THE WINSTON CHURCHILL MEMORIAL TRUST OF AUSTRALIA

Report by - IAN DICKER – 2001 Churchill Fellow

To study the integration of light fixed wing agricultural aircraft into bushfire suppression operations.

An investigation of practices and procedures of fire services and industry in the United States of America and Canada.
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Introduction

Aircraft have been used to support wildfire operations since the era of the First World War. Initially, aircraft were used to provide detection and reconnaissaince information, however, as aircraft size and capacity increased, more innovative use occurred. The first documented research into the use of aircraft is identified in the late 1930’s, where water and sometimes chemicals were dropped from the air to reduce fire behaviour.

In the United States and elsewhere, these early efforts involved the use of small agricultural aircraft employed at the time as crop dusters. Most of these machines had small hopper capacities of less than 250 US Gallons (1000 litres), with delivery systems designed for spreading dry fertiliser or herbicide through spray systems.

With the conclusion of World War Two, there was an immediate availability of much larger and faster aircraft, whose history and design was either carrying payloads of bombs or cargo. Fire managers in the United States during the 1950’s and 60’s were able to modify a wide range of such aircraft; supported with big spare parts inventories. The arrival of these aircraft also witnessed the start of the era where the most research and development took place, particularly into chemical fire retardants and aircraft tanks and door systems.

The introduction of the larger machines, and the philosophy that bigger was better, meant that the agricultural aircraft, which had started off the aerial fire fighting industry, were essentially squeezed out. This was not the case in Australia, where, light agricultural aircraft have continued to be used to drop water on fires.

It would not be until the mid 1980’s that the single engine air tanker (SEAT) would make a resurgence. This is in part due to the improved capability of modern agricultural aircraft, but also the phasing out of many of the large machines due to restricted parts availability, and airframes reaching the end of their working life. There has also been recognition that SEATs provide a better solution in the delivery of fire suppressant and retardant chemicals in certain vegetation types and terrain.

The numbers of SEATs employed in the USA and Canada is increasing. This year, 21 SEAT aircraft will be contracted by the US Department of the Interior, and at least seven in Canada. Training courses for flight crews and ground personnel has been developed, and there is increasing acceptance of the arrival of the agricultural aircraft into the fire-fighting marketplace.

As identified, Australia has a history of employing light agricultural aircraft in the support of fire suppression operations. With the increasing use of SEATs in both the USA and Canada, the opportunity was identified to undertake a study tour to review current North American practices and compare those with Australia. The study tour was designed to review a wide spectrum of the industry. A range of Government agencies, employing SEAT aircraft for fire suppression were visited, as well as industry manufacturing fire retardant and suppressants, aircraft contractors and specialist support equipment manufacturers. Opportunities to discuss and participate in training courses and observe actual fire fighting operations were also possible.
Acknowledgements.

The study tour was considered to be an exceptional opportunity to review overseas practices in the field of Single Engine Air Tanker operations. In making the tour a success, it is important to acknowledge the significant contributions of support made by some individuals and organisations.

Firstly, without the support of the Churchill Trust, this experience would not have been possible, and I am eternally grateful for this opportunity. I am also extremely indebted to my wife, Christine for putting up with me being away for the duration of the trip.

I also wish to acknowledge all of the organisations and agency personnel who made time available to meet and talk with me about their industry. Several people require special mention both for their efforts and support of the trip, but also their friendship, which made the time away more bearable. This includes George Roby, and all of the staff at Astaris, Wally Born of the Alberta Department of Environment Protection, Shawn Bethel of the British Columbia Ministry of Forests, and last, but by no means least Peter de Bruin of Bruin Woodland and Fire Services.

I am also appreciative of the NSW Rural Fire Service for supporting the program in providing study leave for the study tour, and to my three referees, whose advice and support in establishing the proposal was appreciated.
Executive Summary

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Topic: Investigate the integration of light agricultural aircraft into bushfire suppression operations in the USA and Canada.

Given the reported increases in the use of single engine air tankers in the USA and Canada, the proposal to investigate the approaches used overseas and compare them with Australia was developed. The study tour endeavoured to review all aspects of the light fixed wing program in North America, to compare with current Australian practice. To achieve this, a range of government agencies and industry were visited. Opportunities were also taken to participate in training programs and to observe actual fire suppression operations involving the use of agricultural type aircraft.

A wide range of lessons have been learnt as result of this investigation. These include issues relating to: contracts management and contract compliance auditing; aircraft selection; retardant and suppressant mixing and delivery systems; airframe modification and specialised equipment; protective equipment for both ground personnel and flight crews; training and qualification systems for ground personnel and flight crews; air attack strategies and tactics; operational evaluation; interagency coordination; and administration processes.

Recommendations have been made specifically in relation to the following:

**Contract length.** Significant advantages have been identified with the use of 10 year contracts in Canada, rather than three year with extension options.

**Flight crew qualifications.** All pilots employed to fly on fires in North America are required to possess both aviation industry and fire industry qualifications.

**Changes to air attack strategies and tactics.** The approach used in Canada is considered to have significant safety and efficiency benefits over the methods employed in Australia presently.

**Protective equipment.** Recommendations are made to the standardisation of protective equipment issued to both ground and aircrews.

**Airframe modification.** Recommendations are made with regard to modification of air attack aircraft to enhance safety standards and make the job more efficient.

**Air Attack Officer qualifications.** The approach used in Canada encourages the concept of mentoring, to bring trainees up to the desired standard, and employs competency based assessment. Recommendations are made to review this program with consideration for adoption in Australia.

In Australia, the central body for fire agencies is the Australasian Fire Authorities Council (AFAC). It is proposed that copies of this report be forwarded to AFAC for further distribution to fire and land management agencies involved in aviation programs for fire management. Copies of the document will also be forwarded to both the NSW Rural Fire Service and the Victorian Department of Natural Resources and Environment (DNRE) for consideration. DNRE are the primary agency involved in aviation management and training in Australia.
Programme

Travel as part of the fellowship study tour was timed to take place in April and May, to coincide with pre fire season preparations in North America, including training courses, equipment readiness and contracts administration. A full itinerary of the tour is included as Appendix 1.

The following agencies were visited during the seven-week programme:

- Los Angeles City Fire Department Air Wing
- Los Angeles County Fire Department Air Wing
- Astaris Corporation (manufacturer of Phos-Chek fire retardant and suppressant products)
- ROBWEN (manufacturers of specialist pumps and fire suppressant mixing equipment)
- United States Bureau of Land Management
  - Safford District Office, Arizona
  - Phoenix District Office, Arizona
  - National Interagency Fire Centre, Boise Idaho
- United States Bureau of Indian Affairs, Whiteriver Arizona
- United States Forest Service
  - San Bernardino California (research station, fire cache, radio workshop, air tanker base)
  - Fox Air tanker base, Lancaster, California
  - National Interagency Fire Centre, Boise Idaho
- National Interagency Fire Centre, Boise Idaho
- Air Tractor Corporation (manufacturers of Air Tractor range of fixed wing agricultural aircraft), Olney Texas.

- Ministry of Forests, British Columbia, Canada
  - Provincial Air tanker Centre, Kamloops
  - Rappattack Centre, Salmon Arm
  - Provincial Protection Office, Victoria
- Alberta Environment Protection (Formerly Alberta Forest Service), Canada
  - Provincial Forest Centre, Edmonton
  - Edson Air Tanker Base
  - Environment Training Centre, Hinton
- Fire-Trol Canada (manufacturers of Fire-Trol retardant and suppressant products), Kamloops, BC.
- SEI Industries, Canada (manufacturers of support equipment including buckets, portable dams, floating pumps), Delta BC
- Conair Aviation (private aircraft contractor), Abbotsford BC
- Forest Technology Systems (manufacturers of remote weather monitoring equipment), Victoria BC
- Wildfire Inc (manufacturers and suppliers of fire fighting pumps and support equipment), Abbotsford BC
- Bruin Woodland and Fire Consultants (specialist fire training and fire retardant consultant), Chilliwack BC
- Forest Industry Flying Tankers (private aircraft contractor), Port Alberni BC
Lessons Learnt

1: Contract, Call When Needed and Agency owned aircraft fleets

Agencies in North America employ a range of aircraft to carry out roles in fire management. The approaches are based on history, aircraft availability and also Government policy and management practices. Several Federal US agencies, including the USDA Forest Service and USDOI Bureau of Land Management (BLM), own their own aircraft. These are used primarily for lead plane, remote sensing (infrared scanning) and smoke jumper delivery roles. All of the air tanker and helicopter fleets managed by the Federal Agencies of the USA are contracted to the Government for either Absolute Availability’ or ‘Call When Needed’ roles. Contracts range from 60-day duration up to 14 weeks. Contracts are administered by the US Department of the Interior, Office of Aircraft Services, located at the National Interagency Fire Centre at Boise Idaho.

State government agencies such as the California Department of Forestry and Fire Protection (CDF) also own their aircraft fleet. This results from history, and aircraft availability, where the Federal Government makes available its excess military aircraft to other government agencies for other purposes. CDF modify a fleet of ex Navy S2 Grumman Tracker aircraft for air tanker roles, and also maintain a fleet of OV-10 Bronco and 0-2 Bird Dog aircraft for air attack coordination. CDF also maintain a fleet of modified medium helicopters.
Observations made in Canada indicate that all aircraft managed by the Provinces involved in aerial fire operations are contracted to the Government.

Single Engine Air Tanker (SEAT) aircraft contracted in both the USA and Canada are primarily used for initial attack operations. Quite often, these aircraft will be the first suppression resources on scene. In the USA, a total of 21 SEATs will be employed during the 2001 fire season. These aircraft are contracted for a range of periods and may move around the country. For example, aircraft contracted for a 60-day contract in Southern Arizona may be moved to Montana or Idaho for a separate contract, later in the same summer. This is possible as the fire season progresses northwards. There are advantages to this approach. Firstly the aircraft contractor may make sufficient income, so as to reduce the need to multi role the aircraft. These aircraft are, after all agricultural machines, however, some concerns were identified about perceptions of the public where an aircraft dropping retardant has also been used to spread herbicides and pesticides. Secondly, this approach facilitates well-trained flight and ground crews, and encourages contractors to invest in suitable mixing and pumping equipment. The contract length used in the USA is for 3 years, with possible 2-year extension, based on Government policy.

‘Call When Needed’ contracts are used to identify suitable aircraft and crews before the start of the fire season. In situations when all other SEAT resources are allocated, supplementary aircraft may be brought in to enhance the air attack capability of the agencies. The content of these contracts is the same as the ‘absolute availability’ contracts, regarding training and qualification standards of crews. The major modification in the two contracts is in the availability (time of arrival) and activation of aircraft.

All aircraft observed in Canada are contracted to the provincial governments for fire operations. It is understood that no aircraft are owned by the provincial agencies. A range of contracts are used in Canada. Some are similar to those used in the USA, with one main exception, being contract length. Some agencies identify in the tender documentation the type of aircraft and support equipment to be supplied. Others are broader, allowing the contractor to make available a range of aircraft types to meet the contract specifications. Qualifications that flight crews must possess are clearly identified.

Contracts signed in both British Columbia and Alberta in the past couple of years have been for 10 years, rather than the previously used 3-year contracts with extension options. This approach creates a range of benefits, to both the government and the contractor. As the contractor has guaranteed employment for their aircraft for a longer period, the hourly rates charged are reduced. Further, the contractor is able to safely make capital investment, with the knowledge that there is secure income for longer periods. As a result, better quality aircraft and support equipment are made available. The contracts are drafted in such a way as to allow changes to aircraft during the contract period. Evidence of this was discussed, both in British Columbia and Alberta, where the contractor and government had negotiated to change an aircraft type during the contract. Observations made of these longer contracts are that all parties are much happier with the arrangement, with the overall benefit of reduced annual expenditure, and a more modern and effective aircraft fleet.
2: Compliance auditing

Within the USA, the Office of Aircraft Service (OAS) is responsible for the administration and audit functions of aircraft contracts. These audits include maintenance inspections, aircraft equipment inventories and pilot qualifications.

Audit inspections are made prior to the awarding of contracts and during the contract period, to ensure continued compliance with contract requirements. Inspections are carried out using standard checklists, and reports made using examples of the forms shown below. These forms are in triplicate, with copies sent to the contractor, contracting agency and the OAS.

Situations when defects are identified include a period for remedial action to be undertaken. Failure to achieve this will result in contract penalties, and in the worst cases, contract termination.

Figures 3 and 4 - Audit checklists used for aircraft operators in the USA

Reports on SEAT pilot performance are also made by Air Attack Officers. These assessments are considered when reviewing the air tanker pilot for upgrading from level 2 to Level 1 qualifications. These assessments review mainly drop accuracy.

In Canada, all aircraft contracts for fire suppression are done on a provincial level; however, some of the compliance auditing is carried out federally. Contractors, such as Conair are authorised by Transport Canada to train and qualify their flight crews for fire related operations. Check rides are carried out by Transport Canada officials to confirm that this training meets government standards. All other auditing is undertaken by the contracting agency. As in the USA, if deficiencies are identified, rectification periods and reinspections are identified. There are contract penalties, and possible contract termination for continued breaches.
3: Aircraft selection process

3.1 Air Tankers

As discussed in the introduction of this report, the air tanker program began in the USA with small, agricultural type machines, in the late 1930’s. With the increased availability of larger cargo and bomber type aircraft, the smaller machines were squeezed out of the market, based on the concept of ‘bigger is better’. Many of these larger aircraft were built in the era of World War Two, and are now approaching the end of their useful working lives. Whilst there are more modern, large capacity aircraft now being modified for the roles of air tankers, such as the C130 Hercules, P3 Orion and the Convair 580, there is also increasing use of smaller single engine machines (SEATs). One of the traditional methods of rating the efficiency of air attack operations is the gallons per hour delivered concept. Large, fast machines will always rate better in such circumstances; however, other factors are being considered when making aircraft selection for air tankers. Accuracy of drops, and the safety considerations of operating aircraft in steep, confined areas, are leading to the use of smaller, more manoeuvrable aircraft as air tankers.

One concern raised by some fire managers is a reluctance to utilise air tankers that are fitted with jet engines. The contention is that jet engines react more slowly to changes in throttle compared with propeller aircraft, which may make them more dangerous to operate in steep, mountainous terrain, where constant throttle changes are necessary. Most large modern cargo aircraft now available in the USA are jet powered. There remains reluctance on the part of some agencies to employ the smaller machines. The USDA Forest Service for example does not contract any SEAT aircraft at all. All aircraft contracted to the Forest Service as air tankers are large, multi engine machines, with a wide range of tank capacity and door systems. Agencies committed to the larger aircraft concept, such as the US Forest Service are often involved in fire suppression operations in more heavily timbered environments, requiring larger volumes of retardant to ‘punch’ through the tree canopy, for effective fire control. Other benefits of the larger aircraft are that they are generally faster, reducing travel times to the fire. They also have the capacity to carry larger volumes of retardant, therefore can be used to build longer lengths of fire control line. The Convair 580 shown above has a cruising speed of 270 knots, compared to 150 knots for the Air Tractor 802 F, and 120 knots for the PZL M18 Dromader (next page). The 580 is fitted with a 7950 litre tank, compared with 3200 litres in the AT 802, and 2250 litres for the Dromader.

US Department of Interior agencies, such as the Bureau of Land Management (BLM) and Bureau of Indian Affairs (BIA) are responsible for fire management in areas, of generally lower vegetation canopy height. Typical of their areas of responsibility are the desert and plains environments, typical of California, Arizona, New Mexico,
Idaho, Utah and Montana. In these areas, it has been identified that SEAT aircraft can play an effective role, particularly in initial attack of fires.

In the USA, there are generally two types of Single Engine Air Tanker (SEAT) employed. Most are the PZL M18 Dromader, manufactured in Poland, with the remainder being made up of Air Tractor and Thrush aircraft.

 Whilst the Dromader type aircraft (above) are equipped with a radial engine, running on aviation gasoline, the Turbine Thrush and Air Tractor (left) aircraft operate with jet fuel powered turbine engines. These engines generally provide greater reliability and safety, with the Air Tractor and Thrush being faster and able to carry greater loads than the Dromader.
In Canada, a wider range of SEAT aircraft are employed for fire management roles, than in the USA. Of the 123 air tankers contracted nationally in Canada, 21 are single engine machines. Four provinces contract SEATs, that include Air Tractor models 502, 602 and 802, and M18 Dromader. There is also a group of World War Two era single engine torpedo bombers used in New Brunswick, however, these aircraft are being phased out and replaced with more modern SEATs.

### 3.2 Air Attack Aircraft

There are several considerations made when selecting suitable Air Attack Aircraft. Firstly, the aircraft must provide a safe and manoeuvrable platform for the Air Attack Officer (AAO) to operate from. This includes not only an aircraft that operates well in mountainous terrain, but at slow speeds, and provides the AAO good visibility from a range of attitudes (aircraft positions relative to the ground). Secondly, aircraft performance is considered and matched to the air tankers being coordinated. Most aircraft identified for the role of Air Attack in both the USA and Canada are twin engine, with the exception of the Cessna Caravan, currently being evaluated in Alberta to work with the Air Tractor 802 group.

The Cessna Caravan (left) is fitted with the same turbine engine type as the Air Tractor 802 F, giving it similar performance. Visibility for the AAO is excellent with the high wing design, and the AAO seat located in front of the wing. This feature allows the AAO to maintain a good view, even with the aircraft turning. A third seat has been left in the aircraft to allow AAO training to take place.

The photo to the left shows the view from the Cessna Caravan of an Air Tractor 802 retardant drop in Alberta. The dark image on the upper left of the photo is the headset of the AAO observing the drop.

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![Figure 9: Cessna Caravan Air Attack Aircraft, under appraisal by the Alberta Department of Environment Protection, Edson Alberta, Canada](image)

![Figure 10: Aerial view of retardant drop – aircraft straight and level, Alberta, Canada](image)
The photo to the left shows the excellent visibility provided from the aircraft in a high degree of bank turn. The photo is taken from a rear seat, however the visibility provided from the front is better, with the wing behind the AAO field of view. Other aircraft commonly used for the air attack role include the Piper Aerostar, Grumman Commander and Beechcraft Baron, shown below. To assist the AAO, these aircraft are fitted with fire agency radios, Satellite navigation (GPS) and intercom.

In all observations of air attack aircraft in both the USA and Canada, the common criteria applied, were to match the aircraft with the air tankers, based on aircraft performance, while ensuring the aircraft was manoeuvrable and provided good crew visibility.

In none of the places visited were helicopters used in the role of Air Attack. Helicopters are identified for other roles, particularly crew transport, water bucketing and reconnaissance. The attitude of all fire managers visited, and contractors providing aircraft, only fixed wing aircraft are suitable for air attack roles.
The type, and brand of retardant used in air attack operations, was possibly the most controversial topic investigated as part of this study tour. Two companies produce fire retardant in North America, being Astaris, manufacturer of the Phos-Chek range of retardants and suppressants, and Fire-Trol, manufacturers of products of the same name. Both companies compete strongly for government contracts to provide retardant to bases in both the USA and Canada. While Astaris is very strong in the USA, Fire-Trol has managed to win some US contracts. At the time of producing this report; only Fire-Trol provides retardant in Canada, although Astaris also compete for contracts in Canada.

Traditional fire retardant, based on many years of research is a gum thickened dry powder product, mixed into a slurry on the airbase, then loaded into the air tanker for delivery to the fire. Many of the larger air tanker bases in the USA still employ this type product quite effectively. Transportation and storage is relatively easy and technology has developed to quickly and easily mix the product. An example of a dry powder, gum thickened retardant is Phos-Chek D75R, which is the same retardant that is available in Australia. Typically, air bases where gum thickened retardant is used, are managed by the USDA Forest Service or agencies employing large aircraft, such as the California Department of Forestry and Fire Protection. Most research carried out by the US Forest Service, as part of the Operational Retardant Evaluation project in the 1980’s, indicates that there are significant benefits in gum-thickened retardants, particularly in how the product retards fire behaviour, how it flies after leaving the aircraft, and how fine fuels are coated on the ground.

All Single Engine Air Tanker (SEAT) operations in the USA and Canada utilise liquid concentrate (LC) fire retardant, although this was not always the case. In the late 1980’s and early 90’s, when SEAT operations were first commencing in Arizona, support was provided to the fire managers working to get the program started by the manufacturers of Phos-Chek. Indeed, at Safford, Arizona, there are still stores of D75R located at the airbase, although the Bureau of Land Management now uses Fire-Trol LC.

While the fire retardant capabilities of Gum thickened and LC products are based on similar chemistry, being the effect on combustion process by ammonium phosphate salts, there are significant other differences, some of which relate to environmental impact. Investigations are currently underway to determine the risk of using LC products that include sodium-fero-cyanide, as a component. Early reports indicate that, under certain conditions, of sunlight and temperature that cyanide may be a bi product of dropping retardant on fires, particularly if some retardant lands in water. This is of obvious concern to fire authorities and environmental agencies.

Currently, only Fire-Trol, based in Kamloops, British Columbia, and Phoenix Arizona, manufactures an LC product. Astaris are researching both a liquid concentrate and fluid concentrate to provide competition, with new products expected in the near future.
There appears to be a conscious decision on behalf of the fire services utilising LC to accept a product, whose mixing and handling is easier, over the benefits of improved fire retardant effectiveness, and possible environmental concerns. Interestingly, while using the same brand of product, there is a variation in the chemical concentration used in the US and Canada, with the Canadian authorities choosing a slightly lower concentration for their situation. No research was identified to explain why this change in concentration has been adopted.

As mentioned later in this report, the party responsible for mixing and loading retardant into the aircraft varies, both throughout the USA and within Canada. For bases run by agencies including the US Forest Service, California Department of Forestry and Forestry Protection and Forestry British Columbia, the contractor supplying retardant is also responsible for supplying equipment and personnel to load and mix retardant. US Bases run by the Bureau of Land Management utilise personnel and mixing/loading equipment, supplied by the aircraft contractor. Airbases managed in Alberta are operated by staff of the Department of Environment Protection, but using retardant company equipment. The result of this is a wide range of equipment that is used to mix and load retardant into aircraft.

The following set of photos shows a range of retardant equipment available in the USA and Canada.

Fig 14: Can Blender – Fire-Trol Retardant Alberta, Canada. This is an Air Tractor 802 base

Fig 15: Air Tractor 802 Aircraft, with bulk retardant storage tanks, Edson Alberta

Fig 16: Bulk liquid concentrate tanks, Kamloops Air Attack Base, British Columbia, Canada

Fig 17: Automated liquid concentrate mixing unit, Kamloops, British Columbia
Whilst most of the equipment seen was on fixed bases, there were also opportunities to observe mobile mixing and loading equipment. Both Astaris and Fire-Trol have a range of mixing and storage equipment and personnel available to fire authorities that can be used to support air attack operations at less established bases. Planning is in place, both in the USA and Canada, to set up such facilities at short notice, although it was identified in South Eastern Arizona, that moving operations from a fixed base to a mobile facility was often more trouble than it was worth. It was considered that the time and effort to move to an airfield, closer to a fire, in areas where water is scarce, particularly in fast moving desert type fire, may take more time, than might be available to suppress the fire.

Some of the mobile retardant technology observed is considered worthwhile investigating further for Australian implementation.
Of particular interest to Australian Fire Authorities could be the concept of the self-contained fire retardant mixing unit, developed by Astaris, in conjunction with the square frame wall portable tanks. Such a unit could be moved to remote air attack bases and be used to mix retardant at relatively short notice.

Figure 30: Fire-Trol Dip tank, Kamloops, British Columbia, Canada
5: Ground Crew training and qualification systems

A range of approaches to the management of ground resources on the airfield has been observed. The variety of methods employed is based, both on history and the nature of the contracts used. It is interesting that within both the USA and Canada, there are varieties to ground crew training and qualifications.

In the United States, agencies such as the US Forest Service and California Department of Forestry and Fire Protection (CDF), employ the contractor supplying retardant chemicals to be responsible for mixing retardant and loading the aircraft. The contractor carries out any training in house, and there is no formal qualification requirement, beyond those set by the contractor. The fire agencies supply trained personnel to manage the air base, responsible for logistics and administrative management, for example ordering fuels and retardant, managing safety and all paperwork. Specific courses for airbase management are available.

Contractors supplying SEAT aircraft to the US Bureau of Land Management (BLM), also provide ground crews to mix and load their aircraft, while the BLM only provide the retardant to the base. The fire retardant contractor is only required to supply their product to the air base. Again, any training required of these ground crews is the responsibility of the contractor. Indeed it was identified at Safford Arizona, that BLM Officers are not required, nor encouraged, to enter the aircraft loading area during operations, leaving everything to the contractor to manage. As with US Forest Service bases, BLM provide trained airbase managers to oversee the operation.

Within the western provinces of Canada, a variety in approaches was observed. In British Columbia, the contractor providing retardant is responsible for the mixing of product and loading of aircraft. However in Alberta, the staff of the Alberta Department of Environment Protection (formerly the Alberta Forest Service) is required to carry out the role. As in the USA, the relevant agency provides airbase management, taking responsibility for logistics, administration and safety issues.

All aircraft are potentially dangerous when sitting on the ground at idle. As all contract aircraft in Canada can be loaded at any base, this issue must be taken into account. When an aircraft arrives at a base for the first time, even in operational conditions, the loader is asked if they are familiar with the aircraft and its loading systems, and have they loaded one before. If they indicate no, then the aircraft is required to shut down, the flight crew then gives the ground crew a full safety and loading briefing, and the aircraft loaded while shut down.

Training for the management of airbases is available within all agencies visited, however, the US Bureau of Land Management were the only service who undertake a training package specifically for SEAT base management. Duration of all airbase management courses is roughly the same, taking approximately one week. Subjects covered include: airbase safety, mixing and loading procedures for different aircraft types, administrative processes, airbase equipment and its maintenance, communications, retardant and suppressant types and their roles. As identified, the BLM course is specifically oriented to the SEAT program, and closely mirrors similar training in Australia.
6: Aircrew training and qualification systems

6.1 Flight Crews (Pilots)

6.1.1 United States

Within the USA, the qualifications required to fly Single Engine Air Tankers (SEATs) is set down in Agency policy. The qualifications and training programs identified below are clearly set out in the ‘Interagency Single Engine Air Tanker Operations Guide 2001/2002’, produced by the US Bureau of Land Management. All pilots flying aircraft involved in fire suppression operations must hold certain qualifications within the aviation industry, but must also be qualified within the fire industry. It is this latter qualification that ensures that SEAT pilots understand fire suppression strategy, and how they fit into fire management organisation.

To meet federal aviation requirements, all SEAT pilots must possess a FAA commercial pilots licence, with an instrument rating, appropriate medical certificate, and be endorsed on the aircraft being flown. It is also expected that SEAT pilots will have flown at least 100 hours, with a minimum 5 takeoffs and landing in the SEAT type, during the previous 12 months.

To meet fire industry requirements, pilots must complete the following training related to fire operations:

- Fire behaviour
- Air and ground tactical operations
- Incident management and organisation, including terminology
- Fire perimeter design
- Radio communications and procedures
- Use of retardants and suppressants
- Other policies and procedures

Further, fire industry identifies two levels of SEAT pilot qualification, based on experience.

Level 1 rated pilots are those who are qualified to fly SEAT operations in any situation. These are experienced fire pilots, who generally will have flown a minimum of 25 drops of retardant or suppressant on fires, under air attack supervision, on an incident where there have been more than 3 other aircraft. Other ways to attain this qualification include significant levels of experience in commercial aviation, or, to have been co-pilot flying larger air tankers in fire operations.

Level 2 rated pilots are required to have the basic aviation industry qualifications, but also have completed the fire industry training program.

Under certain situations in South Eastern Arizona, it was reported that it is not unusual for Level 1 SEAT pilots to be dispatched without an air attack officer (AAO) to provide supervision, to undertake initial attack of fires. This is aimed at reducing response times to the fire. Confidence exists into the experience and understanding of
these pilots into initial attack operations. Level 2 pilots may be dispatched to a fire without AAO supervision; however, this will only be if accompanied by a Level 1 rated pilot.

It is the responsibility of the contractor to ensure that their flight crews are suitably qualified. As mentioned in other areas of this report, all aspects of contract management are carried out by the US Department of the Interior, Office of Aircraft Services, located at Boise. Officers from this department carry out audits of flight crew qualifications using standard format documentation. This department is also responsible for recertification of flight crews each year.

6.1.2 Canada

In Canada, Transport Canada, the equivalent of the Civil Aviation Safety Authority is responsible for issuing qualifications for fire related positions. Organisations such as Conair are authorised by Transport Canada to conduct training courses and certify flight crews. Auditing of this process is carried out by transport Canada officers conducting check rides, to confirm compliance with standards.

6.2 Flight crew (Air Attack Officers).

6.2.1 Canada

The most comprehensive training and assessment process for air attack officers (AAO) is that conducted in Canada. Efforts are being made to conduct AAO training, coordinated by the Canadian Interagency Fire Centre in Ontario. This is done to ensure that all AAO working in Canada are consistent in their approach. This consistency in turn leads to increased safety, with less chance for confusion from unusual radio calls and increased effectiveness, due to less lost time while people try and work out what is being said over the radio.

AAO training involves three phases, each building on the experience of the previous. Level 1 training is the most basic, where the principles of air attack, retardant and suppressant types, aircraft types and administration are covered. There is also an opportunity for course participants to experience the role of the air tanker pilot, and carry out the role of AAO in simulated initial attack flight scenarios. Assessment at this level is by written exam, with a minimum 75% pass requirement to proceed to level 2 training. Level 2 and level 3 involve more competency-based training, with trainees becoming more familiar with the cockpit environment, and the tasks carried out by the AAO. As trainees progress into level 3, they transition from observing air attack operations from the back seat, to running operations from the front seat, with progressively less supervision. Trainees are also introduced to more advanced training courses, including Crew Resource Management (CRM) as part of this process.

Final assessment is by a senior check instructor riding back seat with the trainee, whilst coordinating firebombing operations over a real fire.
The time required to progress through level 2 and 3 training is dependent on the number of fires that a trainee can experience. In a quiet fire season, it may not be possible for a trainee to carry out all the necessary requirements to complete the assessment, causing the process to extend beyond one year. Conversely, in a busy fire season, it may be possible for a trainee to complete all assessment within 2 months of starting level 1 training.

Whilst there is no specific AAO training in Canada for single engine air tanker operations, aspects of utilising these aircraft are covered as part of Level 1 training, and trainees are introduced to the Air Tractor 802, as a part of aircraft familiarisation during the level 1 course (picture left).

![Air Attack students conducting familiarisation of Air Tractor 802, Kamloops, British Columbia, Canada](image)

In Alberta, there is some use made of laser videodisc simulation in AAO refresher programs. This simulation enables the participants to practice the tasks carried out as part of the AAO role, based on visual and audio stimuli. Scenarios are developed to analyse a fire on arrival, and develop a suppression strategy. Role-playing is carried out to provide extra reality to the scenario. Simulation training is an effective means to practice and refine skills, without the costs associated with operating aircraft, and is an ideal way to demonstrate safety issues in a controlled environment.

The laserdisc technology is now being replaced by Digital Video Disc (DVD), which, at the time of preparing this report, had not been installed.

### 6.2.2 United States

AAO training is carried out by all agencies employing aircraft for firebombing operations. Significant differences exist between the format of air attack in Canada and much of the USA. These differences are explained in the following section. The differences in strategies and tactics appear in the training presentations and the student involvement in training exercises.

Whilst there is a mentoring approach to AAO training in the USA, there did not appear to be the distinct pathway to achieve final competence that was identified in Canada.

The recently introduced program with the Aviation Support Module (ASM) more closely follows the Canadian approach, and includes CRM components in its training for both flight crews and ASM Officers.
Air Attack Strategy and Tactics

Within the USA, there is a range of approaches used for the aerial coordination of fire bombing operations. These tactics are somewhat agency specific, and are based on history. Essentially, there are three methods used in the USA, described as:

A: *Air Attack Supervisor* (AAS). This position is a trained fire fighter, who coordinates the fire bombing operation, generally from a position of 2000 feet above the fire. At this altitude, a good overview of the operation is given, and the air attack aircraft is above the air tankers and helicopters. Incoming air tankers are set up in a racetrack or salad bowl pattern outside the fire area and called in one at a time by the AAS. This approach is common in California, and is essentially the same as the method used in much of Australia.

B: *Lead Plane*. This position employs a single person aircraft that flies at the same speed and altitude as the air tankers, leading each tanker in to the drop area. The major advantage of this approach is that the heavy air tanker only has to follow the lead plane, so the potential for confusion from the direction calls of the AAS is largely removed, and the lead plane, being lighter and more manoeuvrable, can determine if the approach and departure paths are safe for the larger aircraft. It is not uncommon for a combination of AAS and Lead plane to be employed, particularly on larger incidents, where there are numerous aircraft employed.

C: *Aviation Support Module* (ASM). ASM is a relatively new concept within the USA and is roughly speaking, a combination of Lead plane and AAS tactics. The basic principle involves a two person aircraft operating at lower altitude than normal for the AAS, and has the benefit of a team operating in the lead aircraft. Much of the concept appears to mirror the Birddog approach employed in Canada, and indeed officers of the Bureau of Land Management (BLM) confirmed that they closely reviewed the practices employed in British Columbia when setting up the ASM program. While this is now a nationally approved program, ASM is slow to gain acceptance with all agencies. US Forest Service are considering how it will implement the ASM strategy, and are considering a minimum ceiling of 500 feet above ground, i.e. the ASM machine will not be permitted to come lower than 500' above the fire. Other agencies, such as the BLM have accepted ASM more quickly, and have developed training courses for both ASM pilots and ASM crew.

In Canada, the approaches to air attack coordination are far more standardised, with similar tactics applied across the provinces. Opportunities were taken as part of this study tour to undertake training in air attack in Canada and also to observe air attack operations against fires, utilising SEAT aircraft in Alberta. The approaches used in Canada stood out as being very safe, with the more manoeuvrable air attack aircraft responsible for checking all drop runs for hazards. The operations also stood out for effectiveness and efficiency as a result of all aircrews understanding the common terms used and the tactics employed. It was apparent that time was saved in the way drop runs were shown to air tanker pilots, with the Air Attack Aircraft demonstrating the drop by a dummy run, rather than the run being described by an AAO from above the fire. Operational effectiveness was also identified during fire operations when only 2 drops out of 27 observed were not fully in the area requested by the AAO.
It is worthwhile to briefly describe the air attack operation, as it develops in Canada.

The Air Attack Aircraft will generally be the first aircraft to arrive on scene. The aircraft will generally overfly the fire at approximately 1500 – 2000 feet above ground. The AAO and pilot identify the shape and alignment of the fire, and discuss the tactics that the AAO wishes to employ to contain the fire. The AAO also contacts any ground resources to ascertain how the plan is being developed. Once happy with the overview of the fire, the crew then start to look for hazards and commence to reduce altitude.

Once at the height that the air tankers will drop the retardant loads, the crew note their altitude (called the target elevation). This reference will be given to the incoming air tanker pilots to enable them to set up for the bombing run and will be used by the AAO to assign holding altitudes to the incoming air tankers for safe staging points, while waiting to be called in for their bombing runs. The Air Attack Aircraft carries out the range of drop runs that have been discussed by the AAO and the air attack pilot. This is to identify any key landmarks that can be used to assist the air tanker pilots, but importantly identify any hazards, such as powerlines and dominant trees that could pose safety risks.

As the air tankers arrive, they are assigned a position in the order for completing their retardant drops, and an elevation to remain at until called down. This is referred to as the stack, and it ensures that the air tankers are vertically separated by 500 feet. The stack is established above the fire, giving most of the air tankers the opportunity to look down and watch the dummy runs of the Air Attack Aircraft and the progress of retardant drop by the aircraft in front. Where needed, the Air Attack Aircraft will repeat the dummy runs for air tankers arriving later, or as the tactics and direction of drops change. As the air tankers commence their drops, the Air Attack Pilot will position the aircraft to provide the AAO with the best view of all retardant drops. This may be from behind, beside, or above the air tanker and it may be travelling the same way or on the opposite heading. That decision is based on each individual situation.

Depending on the workload, and the level of teamwork, either the AAO or the Air Attack Pilot will carry out the radio work. It may be that the AAO is liaising with the ground crews, while simultaneously; the AAP is coordinating the retardant drops. This alone shows the benefit of having fire qualified pilots operating air attack aircraft. Personal experience and observation show this role to be a very high workload, where the level of teamwork is high. To clearly show the drop run set up, each aircraft flies a circuit, with the distinct downwind, base, and final legs leading up to the target drop point. Where necessary, landmarks are identified to show where to make the necessary turns to set up for the bombing run on the right alignment.

The overall assessment of the practices employed in Canada, were that safety and efficiency were maximised in what is an inherently dangerous environment.

Fig 32. Circuit pattern for fire bombing, Canada
8: Protective equipment (PPE)

8.1 Flight Crews

In general, personnel expected to fly in tactical aircraft are provided with similar personal protective equipment to that issued by some agencies in Australia. In some agencies visited, crews were not required to wear nomex flight suits if their operations were above 500 feet above ground (500’ AGL). However, all agencies where operations take place below 500’ AGL were consistent in the requirement for wearing nomex flight suits and leather boots. Air Attack Officers and agency pilots operating below 500’ AGL are all supplied with all required PPE.

Requirements placed on aircraft contractors varied throughout the study tour. Certain contractors, for example Conair Aviation, included components on PPE in their crew training programs. All flight crews were supplied with nomex flight suits, and there is an expectation that they will be worn. Other contractors do not have PPE requirements of their crews. In several instances, it was made apparent that there were contracts in place in Canada, which placed a requirement on aircraft contractors to supply flight crews with PPE, and insist that it be worn. This was not consistent across either Canada or the USA, where it was generally considered to be the responsibility of the contractor to ensure flight crew safety standards.

Although not a requirement of flight crews operating larger air tankers, it was common to observe pilots wearing flight helmets in SEAT aircraft. This is in line with most agricultural operations in the USA and Canada, where helmets are common PPE.

Figure 33: Protective equipment being worn by aircraft loader and air tanker pilot, Edson, Alberta, Canada
8.2 Ground Crews

Hazards to ground crews on an airbase are numerous. Safety hazards to ground crews include: potential damage to eyes from objects blown by propeller wash; chemical splash during mixing and loading operations; working in close proximity to loud engines, particularly turbines affecting hearing; falling objects; and the possibility of head injury from walking into objects around aircraft, and potential retardant and foam spills.

There is a general consistency in the type of ground crew protective equipment observed. All ground crews observed were supplied protective coveralls, goggles, hearing protection, hardhat, rubber gloves and boots. Efforts have been made in certain areas to clearly identify the airbase ground crew from other personnel. For example, crews in British Columbia, employed by Fire-Trol wear bright blue overalls.

![Fig 34: Protective equipment worn when washing aircraft](image1)

![Fig 35: Protective overalls used by airbase personnel in British Columbia, Canada](image2)

![Fig 36 (left): Airbase personal protective equipment used in Alberta, Canada.](image3)

![Fig 37 (above): Airbase personnel, preparing to load air tanker, British Columbia, Canada.](image4)
9: Operational Effectiveness Evaluation

As with other efforts to suppress fires, air attack operations are at their most effective when they are employed against fires that are small. Under such conditions, retardant and suppressant have higher probability of working. Aircraft are also able to operate closer to the fire front safely, again improving the likelihood of success. It becomes important for ongoing operational effectiveness evaluation, as fires increase in size and behaviour. It is important to note that aircraft employed for air attack roles in both the USA and Canada are employed on contract for immediate availability to carry out the role of initial attack. That is, being responded to a fire, when it is first reported, and the fire is still small. Often, they are the first resource on scene. There were many anecdotes provided of fires, which had been surrounded by retardant from the air, which on arrival of ground crews, were declared out.

In both the USA and Canada, operational effectiveness evaluation is the responsibility of the air attack officer (AAO). Through training and experience, they are able to evaluate the effectiveness of retardant and suppressants in reducing fire behaviour. The best vantage point to assess effectiveness is from the air; however, Air Attack Officers will regularly liaise with ground crews to seek their viewpoint on the effectiveness of drops.

The AAO will assess the accuracy and effectiveness of each drop, reporting these assessments to the air tanker pilot, but also recording the accuracy of each drop to be discussed in a post incident debrief, and report on pilot effectiveness, as part of pilot evaluation.

Under certain conditions, where fire behaviour has developed under very hot, dry, windy conditions, fire retardant may not contain a fire. Under these conditions, it may be necessary to modify tactics, or to withdraw aircraft due to limited effect. It is also likely that under these conditions, where winds are very strong and the atmosphere is extremely unstable, that there is increased risk of damage to aircraft or injury to the aircrews. US Bureau of Land Management (BLM) officers indicate that it is more likely that aircraft operations will cease due to safety considerations than retardant effectiveness. This is particularly so in typical BLM country, where vegetation and fuels are typically light shrub types and fires are wind driven.

Other methods of evaluating effectiveness of operations are carried out by air base ground crews. Overall effectiveness of their role may be measured by the total number of gallons of retardant applied to a fire per hour, measuring both the speed of the aircraft, its carrying capacity, but also the skill of ground crews in loading the aircraft.

Overall operational effectiveness in Canada is measured by the 10 am concept, that being that 95% of fires will be contained by 10am on the following morning after detection. Further, air attack operations are assessed by the one strike concept, being to contain all fires with one round of aircraft. To achieve this, adequate numbers of aircraft are dispatched in the first dispatch to the fire. Where a fire has exceeded the 10am or one strike concept, reviews are carried out, and if necessary, policy changed, or further training carried out.
.10: Interagency coordination

Interagency coordination is essentially only an issue in the USA. In the Canadian Provinces, the Forest Services (or land management agencies) are the sole agency responsible for aviation management over wildfires. In the US, both federal and state agencies may operate aircraft in support of fire suppression operations. As identified in other sections of this report, history and government policy has meant that different agencies have developed different strategies and tactics for aircraft management. There also exist different philosophies regarding what is a suitable aircraft type. For example, all air tankers employed by the US Forest Service are large, multi engine aircraft, capable of carrying large volumes of retardant. Whilst employing smaller aircraft, agencies such as the California Department of Forestry and Fire Protection still insist on a multi engine fleet. It is only the US Department of the Interior, Bureau of Land Management (BLM) and Bureau of Indian Affairs that utilise SEAT aircraft.

While there appears to be a slow increase in the acceptance of SEAT operations, BLM officers provided anecdotal evidence that there has been previous reluctance on behalf of other agencies to even reload SEAT’s with retardant.

Fig 38: Interagency SEAT Guide used in USA

To assist fire managers to understand the issues relating to managing smaller aircraft, an Operations Guide (cover shown at left) has been developed. Supplementing this document is an administrative package, including copies of all necessary paperwork to manage a SEAT operation.

The SEAT Operations Guide is a nationally endorsed document. In summary it outlines the range of issues that must be addressed, including:

- Training standards for pilots and SEAT Base Managers
- Administrative processes (paperwork)
- Pre planning
- Operations management
- Aircraft capabilities

The SEAT Operations Guide is reviewed annually by a panel of operational personnel from around the country. This maintains the document with current field practices. It is expected that, given increased number of SEAT aircraft employed each year, that there will continue to be increased acceptance of their role in fire suppression operations, particularly as more of the older aircraft start to retire from service.
11: Administrative Processes (paperwork)

Administrative processes are developed for a range of reasons. For air attack operations, these include: record keeping to facilitate contractor payments, resource tracking, product consumption (for example, fuel and retardant), and statistical analysis, and records kept for any future enquiries or explanation.

All agencies have their own forms to assist with administrative management, and whilst some of these forms have agency specific detail, there is a common thread throughout, that being the maintenance of good records for payment of contractors and reporting. In both air attack officer and air base management training in the USA and Canada, the different forms, their importance, and how to fill them in is covered. While there are some agency specific changes to the paperwork, generally speaking documentation of this type is similar throughout the world.

Paperwork is the responsibility of all to complete. Air Attack Officers keep records of the flight times of their own aircraft. They also complete forms which identify the fire, the air tankers involved, and the accuracy of each drop. Personnel on the airbase also manage flight time paperwork for the air tankers, and documentation relating to aircraft maintenance, pilot hours, and consumables.
12: Aircraft Modification and Other Specialised Equipment Observed

12.1 Tank and Drop Door Design

A range of drop door systems and tanks is available for fire bombing aircraft. Traditional aircraft, including most of the older machines are fitted with compartmentalised tanks. These systems rely on a network of doors, releasing individual compartments from within the tank. The quantity of chemical departing the aircraft is a function of the sequencing of doors. For example, if higher concentrations of retardant are required on the ground, more doors are opened simultaneously, to increase the volume, but shortening the length of area covered. Conversely, if less retardant is required, but a longer line is the objective, then fewer doors may be opened, or increased time separation between each door opening used, to string the load out.

More recent innovations have been the constant flow door systems. These tanks are fitted with a computer controlled, single compartment tank, with computer controlled doors that work to ensure that the coverage of retardant on the ground is very constant. The opening of the door is varied by the computer during the drop, to ensure that the flow rate of retardant is constant and to the specifications requested. Research carried out by the US Forest Service indicates that changing the concentration of retardant on the ground will result in a range of retardant effectiveness. As a result, a range of coverage levels was identified, for different fuel types and fire behaviour. Coverage levels refer to the number of US Gallons of retardant per 100 square feet on the ground, so a coverage level 5 refers to 5 US gallons of product in a 10’x10’ area. With computerised, constant flow systems, it is possible to identify the coverage level requested, and allow the computer to achieve that result, by widening or restricting the opening as the retardant flows out. In compartmentalised tanks, achieving a selected coverage level is based on the number of doors opened and the timing between door openings.

Within the ranks of the SEAT aircraft observed and discussed, a range of tank and door systems is employed. This reflects the research and development carried out by individual aircraft owners trying to make their aircraft more effective fire suppression tools. Current technology available in SEAT aircraft is the same as for the new generation large air tanker fleet. Air Tractor currently offers their 802 model with a constant flow, computer controlled drop door system (picture left). This system accurately delivers retardant to the ground in coverage levels selected, and allows the pilot to select how much of the load is to be dropped in one pass, greatly enhancing the aircraft’s flexibility and effectiveness. All known 802’s being deployed in Canada are fitted with

Figure 41: Computer controlled drop doors – AT 802 F
constant flow system, although of the 21 SEAT aircraft contracted in the USA, only two are fitted with the latest door technology. Other door systems used, such as the Transland and 60:40 gates, must comply with agency criteria, including the ability to split loads between two or more drops.

Conair Aviation, based in Abbotsford, British Columbia, and potentially the largest aircraft contractor in North America have further modified the Air Tractor 802. They have fitted a recirculation system to the aircraft to maintain the retardant load agitated during flight. One downside of Fire-Trol liquid concentrate retardant is the characteristic for the solution to change after blending. In particular, the red dye used to assist in aerial detection tends to settle out of solution, so that some of the load will be clear, and some extremely bright red. To reduce this tendency, Conair’s 802’s recirculate the load to maintain the mixture rates. Of the eight or so loads of retardant observed being dropped by Conair 802’s in Alberta, there was no apparent change in colour of the retardant as it left the aircraft.

Siren

As part of safety procedures, particularly in Canada, air attack aircraft are fitted with sirens. Two tones are used to warn crews on the ground that either an air tanker is inbound, warning the crew to clear the area or that bombing operations have finished and it is safe to enter the area.

Figures 44 and 45: Siren unit in Piper Aerostar
In the Piper Aerostar, the most common air attack aircraft employed by Conair in Canada, sirens are fitted to both the tail and nose of the aircraft (two photos previous page), ensuring that good coverage of sound to the ground is achieved. Ground crews are trained to understand the meaning of the two siren types, so that, even if there has been a break down with radio communications, they can move to safety. The siren is used during the AAO completing a dummy run (photo above), to show the bombing run to the air tankers, so ground crews will know from which way the tankers are approaching and can move away.

**FLIR (Forward Looking Infrared)**

In Alberta, air attack aircraft are further modified to include FLIR sensors. Infrared cameras, generally fitted to the nose of the aircraft enable the Air Attack Officer to detect heat, even though visibility is reduced by smoke. FLIR is used to aid the AAO to detect areas of greater heat on the ground, where the fire may building up, requiring priority consideration for retardant drops, and is also used to detect aircraft and ground crews in the smoke.

**Loading Points**

Tanker refill points are set up to allow the loader to maintain awareness of the amount of load delivered to the aircraft. Air Tractor 802’s employed in Canada have refill points behind the wing, with retardant and foam loading connections together, but different diameters, to reduce confusion. Also located beside the refill point is the tank gauge, shown below. This enables the loader to know how full the tank is during the loading process. All air tankers are fitted with the same diameter camlok fitting, so that any air tanker can arrive at any base and be refilled.
Hose Trolleys

The reloading process of air tankers is a heavy business. Retardant, by nature of the components of the slurry mixture is quite dense. Further, there is a desire to load aircraft as quickly as possible, so hoses of larger diameter (at least 3 inch) are employed, to reduce the time required to pump large volumes of retardant. The result is that the delivery hoses to the aircraft are very heavy. Coupled with these two points is the issue that most air attack bases in the USA and Canada are sealed, and the constant dragging of hoses across bitumen will quickly wear hoses out. To combat these problems, hose trolleys have been developed. These trolleys keep the hose off the ground, to minimise friction wear, and the uni directional wheels allow the loader to more easily drag the hose from the storage point to the aircraft for loading.

Figures 49 and 50: Delivery Hose trolley – Edson, Alberta Canada

2: Other specialist Equipment

Digital Camera

Use of Digital Camera technology is increasing in air attack operations. Without significantly increasing the workload in the cockpit of the air attack aircraft, AAO’s are now commonly taking photos of fire behaviour on arrival, and during the fire bombing operation. These photos can then be emailed to the relevant sections from the air attack base for review.

Sun glasses.

British Columbia Ministry of Forestry Officers are issued with a pair of sunglasses upon successful completion of air attack officer training. It has been identified that the red tinted lenses in Serengeti Sunglasses assist in observing retardant that has been dropped in dense coniferous forest canopies, common in much of Canada. This was the only observation of specialist equipment issued to Air Attack Officers.
Conclusions

The objective of this study tour was to visit and observe a wide range of components that make up the single engine air tanker (SEAT) industry in North America. In achieving this, a large group of people, agencies and organisations have been visited. Some of the highlights include taking the opportunity to meet some of the people who first introduced the SEAT program into the USA and Canada. Further, the chance to meet with representatives from government agencies employing SEAT aircraft at the local, provincial and national level was invaluable. The investigation was enhanced by having the opportunities to meet with industry representatives, responsible for providing contract aircraft to the government and manufacturers of retardant and suppressants and other specialised equipment. Participation in air attack training and the chance to observe, first hand, fire suppression operations, involving SEAT aircraft, brought the whole package together.

Overall, it is apparent that the SEAT program, both within the USA and in Canada is on the rise. Each year in recent times, more SEAT aircraft have been engaged on contract. There is increasing recognition by fire authorities, that there is a role for SEAT aircraft in fire management, particularly in initial attack operations. The aviation industry in North America is sufficiently large to allow the use of a wide range of aircraft for fire management. There are roles for large and small aircraft, and other specialised machines, such as the range of water scoopers. This flexibility allows the fire manager to select the most appropriate tool for the job.

As identified in the introduction of this report, the use of fixed wing aircraft in Australia has revolved around the use of SEAT aircraft, mainly as a result of their availability. As a result, many Australian practices are comparable with those overseas. Some recommendations have been made as a result of this investigation, which would enhance both safety and effectiveness of air attack operations. These recommendations relate to practices and procedures, training and equipment.

To promulgate the lessons learnt from this study tour, it is proposed to distribute this report to fire agencies throughout Australia, via the Australasian Fire Authorities Council. Presentations are also scheduled to be made to air attack specialists in NSW via a multi agency workshop late in 2001.


**Recommendations**

1: **Contract Duration.** Significant advantage was identified in long duration contracts for aircraft operators. In both British Columbia and Alberta, the current series of aircraft contracts are for 10 years. This allows a reduction in the hourly costs associated with operating SEAT aircraft, but also provides the contractor with financial security to purchase better equipment, or carry out development programs, which may make operations more effective.

It is recommended that Australian Fire Authorities review and consider extending the length of contracts related to aircraft, with the view of extending to 10 years.

2: **Flight Crew (Pilot) Qualifications.** In all agencies visited as part of this study tour, pilots involved in any aspect of fire operations must be suitably qualified. This involves not only aviation industry, but also fire specific qualifications. This is currently not the case in Australia. Significant safety and operational effectiveness increases are likely from such training, should it be implemented here.

It is recommended that a national fire industry pilot qualification be introduced in Australia. This should be undertaken to have consistent fire industry standards applied in Australia for all pilots employed for fire operations. Such training to include as the minimum:

- Basic fire behaviour
- Fire suppression strategies and tactics
- Roles of aircraft in fire management
- Radio communications procedures
- Use of retardant and suppressants
- Fire agency policies
- The incident command system
- Crew resource management (CRM)

Further, fire agencies in Australia should be encouraged to only engage pilots who are suitably qualified for work in fire management operations. For pilots seeking to be involved in Air Attack Operations, as an Air Attack or Fire Bomber pilot, more specific training related to that role should be carried out. For example, pilots should be expected to participate in Air Attack training programs as part of their professional development.

3: **Consideration of changes to Air Attack practices.** The safety and effectiveness identified within the practices employed by the Canadian land management agencies is very impressive and considered valid for Australian conditions. The recommendations for consideration in this section are numerous, including:

- Using air attack aircraft whose performance is suited to the fire bombing aircraft. This may mean only using fixed wing aircraft for the role of air attack
- Using Air Attack Pilots who are fire industry qualified, with low level endorsement, to enable the Air Attack Aircraft to be used to assess the drop area for hazards, be used for dummy runs, or lead in as appropriate in each
situation. This reduces the need for the fire bombing aircraft, which are far heavier and less manoeuvrable to conduct the hazard assessment.

- Having the Air Attack Aircraft conduct the dummy run for the fire bomber aircraft. This tactic clearly shows the fire bombing pilot the desired orientation for the bombing run, and reduces the chance of inaccurate drops.
- Using the Air Attack Pilot to coordinate fire bombing aircraft to ease AAO workload.
- Introduce a vertical stacking system, over the fire, with 500 feet vertical separation, above the drop zone, to enable air tanker pilots to look down on the drop area.
- Train AAO to be able to lead in air tankers should the situation warrant
- Train all aircrews to make use of formal circuit procedures, with known entry and exit points, and altitudes.

Consideration and endorsement of these points should be done at a national workshop to ensure uniform standards are employed in Australia.

4: Personal Protective Equipment.

Flight Crews: All flight crews expected to operate in the role of Air Attack or personnel working in aircraft below 500 feet AGL should be supplied and expected to wear flight suits, with appropriate standard thermal protection. Industry standard in the USA / Canada currently is summer weight Nomex 3 light suits. Footwear should be leather boots. Crews operating consistently above 500 feet should be provided with suitable light weight cotton based clothing.

Ground Crews: All ground crew should be issued with the minimum personal protective equipment that includes

- Goggles
- Rubber gloves
- Helmet with hearing protection
- Rubber boots and overalls.

To identify ground crew on an air base, it is recommended that ground crews, trained and working specifically on an airbase be provided with distinctive colour overalls. Colour will identify their role and will remove the need to have safety vests, which may provide their own hazards.

Aircraft contractors. Aircraft contracts should be written to include provision for personal protective equipment to be issued and worn by flight crews. Contractors supplying aircraft should supply and insist on suitable Personal Protective Equipment being worn. This standard should be the same as fire industry personnel, dependant on the role of the aircraft and the altitude of operation above ground. Fire bombing pilots should further include the provision of gloves where necessary, and flight helmets.

5: Airframe modification. Australia appears to be at the same point of development, or indeed, in front of other countries with regard to modification of fire bomber airframes for the purpose of dropping retardant. It is recommended that all fire
agencies in Australia continue to employ only those aircraft equipped with fire
bombing door systems, suitable communications equipment and global positioning
system (GPS).

It is recommended that a nation wide approach to aircraft tracking be implemented.
This will enable real time tracking of aircraft both within and across state borders, and
greatly enhance safety of aircraft operations. It is known that resource tracking is
employed in Victoria already. Consideration should be given to expanding this
program to other states.

Aircraft employed for the role of Air Attack should be modified to better undertake
this task. To achieve this may require aircraft to be employed on contract specifically
for the role of air attack. It is recommended that the aircraft used in the air attack role
be fitted with warning sirens, to be heard from the ground notifying ground crews of
incoming retardant drops. This approach provides more warning, enhancing fire
fighter safety, than fitting a siren to the fire bomber. Air Attack Aircraft should also
be hard wired with fire agency radio, therefore available to either the pilot or AAO to
use via the audio panel.

All aircraft involved in the fire bombing operation should be fitted with Global
Positioning System (GPS) to aid with navigation directly to the area of operation. To
minimise confusion, use of latitude / longitude coordinates should be encouraged for
all air operations, as this is the standard for the aviation industry.

6: Air Attack Officer Qualifications. The approach employed in Canada, whereby a
trainee Air Attack Officer undergoes three phases of training closely meets the
requirements of competency based training and assessment, employed in Australia.
The use of mentoring, rather than qualifications on completion of the course, and on
the job assessment should be closely reviewed and considered for implementation in
Australia.

It is recommended that new Air Attack Officer trainees be taken through three phases
of training and assessment. Phase one to be an introduction to the basic concepts of air
attack. Phase 2 to start to build on the trainees skills in observing fire operations, and
participation in scenario training. Phase 3 to introduce the trainee to fire operations
under gradually reducing supervision.

It is recommended that air attack officers be required to be assessed on a regular basis
by suitably qualified assessor. Regular basis could be every two years, depending on
flight experience of the AAO.
### Appendix 1: Itinerary – Churchill Fellowship Study Tour

**13 April – 3 June 2001**

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<tr>
<th>DATE</th>
<th>PLACE</th>
<th>PROGRAM</th>
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<td>14 April</td>
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<tr>
<td>15 April</td>
<td>Van Nuys Airport</td>
<td>LA City Fire Department</td>
<td>Air Attack Operations</td>
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<td>16 April</td>
<td>Van Nuys Airport</td>
<td>LA City Fire Department Air Wing</td>
<td>Flight Ops meeting – flight over LA City interface areas</td>
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<td>LA County Fire Department Air Wing</td>
<td>Flight Ops meeting</td>
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<td>ROBWEN Industries</td>
<td>Fire fighting foam technology, foam induction and pumping equipment</td>
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<td>17 April</td>
<td>ASTARIS</td>
<td>Phos-Chek plant</td>
<td>Visit Phos-Chek Plant – how retardant and foam is manufactured. – Quality control, marketing, mobile retardant delivery and mobile mixing systems for fixed wing air attack operations</td>
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<tr>
<td>18 April</td>
<td>Lancaster California</td>
<td>Fox Air Tanker base</td>
<td>Air attack technology – large air base equipment, airbase design</td>
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<tr>
<td>19 April</td>
<td>Riverside / San Bernardino</td>
<td>Fire Research Laboratory</td>
<td>Fire related research programs</td>
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<td>South Zone Coordination Centre</td>
<td>Interagency aircraft dispatch for southern California Use of ICS software Meteorology brief</td>
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<td>San Bernardino National Forest communications workshop</td>
<td>Aircraft tracking systems Communications support for aviation operations</td>
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<td>San Bernardino Air Tanker Base</td>
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<td>Date</td>
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<td>Location 2</td>
<td>Description</td>
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<tr>
<td>20 April</td>
<td>Ontario</td>
<td>South Zone Fire Cache (warehouse)</td>
<td>Fire support aviation equipment stores</td>
</tr>
<tr>
<td>21 April</td>
<td>Ontario - Phoenix</td>
<td>Travel</td>
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<tr>
<td>22 April</td>
<td>Phoenix - Safford</td>
<td>Travel</td>
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<tr>
<td>23 April</td>
<td>Safford</td>
<td>Bureau of Land Management – Safford District Office</td>
<td>Single engine air tanker operations and air base</td>
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<tr>
<td>24 April</td>
<td>White River</td>
<td>Bureau of Indian Affairs – Fire Management Office – Fort Apache Indian Reservation</td>
<td>Single engine air tanker operations and air base</td>
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<tr>
<td>25 April</td>
<td>Return to Phoenix</td>
<td>Travel via site of Dude Fire (1990)</td>
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<td>26 April</td>
<td>Phoenix</td>
<td>Bureau of Land Management – Phoenix District Office / Arizona Department of Lands Regional Office</td>
<td>Single engine air tanker operations, including history, lessons learnt, contracts, training, and effectiveness.</td>
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<tr>
<td>27 April</td>
<td>Rest day - Phoenix</td>
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<tr>
<td>28 April</td>
<td>Phoenix – Salt Lake City</td>
<td>Travel</td>
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<tr>
<td>29 April</td>
<td>Salt Lake City – Vancouver - Kamloops</td>
<td>Travel to Air Attack Course</td>
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<tr>
<td>30 April</td>
<td>Kamloops</td>
<td>Forestry BC</td>
<td>AAO Course</td>
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<td>Fire-Trol</td>
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<td>Aerial fire suppression trade show and static display</td>
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<td>2 May</td>
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<td>4 May</td>
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<td>Forestry BC</td>
<td>AAO Course</td>
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<tr>
<td>5 May</td>
<td>Vancouver – Salt Lake City - Dallas</td>
<td>Travel</td>
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<td>6 May</td>
<td>Dallas</td>
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<td>7 May</td>
<td>Olney Texas</td>
<td>Air Tractor plant</td>
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<td>8 May</td>
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<td>9 May</td>
<td>Dallas – Salt Lake City</td>
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<td>Salt Lake City - USDA Forest</td>
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<td>Service</td>
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<td>10 May</td>
<td>Boise</td>
<td>US Bureau of Land Management</td>
<td>SEAT contracts, ground equipment and crew training</td>
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<td>11 May</td>
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<td>US BLM</td>
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<td>12 May</td>
<td>Boise - Vancouver</td>
<td>Travel</td>
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<td>13 May</td>
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<td>14 May</td>
<td>Delta</td>
<td>SEI Industries</td>
<td>Specialist support equipment eg portable water and fuel carrying systems</td>
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<td>15 May</td>
<td>Abbotsford</td>
<td>Conair Aviation</td>
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<td>Forest Industry Flying Tankers</td>
<td>Martin Mars Air Tanker Program</td>
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<td>17 May</td>
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<td>Forest Technology Systems</td>
<td>Remote weather sensing</td>
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<td>18 May</td>
<td>Victoria</td>
<td>British Columbia Ministry of Forests</td>
<td>Provincial level fire and aviation management programs</td>
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<td>Travel</td>
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<td>Edmonton</td>
<td>Alberta Department of Environment Protection – Provincial Fire Centre</td>
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<td>22 May</td>
<td>Edson</td>
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<td>Single Engine Air Tanker Operations AT 802 group operations</td>
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<td>Hinton</td>
<td>Environment Training Centre</td>
<td>Aviation training specific to fixed wing fire bombing</td>
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<td>Hinton</td>
<td>Environment training Centre</td>
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<td>Edson</td>
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<td>Edson Air Attack Base / Travel</td>
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<td>Kamloops, British Columbia</td>
<td>Provincial Air Tanker Centre</td>
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<td>29 May</td>
<td>Salmon Arm, BC</td>
<td>Rapp attack Base</td>
<td>Specialist training and equipment</td>
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<td>30 May</td>
<td>Abbotsford</td>
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<td>Pumps and support equipment supplier</td>
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<td>Retardant sales in Canada</td>
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<td>31 May</td>
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<td>Travel – preparation for return</td>
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<tr>
<td>1 June</td>
<td>Depart Vancouver</td>
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<tr>
<td>3 June</td>
<td>Arrive Sydney</td>
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