Department of
Sustainability and
Environment

Fire Boss amphibious single engine air tanker:

Final Report, November 2008

Fire and adaptive management

report no. 81

A Victorian Government initiative

Victoria
The Place To Be

This investigation was commissioned by the Department of Sustainability and Environment and the Country Fire Authority Victoria. It was undertaken by the State Aircraft Unit Victoria.

State Aircraft Unit, Victoria.

The State Aircraft Unit (SAU) was established as an initiative of the Country Fire Authority (CFA) and the Department of Sustainability and Environment (DSE). The aim of the SAU is to provide specialist aviation resources to satisfy fire and land management objectives in the state, to raise the safety standards, increase the efficiency, and promote the economical operation of aircraft activities in Victoria.

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Front cover: Bomber 718, Grafton Airport NSW, November 2008.

Fire Boss amphibious single engine air tanker:

Final Report, November 2008

Ulmarra New South Wales

Hayden Biggs

This report summarises information, data collected and observations in relation to an investigation conducted into the operational capabilities of the Fire Boss Air Tractor AT-802F Single Engine Air Tanker (SEAT), in the event the aircraft is engaged and positioned for use in Victoria.

Contents

Executive Summary

Recently a Fire Boss[1] Air Tractor AT-802F[2 3] aircraft has been purchased and imported into Australia with the prospect of providing a scooper[4] fire bombing service in Australia. It is the first time a Fire Boss has been positioned for operational use in Australia.

The Fire Boss is a highly modified Air Tractor AT-802 which has after market amphibious floats fitted along with other airframe modifications which allows the aircraft to scoop water into the hopper while aquaplaning from suitable water bodies. In addition it has been fitted with a more powerful engine which produces up to 250-shaft horsepower (-shp) more than a standard AT-802.

It has the capability to scoop up to 3104 litres[5] of water in less than fourteen (14) seconds, ram loading water at the rate of 400 litres per second at over 100 kilometres per hour and return within minutes to the wildfire from either lakes or rivers.

The Fire Boss has the ability to work as a land-based aircraft or as a scooper. It can drop an initial load of retardant and then remain close to the wildfire by scooping water from a nearby lake or suitable water source, injecting foam concentrate into the load of water.

Observations and information gathered indicates that operating as a single scooper the Fire Boss has a capability which Victoria currently does not have access to, by providing high volumes of suppressant from a SEAT in areas where there are suitable water bodies in close proximity to wildfires.

Operating as a scooping fire bomber in Victoria the Fire Boss may be limited by access to suitable water bodies and would require a management plan for implementation and operation to effectively use the aircraft in scooping configuration.

Uniquely, the Fire Boss still retains the same capabilities of Air Tractor AT-802 aircraft with a conventional undercarriage[6] but provides equal if not better performance in some circumstances with the addition of a more powerful engine and additional airframe modifications.

Notes

1 Is a proprietary name of Fire Boss Limited Liability Company (LLC) which is a business division of Wipaire Incorporated USA, a manufacturer of aircraft amphibious floats.

2 There are two "official" Air Tractor AT-802 models, the AT-802 (two seat cockpit) and AT-802A (single seat cockpit).

3 If a fire fighting model AT-802 is equipped with the Air Tractor computerized fire gate it is called it an AT-802F or AT-802AF.

4 Refers to a class of aircraft, which has the ability to scoop up water while skimming across the surface of a water body.

5 Maximum volume of the hopper.

6 There are two main wheels towards the front of the aircraft and a single, much smaller, wheel or skid at the rear, IE "taildragger".

Objectives

Several objectives were identified for consideration during the investigation into the operation of the Fire Boss in the event it was positioned or considered for operational use in Victoria.

1. Observe and asses the operational performance and associated operations to determine the suitability of the Fire Boss to operate in the forested areas of Victoria.

2. Make an assessment in relation to the capability of the Fire Boss and determine if it has the potential to offer operational capabilities Victoria currently does not possess.

3. Investigate and determine if there are any regulatory limitations or operational factors limiting the use of the Fire Boss may affect the capabilities of the aircraft operating in Victoria.

Introduction

Air Tractor AT-802 single engine air tankers (SEATs) have been utilised in fire bombing operations in Australia, Canada and Europe for the past 10 years. Initially AT-802 aircraft were equipped with wheels, and delivered long term fire retardants[7] and suppressants[8] onto fires.

In a standard configuration, the aircraft utilises a conventional undercarriage with landing gear[9] consisting of two main wheels and a tail wheel. However, a number of aircraft in North America, Canada and Europe have been converted to the amphibious configuration, which utilises Wipline 10000 amphibious floats manufactured by Wipaire Inc. USA, so the AT-802 can land and take off on either a traditional runway or on water.

The AT-802 on amphibious floats is known as a Fire Boss.

In 2003 the first AT-802AF equipped with amphibious floats was introduced into aerial fire fighting operations in British Columbia.[10] In the first year of operation this aircraft was operated for approximately 80 hours of operational fire bombing.

Because the Fire Boss is an amphibious aircraft it can either take off or land at land based fire bombing bases or on water.

Operating as a traditional SEAT, carrying retardant from a bombing base it can now provide the capability to remain onsite, scooping water from nearby water bodies until the other land based fire bombing aircraft return with more retardant or suppressant.

In addition to the standard fuselage-mounted suppressant reservoir tank, the Fire Boss has two additional supplementary tanks mounted in each of the floats. The additional volume allows the Fire Boss to operate with a high number of turn around flights for a one hour period over the duration of an operational cycle.

Fire bombing operations using the Fire Boss configured with the floats have been shown to produce a shorter and narrower retardant drop pattern[11] than conventional undercarriage AT-802A and AT-802F.

Notes

7 Any substance (except water or foam) that, by chemical or physical action, reduces the flammability of fuels or slows their rate of combustion.

8 An agent directly applied to burning fuels to extinguish the flaming, smouldering or glowing stages of combustion.

9 Usually includes wheels equipped with shock absorbers for solid ground, but some aircraft are equipped with skis for snow or floats for water.

10 Berry Jeff, Provincial Airtanker Operations, British Columbia Forest Service, August 2006.

11 Mc Cullouch Wally, Forest Engineering Research Institute of Canada, June 2008.

Findings

1) The Fire Boss offers a capability which is not currently available with the Contract or Call When Needed (CWN) resources available in Victoria.

2) The operation of the Fire Boss would require the SAU to develop an implementation and operational management plan for the Fire Boss including but not limited to; a central Nominated Operational Base (NOB), identify all suitable land based operating airstrips, identify optimum Scooping Sources[12] and classification of Scooping Zones.[13]

3) There appeared to be no difference in the provision of logistical support for either a Fire Boss or a wheeled AT-802F. An initial assessment of the NOB indicated that it had all facilities present to maintain a normal SEAT operation.

4) There appeared to be no significant difference in the flight preparation and operation of the Fire Boss during take off and landing and circuit procedures.

5) The Fire Boss has the ability to take off and land on most grass and surfaced runways with reasonable evenness; further investigation is required to eliminate airstrips that are not suitable.

6) An initial review indicates that the Fire Boss it has the ability to operate from most fire bombing bases specified in the Cockpit Handbook SAU, several facilities have been excluded because unknown status of the evenness of the main runway surface, IE Dartmoor.

7) There is a difference in the maximum take off weight of the Fire Boss compared to the AT-802F because of the weight penalty conceded for the fitment of the floats and additional modifications.

8) A pilot endorsement for the operation of an aircraft with floats does not automatically qualify the pilot for scooping operations however it is a prerequisite. The process of scooping is a separate endorsement.

9) Because of the complexities associated with the take off and landing procedures and the scooping process, landing gear down/up, scoops down/up there would be a need for a specific planned proficiency program built in to the engagement period to ensure currency for the pilot.

10) Gaining access to similar water bodies as compared to northern-hemisphere countries would be limited within Victoria and this factor is recognised by both the Operator[14] and the SAU.

11) The will be a requirement to gain approvals from the relevant water authorities and management bodies to gain access for scooping operations on fresh and salt water bodies.

12) There is a requirement to identify a minimum standard for Scooping Zones to enable the Agencies[15] to determine suitable Scooping Sources on bodies of water.

13) To ensure efficiency of the Fire Boss it is engaged as a SEAT that will conduct normal fire bombing operations similar to wheeled based SEATs and when required considered and reassigned for scooping operations when the circumstances are suitable.

14) Ideally, engagement provisions for the Fire Boss should ensure that it is located at a central NOB which fulfils the requirement of a conventional undercarriage service but has the capacity to utilise the scooping capability.

15) The current retardant reloading fittings on the Fire Boss are in an inappropriate location because of the height of the refilling ports, the positioning of the floats and additional airframe modifications.

16) Current procedures and guidelines for fixed wing fire bombing operations limit the use of water being dropped from SEATs. Therefore the SAU would have to issue an general approval on behalf of the Agencies to allow the Fire Boss to exclusively use water in fire bombing operations where turn around times do not exceed five minutes, the operational use would be subject to the authority of the respective Incident Controller.

17) It appears that the size and position of the floats positively affect the airflow under the aircraft and as a result the suppressant dropped from the Fire Boss appears to hold together better as it exits the drop doors, which would result in a polentially narrower pattern on the ground with more even coverage within.

Notes

12 A water body which can provide areas where the Fire Boss can scoop water.

13 An area within a water body that provides a safe area for the Fire Boss to scoop with out impediment.

14 R & M Aircraft, Ouse Tasmania.

15 Country Fire Authority and Department of Sustainability and Environment.

Findings (Continued)

18) One of the Contract Service requirements for pilots undertaking helicopter hover filling operations in Victoria is the that they must have undertaken a formal Helicopter Underwater Escape Training (HUET) course and it is apparent that the scooping operation is similar and will require the same level of risk mitigation for scooping pilots.

19) More evident is the requirement to have undertaken an extensive fly the wire environment training course, most courses are orientated towards helicopter hover filling operations which have a level of complexity for approach and departure procedures. Similar complexities would apply with a fixed wing scooping operation but would become extremely exaggerated with the high speed traverse and distance that is covered on the surface of the water.

20) It would be imperative that the intended Scooping Zone is free of any potential floating and submerged natural or man made objects. A higher level of vigilance would be required in vegetated steep and narrow valleys within scooping water bodies.

21) It is identified that extended and continuous fixed wing scooping operations conducted in remote locations and on large water bodies will require a safety monitoring process to ensure an appropriate response to emergency situations. The use of Top Cover[16 17] using a fixed wing reconnaissance aircraft would be suitable and the same observation process should be applied to helicopter hover fill operations that are not directly observed by ground or other aerial resources.

22) The Fire Boss has the capacity to operate in salt water continuously with a maintenance wash down at the conclusion of the daily flight operations.

23) The Fire Boss does not have the capacity to operate in salt water with a swell.

24) Knowing whether the amphibious floats affect the drop (i.e., immediately as the load exits the tank or later as the load passes between the amphibious floats), may allow the AT 802s fitted with a conventional undercarriage to be modified to improve their drop patterns. A modification similar to a pair of inboard wheel spats may have the ability to improve the evacuation process of the drop from a standard AT-802.

25) Using water injected with foam concentrate and referring to the Table 2 and a rudimentary evaluation indicates that the Fire Boss operating as a scooper from a suitable water body will prove to be effective for a distance up to 32-kilometres from the fire area.

26) A basic analysis of airframe costing between the Fire Boss AT-802F and a Bombardier CL-415 (CL-415) (See Plate 6) indicates that the Fire Boss operates for about 1/30th of the cost of the CL-415 and carries more than half of the volume.

27) A preliminary investigation into the availability of suitable water bodies within Victoria based on the current seasonal weather conditions and water body capacities indicates that there are in excess of 20 suitable sites for scooping, the majority within the central and eastern districts of Victoria. Refer to Appendix 4.

28) The practice of extending the scooping probes prior to making contact with surface of the water body may result in the aircraft sustaining a loss of directional control and result in the airframe receiving an unnecessary shock impact, all though it may be considered to be relatively minor the cumulative effect may be detrimental for the equipment and contribute to increased fatigue on the pilot.

29) If the longitudinal length of a Scooping Zone are shorter than the minimum specifications and it offered generous entry and exit azimuth paths the practice of conducting a "top up scoop" from the same site should not be considered because of the increased weight from the previous scooping operation and the resultant reduction in performance of the Fire Boss which may expose the pilot to unnecessary risk.

Notes

16 A procedure where an aircraft with trained personnel provides a communications and surveillance of multiple hover filling and fire bombing operations including the safety of ground based resources.

17 Operationally implemented using Firespotter 390, Mt Lubra Fire, Grampians 2007.

Recommendations

1) Register the Fire Boss on the Victorian CWN Register to allow the aircraft to be used in the event the demand for SEATs exceeds the current State Fleet resource level.

2) The SAU develops an implementation and operational management plan for the Fire Boss including but not limited to; a central NOB, identify all suitable land based operating airstrips, identify optimum Scooping Sources and classification of Scooping Zones.

3) A survey is conducted by the Operator and the SAU to determine the status of runway surface evenness for Agency owned and managed fire bombing bases.

4) If the Fire Boss operates in Victoria it is engaged as a fixed wing bombing service, which offers an additional capability, it is not engaged as an exclusive Scooper aircraft.

5) If the Fire Boss is engaged it is integrated into normal fixed wing bombing operations with consideration given to re-tasking/swapping the resource with a wheeled SEAT if an advantage can be achieved with the scooping capability of the Fire Boss.

6) The Agencies are to obtain all relevant approvals from the appropriate water management authorities for the use of inland fresh water bodies for scooping sources.

7) The Agencies are to obtain all relevant approvals from the appropriate bay and coastal management authorities for the use of estuarine/coastal salt water bodies for scooping sources.

8) Prior to the Fire Boss being engaged for lengthy period of time it would be subject to the modification, lowering and extension of the retardant loading facility, to allow for ground filling with out the use of steps or above shoulders loading processes for ground support crews.

9) Approval on behalf of the Agencies is given by the SAU for the use of approved retardant and suppressants including water for use in fire bombing operations for the Fire Boss.

10) The SAU issues an general approval on behalf of the Agencies to allow the Fire Boss to exclusively use water in fire bombing operations where turn around times do not exceed five minutes and the respective incident controller is satisfied with the objective.

11) If the opportunity arises The SAU undertakes an evaluation program to determine any differences in drop characteristics between the Fire Boss on amphibious floats and the AT–802 with a conventional undercarriage.

12) In the event that the Fire Boss is engaged to provide a service and it undertakes operations in a salt water environment, there is an immediate provision for a wash down facility.

13) The SAU issues a directive that all fixed wing pilots engaged in over water refilling operations, specifically scooping, must have undertaken in the absence of a fixed wing underwater escape training module, a formal Helicopter Underwater Escape Training (HUET) course.

14) The undertaking of a scooping operation with the scooping probes extended prior to making contact with the water surface is prohibited.

15) The requirement for a “top up scoop” is prohibited.

16) The SAU and the Operator undertake an aerial reconnaissance survey of proposed Scooping Sources to asses and determine the availability for scooping operations.

17) The SAU continues to monitor the development of scooping aircraft both nationally and internationally and the operational performance of the Fire Boss in Australia.

Background

Often the SAU is invited to participate in a range of activities to assist nationally and internationally, land management agencies, fire authorities and the aviation industry: to initiate, develop and evaluate aircraft related equipment and systems which assist in aerial fire fighting land management activities.

The most recent program has been the formal delivery system and drop pattern assessment of the Martin Mars (Refer to Plate 5).

Activities include and are not limited to:

a. assessment of rotary wing and fixed wing aircraft and their suitability for use in aerial fire fighting,

b. consultation on the design and development and operational assessment of delivery systems and

c. the evaluation and development of land management equipment for a range of activities.

As a result of the recent National Aerial Fire fighting Centre's (NAFC) Invitation to Tender (ITT) for Aerial Fire Fighting Services, the State of New South Wales (NSW) selected an Air Tractor AT-802. A component of the tender submission from the successful bidder included subject to conditions a Fire Boss, which is a highly modified Air Tractor AT-802F fitted with amphibious floats.

Wipaire Inc USA. has partnered with Air Tractor Inc[18], and a new company, Fire Boss, LLC[19], to create the Fire Boss fire fighting system. A set of Wipline amphibious floats, originally designed for a de Havilland Canada DHC-6 Twin Otter float plane, *(Refer to Plate 7)* were re-designed to fit the Air Tractor 802.

For more than 10 years Victoria has contracted a minimum of three (3) conventional undercarriage Air Tractor AT-802AF/F fire bombing aircraft and has used them extensively, successfully delivering both suppressant and retardant in fire bombing operations. The capabilities of the Air Tractor AT-802 SEAT are well known and documented by the SAU.

The Operator, R & M Aircraft, Ouse Tasmania[20] purchased and imported the Fire Boss Air Tractor AT-802F with the prospect of providing a scooping fire bombing service in Australia.

R & M Aircraft currently provides a Fixed Wing Fire Bombing Service (FWFB-Service) to Victoria, the contract service is provided by a PZL Dromader M18A, BOM 365 based at Bendigo. It has been modified with the addition of a turbine engine, a larger hopper and subsequent airframe and aircraft system modifications. R & M Aircraft are no strangers to seeking and providing new and innovative equipment and solutions.

The Fire Boss is a highly modified Air Tractor AT-802F which has after market amphibious floats fitted along with other air frame modifications which allows the aircraft to scoop water into the hopper while aquaplaning from suitable water bodies.

It is capable of rapid turn around times carrying up to 3104 litres[21] and can scoop a water load from either lakes or rivers in less than fourteen (14) seconds, ram loading water at the rate of 400 litres per second at over 100 kilometres per hour and return within minutes to the fire. An important feature of the Fire Boss is that has been fitted with a more powerful engine which produces 1600-shp.

The Fire Boss is similar to the AT-802 and is designed to operate and will successfully operate at max take off weight 7257 kilograms[22] from 1.60 kilometre water ways, from water depths of less than 3.0 metres[23] and with water chop up to depths of 0.3–0.6 metre[24].

While the traditional Air Tractor AT-802F can be loaded with water and retardant at an airport, scoops and foam tanks were added to the Fire Boss, allowing the plane to reload by skimming a nearby lake or river.

The SAU was given the opportunity at the invitation of the R & M Aircraft to attend aircrew training and endorsement program as well as an operational evaluation of the capabilities of the Fire Boss. The operator of the Fire Boss enlisted the services of Air Tractor Inc. and Wipaire USA to assist with the program.

The SAU recognised that the implementation program offered the ability to inspect, collate and asses the unique amphibious capabilities of the Fire Boss first hand.

The SAU was aware that the ability of the amphibious Fire Boss to operate may be limited because of the minimal access to expansive water sources in Victoria.

Nationally the current perception in respect to the operation of the Fire Boss amphibious aircraft is based on a collection of information and opinions without critical practical and operational analysis.

The opportunity to participate in the Operator's program provided additional information for consideration in future procurement processes in particular the forthcoming FWFB-Services in Victoria.

Notes

18 Air Tractor Inc. Onley Texas USA

19 Fire Boss LCC. a business division of Wipaire Inc.

20 Contract Service Provider, State of Victoria.

21 Volume specified is the capacity of the hopper not the actual continuous uplift of retardant or suppressant during operations.

22 Air Tractor Inc. Onley Texas USA.

23 Fire Boss, LLC.

24 Fire Boss, LLC.

Seaplanes and amphibian aircraft

Generally there is a level of confusion about the classification of fixed wing aircraft which have the ability to take off and land on water. Fixed-wing aircraft that are capable of taking off and landing on water are described as either a: "seaplane" which, are generally divided into two categories: float planes and floating hull aircraft or an "amphibious or amphibian aircraft".

Seaplanes

A floatplane has pontoons mounted under the fuselage. Two floats are the most common configuration, only the "floats" of a floatplane normally come into contact with water. The fuselage remains above water. *Refer to Plate 1.*

A floating hull aircraft utilise the fuselage as the main source of buoyancy which is similar to the hull of a ship/boat in the water, most flying hull aircraft have small floats mounted on their wings to keep them stable. *Refer to Plate 2.*

Amphibious or amphibian aircraft

An amphibious or amphibian aircraft is an aircraft that can take off and land both on conventional runways and water. Amphibious aircraft are normally floating hull aircraft and floatplanes with retractable wheels. *Refer to Plate 3 and 4.*

Plate 1. *de Havilland Canada DHC-6 Twin Otter dedicated float plane.*

Plate 2. *Short S-25 Sunderland 5(AN) floating hull aircraft.*

Fantasy of Flight USA

Plate 3. *Amphibious float equipped Cessna U206G Turbine.*

Coulson Flying Tankers

Plate 4. *Amphibious floating hull aircraft, Beriev Be-200.*

Georgio Maridakis, Scorpion International Services

Scooping aircraft

Scooping type fire-suppression aircraft have been around for many years.

The early 1960's saw the development of the Martin Mars, a floating hull aircraft which still operates today. The Martin Mars was the first large scooping aircraft developed which skims across the water surface to refill its' tanks with the ability to deliver 27,276 litres in a single or multiple drops. *Refer to Plate 5.*

During the late 1960's the Bombardier Canadair CL-215 was the first model in a series of firefighting aircraft able to land and take off from short, unpaved airstrips. It has an internal tank system that can hold up to 6137 litres of water/foam mixture and refills by skimming. The latest variant is the CL-415 ("Superscooper") which is turbine powered. *Refer to Plate 6.*

In the 1960's float equipped de Havilland DHC-6 Twin Otters were developed and used for fire fighting operations. The aircraft were equipped with amphibious Wipline 13000 floats which were modified with water holding tanks and probes. The probes were located on the bottom of the floats and were extended to provide the filling points for the water tanks. The drop doors, two on the bottom of each float, and the probes were electro-hydraulically operated. *Refer to Plate 7.*

Plate 5. *Martin Mars scooping floating hull aircraft.*

Coulson Flying Tankers

Plate 6. *Bombardier CL-415, "Superscooper".*

Plate 7. *Amphibious scooping de Havilland DHC-6-300, 1960's.*

Ministry of Natural Resources Ontario Canada

Summary Air Tractor AT-802 models

Air Tractor from Olney, Texas USA, has been building agricultural aircraft since 1970. The AT-802 and the version adapted for fire fighting, the AT-802F were introduced in 1993.

The AT-802 has a wingspan of 18 metres, an empty weight of 3197 kilograms and a gross weight of 7257 kilograms it is the largest single engine agricultural and fire bombing airplane currently in service. It is normally equipped with the PTA-67AG with 1350-shp. It has been purpose built for fire bombing carrying a payload[25] up to 4,300 kilograms[26]. More than 200[27] aircraft have been delivered around the world.

There are two certified AT-802 models, the AT-802 (two seat cockpit) and AT-802A (single seat cockpit). Either of these aircraft can be used for agricultural work or for fire fighting. If a fire fighting model AT-802 is equipped with the Air Tractor computerized fire gate and Fire Retardant Delivery System (FRDS) it is called an AT-802F or AT-802AF. The AT-802F/AF model equipped with amphibious floats is known as a Fire Boss. In Australia some AT-802 models have been fitted with other commercially available delivery systems.

The equipment and engineering dynamics of Air Tractor Inc allows a range of flexibility with engine, propeller and airframe combinations for a range of operational tasks. The table provided below gives a general indication about the AT-802 model designations for fire operations.

Table 1. *Air Tractor AT-802 models.*

Model	Comment	Engine	Horse-power	Hopper Volume
AT-802A	One place, conventional undercarriage, commercial delivery system.	PT6A-65AG	1295-shp.	3104-lt.
AT-802	Two places, conventional undercarriage, commercial delivery system.	PT6A-67AG	1350-shp.	3104-lt.
AT-802AF	One place, conventional undercarriage, Air Tractor FRDS.	PT6A-65AG	1295-shp.	3104-lt.
AT-802F	Two places, conventional undercarriage, Air Tractor FRDS.	PT6A-67AG	1350-shp.	3104-lt.
Fire Boss AT-802AF	One place, amphibious float equipped, Air Tractor FRDS.	PT6A-67AG	1350-shp.	3104-lt.
Fire Boss AT-802F	Two places, amphibious float equipped, Air Tractor, FRDS.	PT6A-67AG	1350-shp.	3104-lt.
Fire Boss AT-802F #	Two places, amphibious float equipped, Air Tractor FRDS, high performance engine.	PT6-67F	1600-shp.	3104-lt.

F Air Tractor Fire Retardant Delivery System (FRDS).
New generation Fire Boss fitted with modified and enhanced 1600 –shp. turbine engine.

Refer to Appendix 1 for examples of the aircraft listed in Table 1 and Appendix 2 for a general comparison of the AT-802A/F and Fire Boss AT-802A/F.

Notes

25 Includes aircrew, fuel, foam concentrate and retardant (specific gravity 1.15-kilograms/litre).

26 Source Air Tractor Inc. USA.

27 Source Air Tractor Inc. USA.

Air Tractor AT-802

The AT-802 carries up to 3104 litres of fire retardant or suppressant. The standard AT-802 is powered by a 1350-shp Pratt & Whitney turbine engine. The aircraft has a top cruise speed of approximately 300 kilometres per hour or 160 knots per hour. It has been fitted with a specially designed computer controlled fire bombing system known as the Air Tractor FRDS.

Plate 8. *Bomber 351, AT-802F (Stawell, VIC) delivering a full salvo of water injected with foam concentrate.*

Standard Equipment AT-802

- Pratt & Whitney PT6A-67AG 1350-shp turboprop engine
- 5-blade constant speed reversing Hartzell propeller
- 75-mm dual bottom loading valves
- 3104 litre fibreglass hopper, with 18-gallon foam tank
- Hydraulically driven rotary actuator to operate fire gate doors
- Computer-controlled doors to provide even flow rate
- Interface to select gallons to drop, coverage level, and ground speed adjustment
- Accelerometer for automatic adjustment for fire doors
- 1767 square millimetre vent door
- Streamlined fibre glass fairings for fire gate
- 812 millimetre low-pressure tires with dual 4-piston brakes
- 961 litre fuel tanks
- Strobe lights
- Nose mounted taxi lights
- Air conditioned cockpit
- Windshield washer and wiper
- 7257 kilogram FAA certificated gross weight

The robustness and power of the AT-802 enables them to work from short, less sophisticated airstrips that are numerous across the State.

Summary Air Tractor AT-802 models (Continued)

AT-802 Fire Retardant Delivery System

The Air Tractor AT 802 fire retardant delivery system contains a constant flow tank made of stainless steel. The 3104 lt. single tank is divided into two upper hoppers with a connecting lower section.

Equipped with a Pilot Interface System, the patented AT-802F fire gate allows the pilot to select the coverage level[28], amount to be dropped and ground speed application. The computer makes continuous adjustments to deliver coverage levels in changing airspeeds and turbulence conditions. The pilot can select the mixing ratio of water and suppressant to be applied as well.

Two opposing doors that hinge on the system's longitudinal axis are used to control the flow and allow the load to exit the aircraft in less than two (2) seconds. The control system specifies the amount of retardant to be dropped; this system can offer variations in drop options. The drop system control panel allows the pilot to select coverage level settings of 0.5 to 4 producing minimum of 291 to a regulated maximum of 1700 litres per second and includes the option of a full salvo drop, which opens the doors completely. A hydraulic system actuates the door opening.

Plate 9. *The FRDS longitudinal doors in the closed position.*

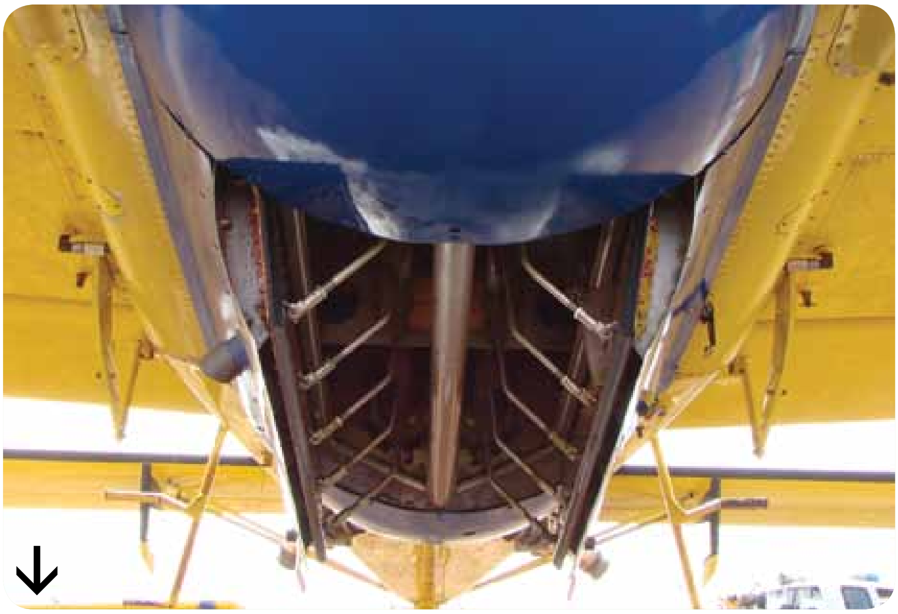

Plate 10. *Shows the FRDS longitudinal doors in the open position set for a full salvo.*

Notes

28 Coverage level is expressed as the volume of retardant per unit area. This is an expression of the volume in US gallons of retardant delivered per 100 square feet of horizontal surface.

Fire Boss Air Tractor AT-802F

The Fire Boss is a design of Wipaire, Inc. of Saint Paul, Minnesota and is originally adapted from the Air Tractor AT-802 aircraft.

Wipaire Inc. has partnered with Air Tractor Inc, and a new company, Fire Boss, LLC, to create the Fire Boss fire fighting aircraft. Wipline 13000 amphibious floats were re-designed to fit the Air Tractor AT-802. While the traditional Air Tractor AT-802A/F can be loaded with water and retardant at an airport, with the two scoops and additional foam tanks added to the Fire Boss, it allows the plane to reload by skimming a nearby lake or river.

The Australian Fire Boss retains the same size hopper as the AT-802F but has been fitted with a high performance PT6-67F 1600-shp turboprop engine.

Key features of the Fire Boss include;

- amphibious floats with hydraulically actuated water scoops.
- Air Tractor Fire Retardant Delivery System.
- Air Tractor foam injection system and controls.
- additional foam tanks in the floats supplement the standard firewall tank.
- changes to the hopper venting system are incorporated.
- new upper instrument panel is added to display the scoop related and system controls and indicators.
- bilge pumping system and water in floats warning system are incorporated.
- upgraded turbine engine 1600-shp PT6-67F turboprop engine.
- A new Engine Ram Air Inlet.

Plate 11. *Bomber 718 Fire Boss AT 802F, Grafton Airport, NSW.*

Airframe modifications

As a part of the float installation, the following changes are made to the conventional undercarriage aircraft:

- Ventral fin added for improved directional stability.
- Four auxiliary finlets for improved directional stability.
- The vertical fin is sealed to the fuselage/stabilizer top for improved directional stability.
- The open fuselage structure near the landplane tail-wheel mount is faired over for improved directional stability.
- Vortex generators added to the wing leading edges for improved longitudinal controllability.
- Vortex generators added to the horizontal stabilizer leading edges for improved longitudinal controllability and stall speed reduction.
- The elevator trim/servo tabs incorporate a 25 millimetre chord extension for improved longitudinal controllability.

Plate 12. *View of ventral fin, the sealed fuselage/stabilizer, top vertical fin and the fairing over the open fuselage structure near the landplane tail-wheel mount and the retractable steering water rudders.*

Plate 13. *View of the two auxiliary finlets added to each side of the horizontal stabilizer.*

Amphibious floats

The Wipline 10000 amphibious float is an all aluminium construction with twelve (12) watertight compartments of approximately 4353 kilograms buoyancy, featuring:

- hydraulic landing gear retraction system components and cockpit controls.
- cockpit landing gear controls and emergency hand pump and system.
- float water rudder retraction system and cockpit controls (the water rudders are locked centre when retracted for improved directional stability).
- pump-out cups on float top deck are placed between each float watertight compartment to pump out any water in floats before flight.
- two water scoops, one in each float.

Amphibian landing gear system

The landing gear incorporated within the amphibious floats on the aircraft is retractable, quadricycle type with two swivelling nose (or bow) wheels and four (4) (two (2) sets of dual) main wheels.

Landing gear extension and retraction is accomplished by two (2) electrically-driven hydraulic pumps and four (4) hydraulic actuators one (1) for each gear.

The brakes are hydraulic and have a calliper on each main wheel for a total of four brakes and the steering on land is accomplished by differential braking. The nose wheels are full castering.

Plate 14. *View of the Wipline amphibious floats and the retractable wheeled landing gear. Left side of image shows, the retractable nose mounted wheels and centre of image the retractable dual main wheels.*

Source Fire Boss LLC, USA

Summary Air Tractor AT-802 models (Continued)

Scooping system

The Fire Boss has two water scoops, one in each float. The scoops are 75 millimetres in diameter and are hydraulically operated by the pilot.

The hydraulic system has an accumulator to enhance the speed of scoop deployment and retraction and the scoops can complete the down or up cycle in approximately one second.

A trigger switch located on the front of the control stick grip controls the scoops. Pulling in the top of the trigger switch puts the scoops down.

Releasing the trigger switch puts the scoops back up.

In an emergency or unplanned occurrence the pilot can abort the scoop operation by simply releasing the rocker switch which will retract the scoops.

Foam system

The Fire Boss foam system consists of two individual tanks. The original 68 litre Air Tractor firewall tank is supplemented by an additional 113 litre tank in each float. A total of approximately 290 litres can be delivered to the hopper.

The float tanks are optional and one or both can be removed depending on the type of operation.

Plate 15. *Shows the location of scoop which is forward of the wheeled landing gear.*

Plate 16. *Shows the transfer plumbing from the scoops to the hopper of the Fire Boss.*

Plate 17. *Shows scoop in retracted position.*

Plate 18. *Shows scoop in lowered open position.*

Source Wipaire Inc, USA

Overflow and venting

The standard 75 millimetre vent located on the aft right side of the fire gate is supplemented with the addition of a new 125 millimetre vent that exits on the right side of the rear fire gate fairing. The original hopper vent/door has been modified to allow for a greater venting volume during scooping operations.

In the event of an overflow during scooping operations, a spring loaded relief valve door is located at the rear of the main drop vent door located on the top of the hopper. Water will exit the hopper to the right and forward of the cockpit windshield. The pilot can see ahead out of the left side of the windshield during an overflow condition.

Fire Boss Fire Retardant Delivery System

See AT-802 Fire Retardant Delivery System, Page 16 for further information.

Plate 19. *Shows the original 75 millimetre and new 125 millimetre fire gate venting.*

Plate 20. *Shows the upper relief valve door.*

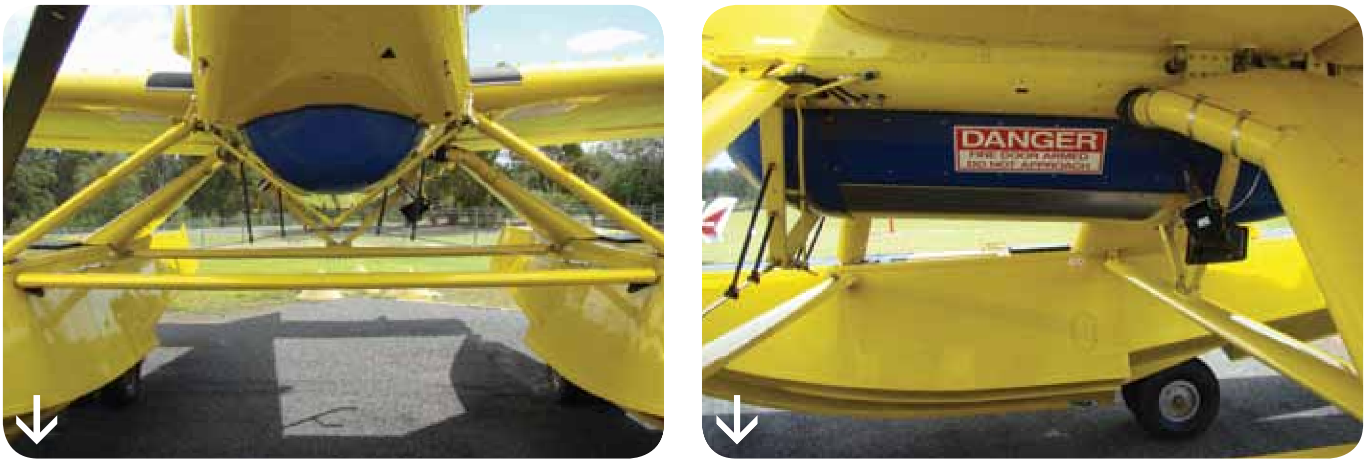

Figure 1. *Both images show the standard Air Tractor FRDS and the location of the fuselage supports for the amphibious floats which appear to offer no interference to the drop evacuation process.*

Summary Air Tractor AT-802 models (Continued)

Ram air system

An additional improvement to the Fire Boss that enhances turbine engine performance is the new Engine Ram Air Inlet. The inlet is positioned beneath the propeller spinner which provides increased airflow to engine.

The increased airflow reduces inter-turbine temperatures (ITT) or produces a net horsepower increase at the same ITT.

The Engine Ram Air Inlet is available as a retrofit upgrade for existing AT-802 and AT-802A aircraft.

One of the features of the new inlet system is an alternate induction air door that can be opened in flight in case of filter blockage.

Plate 21. *Shows the new Engine Ram Air Inlet located under the front spinner. Note also the Vortex generators added to the wing spar upper surface leading edges, a series of small vertical finlets.*

Discussion

Fire Boss AT-802F (1600-shp.)

A Fire Boss is the result of years of design and testing from AirTractor Inc. and is now combined with the performance of amphibious floats with an integrated scooping system.

The Fire Boss imported into Australian is fitted with a new military specification Pratt & Whitney PT6-67F 1600-shp turbine engine and is supplied with the fully certified Wipaire Inc. float system allowing the aircraft to be operated from either suitable water bodies and airports.

The Fire Boss still retains the Air Tractor advanced, patented computer-controlled fire gate and RFDS to deliver optimum coverage levels with reasonable accuracy.

The Fire Boss can be an initial attack fire suppression aircraft with a scooping option that has the ability to integrate into any aerial fire fighting fleet. The amphibious floats can provide an additional capability to an already established fire fighting aircraft.

In the cockpit of the Fire Boss there is a separate scooping control panel it provides information for angle of attack, foam transfer system; auto-bilge and water-warning system; torque gauges and overpower warning system, auto-fill probe retraction system and probe position indicators.

Plate 22. *Additional upper instrument bank, to monitor landing gear, manage scooping operations, including payload management.*

Additional capabilities

One capability of the Fire Boss is the Instrument Flight Rules (IFR) capacity which under the appropriate management may allow the Fire Boss to be repositioned long distances overnight IE: Inter-State deployment.

The Operator has the availability to supply a conventional undercarriage if required, which was supplied in the first instance with the purchase of the aircraft.

Discussions with the Operator have indicated that in the event there is a request to convert the Fire Boss from amphibious to conventional undercarriage and vice versa they are confident it can be comfortably achieved in 32 person hours.

The installation of the 1600-shp PT6-67F high performance turbine engine provides added performance for the Fire Boss. (See also Take off and Landing Performance). The Operator reviewed the performance of the Fire Boss AT-802 1350-shp aircraft and realised that there was potential to install a high performance military specified turbine engine.

The installation of the 1600-shp PT6-67F high performance turbine engine requires a dispensation from the United States (US) Department of State (DoS) and the US Department of Defence (DoD) US, because it was designed for installation into various DoD aircraft. Currently only one other Fire Boss has been fitted with the 1600-shp PT6-67F turboprop engine and it is located in Canada.

Operational base

The current Nominated Operational Base (NOB) is at Grafton Airport.

A review of overseas operations with the Fire Boss shows all of the known overseas bases are land based as well. The infrastructure associated with refuelling and reloading at Grafton is not dissimilar to that required for a conventional undercarriage AT-802.

Temporary mooring bases have been established during fire bombing operations overseas however they do not offer refuelling or retardant or suppressant reloading capacity.

Ground based operations

Initial observations reveal that the Fire Boss has a much taller profile than a wheeled AT-802, the aircraft sits higher with the installation of the floats and has a horizontal attitude. An average height[29] person has the ability to walk around under the fuselage and wing spar. The ground foot print is very similar but has obvious obstructions with the floats.

There are potentially two issues that may develop with the logistical support for the Fire Boss, the height of the aircraft and easy walking access within the footprint of the aircraft. Ground crews may become complacent with safety when working around the aircraft and the over wing refuelling with height of the wing spar from the ground, which may require monitoring for working at heights.

Plate 23. *Mark Mathisen, Chief Pilot Fire Boss LCC, standing on the wing spar, indicating the relative height and size perspective of the Fire Boss.*

Plate 24. *Refuelling operation for the Fire Boss, indicating the height perspective and showing also the height of the reloading ports under the fuselage.*

Note

29 >/= 1.80 metres.

Water based operations

The right-of-way rules for operation on water are similar, but not identical, to the rules governing right-of-way between aircraft in flight.

According to Civil Aviation Safety Authority (CASA) regulations, the definition of a vessel includes virtually anything capable of being used for transportation on water, including float planes, floating hull aircraft and amphibious aircraft on the water. Therefore, any time the Fire Boss is operating on the water, whether under power or not, it is required to comply with navigation rules applicable to vessels.

Taking off from and landing on water has several added variables for the pilot to consider. Waves and swell not only create a rough or uneven surface, they also move, and their movement must be considered in addition to the wind direction during all aspects of the water based operation.

A land based aircraft pilot can rely on windsocks and indicators within close proximity to the runway. A float plane pilot needs to be able to read wind direction and speed from the water itself.

Some land based aircraft may be restricted to operating in a certain direction because of the orientation of the runway, but the float plane can usually takeoff or land directly into the wind.

Many of the operational differences between land-planes and float planes relate to the fact that they have no brakes. The float equipped aircraft continues moving after the engine is shut down.

In addition the soaking of brakes and wheel bearings in water may not improve their reliability for use in land based operations. The moving parts will need regular lubrication and maintenance, and are at risk of malfunctioning. Extra vigilance is required because of the potential for foreign objects to jam moving parts.

With land based aircraft, the wind tends to make the aircraft weathervane, or yaw, until the nose points into the wind. This tendency is minor on landplanes with tricycle landing gear, but does occur with tail wheel gear equipped aircraft, and very evident in float planes.

Take off and landing performance

The flight management of the Fire Boss by the pilot has an added complexity of ensuring that during land based take off/landing and scooping procedures the wheeled landing gear is retracted and extended at the respective times.

The new PT6-67F turboprop engine of 1600-shp provides better performance for take off distance and climb performance at 7257 kilograms simply because it has an extra 250-shp or approx 17% more power than a conventional undercarriage AT-802 with the 1350-shp engine.

The use of lower power settings allows for a better and more economical fuel consumption rate.

Retractable "amphibious" landing gear may not be able to withstand as much side loading in crosswind situations as conventional landing gear.

Poorly executed land based crosswind landings are more likely with a floatplane, because the floats on an airplane reduce its roll responsiveness, making it more difficult to land in a crosswind. It is possible that the gear may be more likely to fail during these scenarios.

Many amphibious designs do not incorporate shock absorbers or springs into the system. If fitted they do not offer as much absorbing capability as conventional undercarriage landing gear. See also Scooping Operations.

Takeoffs on rough water can subject the floats to hard pounding as they strike consecutive wave crests as experienced in the sea ocean environment. Operating on the surface in rough conditions exposes the float equipped aircraft to forces that can potentially cause damage.

Operational performance

The Fire Boss has been operating for the last six years on fire fighting contracts in Canada and Europe. There are currently six[30] Fire Boss aircraft operating in Canada and twenty-three[31] aircraft operating in Europe, including Spain, Portugal, France, and Italy.

As a land based operation the Fire Boss has the capacity to delivery either retardant or water injected with foam concentrate.

The volume carried by the Fire Boss in initial dispatch from a fire bombing base will be dictated by the length and type of runway surface and the weather conditions as it is with conventional undercarriage AT-802 aircraft.

Notes

30 Fire Boss LCC USA.

31 Fire Boss LCC USA.

Discussion (Continued)

It is acknowledged that the additional weight and drag of the floats will decrease useful load and performance of the Fire Boss compared to a conventional undercarriage AT-802.

From a desktop working scenario for the Fire Boss it appears that operationally on an average the Fire Boss is initially load limited to 2100 litres.

This basic assessment is inclusive of a calculation of performance during a land based operation from a 1000 metre grass surface strip located at 1800 feet above mean sea level (AMSL).

As fuel and foam are consumed the load can increase to 2900 litres. These loads have been calculated on the maximum weight of 7257 kilograms. Average loads were calculated to be and can be based on ≥2500 litres.

The reduction in retardant/suppressant capacity is due to the added weight of the floats. As it burns off fuel, the Fire Boss can increase its' load.

Table 2 provides an indication of the expected performance of the Fire Boss during a scooping operation after dispatch from a land based operational base.

The table is provisional and does not incorporate all factors and aspects that can be experienced in fire bombing operations.

Scenario based evaluation

Distance water to fire	Average Turnaround	Average volume uplift	Operational Fuel cycle	Water delivered per hour
1.60-km.	2-min.	2,100-lt.	2.7-hrs.	71,922-lt.
8.0-km.	3-min.	2,100-lt.	2.7-hrs.	49,210-lt
16-km.	5-min.	2,100-lt.	2.7-hrs.	29526-lt
24-km.	8-min.	2,500-lt.	2.7-hrs.	19,161-lt.
32-km.	10-min.	2,500-lt.	2.7-hrs.	15,330-lt.

Table 2. *Scenario based table, Fire Boss operation.*

The following two tables, Table 3 and 4 have been produced after consultation and discussion with a European operator of the Fire Boss aircraft, Avialsa, Valencia, Spain. The tables are based on the operation of two Fire Boss AT-802AF aircraft.

Aircraft Type	Total Missions	Total Hours	Total Loads			Vol. Avg. 2200-lt.
			Retardant	Foam	Water	
Fire Boss AirTractor AT-802A 1350-shp	54	134	64	278	144	941600-lt.

Table 3. *Availability summary for two contracted Fire Boss aircraft, season 2006.*

Aircraft Type	Total Hours	Total Loads			Vol. delivered Avg. 2200-lt.	Decimal TAT*	Actual TAT
		Retardant	Foam	Water			
Fire Boss AirTractor AT-802A 1350-shp	4.31	0	10	19	63800-lt.	0.15 min	9.30 min.

Table 4. *Single dispatch activation summary for two Fire Boss aircraft.*

TAT Turn around Time.*
Source Avialsa Valencia, Spain.

If a conventional undercarriage AT-802 and a Fire Boss were to continually operate from a fire bombing base delivering retardant then it would appear that the conventional undercarriage AT-802 may have the ability to deliver a higher volume because of the weight penalty for the float gear.

It is possible if the Fire Boss has the 1600-shp engine fitted the additional horsepower may allow it to carry a volume equal if not greater to the lighter but less powered conventional undercarriage AT-802 in some circumstances.

The optional foam tanks in each float give an additional foam product to the Fire Boss system. The total capacity of the foam reservoirs has the potential to allow up to 20-three minute turn around cycles of for a one hour period based on a two and a half hour fuel cycle.

In flight the Fire Boss appears to fly very similar to conventional undercarriage aircraft.

Directional stability would be influenced to some extent by the installation of the floats this would be caused by the length of the floats and the location of their vertical surface area in relation to the Centre of Gravity (CG). Because the floats consist of a large vertical area ahead of the CG, they may tend to increase any yaw or sideslip.

Scooping operations

The average speed of the Fire Boss during the scooping operation while on the surface of the water is maintained at approximately 85 knots. Prior to the commencement of the operation the pilot selects the load he requires and the system automatically fills to that amount.

Forces created when operating a hull or float equipped aircraft on water can be more complex than those created on land. Water friction forces are active along the entire length of a float or hull. These drag forces vary constantly depending on the pitch attitude, the changing motion of the float or hull, and action of the waves. See also Take off and landing performance.

Because floats are mounted rigidly to the structure of the fuselage, they provide no shock absorbing function, unlike the landing gear of conventional undercarriage aircraft. Potentially damaging forces and shocks can be transmitted directly through the floats and struts to the basic structure of the airplane. See also Take off and landing performance.

Observations indicated that small waves and a chop on the water's surface either fresh or salt water reduced the surface area and subsequent surface area drag of the floats allowing for efficient take off processes. The operation of the Fire Boss on smooth water inhibited the float performance because of the greater surface area contact of the floats.

At the completion of the scooping process and after the floats break clear of the water surface a flow of water discharges from the extended scooping probes. The discharge is what remains within the loading system which has not entered the hopper.

The discharge is a gravity flow and this is a result of the ram pressure being reduced and not having the energy force the water passed the inline return valve. The return valve restricts the accidental discharge of any suppressant residue into the water body.

In a scenario where the Fire Boss is delivering multiple drops in a short period of time the workload on the pilot will increase to a frequency that is similar for a helicopter pilot.

In a normal conventional undercarriage SEAT operation the pilot would ferry the aircraft between the loading base and the fire allowing him a period of time to evaluate and plan the operation, the time would be reduced for the pilot of the Fire Boss. This type of scenario may require the use of multiple aircrew for the Fire Boss during a campaign fire.

While amphibious aircraft appear to be heavier and slower, more complex and more expensive to purchase and operate than comparable conventional undercarriage aircraft they have the potential to be more versatile.

They have the ability to compete favorably with helicopters in some multiple drop scenarios in some circumstances for the same types of jobs. The have the capacity to offer longer endurance than the comparable helicopters, and can achieve a similar range of conventional undercarriage aircraft.

Discussion (Continued)

Scooping Zones

In recent years proponents for fire bombing aircraft with scooping capability have not fully evaluated the suitability of water bodies in Victoria and including other states of Australia. While a very small number of water bodies may be suitable a high proportion are excluded because of the annual drying cycles, shallowness, obstructions that may be present and the potential effect of prevailing weather conditions to name a few.

The majority of the proponents have presented information developed from desk top assessments by marketing units within their own organisation without ground proofing the information they present when lobbing with their respective aircraft.

In consideration of these factors a conscious effort was made to ensure that the operation of the Fire Boss was assessed to determine the best operating environment.

As a result a reference table was developed indicating the desirable minimum specifications for Scooping Zones to assist fire agencies and authorities to determine optimum operating areas for the Fire Boss.

The Scooping Zones are rated by the length, width and water depth for a suitable surface area on a water body intended for scooping. The Scooping Zones do not identify the minimum heights and distances above water and other obstacles for entry and exit azimuths.

The ability to complete a scooping operation in any of the Zones identified is provisional on many factors and is not limited to the following: fuel uplift, suppressant reservoir capacity, prevailing weather conditions, height of water chop, visibility and angles of deviation while scooping.

The table is to be used by fire agencies and authorities as a guide to identifying suitable water bodies for scooping operations. The selection of the scooping zone will always be determined by the pilot of the Fire Boss.

Limitations

Current SAU and Agency procedures and guidelines regulate the use of water being dropped during fixed wing fire bombing operations.

Given the scooping performance of the Fire Boss with suitable water in close proximity there is a potential for the aircraft to provide numerous drops of water with in one hour. There would be a requirement to authorise the dropping of water from the Fire Boss subject to the approval of the respective Incident Controller.

The most obvious limiting factors in operations are the same as for all aircraft, visibility and turbulence.

Provisional Scooping Zone Reference Table				
Classification.	**Min. Length Metres**	**Min. Width. Metres**	**Water Depth Min. Metres**	**Comment**
Zone A.	2000-mt.	700-mt.	3.0-mt.	• Similar specifications to an established sealed general aviation airport. • Limited by fuel uplift and volume of suppressant.
Zone B.	1500-mt.	500-mt.	2.0-mt.	• Similar specifications to DSE & PV owned and managed serviced airstrips. • Limited by fuel uplift and volume of suppressant.
Zone C.	1000-mt.	300-mt.	1.5-mt.	• Partially reduced volume of water scooped. • Limited by fuel uplift and volume of suppressant.

Table 5. *Provisional Scooping Zone reference table.*

Source Justin Mace & Hayden Biggs.

Risk management

A rudimentary literature search has indicated that malfunctions or human errors related to retractable landing gear have been the cause of numerous accidents and incidents with the operation of amphibious aircraft in general.

Distraction and preoccupation during the landing sequence play a prominent role in gear-up landing incidents that occur each year in the United States[32].

The gear-up landing incident may also result from a mechanical malfunction that does not allow the landing gear to be lowered.

The most common accident during amphibious airplane operations is landing in the water with the wheels extended.

There is also a very high element of risk associated with undertaking a scooping operation having the scooping probes extended prior to the floats making contact with the water surface. An observation during the operation evaluation indicated that the aircraft suffered a contact shock resulting in the aircraft "bumping" off the water and changing direction slightly.

Additionally if the longitudinal length of a Scooping Zone was shorter than the minimum specifications but, it offered generous entry and exit azimuth paths there is a potential for inexperienced observers to suggest that with half a load from the initial scoop the Fire Boss could conduct a "top up scoop" from the same site to get a the remaining volume to fill the hopper.

The request for a "top up scoop" would place an unacceptable exposure and risk on the pilot and should not be considered at all.

Notes

32 National Transport Safety Bureau, USA.

Endorsement and evaluation zones

The area of operation for the Fire Boss during the training and evaluation program was the regional Northern Rivers area of NSW. The Fire Boss is located at Grafton Airport and is co-located with the Contracted NAFC & RFS NSW conventional undercarriage AT-802A, Bomber 719.

Scooping zone 1, was located on the Clarence River adjacent to the township of Ulmara and was used for the aircrew training and endorsement.

At the completion of the aircrew program the evaluation program was undertaken which included the primary and two additional zones, scooping zone 2 and 3. Scooping zone 4 was discounted because of the width and length of the selected site. Refer to also to Appendix 3.

Initial drop assessment

Although no formal drop assessment was conducted with the Fire Boss it was obvious that there was some significant differences in the evacuation process of the suppressant from the float equipped Fire Boss compared to the conventional undercarriage AT-802.

All the drops observed during the training and endorsement program were delivered almost immediately back into the water body after the completion of the scooping process and clearing water surface contact.

The volume dropped ranged from 1200 up 2500 litres in accordance with Wipaire's standard training procedures. All drops delivered consisted of water only.

A considered opinion of the investigation officer[33] after the initial observations of the evacuation process is that the drops from the Fire Boss would be narrower, shorter and potentially producing a more consistent and uniform distribution of coverage on the ground than those from the AT-802 with a conventional undercarriage.

The physical design and size of the floats have a significant effect on the flow of air in, around and over the surface of the floats and fuselage of the aircraft. The angle and depth of the inboard surface areas direct the airflow into the centre of the aircraft.

The inboard concentration of air flow contains the load to a more stable mass and prevents erosion during the evacuation process.

Further investigation is required to validate the initial observations and assessment.

Notes

33 Hayden Biggs, Coordinator, Aircraft Delivery System Program SAU.

Figure 2. *The above images show the full salvo drop.*

Source Fire Boss LCC, USA.

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Air Tractor, Inc. Olney, Texas USA.

Fire Boss LCC St. Paul, Minnesota U.S.A.

Mace Justin, R & M Aircraft.

Mathisen Mark, FireBoss LLC.

Wipaire Inc. St. Paul, Minnesota U.S.A.

Wiplinger Bob, Wipaire Inc. U.S.A.

List of Appendices

Appendix 1

Images of Air Tractor AT 802 aircraft

Air Tractor AT-802AF (1295-shp.)

Plate 25. *Bomber 354 (Delatite, VIC) a standard one seat Air Tractor AT-802AF fitted with a conventional undercarriage, Air Tractor FRDS and a PT6A-65A fitted with a 1295-shp turboprop engine.*

Source Bryan Rees State Aircraft Unit, Vic.

Air Tractor AT-802F (1350-shp.)

Plate 26. *Bomber 351 (Stawell, Vic) a standard two seat Air Tractor AT-802F fitted with a conventional undercarriage, Air Tractor FRDS and a PT6A-67AG fitted with a 1350-shp turboprop engine.*

Fire Boss Air Tractor AT-802AF (1350-shp.)

Plate 27. *Tanker 83 (Kamloops B.C. Canada) a one seat Fire Boss Air Tractor AT-802AF fitted with the Wipline amphibious undercarriage with subsequent airframe modifications, Air Tractor FRDS and fitted with a PT6A-67AG fitted with a 1350-shp turboprop engine.*

Fire Boss Air Tractor AT-802F (1600-shp.)

Plate 28. *Bomber 718 (Grafton, NSW) a two seat Fire Boss Air Tractor AT-802F fitted with the Wipline amphibious undercarriage, Air Tractor FRDS with subsequent airframe modifications and fitted with a PT6-67F 1600-shp turboprop engine.*

Appendix 2

General comparison AT-802A/F and Fire Boss AT-802A/F

Air Tractor AT-802A/F (1350-shp.)		
Engine type	PT6A-67AG	
Engine SHP & RPM	1350-shp. @ 1700 RPM	
Propeller (Hartzell)	HC-B5MA-3D/M11276NS	
Propeller diameter	115.0-in.	292.1-cm.
FAA Cert. Gross Wt.	16,000-lb.	7257-kg.
FAA Cert. Land. Wt.	16,000-lb.	7257-kg.
Empty Wt. (1-seat)	7050-lb.	3197-kg.
Empty Wt. (2-seat)	7210-lb	3270-kg.
Useful Load (1-seat)	8950-lb.	4059-kg.
Useful Load (2-seat)	8790-lb	3987-kg.
Hopper capacity	820 U.S-gal.	3104-lt.
Foam tank capacity	18.0 U.S-gal.	68-lt.
Fuel capacity	254 U.S-gal.	961-lt.
Wingspan	59.25-ft.	18.05-mt.
Length	35.7-ft.	10.88-mt.
Height	11.0-ft.	3.35-mt.
Rate of Climb (feet per minute)	850/fpm.	259/mpm.
Wing area	401-sq. ft.	37.25-mt^2.
Never exceed speed <12,500-lbs.	227-mph/197-Kt CAS	365-kl/hr CAS
Never exceed speed >12,500-lbs.	167-mph/145-Kt CAS	268-kl/hr CAS

Table 6. *General specifications AT-802F/AF*

Source Air Tractor LCC USA (2008).

Fire Boss Air Tractor AT-802A/F (1600-shp.)		
Engine type	PT6-67F	
Engine SHP & RPM	1600 shp- @ 1700 RPM	
Propeller (Hartzell)	HC-B5MA-3D/M11691NS	
Propeller diameter	118.7-in.	301.4-cm.
FAA Cert. Gross Wt.	16000-lb.	7257-kg.
FAA Cert. Land. Wt.	11500-lb.	5216-kg.
Empty Wt. (1-seat)	8300-lb.	3764- kg.
Empty Wt. (2-seat)	8600-lb.	3900-kg.
Useful Load (1-seat)	7700-lb.	3492-kg.
Useful Load (2-seat)	7400-lb.	3356-kg.
Hopper capacity	820 US-gal	3104-lt.
Foam tank capacity	74-US-gal	280-lt.
Fuel capacity	380-US-gal	1438-lt.
Wingspan	59.25-ft.	18.05-mt.
Length	35’7”-ft.	10.88-mt.
Height	16’2”-ft.	4.93-mt.
Wing area	401-sq ft^2.	37.25-m^2.
Rate of Climb (feet per minute)	670-f/pm	204 mt/pm
Never exceed speed <12,500 lbs.	184-mph/160-Kt CAS	296-k/hr. CAS
Never exceed speed >12,500 lbs.	166-mph/145-Kt CAS	267-k/hr. CAS

Table 7. *General specifications Fire Boss AT-802F.*

Source Air Tractor LCC USA (2008) and Fire Boss LCC USA.

Appendix 3

Endorsement and evaluations zones, Ulmara New South Wales, November 2008

Figure 3. *Shows the Operational Base, Grafton Airport and the Clarence River with the evaluation sites.* *Source Google Earth*

Scooping evaluation zones

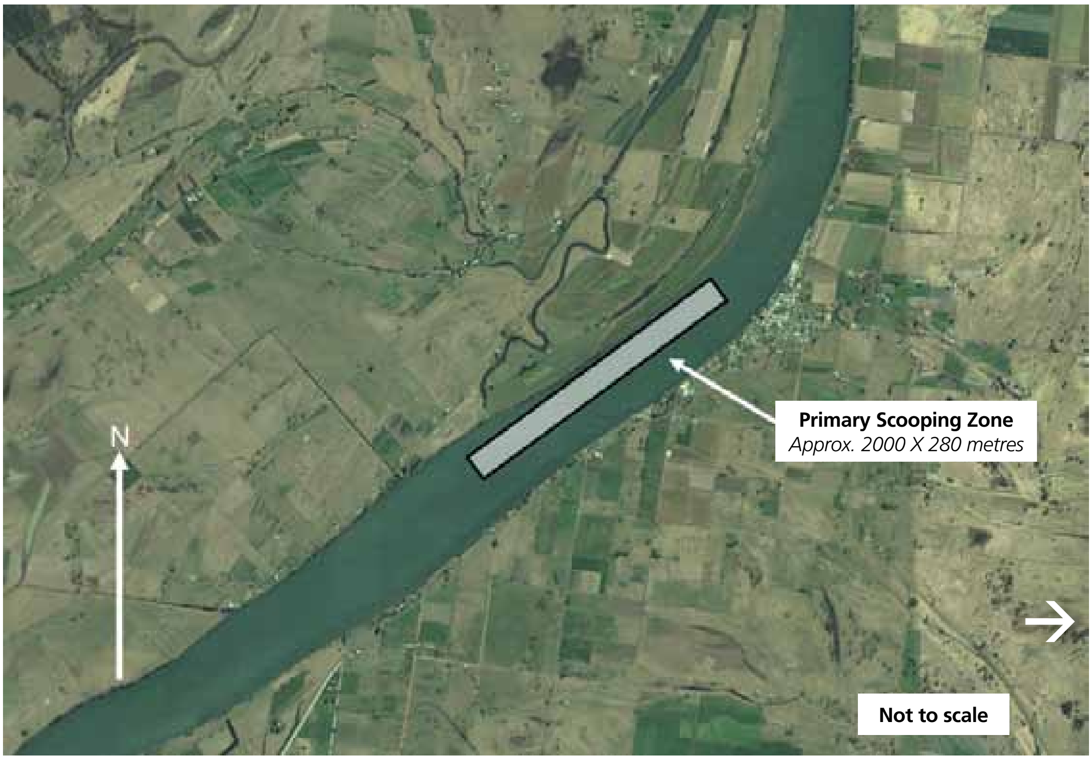

Figure 4. *Site 1 Clarence River, Ulmarra, NSW.*

Source Google Earth

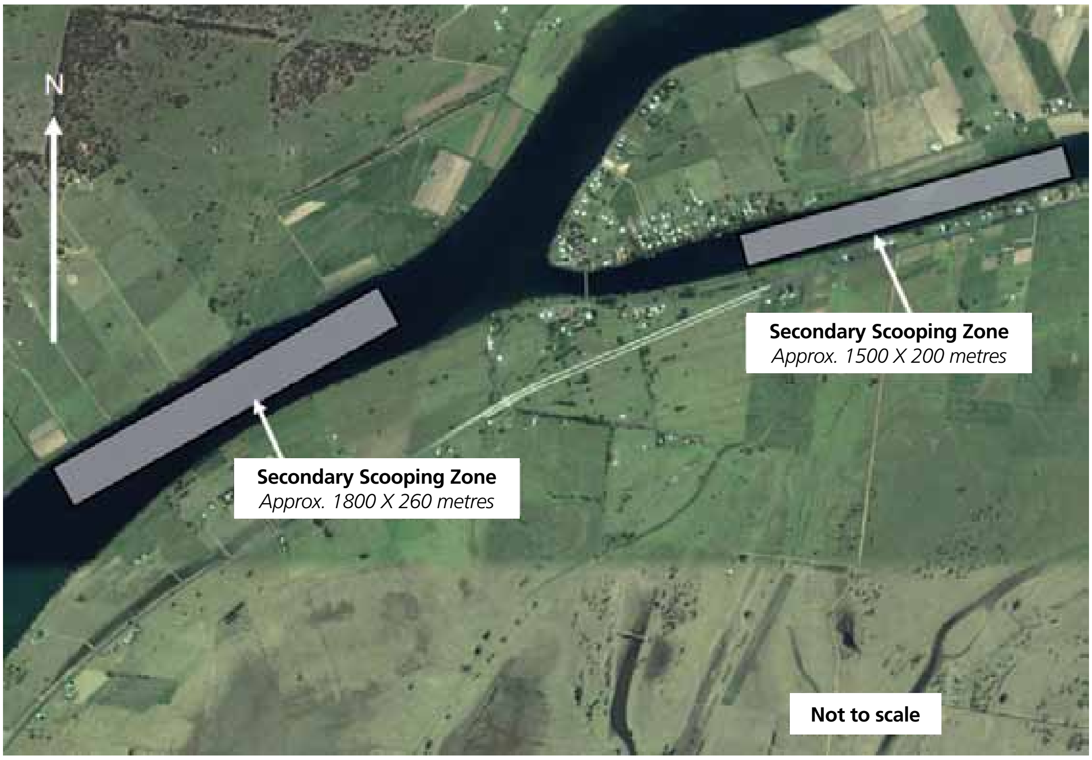

Figure 5. *Site 2 Clarence River, Cooper and Brushgrove, NSW.*

Source Google Earth

Appendix 4

Examples of proposed Scooping Sources, Victoria.

Figure 6. *Lake Belfield Halls Gap, Grampians Western Victoria.*

Source Fire Information Systems Group, DSE 2009.

Figure 7. *Maroondah Reservoir Healesville, Outer Metropolitan Melbourne Victoria.*

Source Fire Information Systems Group, DSE 2009.

Figure 8. *Barwon Reservoir Otway Region, Western Victoria*

Source Fire Information Systems Group, DSE 2009.

Figure 9. *Happy Valley Reservoir Falls Creek, North East Victoria.*

Source Fire Information Systems Group, DSE 2009.

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6. 1980. A low intensity prescribed burning operation in a thinned Radiata Pine plantation. P. R. Billing.
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