minutes and this information is considered sufficient when combined with weather, risk, resource and fire behaviour modelling information available in the Forest Fire Management System (FFMS), for the District Fire Dispatcher to make a request to deploy aircraft and crews. The request to dispatch airtankers is automatically made through the FFMS and sent electronically to the Provincial Bomber Base at Kamloops. See <http://www.for.gov.bc.ca/protect/aviation/airtankers.htm>

The dispatch arrangements provide for the immediate despatch of an Air Tactical Group Supervisor (ATGS – known as Air Attack Supervisor or AAS in Australia) in a Lead Plane aircraft and usually two firebombing aircraft loaded with retardant (Grumman S-2T or AT802) to such a request (11,000 to 15,000 litres). This immediate response to an airtanker request from a regional fire dispatcher enables for a very rapid response and provides statistical verifiable improvements in efficiency and initial attack success. This one strike rapid response concept is considered by BC Forestry to be the most effective use of their aerial resources as it provides a first attack capability when fires are small and provides time for ground crews to arrive and establish control lines. Whilst aircraft are used to support crews in suppressing the fire, it is considered more important that aircraft be available for dispatch to new fires and an ATGS can suspend air attack if they consider it is not being effective.

The success of such an approach is directly attributable to a highly integrated reporting and fire management system that effectively provides all available information to the dispatchers and other Provincial Centres in real time. This sophisticated system supports rapid initial deployment of aerial resources and integrates all relevant information from the initial report from the public, right through to after-action reviews. It is also the basis of the daily reporting on expenditure reporting provided to Government. The system is specifically designed to speed response and demonstrate effectiveness and to ensure resources are efficiently tracked and responded to incidents.

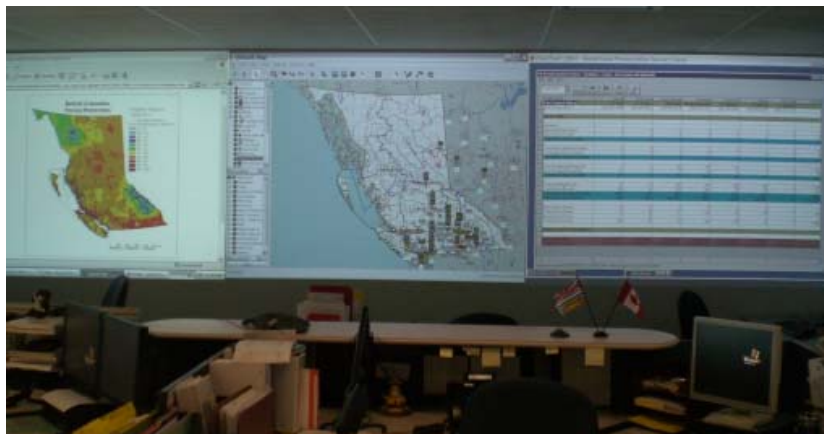


Photo: BC Forest Fire Management System displayed at Coordination Centre in Victoria BC



## **United States of America**

Aerial resource management in the USA is largely manually-based at a regional or state level and is largely at the discretion of the local fire control centre. While significant resources are available in the USFS and BLM, it is largely the responsibility of the local or Incident Controller to manage aerial resources and to demonstrate effective use during an incident. Requests for large multi-engine bombers are made through a Regional Coordination Centre which is responsible for managing large aircraft placed in their control by the National Interagency Fire Coordination Centre. Movement and operational base location of such aircraft is tracked centrally through the NIFC centre but dispatch is not undertaken by the national centre.

This national coordination includes large multi-engine aircraft, Type 1 rotary-wing aircraft but does not include the smaller Type 2 or 3 aircraft.

The concept of national coordination of aircraft is only fully implemented at NICC in Boise, where one of their roles is to determine the operational base locations of large multi-engine bombers (USFS) and SEATS (BLM) across the US federally administered agencies. These decisions are made in response to changing fire danger indices, current incidents, and seasonal risk profiles. It is clear that the Federal Agency Regional office and state-based agencies engage and co-ordinate other aircraft for their own purposes. This level of management concentrates particularly on smaller fixed-wing, Type 2 and Type 3 rotary-wing aircraft which are available locally. Other than the California Department of Forestry & Fire Protection (CDF) and the Los Angeles County Fire department the engagement and coordination of large aircraft is not conducted at a regional level.



Photo: National Interagency Coordination Centre at Boise

Other than the California Department of Forestry & Fire Protection (CDF) and the Los Angeles County Fire department the engagement and coordination of large aircraft is not conducted at a regional level.

The reasons for this appear to relate to the fact that the effective range of large aircraft is larger than state boundaries and therefore they have significant capability to be dispatched to incidents outside regional responsibilities. The level of coordination in the management of these assets is largely limited to tracking their location by NIFC and coordination of relocations in response to changing risk profiles. Day-to-day management is undertaken by local agencies and dispatch is undertaken by manually-based processes at the operational bases. There was no equivalent system to that demonstrated by BC Forests (FFMS) to track and display resource information across the region or beyond the agency.

## **Improving aircraft coordination at a state or national level**

In any proposal to provide improved coordination of aircraft at state or national level the importance of electronic resource tracking and management systems cannot be overstated. For any coordination to be effective, the accurate information provided by a system such as the web-based Forest Fire Management System in British Columbia Forest Service, is essential. Establishing a common resource tracking platform for all agencies to use allows for the development of a regional or national coordination system at a later date but without this platform it would be onerous to establish independently.

It was not apparent whether any jurisdiction utilised any clear model for risk management-based resource deployment, but all utilised the priorities of protecting life, property, economic and environmental assets. Most relied upon the local knowledge and experience of skilled staff to make resource deployment decisions utilising available information and seasonal trends. This approach detracts from the ability to establish a national coordination function beyond the location of resources that are then dispatched by local agencies. It would not be possible to deploy aircraft to incidents from a single national centre based on any available risk/consequence real time evaluation model. It is likely that local knowledge and experience will always hold the key to effective and efficient use of aerial suppression resources.

A critical element of supporting effective decision making was the provision of consistent weather and risk analysis data in the form of usable tools. This was most effectively achieved in mapped form or linked tables in a web-based system used in BC Forests. Both the USA and Canada have invested significant resources in providing technical experts and decision support systems to dispatchers and managers to inform effective resource deployment. Embedding such expertise into the agency provides for informed debate and discussion with other specialised agencies and allows for the direction of research and development in a way that meets end-user needs and resolves deficiencies.

## Findings

- F8.** Although a number of jurisdictions have developed risk-based resource allocation tools, all have a number of issues and all still rely heavily on expert judgement.
- F9.** Rapid initial attack using aerial resources is considered to be the most efficient use of aircraft in firefighting in every jurisdiction studied. The results of the recently published Bushfire CRC research [M. Plucinski, J. Gould, G. McCarthy, J. Hollis 2006 *Effectiveness and efficiency of aerial firefighting in Australia - executive summary Bushfire CRC*]<sup>1</sup> are reinforced by the international approach to rapid initial attack.
- F10.** There is a clear worldwide trend towards ensuring sufficient weight of initial aerial attack. Effective response by aerial resources can be achieved by directing sufficient weight-of-attack in the first instance and not relying upon the continued presence of aerial resources after the fire has grown.
- F11.** Effective decision-making on deployment is best made by staff close to the incident who are supported by real time information (e.g. USA and Canada) or who are initially applying a pre-planned weight of response (e.g. France)
- F12.** Centralising dispatch and strategic coordination of larger resources at a provincial/state level is effective and achievable.
- F13.** National coordination is effective in providing surge capacity for unmet demand, and in coordination of the location of assets in response to seasonal or medium term risk. The engagement of large fixed-wing aircraft would also benefit from national coordination because of the capacity and speed of response that these aircraft can provide.
- F14.** Efficiencies in aircraft deployment are achievable by co-ordinated first attack response which is initiated by local dispatchers and supported by Regional coordination centres and common integrated decision support systems.
- F15.** Common, or at least inter-operable, integrated information and decision support systems (e.g. along the lines of the B.C. Forest Fire Management System) offer potential to improve the efficiency of Australian operations.

<sup>1</sup> [http://www.bushfirecrc.com/research/downloads/A3.1-EXECUTIVE\\_SUMMARY\\_090806.pdf](http://www.bushfirecrc.com/research/downloads/A3.1-EXECUTIVE_SUMMARY_090806.pdf)



- F16.** Australia is the only jurisdiction studied that does not currently utilise large multi-engine, fixed-wing aircraft for firefighting. This is considered to be largely due to a relative lack of suitable runways and subsequent longer turnaround times reducing cost-effectiveness.
- F17.** Retardant is commonly used in first response to significantly improve effectiveness.

## **Recommendations**

- R7.** Within Australian fire agencies continue to reinforce the notion that the most efficient application of aerial resources is as a rapid initial attack tool.
- R8.** Task WATG to undertake a review of the effective first attack capability of available aircraft and develop guides to achieve sufficient weight-of-attack in different situations.
- R9.** Advise jurisdictions of the benefits of centralising, within any particular jurisdiction, dispatch and strategic coordination of aircraft.
- R10.** Confirm the role of NAFC (or similar national entity) in providing national facilitation of inter-jurisdiction resource movements; coordination of the location of assets in response to seasonal and medium-term risk; and in activities such as the coordination of supplementary resources and the engagement of large fixed-wing aircraft.
- R11.** Ensure the development of pre-agreed mutual aid arrangements between jurisdictions.
- R12.** Further research the potential applicability of large multi engine fixed-wing aircraft for firefighting in Australia.
- R13.** Improve effective decision making in the deployment of aircraft to incidents by adopting a decision support tool based on real time information such as the BC Forests FFMS.
- R14.** Implement a standardised nation-wide real time aircraft resource tracking system, with a view to future incorporation in a fully integrated management system. The British Columbia FFMS represents a currently available system for resource management that could be useful as a national platform and should be considered for adoption by all jurisdictions contracting NAFC aircraft.
- R15.** Identify standard weather and fire risk forecasting products (e.g. four-day outlooks, seven-day outlooks) that enable consistent comparison of imminent and forecast medium term risk within and across jurisdictions.

## INTER-AGENCY INTEGRATION & COLLABORATION



Fire services within Australia, and in France, Canada and the USA are all facing challenges associated with:

- climate change with subsequently increased wildfire risk and longer fire seasons;
- increasing political and public scrutiny of fire management;
- increasing fuel loads in forested regions; and
- limited availability of specialist resources and personnel for aerial firefighting.

Whilst the challenges are similar in each country, the respective strategies employed with regard to aircraft are quite varied. Although it is not entirely clear as to why this is the case, anecdotal evidence suggest that different approaches are shaped by historical, cultural, political and financial factors specific to each country.

### **France**

France maintains a high cost, resource-rich fire bombing aircraft program organised on principles which reflect a military heritage. Whilst managed and coordinated on a provincial basis, federal funding and limited coordination is also apparent.

### **Canada - British Columbia**

British Columbia exhibits cultural and political similarities to Australia. A province-based process exists for contractual requirements with minimal federal involvement in funding or coordination. The sharing of aircraft resources across provincial (i.e. state) boundaries relies largely on the good will of fire services based on information sharing regarding resource demands and capacity issues.

Cost efficiency programs and continuous improvement gains are initiated at provincial level and shared between provinces. Canada's use of satellite tracking of aircraft is representative of this approach.

### **United States of America**

The United States aerial firefighting program demonstrates a similar historical and cultural basis to BC, Canada. However, attempts to introduce comparable levels of cost efficiency and monitoring have been difficult in a complex multi-level political environment. Federal, state and provincial authorities all independently contract aircraft based on their respective demands.

### **Comparison with the Australian context**

Common to all three countries is a significant level of federal involvement. Although variable, fire services in France, Canada, and the US are supported by significantly greater levels of federal funding for aircraft contracts than in Australia.

Resource sharing and coordination varies from complex mutual aid arrangements, to some level of federal coordination, with the obvious exception of federally-based fire services in the United

States. International mutual aid arrangements extend across Canada and the United States for areas where they share a common border; however contractual programs are again independent. All fire services are experiencing increased difficulty in sourcing experienced aircraft personnel and specialist aircraft resources.

It is generally accepted by fire service personnel in all countries that significant cost benefits, as well as fire response efficiencies, can be gained by greater sharing of aircraft at national and international levels. This view extends to the need for more formalised information-sharing regarding improvement programs, best practice, and the potential for international contract sharing. This is seen as a way of dealing with resource and personnel shortages.

## **Findings**

- F18.** When compared with France, Canada and the USA, Australia is a relatively small user of firefighting aircraft. However, Australia is amongst the world's best practice in systems and protocols for collaboration and cooperation in the contracting and application of aerial firefighting resources.
- F19.** As in any successful organisation, there is opportunity for continued improvement and a subsequent requirement for ongoing work to remain successful and strive for best practice. This need is further enhanced by the demand to minimise total fire service costs at national levels in an environment where personnel and resources are becoming increasingly scarce.

## **Recommendations**

- R16.** Identify opportunities for individual states to “champion” the way forward in developing agreed national standards with respect to training, systems and approaches without encroaching on individual state or fire service methods of aerial firefighting. Federal or centralised funding would provide leverage and consistency across the states.
- R17.** Seek opportunities for improved contractual arrangements nationally and internationally on a longer term basis that offer cost benefits as well as technological improvements (i.e. satellite tracking systems).
- R18.** Develop improved mutual aid arrangements for interstate opportunities (proactive and predictive basis) to share aircraft based on risk (likelihood and consequence models).
- R19.** Investigate the benefits in extending the role of NAFC to include national coordination of aircraft placement and sharing, and, on the basis of a pilot program, potentially extend it to include a broader emergency service resource coordination role.

## TRAINING & CERTIFICATION

The best practice visit provided an ideal opportunity to view a number of different approaches to the training and certification of specialist personnel involved in aerial fire management.

All of the agencies and contractors visited during the trip stressed the importance of maintaining highly skilled and experienced personnel responsible for coordinating, supervising and managing safe, efficient and effective aerial operations. This reinforces current Australian thinking and approaches.

The importance of integrating ground and aerial operations to ensure maximum cost benefit and to assist in developing a safety culture within fire agencies was also stressed.

### France

Sécurité Civile adopts a significantly different approach to air attack supervision which is tailored to their rapid initial attack focus on typically small fires. Air attack is often initially directed by pilots of the actual water-bombing aircraft with overall direction provided by ground-based operations officers.

They have developed a computer-based training simulator which was inspected at their base in Valabre. The simulator includes a number of operations “cells” for operational roles from



Photos: Computer based simulation training - Sécurité Civile, Valabre France

incident management personnel, to crew leaders, fire vehicle drivers, and pilots of fixed-wing and rotary aircraft. This integration and interaction of all fire roles including aircraft operations was considered to be a particularly valuable approach.

Training of pilots in the fire suppression aspects of their job is also conducted largely in-house. The use of multi-crew aircraft provides an opportunity to introduce pilots to fire suppression through a structured mentoring system. The simulator at Valabre is also used for training pilots in fire suppression, and pilots are involved in the integrated multi-participant simulator sessions. Only pilots with a reasonable amount of flying experience are employed. Flying skills are maintained through a largely conventional check and training program.



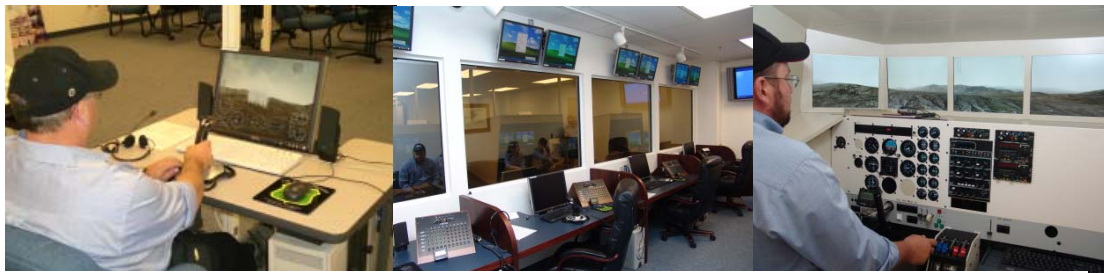
Photo: Aircraft simulator - Sécurité Civile, Valabre France

## **United States of America**

The USA training and certification system is highly structured and complex with significant variation in training requirements between agencies and jurisdictions. Whilst a number of agencies, particularly at the federal level, are moving towards common standards, differing operational approaches continue to necessitate specific training approaches. For example, the US Forest Service (USFS) continues to use lead planes operated by experienced fire pilots to supervise and co-ordinate airtanker operations. However, in recent times, they have started to operate lead planes with Air Tactical Group Supervisors (Air Attack Supervisors) on board to provide a more tactical approach to air operations. This is more consistent with the operating procedures of other agencies.

The USFS and Bureau of Land Management (BLM) also have specific training and accreditation requirements for pilots. The accreditation process includes computer-based training, oral tests, flight tests and attendance at an aerial firefighting academy, which in addition to air operations, provides background training in ground operations. The system also includes currency requirements and a multi-level carding or certification process.

The USFS has also developed a sophisticated computer-based training simulator for air operations. The group observed a demonstration of the simulator in Sacramento, California, which provides for the simultaneous interactive operation of up to five aircraft in a variety of fire scenarios. Whilst the simulator is extremely realistic, it does not currently integrate ground-based operations into its scenarios.



Photos: US Forest Service simulator centre - Sacramento

In all discussions with US agencies regarding training and accreditation, the importance of a rigorous training and selection process for air operations specialists was continually reinforced, particularly for Air Attack Supervisors (AAS). A key message was the importance of selecting personnel with strong fire management backgrounds and well developed understanding of fire behaviour, tactical strategies, and the ability to safely and effectively integrate ground and aerial suppression operations.

The US system also recognises that experienced fire aviation specialists are a scarce resource and emphasises that specialists need to be made available for multi-agency tasking across jurisdictions.

## **Canada**

Detailed discussions were also had with the British Columbia Forest Service (BCFS) in Canada. The BCFS air operations program was particularly impressive and certainly the most directly relevant in terms of the Australian fire management environment. Of particular interest was the continual focus on safety, efficiency, effectiveness of aircraft use, and evaluation of operations and systems.

Key issues raised in discussion included:

- The importance of rigorous selection of air operations personnel, particularly Air Attack Officers (AAO, also known as AAS or ATGS).



- The role of the AAO in monitoring effectiveness and controlling government expenditure.
- The BCFS have detailed pre-requisites for air operations candidates and set extremely high standards that include initial suitability interviews and reference checks.
- Training is based on a multi-level approach with progression involving formal mentoring, supervised practical experience and evaluation.
- Training is conducted at a state level but is recognised nationally.

The BCFS does not currently specify or require specific firefighting accreditation for pilots of firebombing aircraft. This is largely due to the fact that Canadian aerial firefighting contractors already have excellent in-house accreditation and progression systems for their pilots. BCFS is in the process of formalising the current approaches into contract documentation.

A common theme in all discussions with contractors was the need for security of tenure of contracts, and the need for contracts of reasonable length to support the provision of effective in-house pilot training and progression systems.

The group also observed the training and certification systems for highly specialist remote-area firefighters, such as rappel crews in British Columbia and smokejumpers in the U.S. In all cases the group was impressed with the comprehensiveness and rigour of the training programs. There is already a high degree of commonality in standards between BC and Australian programs due to an existing exchange program between BC and the state of Victoria. There are very clear benefits from continuing this type of exchange.



Photo: Rappattack training,  
Salmon Arm BC Canada

## Findings

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|--|
| <p><b>F20.</b> The need to continue developing rigorous, comprehensive, and structured training and accreditation programs for agency personnel involved in supervising and supporting aerial operations was strongly reinforced.</p> <p><b>F21.</b> There is considerable benefit from commonality of training and certification programs across jurisdictions.</p> <p><b>F22.</b> Use of computer-based simulation and procedure training technology - ranging from simple PC-based programs to complex dedicated multi-faceted virtual-reality facilities, is now well established in several countries. The technology provides a very valuable tool for selection, training and re-currency of individuals and teams.</p> |
|--|

- F23.** There is an opportunity to improve the overall training and certification of personnel undertaking key roles in Australia, such as Air Attack Supervision, by refining selection processes and adding structured mentoring programs.

## **Recommendations**

- R20.** AFAC to finalise and continue to maintain the development of uniform national standards for training of fire aviation specialists and agencies to fully implement consistent, nationally recognised and accepted training programs across Australia.
- R21.** The nationally implemented training programs should adopt a more rigorous approach to selection of candidates for key air operations roles, based on experience and demonstrated aptitude.
- R22.** For key roles, such as Air Attack Supervisor, national programs should include a formal mentoring approach to training with staged introduction to operational roles and a defined progression path.
- R23.** AFAC/NAFC pursue the implementation of the previously mooted pilot certification program for pilots involved in fire operations, on the basis that the program will set appropriate standards for contract service providers to implement.
- R24.** AFAC/NAFC implement a major project to further research and develop the use of computer-based simulator technology for training, ranging from the use of PC-based procedure trainers through to complex multi-role, interactive simulators.



## RESEARCH & DEVELOPMENT

### Capturing and monitoring operational data

Of those agencies visited, only the British Columbia Forest Service have a structured program to continually monitor the effectiveness of aerial suppression deployments.

The British Columbia Forest Service Provincial Air Tanker Centre monitors the performance of airtanker deployments on initial attack fires through its Response Analysis and Management Program (RAMP). This program computes an Efficiency Index for all of their airtanker deployments to initial attack fires. The program does not monitor the use of airtankers on larger fires and this aspect of fire suppression is not actively evaluated. The success of initial attack is defined as fire containment by 10am on the morning following ignition with a final burnt area of less than 4 hectares. [Note: the Provincial Air Tanker Centre only deals with fixed-wing aircraft, and does not currently coordinate the helicopter fleet].

RAMP also generates statistics related to the severity of the fire season and subsequent airtanker responses. Data for each airtanker deployment is entered on a form called the “Airtanker Action Report” by the Air Attack Supervisor. This report is similar to the Air Attack Supervisor report used in Australia. Airtanker Action Reports are entered into a network database within 24 hours of return to base. The resulting data is used to generate up-to-date annual and current season-to-date statistics on parameters such as:

- distance to fire
- fire size
- lag times
- fire size on arrival
- fire size on completion
- cost efficiency (using the Efficiency Index)

These statistics, particularly the Efficiency Index, are used as performance measures to justify budgetary expenditure on the Airtanker Program and to monitor the effectiveness of resource positioning, response times, and detection systems.

The Efficiency Index can be applied to single fires, airtanker groups, and individual airtanker personnel. It can also be used to compare seasons. The Efficiency Index is generated as a percentage, with 100% being a target value. Values of less than 100 trigger a review for action to determine the causes of efficiency declines. This is based on the following factors:

- area on completion (hectares)
- fire shape (length: breadth ratio)
- fuel type (suppression cost related)
- fire rank (a fire behaviour measure)
- values at risk
- total cost

Data captured on the Airtanker Action Report form has not been used to model initial attack success or to develop decision tools. Although this had been considered during the development of the system, it would require links to other data sources (e.g. weather, fuel, and ground crew deployments) which are yet to be made.

The adoption of a mandatory reporting system like the airtanker action report in Australia with a central database would be useful for generating basic statistics for monitoring the adequacy of resourcing and comparing seasons, regions and fire events. The combination of these statistics with data related to fire conditions (e.g. weather, fuel, and terrain) and other suppression resources (e.g. ground accessibility, available resources, and timing) could be used to analyse initial attack effectiveness and to develop forward deployment strategies within and between

Australian states. This would extend the operational data collection program currently being conducted by the Bushfire Cooperative Research Centre (Project A3.1).

The development of an efficiency index would be extremely difficult to achieve in Australia because of the large variety of fuel types, terrain, and aerial suppression resources used (fixed and rotary-wing), as well as the different agency's fire management policies and procedures.

The fire rank system (Attachment 1) is well suited to these forms. It categorises fire behaviour into six classes, giving a good description of suppression difficulty in a format suitable for a wide range of users. Such a system may be useful in Australia, however the diversity of fuel types warrants more than a single system.

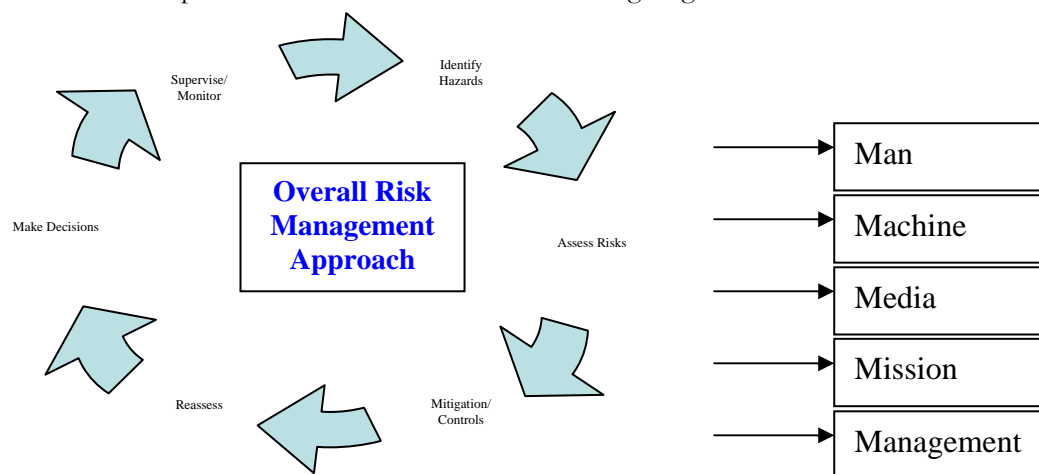
### Developing risk analysis tools

The National Interagency Fire Coordination Centre's (NIFC) Fire Program Analysis (FPA) system was discussed when the tour group visited Boise, USA. The FPA system is aiming to develop landscape-scale budgeting analysis tools to provide a process for evaluating a range of alternative fire management strategies. Such a system would be used to determine the costs required for different levels of preparedness and is likely to highlight the economic benefits of sharing resources between agencies. Details of the FPA development can be found at: <http://www.fpa.nifc.gov/>.

Optimisation modelling of suppression resources will be used to determine the level of effectiveness associated with a range of budgets. The FPA system requires a significant number of sub-models and components to provide information such as fire history, landscape, fire behaviour, and resource effectiveness. The combination of the inputs and their related assumptions makes the development of these systems very difficult.

The FPA System Preparedness Module is the first in a series to be developed. It will provide an automated system for strategic initial attack planning. Additional FPA System modules will address extended attack, large fires, national fire resources, fuel reduction, and fire prevention.

An early version of the System Preparedness Module was trialled operationally but found to require significant reworking. As a result, FPA is transitioning into a new organisation with a new governance structure, including a significant scientific review team. While some members of the FPA development team are happy for Australian fire agencies to use their models as a basis for an Australian fire budget analysis tool, it appears that an operational model will not be available for a few years. The current NIFC approach to risk management used for organising air fleet and aerial operations is summarised in the following diagram.



## **Predictive systems**

A range of predictive systems for determining the level of fire risk are used throughout the world. These are generally in the form of weather indices that are used to determine the severity of conditions for fire behaviour, and drought indices which are used to gauge general trends of dryness. Such indices are used by fire managers to determine response preparedness levels in conjunction with other information.

### ***Canada***

Whilst in British Columbia the tour participants had the opportunity to observe how components of the Canadian Fire Weather Index (FWI) were used in strategic planning by the Forest Service through their computer intranet. Specific components of the FWI are plotted daily on the provincial map showing variations in the severity of burning conditions across British Columbia.

Longer term moisture deficiency codes in the FWI (for Fine Fuel Moisture, Drought Index, Duff Moisture, and Build Up Index) are used to make decisions on the positioning of mobile suppression resources (including aircraft). These have similar inputs to the Byram-Keetch Drought Index and Soil Dryness Index used in Australia, though some inputs are specific to Canadian latitudes and fuel types. Resources are moved to the areas of the province with highest fire potential when other areas are experiencing milder conditions. Other information, such as lightning detection may also be used to assist these decisions. Extra resources may be acquired or put on standby when moisture deficiency indices are consistently high, particularly for days when dynamic weather indices are predicted to be high. This allows for a timely dispatch of resources based on the potential distribution of fires. The success of this recent proactive airtanker positioning policy has been verified through increased Efficiency Index scores.

The Canadian FWI and the Initial Spread Index (ISI) are used to make decisions regarding readiness levels and response times. These indices are also plotted on maps available through the British Columbia Forest Service intranet. Such maps require a significant network of weather stations to calculate weather indices at points across the landscape.

Weather and drought indices are not the only information considered in decision making. Geographically specific information such as terrain, asset values and fuel hazards are also considered. When there are multiple ignitions and multiple airtanker requests fires are prioritised based on their probability of being contained and their accessibility on the ground. The high accessibility of weather information and resource locations on the Forest Service intranet helps optimise preparedness levels and minimise processing times, enabling a faster response to fires.

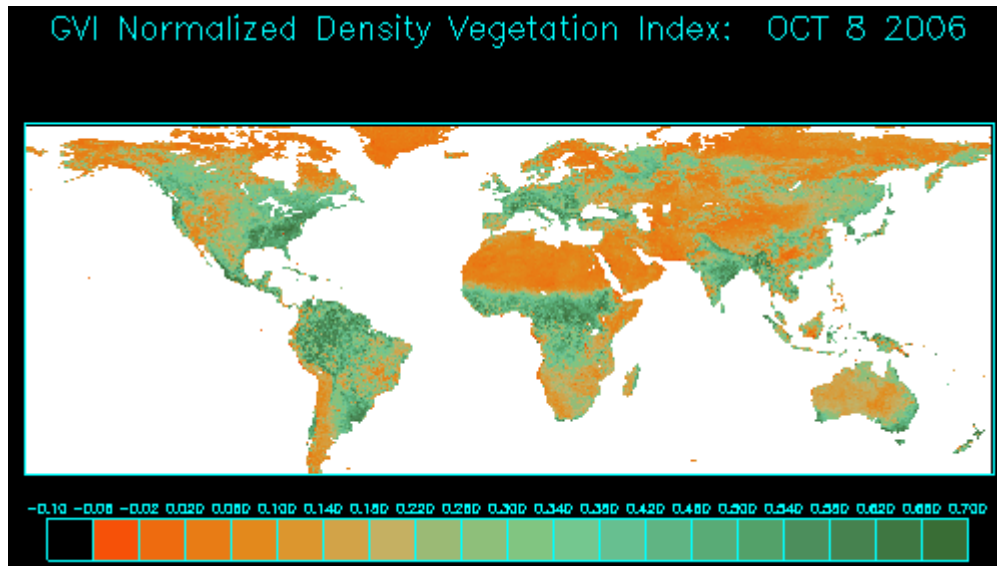
### ***United States of America***

Predictive systems referred to and used on a regular basis by NIFC as part of their predictive toolkit include the following:

- Departure from average greenness using AVHRR (Advanced Very High Resolution Radiometer – satellite imagery)
- Energy Release Component (part of the National Fire Danger Rating System)
- Significant Fire potential model (part of the National Fire Danger Rating System).

A brief explanation of these models follows.

The basic index for measuring the 'greenness' of the earth's surface is the Normalized Difference Vegetation Index (NDVI), which is basically a calculation of the differences between AVHRR channels 1 and 2. A reasonable estimation of the density and coverage of green vegetation can be determined by measuring how green the earth's surface is.



NDVI values range from  $-0.1$  to  $0.703$  and are unit-less. Values greater than  $0.1$  generally denote increasing degrees in the greenness and intensity of vegetation. Values between  $0$  and  $0.1$  are commonly characteristic of rocks and bare soil, and values less than  $0$  sometimes indicate clouds, rain, and snow. Low values of NDVI do not necessarily denote lack of vegetation. For example, during the winter months, deciduous forests may appear more orange than green. NDVI is used in conjunction with other predictive models to assess the dryness of fuels and hence potential fire danger.

The National Fire Danger Rating System (NFDRS) is comprised of many components and indices related to fire occurrence, fire behaviour, and fire suppression. The following items can be plotted on a fire characteristics chart similar to the one used for site specific fire behaviour estimation:

1. Spread Component (SC)-related to rate of fire spread.
2. Energy Release Component (ERC)-related to energy or heat that will be released in a passing fire front.
3. Burning Index (BI)-related to the magnitude of the fire containment problem. The burning index is derived from the spread component and the energy release component.

The three values are related to the corresponding values on the fire behaviour - fire characteristics chart. Procedures used to calculate spread component, energy release component, and burning index were derived from the equations for rate of spread, heat per unit area, and flame length (Andrews and Rothermel 1982<sup>2</sup>). NFDRS indexes and components are designed to give a broad area rating of fire potential and are not meant to predict actual site specific fire behaviour. The indices are based on fuel models that describe large areas and on weather taken at a specific location once per day.

NIFC also use the 7-Day Significant Fire Potential Product as a means of summarising the potential for the development of new large fires and significant new growth on an existing large fire. This product uses fuel moisture inputs from the NFDRS and other gridded inputs from weather models. This data is processed through a series of equations that yield forecasts of fuel Dryness Level (DL) as well as probabilities (some objective and some subjective) of certain critical weather conditions for each of the next 7 days. When appropriate combinations of DL and weather triggers are expected, a high risk day is designated on the chart to warn of a significantly higher than normal chance for a "Large Fire". Fuel dryness is represented on the

<sup>2</sup> Andrews, P. L. and R. C. Rothermel (1982). Charts for interpreting wild-land fire behaviour characteristics. Ogden, Utah, USA, USDA Forest Service, Intermountain Forest and Range Experimental Station: 21.

chart for each day and for each predictive area as one of three colours relating to the chance of large fires.

### **France**

Sécurité Civile have developed state of readiness and forward deployment strategies based on fuel and weather parameters, and have developed daily fire potential/risk maps of the Mediterranean coastal strip. These maps are used to prioritise location/deployment of aircraft as well as which pre-determined flight circuits their surveillance bombers will follow on a day-by-day basis. Predetermined flight paths follow geographic/ fuel/ risk zones designed to ensure a minimum 10 minute response time in any direction.

The predictive services provided by meteorological forecasters are integral to Sécurité Civile's deployment and attack strategies.

### **Evaluation of aerial operations**

The US Forest Service evaluates its airtankers and suppressant delivery systems through Technology and Development centres.

New airtankers need to be evaluated before they can be considered for operational use and must undergo a series of drop pattern and static tests to determine their performance. Drop pattern tests directly measure the effectiveness of airtankers by collecting samples of the suppressant that reaches the ground across a grid to determine coverage levels across a target area. Static testing is a procedure conducted to determine suppressant flow rates out of the tank while the aircraft is parked. Airtankers must also meet other requirements related to flight safety with a tanked load and whilst loading the tank.

Two reports of interest have been recently produced by the San Dimas Technology and Development centre. These relate to two new large airtankers - the Evergreen Boeing 747 Supertanker, and the 10 Tanker Air Carrier DC-10 airtanker. These aircraft have not previously been used for firefighting but are distinct from other firefighting aircraft because of their large size and fast dropping speeds. The Evergreen Supertanker is particularly different from other firefighting aircraft because it ejects pressurised suppressant through nozzles, which point straight down, rather than using a gravity fed system. This allows the aircraft to fly higher than other aircraft while dropping its payload. This potentially allows the aircraft to operate at night.

Summaries from these reports are set out below. As yet, neither aircraft have met all of the test criteria, though most of the failed items are relatively minor. Static testing has yet to be completed for either aircraft.

#### **Summary of USDA Forest Service DC-10 airtanker Drop Test Report**

*The 10 Tanker Air Carrier DC-10 airtanker, Tanker 910, completed a series of tests to measure compliance with Interagency Airtanker Board criteria June 19-30, 2006. The airtanker met most criteria but failed to meet some, while several criteria do not apply to systems of this type. The relevant requirements appear in the Interagency Airtanker Board Charter, Criteria and Forms, February 2006, section VII. Based on these results, the test team recommends that the airtanker complete a second, abbreviated static test after completing the required modifications. However, since the airtanker is capable of operating successfully without the required modifications, the static test need not interrupt active fire operations. The test team encourages 10 Tanker Air Carrier to rectify the deficiencies as soon as the aircraft has at least a month-long break from active service.*

**Summary of USDA Forest Service Evergreen Supertanker Airtanker Drop Test Report**

*The Evergreen Airlines Boeing 747 Supertanker, Tanker 947, completed a series of tests to measure compliance with Interagency Airtanker Board criteria beginning in February, 2006. The Supertanker met many of the criteria but failed to meet some, while several criteria do not apply to systems of this type. The relevant requirements appear in the Interagency Airtanker Board Charter, Criteria and Forms, February 2006, section VII. Based on these results, the test team recommends that certain elements of the test be repeated before the Supertanker begins firefighting service to verify that the necessary changes have been made.*

San Dimas Technology and Development Centre staff also raised other ideas for aircraft-related projects. These included a comparison of the results of funding a single supertanker in comparison to several smaller airtankers, and a comparison of a range of drop coverage levels to determine if wider drops with a lower coverage level are as effective as narrow drops with heavy coverage levels. There were no immediate plans to test these ideas.

**NIFC best value helicopter evaluation**

The NIFC outlined a formula that they use to evaluate the best value helicopters for particular contracts. The figure obtained from this formula provides a basis for comparing different helicopter types and suppliers which assists in identifying the most suitable and cost effective options. It can also be used in decision-making for tasking to specific jobs or when pre-locating helicopters taking into account capability, fuel types, and topography.

$$D + (F \times H) / H \times (L \times P) = \text{Cost Value}$$

where D= average daily rate (\$)  
 F=flight rate (\$/hr)  
 H= average daily flight hours (Their figure is 5.2)  
 L= loads delivered /hour (Their average was 6)  
 P= payload.

**Other research**

In France, the tour participants visited the CEREN research facility (Joint Forest Research Centre) co-located with the Sécurité Civile training centre in Valabre. It is interesting to note that much of the research conducted by CEREN appeared to parallel research in Australia and other countries. This has probably not been evident in the past due to the fact that relevant papers have not always been translated. Greater attention to overcoming language barriers may in the future allow greater synergy in research projects.

Some projects being conducted by CEREN are related to aerial suppression. They have been conducting research on retardants (Fire-Trol 936) to determine their effectiveness in laboratory wind tunnel experiments, as well as their corrosive effects on metals (steel and aluminium) and some environmental impacts related to the germination of seedlings affected by retardant drops. They also have a project investigating concentrated aerial delivery of suppressants through pressurised nozzles that may be of interest.

Some of their other research projects are similar to work being conducted by the Bushfire CRC. These include research into “Stay or Go” policy, smoke chemistry, fuel hazard assessment, fire behaviour modelling, and tanker protection.

## Findings

- F24.** There are a variety of approaches around the world to measuring aerial suppression performance. All systems incorporate some degree of expert judgement and although all have some merit, none appear to be directly transferable in their current form to the Australian context. A synthesis of the best aspects of each system could form the basis of a newly developed, comprehensive Australian approach – however this would need to be in-concert with the development of other measures such as a suitable fire ranking system.
- F25.** Overall, it was well demonstrated that comprehensive research and operational evaluation programs are most important to underpin decision making in resource allocation and to the optimal application of aerial suppression resources.
- F26.** The Australian adoption of a mandatory “after-action” reporting system like the B.C. Forest Service’s Airtanker Action Report would, in conjunction with a central database, be useful for generating basic statistics for monitoring the adequacy and disposition of resourcing and for comparing seasons, regions and fire events.
- F27.** The development and adoption of a fire ranking system (e.g. see Attachment 1) may be useful in Australia, although it would need to account for the diversity of fuel types.
- F28.** There are a range of tools and systems, in various stages of development, for assessing fire risk and allocating resources accordingly. There are no tools currently available that are directly transferable to the Australian situation, and suitable approaches are more likely to develop from current work in Australia, informed by the development experiences in other countries.
- F29.** A range of predictive systems for determining the level of fire risk are used throughout the world. There is an increasing focus on “outlook” products such as the NIFC 7-Day Significant Fire Potential Product, and Canadian Forest Fire Weather Index products such as Build-Up Index, Initial Spread Index etc. It would be useful to develop a range of similar standardised prediction products for the Australian situation.
- F30.** Technical evaluations of very large airtankers in the United States have demonstrated that the DC-10 and 747 conversions have potential to be technically effective, provided that a number of recommended modifications are undertaken. Operational evaluation is still required.
- F31.** In general terms, a significant amount of overseas fire research parallels Australian research being undertaken. In some cases, the near duplication of research has evolved partly due to language issues.

## Recommendations

- R25.** Continue work in Australia, informed by experience in other countries, towards developing standard empirical systems for measuring aerial suppression effectiveness.
- R26.** Investigate the development of an Australia-specific fire ranking system to support record keeping and effectiveness measurement programs.
- R27.** Develop a national “after-action” reporting system, with a central database.
- R28.** Continue and expand Bushfire CRC research into the effectiveness of aerial fire suppression, including detailed research into the effectiveness of different aircraft types, bombing systems and retardants/suppressants.



- R29. Continue and expand Bushfire CRC research into the development of resource allocation optimisation tools, informed by experiences with development of similar tools in other countries.
- R30. Develop and test a suitable range of standard weather and fire risk prediction products in Australia, which will support ready comparison of risk within and between jurisdictions.
- R31. Continue to liaise closely with U.S. authorities on the evaluation of large fixed-wing airtankers, and if practical enter into collaborative programs.
- R32. Continue to closely monitor overseas research, including that published in foreign language journals, and to liaise with overseas research centres in an effort to avoid duplication and to develop collaborative synergies.

## EMERGING TECHNOLOGY

One of the key objectives of the best practice visit was to investigate emerging technologies that could be applied to aerial firefighting practices in Australia. Four significant areas of technology are considered here:

- Aerial delivery systems
- Fire retardants and suppressants
- Aerial incendiaries
- Unmanned Aerial Vehicles (UAVs)

Systems involved with training and development, data/resource management, and risk analysis and assessment are considered elsewhere in this report.

### Delivery systems

Significantly, no new technologies for the delivery of retardants or suppressants were encountered during the visit. The observations reported in this section largely refer to adaptations of existing systems to fit different airframes.

#### *France - Sécurité Civile*

Sécurité Civile uses three fixed-wing bombing aircraft – the Canadair CL-415, the Grumman Tracker S2F, and the Bombardier Dash 8 Q400.

The CL415 is a standard configuration Canadair and its delivery system is the same as that evaluated by AFAC in 1995 in the Australian CL415 trial. Sécurité Civile has had eleven Canadairs in service since 1996. These amphibious aircraft have a 6,000 litre capacity with scoop refill in less than 12 seconds, or can be ground-filled at established bases in 4-5 minutes. The aircraft scoop from either fresh or salt water and direct-inject foam from concentrate tanks within the aircraft. The Canadair is the second response aircraft if sustained bombing operations are required.

Sécurité Civile has a fleet of ten Grumman Tracker S2F (“Firecat”) aircraft developed by Conair in Abbotsford, Canada. Their delivery system is similar to that used in Canadian and US-configured Grumman aircraft. The Grumman S2F are used for surveillance and rapid initial attack and fly pre-defined air patrol routes to ensure rapid response. They have a capacity of 3,200 litres and use fire retardant as the first attack medium. Two aircraft patrol together as fire danger escalates to maximise initial attack effectiveness.

The Bombardier Dash 8 Q400 has been in service for only one year at their main base in Marignanne. At the time of the visit, the current airframe had not been used operationally. The tank was developed in conjunction with Cascade Aerospace in Abbotsford, Canada, and Aero Union in Chico, California. Its design allows for a 10,000 litre capacity and constant flow drop which is similar to the Aero Union tanks fitted to P3 Orions or Convair airtankers. The aircraft can carry 64 passengers or up to 9 tonnes of equipment. Sécurité Civile propose to use it for first attack or for constructing control lines.

#### *Canada - British Columbia Forest Service*

The British Columbia Forest Service (BCFS) has a range of aircraft to meet the requirements of covering 94 million hectares of remote and highly mountainous country. Fuel regimes vary from wet forests in the west coast, conifer forests in high desert environments, to urban/wildland interface areas adjacent to communities. At the peak of the 2003 fire season, the BCFS operated 43 fixed-wing aircraft and over 200 helicopters.

The BCFS has a simple philosophy in procuring aircraft: use large airtankers that are fast, but old aircraft that are relatively low cost. In steep terrain BCFS use more agile aircraft like Airtractors 802s or Grumman Firecats.

Their initial attack goal is to limit fires to less than 10 hectares through indirect attack with fixed-wing aircraft dropping non-viscous liquid concentrate retardants. Direct attack in the incipient stages of a fire generally involves the use of helicopters with either fixed tanks or buckets.

No new technology was observed with respect to delivery systems operated by or for the British Columbia Forest Service. The BCFS principally contract four types of fixed-wing aircraft:

- Convair CV 580 with 7955 litre retardant tank capacity with a constant flow variable volume retardant delivery system. This twin turbine aircraft operated by Conair came into service as an airtanker in 2000.
- Lockheed Electra (L188), similar to the P3 Orion used in USA.
- Radial engine Grumman Firecat S-2, similar in specification to the aircraft used by Sécurité Civile in France.
- Airtractor AT 802F, as used in Australia, with the amphibious version known as the “Fireboss” operational at some airbases

As mentioned earlier, initial attack with fixed-wing aircraft utilises retardants dropped adjacent to the fire however, rather than returning to base, the amphibious Fireboss would refill locally if a suitable scooping site is available and direct attack with foam, while other tankers returned to base to reload with retardant.

The group visited the Salmon Arm rap-attack base from where rappel teams are flown into remote fires. The helicopters at this base were Bell 212s fitted with either Simplex or Isolair type fixed belly tanks. Once the rappel teams are operational on the ground, the helicopter provides support with its 1,400 litre fire bombing capability. This mirrors the systems currently used by the Department of Sustainability and Environment in Victoria.

***Canada – Coulson Airplane, Sproat Lake, Vancouver Island, British Columbia***

Coulson Airplane’s major maintenance facility is located at Sproat Lake, and visiting it was a valuable opportunity to understand the intensive effort required to maintain and operate large helicopters. Two aircraft types of particular interest were viewed at this location:

- The Martin Mars amphibious aircraft. Although developed during the Second World War, it was the only aircraft observed with a direct injection system for liquid gel-based fire suppressant concentrates. This essentially duplicated the foam injection system fitted to the aircraft.
- The Sikorsky S61. Coulson Airplane are also current contractors to NAFC. In Australia the S61 utilises a 3,000 litre Bambi bucket, although there are a number of tanks available and under development.

***Canada – SEI Industries, Vancouver, British Columbia***

SEI Industries manufacture the range of Bambi buckets widely used in Australia. They have also developed two products that were new to the study group. These are:

- The Powerfill II – a retro-fitted self-filling pump for a Bambi bucket for use in shallow water to a minimum depth of 30 cm. This design enables existing buckets to have self filling capability similar to a power fill pump yet maintain the effective drop pattern from a standard Bambi bucket outlet valve.
- The Coverage Level Controller – a computerised digital control designed for the Torrentula-valve Bambi buckets. This gives users the capability to accurately control ground coverage concentrations. It provides programmable drops, adjustable volume capacity, programmable flow rates, displays volume levels, and records data from the drops undertaken.



Photo: Bambi Bucket testing SEI Vancouver

***USA – the National Interagency Fire Centre (NIFC), Boise, Idaho***

Visiting the NIFC at Boise was primarily an opportunity to discuss systems of managing aerial firefighting rather than to observe aircraft delivery systems. At Boise, only two aircraft types were observed, an Airtractor 802, and the Hercules C130 air transport with a fitted MAFF system.

Discussions with the Bureau of Land Management (one of the Federal partners of NIFC), revealed that SEAT (single engine airtanker) drop systems had been certified for bomb gate types that were perpendicular to the direction of travel with the exception of the Airtractor F gate, which was longitudinal. Both the Transland and Marsh 60/40 gates were approved with the mechanical Hatfield and Crackerjack systems certified but not preferred. No SEAT employed by the Bureau has utilised the Transland longitudinal door currently operational in Australia. Comments concerning this longitudinal door included the lack of fairing cowls which may cause feathering of the bomb drop.

The NIFC aviation management team discussed the future of airtanker types suitable for application across USA federal land. The aircraft needed the capability of a ground coverage level of 8 (i.e. 8 US gallons per 100 square feet), with a viable capacity of 3 to 5,000 US gallons.

Airtanker types being considered for the future of fire bombing in the USA include:

- Evergreen Boeing 747-200 (20,000 US gallons – approx 75,000 litres)
- McDonnell Douglas DC-10 (12,000 US gallons – 45,000 litres)
- Hercules C130 H models with 2<sup>nd</sup> generation Modular Airborne Fire Fighting System (MAFFS2) – currently under development - fitted (4,000 US gallons – 15,000 litres)
- British Aerospace BAE 146 (potential 3,000 US gallon – 11,000 litres - capacity)
- Bombardier Dash 8 Q400 (10,000 litre capacity)
- Airtractor AT1002 (1,000 US gallons – 3,800 litres) Prototype being developed for US autumn 2008
- Airtractor AT2002 (2,000 US gallons – 7,500 litres) Concept only

***USA – Isolair, Simplex Manufacturing, Helicopter Transport Service, Erickson Airplane, various locations in Oregon***

Fixed helicopter tank manufacturers Isolair and Simplex were visited in Portland. Isolair was continuing with current manufacture of existing tank technology with the exception of a prototype version of a Kaman Kmax belly tank. No indications were given if this tank was going to be put into production.

Simplex Manufacturing were in the process of refining door design on some models of tanks to improve suppressant evacuation efficiency, as well as improving snorkel pump efficiency to halve refill times. Neither manufacturer offered any innovative solutions to drop pattern efficiency which is often the major hurdle to belly tank firefighting effectiveness.

Helicopter Transport Services and Erickson Airplane provided a tour of their maintenance facilities to enable the study group to view the extensive maintenance programs each current Australian contractor carries out. No new technology affecting delivery systems was encountered on these visits, although it was most useful for the group to understand the extensive infrastructure required to support this category of aircraft.

The US Forest Service has extensive information on its website on delivery system testing and evaluation, see [www.fs.fed.us/rm/fire/delivery/index.htm](http://www.fs.fed.us/rm/fire/delivery/index.htm).

***USA – Evergreen Aviation, McMinnville, Oregon***

A presentation by Evergreen Aviation discussed the merits of the Boeing 747 airtanker. The firefighting system uses a 747 air freighter airframe and has a complex array of tanks fitted internally that rely on a compressed air system to distribute fire retardant or suppressant via four external ports. The concept behind this is similar to the AFFF system developed for the Hercules C130 aircraft whereby compressed air ejects the retardant/suppressant, yet can operate in a pressurised aircraft for crew safety and operating efficiency.

The 747 airtanker has a capacity of 20,000 US gallons. However, unlike AFFF, it relies on ground-based air compressors for recharging the system. Evergreen's engineers plan to recharge the compressed air onboard to minimise down time in refilling the aircraft. Unlike many firefighting aircraft when fully loaded, the 747 is operating well under its maximum takeoff and landing weights so can land fully loaded if not required upon arrival at a fire. The system has an array of tanks so potentially could carry a dual load of retardant and foam (e.g. 10,000 gallons of each). The aircraft would require extensive ground crew and mixing infrastructure to support it and requires a runway length of at least 8,000 feet.

The US Forest Service has indicated it is reasonably manoeuvrable in the mountainous terrain it is likely to encounter. Evergreen has indicated that to maintain an acceptable coverage level when terrain limits the 747's ability to get low enough, it could boost the air pressure during retardant drops to increase the coverage levels.

US Forest Service researchers referred to 747 field trials which indicated that the compressed air system showed marked variation of coverage levels during a single drop with a maximum coverage level of 32 (32 US gallons per 100 square feet) to quite sparse coverage in other parts of the drop. Also observed was mixing of air and retardant when the tank was near empty, affecting the drop quality. Conceptually however, the USFS researchers want to assess whether this style of aircraft provides a much wider drop than conventional bombers, and whether a ground coverage level of half as concentrated yet twice as wide, could be as effective for fire suppression as a narrow high concentration drop.

***USA – Department of Forestry & Fire Protection, Redding and McClennan, California***

The California Department of Forestry & Fire Protection (CDF) has access to ex-military aircraft that it converts and manages for aerial firefighting due to cost effectiveness and the control of safety and quality issues.

CDF has 53 aircraft distributed across 22 bases. It uses converted Grumman S2 aircraft similar to those operated in France and Canada, and Super Huey helicopters and OV10 reconnaissance aircraft previously used in the Vietnam War.

For the 2006 fire season, CDF had contracted a new DC-10 airtanker. After operating in California it had been re-assigned from CDF to Washington State during recent fires with positive anecdotal feedback. This is supported by US Forest Service researchers based at San Dimas, California, in their desert testing of the 747 and DC-10 airtankers. They assessed the modified DC-10 as having a drop pattern suited to effective firefighting. The DC-10 runs three modified constant flow tanks and bomb doors, externally fitted to the air frame. These modified

tanks were derived from the Aero Union tanks developed for the Erickson Airplane. Coverage level and pattern tests were promising for this 48,000 litre capacity aircraft.

#### ***USA - Los Angeles County Fire Department***

The LA County Fire Department operates two types of aircraft with bombing capability. These are the Bell 412 fitted with an aluminium belly tank with no hover fill capability, and the civilian version of the Blackhawk Sikorsky UH-60L/S-70A, commonly known as the "Firehawk".

The Bell 412 are primarily used for EMS work but have dual capability for aerial fire bombing. Although the 1,400 litre tanks can auto-inject foam, they are reliant on ground crew support for filling as the LA County Fire Department had yet to find a suitable hover-fill pump for the tank.

The Firehawk is also used for EMS tasking, and have Aero Union 3,800 litre tanks with constant flow doors. Unlike many hover-fill systems, the pump delivers the water to the tank via a soft delivery hose that is retractable and provides no interference or encumbrance during transit operations.

#### **Delivery systems – findings**

- F32.** Many countries invest significant amounts of money in aerial firefighting; however systems for evaluation of delivery system effectiveness or fire suppression effectiveness remain inherently limited.
- F33.** Marketing of new delivery systems or airframes for firefighting often appears to be ahead of known indicators of bomber effectiveness. Systems are, at times, promoted without proven and evidence-based indicators for fire suppression effectiveness.
- F34.** Delivery systems are not evolving in the same manner as other technologies, and remain relatively static in their development.
- F35.** Delivery system development is often reliant on significant "launch" investment by a government, supplier or contractor. Limitations of current systems are maintained due to the costs of redesign or redevelopment.

#### **Delivery systems – recommendations**

- R33.** Research and develop a greater understanding of the effectiveness of aircraft fire bombing delivery systems within Australian agencies for the role and function undertaken by the aircraft. This should include the development of known criteria for evaluating bomber delivery system effectiveness. (see also Recommendation R29).
- R34.** Australian agencies should establish a collective network of shared information to enable effective evaluation of delivery systems introduced into Australia during tender processes, and ultimately develop a standard national aircraft and delivery system rating and approval mechanism (such as the Air Tanker Board in the United States).
- R35.** Appropriately experienced representatives of Australian Fire Services should participate on evaluation of internationally significant aircraft such as the Boeing 747 or DC-10 airtankers, to determine whether such aircraft could be operationally applied in Australia (see also Recommendation R31.)



## Fire retardants and suppressants

Fire retardants and suppressants can be viewed as three sub-categories:

- **Fire retardants** – chemical concentrates mixed with water which react with and alter the thermal decomposition of fuels so that they do not support flaming or glowing combustion. This deprives the fire of fuel reducing fire intensity and the rate of flame spread. Retardant solutions or slurries are dropped adjacent to the fire to create a chemically-induced fire break at its perimeter.
- **Fire suppressants (foam)** – chemical surfactant concentrates that, when mixed in solution with water, reduce its surface tension thereby creating a foam blanket that surrounds fuels in a thick layer. This creates a barrier between the fuel and the fire and by also expanding the water, increases its efficiency in directly cooling the fire.
- **Fire suppressants (gels)** – chemical concentrates that when added to water, reduce the water runoff, slow the evaporation process, and create a thermal protective gel coating that adheres for long time periods to vertical surfaces, thus reducing the chances of a fire rekindling.

During the study tour, all types of concentrates were discussed, however, only retardant and foam concentrates were being actively used in the respective jurisdictions that were visited.

### France

Sécurité Civile uses *D75R Phos-chek* retardant and foam concentrates, although the foam product type was not determined. CEREN evaluates the quality of the mixed product used to ensure conformity with quality requirements for mixing. They also undertake testing and experimentation of foam and retardant drops as well as commencing experiments on the use of gels, although these products had yet to be used in the field at the time of the visit.

### Canada

On Vancouver Island, the Martin Mars amphibious fire bomber has been using *Thermogel* liquid concentrate in a direct injection system on-board the aircraft. This system is identical to the foam injecting system installed in the aircraft. This product has been used by private forest managers. *Thermogel* has released some reports on its coverage from the Martin Mars but no conclusions on its effectiveness were provided to the study group by the BC Forest Service. It was suggested that the product may not work in salt water.

At the Provincial Air Tanker Centre in Kamloops, British Columbia, all initial attack is with fixed-wing airtankers using *Firetrol* liquid concentrates. This is mixed with water at a ratio of 5.5 parts water to 1 part concentrate. This is provided by the chemical supplier as a mixed product at a cost of \$CA 0.35 per litre delivered to the aircraft. The liquid concentrate is water-like and unthickened. Foam is also injected into the liquid concentrate mix at 0.3% to make the coloured concentrate more visible. The liquid concentrate mixing base at Kamloops was a large fixed operation requiring only 2 personnel to operate the entire system for multiple airtankers. The only manual handling issues were the connection of hoses to aircraft. In addition the liquid concentrate could be moved easily to temporary air bases via bulk tankers and could be proportioned like foam into the airtankers direct with minimal labour.

The Canadian *Firetrol* product is not currently qualified under the USDA Wildland Fire Chemical System. It is important to note that the BCFS staff had no problems with an unthickened product on fire grounds in conifer forests. Fire retardant was always used for indirect attack adjacent to the fire but not on the fire. Direct attack with foam was done with Helitaks or the *Fireboss* amphibious Airtractor. Foam type used was a *Firetrol* product. BCFS concluded that a hybrid (retardant plus foam) product maybe the way of the future for aerial firefighting chemicals.

Through NIFC, the US Forest Service and other Federal agencies such as the Bureau of Land Management and the Bureau of Indian Affairs use a range of products from fire retardant slurries obtained from powder derivatives, through to liquid concentrates and foam products. The Bureau of Land management had commenced trials on the use of gels in its SEAT program but had yet to reach any firm conclusions on its effectiveness or application. The “jury” was still out regarding the application of gels on US Federal lands. Anecdotal evidence of the non-breaking down of gels in the environment, and how it reconstitutes itself after rain was a hot topic for discussion with the US Forest Service, (as it was for the BC Forest Service.)

As in BC, outsourced chemical suppliers provide a contract service to deliver retardant to the aircraft for a fee-per-volume delivered. At the combined USFS and CDF facility at Redding California, Phos-chek had a bulk batch mixing facility capable of serving USFS contracted air tankers and CDF Grumman aircraft. This operation utilised one ton bulk bags of D75R retardant powder into a bulk mixer and then pumped the mixed slurry into bulk tanks. This operation required only 2-3 persons to maintain all mixing and loading for this large airtanker base. The US Forest Service conducts training courses on the tactical application of chemicals for aerial firefighting, although there was little indication that incident management teams undertook the tactical monitoring of chemical effectiveness during major fire operations. Cost effectiveness of application was not an apparent consideration.

CDF in California have been using various gel products, but unfortunately our visit did not allow any consideration of this strategy. Previous discussions with Dan Lang of CDF had indicated the effectiveness of gel for direct attack is in low humidity environments where the residence time of foam products on the fire ground is significantly reduced. This requires further investigation and trialling as information on effectiveness was scant and anecdotal at the time of the visit.

As mentioned in the delivery systems section, US Forest Service researchers at San Dimas were considering whether wide drop patterns with lower coverage levels of retardant could be just as effective as high coverage levels at narrower widths. This will require close monitoring as it may result in a paradigm shift in the application of fire retardants.

### **Retardants and suppressants – findings**

- F36.** Relative to the Australian context, international usage of low and high viscosity retardants occurs in similar fuel types, from similar aircraft, with comparable success.
- F37.** The majority of high volume chemical application for firefighting in North America is via indirect attack with retardants. Direct attack of fires is generally limited to smaller capacity rotary-wing aircraft.
- F38.** The use of gel-based products is still in its infancy with marked differences in opinion with regard to its effectiveness.
- F39.** Bulk handling of fire control chemicals can reduce both the complexity and the health and safety issues associated with mixing and loading of aircraft.
- F40.** Cost effective use of retardant is not always a consideration in tactical application. Cost effective application is a function of the initial attack outcome that agencies are trying to achieve. For example, in Canada, the BCFS regards initial attack as successful when a fire is kept to less than 10 hectares; whereas the USFS regards initial attack success as being when a fire is kept to less than 300 acres (120 ha) in size.

## Retardants and suppressants – recommendations

- R36. Research and develop a greater understanding of the tactical application of fire retardants and suppressants for aerial firefighting within Australian Fire Services. Conduct a national trial and evaluation of fire retardants and suppressants to determine the best and most appropriate application for fire and fuel types.
- R37. Implement competency-based training across the full range of Australian operatives who require an understanding of the characteristics of and the effective application of aerially-delivered chemicals for fire suppression.
- R38. Further investigate the application of gels and liquid concentrate retardants in Australia, including an evaluation of the Canadian use of low viscosity retardants versus the use of gum thickened high viscosity products in similar fuel types.
- R39. Investigate the potential for national bulk procurement of fire retardants and suppressants, within a range of products. Competitive tendering at a national level would assist all States.
- R40. Establish a collective network of shared information on fire retardants and suppressants regarding their respective applications within Australia.
- R41. Continue to utilise the USDA Wildland Fire Chemical System to test and qualify chemicals for use in Australia; and continue to liaise with overseas researchers to maintain a knowledge base for Australian agencies.
- R42. AFAC/NAFC should develop a series of “Practice Guides” or similar instruments to guide the safe, efficient, effective use of suppressants and retardants under various bombing systems.

## Aerial incendiaries

### Canada – SEI Industries, Vancouver, British Columbia

SEI Industries manufacture two incendiary devices for aerial applications called the “Red” and “Blue” Dragon. They also produce proprietary Aerial Ignition Spheres (AIS) for use in their machines which operate using the ‘traditional’ chemical reaction between *Potassium permanganate* and *Monoethylene glycol*. Both machines are essentially the same with the newer ‘Red Dragon’ displaying some additional refinements over its predecessor. The ‘Red Dragon’ holds 950 incendiary capsules and is designed for use only in rotary-winged aircraft under a ‘doors off’ configuration. The machines can vary their ejection rates between 25 and 175 capsules per minute and have inbuilt drop tubes that allow the capsules to clear the aircraft. Both machines can be jettisoned to comply with US air regulations and have inbuilt water-based fire extinguishers.

The devices are similar to incendiary capsule dispensers currently employed in Australia, with the most significant improvements being the greater hopper storage capacity of 950 capsules and the interchangeable mounts which increase compatibility across a greater number of aircraft.

The physical dimensions of the machines are generally smaller than older machines available in Australia, but weight is comparable.

Photo: SEI Red Dragon  
Incendiary dispenser



Their serviceability and ability to eject charged capsules is also comparable with many machines available in Australia.

Disadvantages include lack of an Australian-based support centre meaning that capsules and spare parts are only available from North America. As a number of Australian agencies involved in aerial ignition operate fixed-wing aircraft and or rotary-winged aircraft in a 'doors on' configuration, significant modification will be required to mount the machine and attach a drop tube.

***Canada – FIRETROL, Kamloops***

'Flash 21' is a two part liquid gelling product which is not affected by temperature, should stay in suspension and can be mixed in a variety of fuels including Jet B, diesel, or a gas/diesel mix. This product is a potential alternative to the currently used "SureFire".

***USA – ISOLAIR, Oregon***

**Firefly II – Sling Mounted Ignition system (helitorch)**

The Firefly II has the advantage of being lightweight (i.e. 100 lbs (45 kg)) which improves the ability to be used on different aircraft. It has a high carrying capacity of gel (55 gallons) which allows for increased productivity, whilst two access points improve access for cleaning and mixing if required.

Its disadvantage is questionable directional stability once airborne.

Photo: Isolair Firefly II helitorch



**Unmanned Aerial Vehicles (UAV)**

***Canada – Coulson Aircrane, Vancouver Island***

Coulson gave the study group a presentation on UAVs from Leading Advanced Technologies Systems (UK) Ltd with whom they have an alliance. This Company are an internationally-based aeronautics company with significant experience in the development and application of UAVs primarily for military purposes.

The company provides Air Vehicles – 'Sparrow' – with the capacity to catapult and canister rocket launch includes parachute and airbag recovery with a range of not less than 30km at 5,000ft with OMNI data link (250 km with directional data link). The Air Vehicles can carry sensor capability with day and infra-red camera including video tracking and homing capabilities.

Other integrated systems produced are Ground Control Stations for permanent structures or portable to allow for operational flexibility. Portable Video Receiving Stations a launcher pack canister launcher and vehicle mounting. Air Bag and Parachute Recovery can produce a 20 min turn around time for Air Vehicle. A number of the UAV's seem to have been developed in Israel. (Contact: email [emit@inter.net.il](mailto:emit@inter.net.il)).

**Other**

Other aspects of technology that were canvassed included:

- the use of technology (such as night vision goggles and terrain awareness/warning systems) to safely undertake aerial fire suppression at night;
- automatic traffic management and warning systems for aircraft operating in close proximity; and

- GIS and map production, including compact on-board automated mapping systems.

## Findings

- F41. There are various technological developments in the field of aerial incendiary and gel delivery which have potential to improve efficiencies in the Australian context.
- F42. Unmanned Aerial Vehicle (UAV) technology has now developed to a point where it may have potential application in the Australian context.

## Recommendations

- R43. Ensure agencies are aware of technological/product developments that have potential application in Australia. Continue to monitor developments and liaise with relevant vendors.
- R44. WATG to continue to closely monitor developments in UAV technology and to keep relevant agencies informed.



Photo: Martin Mars operated by Forest Industry Tankers at Sproat Lake BC Canada





## **APPENDICES & ATTACHMENTS**

# APPENDIX 1

## List of participants

<b>John Gledhill</b>	<i>Chief Officer</i> Tasmania Fire Service	Group Leader
<b>Richard Alder</b>	<i>General Manager</i> National Aerial Firefighting Centre	
<b>Hayden Biggs</b>	<i>Acting Manager</i> State Aircraft Unit	Victoria
<b>Claire Bunday</b>	<i>Administrator</i> National Aerial Firefighting Centre	Group Executive Officer
<b>David Cant</b>	<i>Manager, Aviation Services</i> Country Fire Service	South Australia
<b>Ian Cawthorn</b>	<i>Senior Field Officer</i> Tasmania Fire Service	Tasmania
<b>David Crust</b>	<i>Area Manager</i> National Parks and Wildlife Service	New South Wales
<b>Anthony Ferguson</b>	<i>Aviation Planning &amp; Coordination Officer</i> Rural Fire Service	New South Wales
<b>John Fisher</b>	<i>Deputy Chief Officer</i> Rural Fire Service	Australian Capital Territory
<b>John Gresty</b>	<i>Manager, Air Operations</i> Queensland Fire and Rescue Service	Queensland
<b>Tim McGuffog</b>	<i>Regional Inspector</i> Queensland Fire and Rescue Service	Queensland
<b>Natasha Oke</b>	<i>Fire Operations (Aerial) Officer</i> Department of Environment and Conservation	Western Australia
<b>Matt Plucinski</b>	<i>Research Scientist</i> Ensis (CSIRO)	Bushfire CRC
<b>Kevin Rheese</b>	<i>Director, Natural Disaster Mitigation &amp; Relief</i> Department of Transport and Regional Services	Australian Government
<b>Mike Wassing</b>	<i>Operations Manager</i> Country Fire Authority	Victoria



## APPENDIX 2

### List of organisations and sites visited

<b>Wednesday 23 August</b>		
		<b>Key contact:</b>
Sécurité Civile Regional Aircraft Operations Base	Marignane, France	Bernard Rogiers Deputy Director
Sécurité Civile Pompiers Training College (ECASC)	Valabre, France	Col. Robert Bardo Director
Interdepartmental Centre for Forest Research (CEREN)	Valabre, France	Dr Frederique Giroud Director
Centre for Regional Coordination CIRCOSC	Valabre, France	
Cotes du Rhone GIS and mapping centre	Valabre, France	Patrice Manager
<b>Friday 25 August</b>		
British Columbia Forest Service, Headquarters	Victoria, B.C. Canada	Judi Beck
Forest Industry Tankers	Port Alberni, B.C. Canada	Terry Dixon General Manager
Coulson Air-crane	Port Alberni, B.C. Canada	Wayne Coulson Chairman
<b>Saturday 26 August</b>		
SEI Industries	Delta, B.C. Canada	Jens Sigvardt Divisional Manager
Conair Inc	Abbotsford, B.C. Canada	Ray Horton Director, Operations
Cascade Aerospace	Abbotsford, B.C. Canada	Barry Marsden President and CEO
<b>Sunday 27 August</b>		
British Columbia Forest Service, Rappattack Base	Salmon Arm, B.C. Canada	Mark Dahlie Manager
Wildcat Helicopters	Salmon Arm B.C, Canada (based at Kelowna)	Mike Michaud President
<b>Monday 28 August</b>		
British Columbia Forest Service, Provincial Airtanker Centre	Kamloops, B.C. Canada	Jeff Berry Program Manager
Chemonics Industries Inc	Kamloops, B.C. Canada	Colin Cameron Field Services Co-ordinator
<b>Wednesday 30 August</b>		
<b>Thursday 31 August</b>		
United States Bureau of Land Management	Boise, Idaho, U.S.A	Tom Frey International Program Coordinator

United States Forest Service	Boise, Idaho, U.S.A	Pat Norbury National Aviation Operations Officer
National Incident Coordination Centre	Boise, Idaho, U.S.A	Doug Shinn Asst Manager
U.S. Aviation Management Directorate/Federal Acquisition Centre	Boise, Idaho, U.S.A.	Dave Dash Program Manager
Fire Program Analysis	Boise, Idaho, U.S.A.	Howard Roose Project Business Team Leader
<b>Friday 01 September</b>		
Isolair Inc	Troutdale, Oregon U.S.A	Michael Powell, President
Simplex Manufacturing Inc	Portland, Oregon U.S.A.	Steve Daniels, President and CEO
<b>Saturday 02 September</b>		
Evergreen International Aviation Inc	McMinnville, Oregon U.S.A	Del Smith, Chairman
Evergreen Helicopters Inc	McMinnville, Oregon U.S.A	Dick Carmine, Marketing Manager
Helicopter Transport Services	Corvallis, Oregon U.S.A.	Walter Palubiski General Manager, Heavy Lift
<b>Sunday 03 September</b>		
Erickson Air-crane Inc	Central Point, Oregon U.S.A	Lanny Allmaris Fire Marketing Manager
<b>Monday 04 September</b>		
California Department of Forestry – Northern Division	Redding, California U.S.A.	Del Walters
US Forest Service	Redding, California U.S.A.	Mike Chuckel
Smokejumper Centre	Redding, California U.S.A.	
<b>Tuesday 05 September</b>		
California Department of Forestry	Sacramento, California, U.S.A	Mike Padilla Chief of Aviation
Dyn-corp International	Sacramento, California, U.S.A	Arthur Trask Division Manager
U.S. Forest Service Training Centre	Sacramento, California, U.S.A	
California Office of Emergency Services	Sacramento, California, U.S.A	John Craney (CDF)
<b>Wednesday 06 September</b>		
U.S. Forest Service Research and Development Centre	San Dimas, California U.S.A.	Carl Bambarger Aviation Program Leader
Los Angeles Country Fire Department	Los Angeles, California U.S.A	Tony Marrone Battalion Chief

## APPENDIX 3

### List of personnel visited

Organisation	Personnel
Sécurité Civile	Bernard Rogiers, Deputy Director
Sécurité Civile Pompiers	Col. Robert Bardo, Director Training College Colonel Bernard Broglie
Interdepartmental Centre for Forest Research (CEREN)	Dr Frederique Giroud, Director Lieutenant Nicolas Raffalli
Centre for Regional Coordination CIRCOSC	Col. Bernard Broglie
Cotes du Rhone GIS and mapping centre	Patrice
British Columbia Forest Service, Headquarters	Judi Beck Shawn Bethel John Flanagan [Call centre manager]
Forest Industry Tankers	Terry Dixon, General Manager
Coulson Air-crane	Wayne Coulson, Chairman Paul Pashnik Susan Meriverta
SEI Industries	Jens Sigvardt, Divisional Manager Paul Reichard
Conair Inc	Ray Horton, Director, Operations
Cascade Aerospace	Barry Marsden, President and CEO
British Columbia Forest Service, Rappattack Base	Mark Dahlie, Program Manager
Wildcat Helicopters	Mike Michaud, President Ian Wilson, General Manager
British Columbia Forest Service, Provincial Airtanker Centre	Jeff Berry, Program Manager Bruce Noble Pat Dennis Leigh Barratt
Chemonics Industries Inc	Colin Cameron
United States Bureau of Land Management	Tom Frey Winnie Sorenson Mark Bickham Howard Roose
United States Forest Service	Pat Norbury Frank Gomez Tori Henderson [Helicopter Operations Specialist]
National Incident Coordination Centre	Doug Shinn
U.S. Aviation Management Directorate/Federal Acquisition Centre	Dave Dash Harlan Johnson
Isolair Inc	Michael Powell, President
Simplex Manufacturing Inc	Steve Daniels, President and CEO
Evergreen International Aviation Inc	Del Smith, Chairman Tim Wahlberg, Bob McAndrew, Jim Baynes
Evergreen Helicopters Inc	Dick Carmine, Marketing Manager
Helicopter Transport Services	Walter Palubiski General Manager, Heavy Lift
Erickson Air-crane Inc	Pat Pilolla Lanny Allmaris

<b>California Department of Forestry – Northern Division</b>	Del Walters
<b>US Forest Service – Regional Coordination</b>	Mike Chuckel
<b>Smokeyjumper Centre</b>	
<b>US Forest Service (retd)</b>	Alice Forbes
<b>California Department of Forestry</b>	Mike Padilla, Chief of Aviation
<b>Dyn-corp International</b>	Arthur Trask, Division Manager
<b>U.S. Forest Service Training Centre</b>	
<b>California Governor's Office of Emergency Services</b>	John Crancy (CDF)
<b>U.S. Forest Service Research and Development Centre</b>	Carl Bambarger Ryan Becker
<b>Los Angeles Country Fire Department</b>	Tony Marrone, Battalion Chief Erich Goetz, Steve Christiansen Chuck Gutierrez



# ATTACHMENT 1

## British Columbia Forest Service Fire Ranking System



### Rank 1

Smoldering ground or creeping surface fire.  
Little or no visible flame.

### Rank 2

Low vigor surface fire.  
Visible open flame.



### Rank 3

Moderately vigorous surface fire.  
Occasional candling of single or groups of trees.  
Direct-attack strategies may be challenged.

### Rank 4

Highly vigorous surface fire,  
active torching or candling.  
'Passive' crown fire with  
spotting ahead of main front.





## Rank 5

Extremely vigorous surface fire or active crown fire. Parallel or Indirect attack strategies necessary.



## Rank 6

Blow-up or Conflagration. Extreme fire behaviour. Suppression activities may be ineffective until fire intensity decreases.



Photo: California Office of Emergency Services coordination centre  
Sacramento

