Department of
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Environment

Operational performance of the S-64F Aircrane Helitanker

1997–98 fire season

Research report no. 72

Victoria
The Place To Be

Operational performance of the S-64F Aircrane Helitanker 1997–98 fire season

Research Report No. 72

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State Aircraft Unit

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Fire Management
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This report summarises the management, operational performance and effectiveness of Erickson's S-64F Aircrane Helitanker during the 1997–98 fire season. It is not an evaluation of the helitanker's abilities or an operational trail.

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Cover photograph: Aircrane Helitanker, Hayden Biggs.

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www.dse.vic.gov.au/fires (fire management; fire research)

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Executive summary

During the period of extended dryness in the build-up to the 1997–98 fire season, the Victorian Government recognised that additional aircraft resources were needed to supplement the contracted fleet of 17 specialist firefighting aircraft normally used in the State. Amongst others, the additions included an S-64F Aircrane—a heavy-lift helicopter with vertical-lift capabilities.

When it is operating as a *helitanker*[1], a 9500-litre firebombing tank is attached under the fuselage of the Aircrane. The tank is fitted with a snorkel that allows it to self-fill from a range of water sources while the helicopter is hovering. The hover-fill system can draw 9000 litres of water in less than 40 seconds. The retardant delivery system is controlled by a microprocessor that enables the pilot to select multiple drops as well as the volume and coverage level of each drop, providing a variety of options for efficient suppression of *wildfires*.

The S-64F Aircrane Helitanker combines the ability to deliver large volumes of fire retardant with a helicopter's versatility, performance, manoeuvrability and quick turn-around times.

During the 1997–98 season, the Aircrane Helitanker was successfully deployed nine times and flew a total of 50 hours in firefighting operations within the State. It delivered a total of 2 347 458 litres of water injected with foam concentrate on wildfires in a variety of topographic and vegetation types. It was used for direct attack on wildfires in highly-flammable coastal vegetation, various classes of eucalypt forest and in pine plantations and for the protection of assets on farmland and at the forest–private land interface. On one occasion, with an average load of 8500 litres, it delivered 162 000 litres in one hour to contain a very high-intensity wildfire in a pine plantation.

The helitanker was effective in directly attacking the edges of going fires, hot spots and spot fires, in providing valuable support to the ground firefighting resources and in working with both the fixed-wing and other rotary-wing firebombers from the Department's contracted specialist aerial firefighting fleet. Its ability to quickly deliver large volumes of fire retardant in potentially threatening situations under extreme fire danger conditions was well demonstrated. The large volume carried and the ability to *split* the load also allow it to deliver separate drops to several locations without the need to reload, reducing some of the urgency and pressure in the decision-making processes and enhancing the safety and effectiveness of firebombing operations.

By directly attacking high-intensity fires the Aircrane Helitanker was credited with several significant saves where high-value assets were under threat.

[1] Technical terms printed in italics at their first mention are defined in the Glossary.

Introduction

Following a very dry period during the first part of 1997, and experiencing continuing lower than average rainfall due to the *El Niño* Southern Oscillation phenomenon, Victoria was faced with a high likelihood of a severe fire season during 1997–98. The need to be able to suppress wildfires in areas with large quantities of fuel indicated that it would be cost effective to have available an aircraft capable of delivering large volumes of fire retardant in a short period of time.

In 1997–98, an S-64F Aircrane Helitanker, as well as two light helicopters, a medium helicopter and a fixed-wing firebomber, were added to the State's specialist fleet of 17 contracted firefighting aircraft. The Aircrane Helitanker, from Erickson Air-Crane of the United States of America, was included because its ability to rapidly deliver large volumes of fire retardant was known and it was considered that it would complement the capabilities of the existing fleet of fixed-wing and rotary-wing firebombers.

The principal area of operation identified for the Aircrane Helitanker was in a *primary response zone* where there were significant areas of forested public lands with high fire threat interfacing with private land within 100 kilometres of Melbourne. A large number of wildfires in these areas are human-induced and, in the past, many have caused the loss of human life and the destruction of valuable assets. Many of these areas are in inaccessible and steep terrain covered with dense vegetation, have nearby residential development and are subject to high-intensity fires.

Its commitment to the primary response zone, however, did not exclude the use of the helitanker for wildfire suppression operations elsewhere. It was to be managed as a standard firefighting resource and integrated with the other available resources.

An optional forward-mounted pressurised water cannon developed for the Aircrane Helitanker was made available for operational testing and evaluation at this time. Although not subject to the contract requirements, the water cannon and its operation are also described in this report.

S-64F Aircrane Helitanker

Background

Up until the early 1970s, the Sikorsky Aircraft Company manufactured the Sky-crane[2], a purpose-built heavy-lift helicopter. Since that time the Sky-crane has been maintained by Erickson Air-Crane Incorporated. In 1992 Erickson purchased the S-64 Type Certificate from Sikorsky, enabling Erickson to manufacture and overhaul components for and make improvements to the Sky-crane's airframe. Through the modifications, Erickson developed the S-64 Aircrane[3] helicopter for use in precise heavy lifting and remote-area logging operations.[4]

Erickson also modified the Aircrane for firefighting purposes. In its first deployments on firefighting operations, a 2000-gallon (7570-litre) *bambi bucket* was used. Erickson developed a large-capacity fixed firebombing tank in 1993[5] and marketed the combination as the Erickson S64-F Aircrane Helitanker (Figure 1 and Table 1).

Figure 1 The S-64F Aircrane Helitanker

[2] 'Sky-crane' is a registered trademark of the Sikorsky Aircraft Company.

[3] 'Aircrane' is a registered trademark of Erickson Air-Crane Incorporated, Central Point, Oregon USA.

[4] Personal communication - Kenny Chapman, Erickson Air-Crane (1998).

[5] Personal communication - Kenny Chapman, Erickson Air-Crane (1998).

Table 1 Specifications –S-64F Aircrane Helitanker[a]

Overall length	27.2 metres
Height	7.8 metres
Main rotor diameter	22.0 metres (rotor system has six blades)
Powerplant	two Pratt and Whitney JFTD–12 turbo jet engines; each producing 4800 shaft horsepower
Tare weight including the firebombing tank system	10.45 tonnes
Gross weight capable of being lifted	21.36 tonnes
Maximum cruising speed	104 knots
Normal speed for firebombing	between 40 and 60 knots
Certified operating altitudes (*AMSL*)[b]	**transit flight** – sea level to 16 000 feet Density Altitude[1]
	take-off and landing – sea level to 12 500 feet
	engine start – sea level to 14 000 feet
Fuel load	three fuel tanks with a total capacity of 4900 litres
Fuel consumption	2082 litres per operating hour

Note 1: Density Altitude: Pressure/altitude corrected for temperature and humidity. Density altitude indicates the altitude relative to the air density under a standard temperature day rather than the elevation above sea level.

Sources: **a** Information Leaflet Erickson Air-Crane Inc.

b Flight Operations Manual – S-64F Erickson Aircrane, 1998

Purpose-built for heavy lifting, the Aircrane is able to carry its maximum specified payload below 12 000 feet without restriction[6]. Its exceptional lifting capacity is attributed to the powerful jet engines complemented by a large-diameter six-bladed rotor system (cover image, Figure 1 and Table 1).

The Aircrane requires a flight crew of two. The lead pilot flies the aircraft from the left side and is responsible for the control of the firebombing systems. The position of lead pilot is alternated during a sustained operation.

[6] Personal communication - Kenny Chapman, Erickson Air-Crane (1998)

Fire retardant delivery system

Firebombing tank

For firebombing purposes, a specially-designed 9500-litre tank[7] is attached under the Aircrane's fuselage (Figure 2). The delivery system has been designed for and complies with the national requirements of the United States Forest Service (USFS) for fixed-wing airtankers delivering long-term retardant.[8]

Figure 2 The 9500-litre firebombing tank under the Aircrane's fuselage

The firebombing tank is fitted with a 36-cm diameter, 12-metre long flexible snorkel (Figures 1 and 2) that enables the Aircrane to hover-fill from a variety of water sources. It can self-fill 9000 litres in 38 seconds.

[7] The tank is reported to have a 9500-L capacity (www.ericksonaircrane.com/firefighting) but, for most operational purposes, it carries only 9000 L.

[8] Personal communication - Dick Foy, Erickson Air-Crane, (1998).

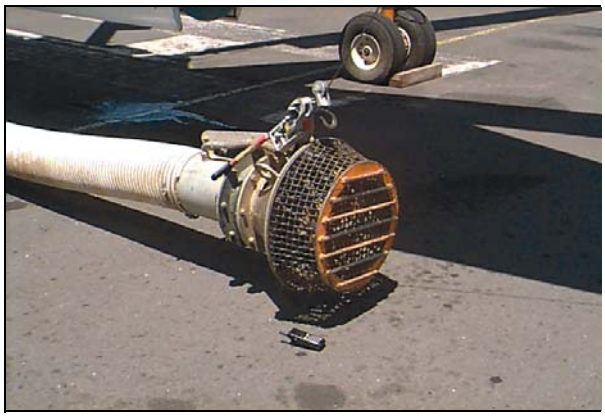

Figure 3 Snorkel pump cage

As the snorkel pump cage (Figure 3) has to be submerged in the water source to operate efficiently, a minimum water depth of 0.5 metres is required for hover-fill operations.

An impeller driven by a hydraulic motor lifts the water. The hydraulic pumping lines and a securing cable are located inside the flexible snorkel hose.[9]

The depth and shape of the firebombing tank allow the retardant to exit the bombing drop-doors (Figure 4) quickly to deliver a concentrated drop pattern. At *full salvo*, a 9000-litre load can exit the tank in approximately 2.5 seconds. The drop-doors are hydraulically operated by a set of rotary gears located at each end of the tank.

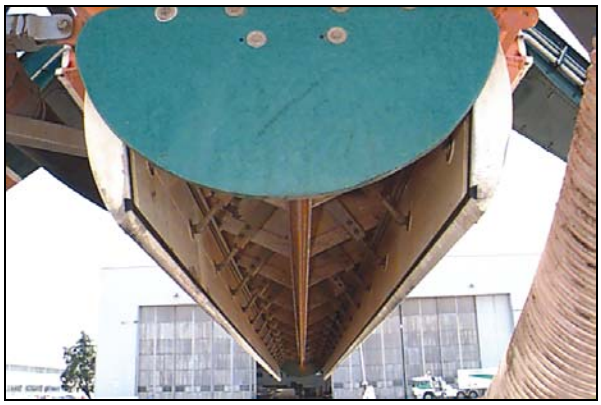

Figure 4 Drop-doors on the firebombing tank in the fully-open position

A series of vertical baffles in the tank (Figure 4) allow for stable flight with either a full or a partial load.

Its design enables the system to effectively deliver water or water injected with foam concentrate or long-term retardant.

All firebombing drops delivered by the helitanker during the 1997–98 fires in Victoria were loads of water injected with foam concentrate.

As an alternative to the hover-fill system, the helitanker can be filled on the ground at a *serviced filling point* using a three-and-a-half inch (about 90 mm) camlock fitting mounted on the tank. It is not common practice to fill the helitanker on the ground, however, because of the associated delays and the need for extra ground support resources.

[9] Personal communication - Allen Wanamaker, Erickson Air-Crane, (1998).

Microprocessor

All the functions of the delivery system are controlled by a microprocessor located in the cockpit and managed by the lead pilot.

A revolutionary addition to the microprocessor is the direct input from a Global Positing System receiver that monitors the delivery speed of the helitanker. In response to the receiver's input, the microprocessor adjusts the flow rate from the drop-doors to compensate for the speed of delivery[10].

Foam concentrate injection

A separate 290-litre foam concentrate reservoir is located inside the firebombing tank. The concentrate is injected into the base of each load of water through eight injectors. It is injected after completion of the filling process and prior to the delivery of a drop.

The rate if injection is controlled by the microprocessor in ten fixed steps, ranging from 0.5 to 5.0 US gallons. The Air Attack Supervisor judges the desired concentration of foam on the basis of the vegetation type to be treated and advises the pilot accordingly. The pilot then adjusts the rate of injection on microprocessor on the basis of the actual volume carried in the tank. If the volume of foam concentrate to be injected into the load of water exceeds 5.0 US gallons, the pilot must first select and inject the maximum (5.0 gals) then select the remaining required volume and inject the balance. Once the drop starts, the rate cannot be changed.

Pressurised water cannon

An additional delivery system fitted experimentally to the helitanker in 1997–98 was a forward-mounted water cannon (Figure 5) that can provide a concentrated stream of fire retardant. The lead pilot controls the cannon through the microprocessor.

Figure 5 Water cannon fitted to the Aircrane

The water cannon is located on the left side and projects forward of the helicopter's cockpit.

The cannon uses water from the firebombing tank and is operated by the same hydraulic system as the tank and hover-fill pump.

It is possible to switch delivery systems during a tactical operation; reinforcing the versatility of the helitanker's systems.

The design of the water cannon's nozzle is such that, under controlled flight conditions, the effect of rotor down-wash on the pressurised stream is eliminated. The cannon is able to

[10] Personal communication - Kenny Chapman, Erickson Air-Crane (1998).

direct fire retardant up to 50 metres (Figure 6) and maintain a constant flow of 1100 litres per minute for eight minutes.[11]

A hydraulic ram mounted on the side of the aircraft controls the direction of the cannon and is restricted to a vertical adjustment of 15 degrees. Under suitable conditions, however, this vertical restriction can be overcome by the manoeuvrability of the Aircrane. Horizontal directional control achieved by turning the aircraft.

Figure 6 Water cannon in action

The water cannon was used operationally during a wildfire at Spring Hill near Trentham (22 March 1998). While the helitanker was engaged in asset protection, a spot fire developed in grassland ahead of the main fire. A controlled drop would have used a large volume of retardant that was required elsewhere. A direct attack using a five-second burst from the cannon extinguished the spot fire, enabling the Aircrane to return to asset protection.

Delivery control

The long drop-doors of the firebombing tank of the Aircrane Helitanker and the narrow drop-door aperture (Figure 4) enable the system to maintain an elongated drop of restricted width (Figure 7).

The microprocessor enables the pilot to select the number of drops from the one load and the volume and *coverage level* of each drop, providing a variety of options for efficient fire suppression.

Figure 7 The long, narrow drop pattern from the Aircrane firebombing tank

The volume of a *split-load drop* can be controlled from a minimum of 25% to 50%, 75% or 100% of the volume contained in the firebombing tank. The Department concluded that, in practice, a maximum of four separate workable drops can be delivered from a 9000-litre load. A digital display in the cockpit indicates the remaining volume.

The flow rate from the firebombing tank can be controlled so that the coverage level of retardant delivered to the ground is appropriate to the type of vegetation and intensity of

[11] www.ericksonaircrane.com/firefighting

the particular wildfire. This is achieved by varying the degree of opening of the drop-doors to regulate the flow of retardant through them.

Coverage level is expressed as the volume of retardant per unit area. The system can deliver coverage levels in nine fixed steps, indicated by the values 1 to 8 and "salvo" on the microprocessor control panel. The indicated steps are in units of gallons (US) per 100 square feet of surface. Translated to metric units, the indicated coverage level values of 1 to 8 are equivalent to about 0.4 litres to some 3.2 litres per square metre respectively (Table 2). The ninth unit, a full-salvo drop, occurs when the flow through the drop-door aperture is unrestricted and the total load is evacuated.

Table 2 Retardant coverage levels available from the Aircrane delivery system

Indicated coverage level[a]	Coverage level in metric units (litres per square metre)
1	0.4
2	0.8
3	1.2
4	1.6
5	2.0
6	2.4
7	2.8
8	3.2
salvo	total contents evacuated

Note a. 'Coverage level' as indicated on the microprocessor control panel. This is an expression of the volume—in US gallons—of retardant delivered per 100 square feet of surface.

From experience gained in the use of the Aircrane Helitanker delivery system during the 1997–98 fire season, the general guide for the coverage level settings on the microprocessor are:

- 1 to 3 for light fuels such as grasslands
- 4 to 6 for fires in eucalypt forests
- 7, 8 and full salvo for high-intensity fires and in areas with high fuel loads.

The pilot selects the required level of coverage prior to each drop and, once the drop starts, the rate cannot be adjusted until the drop is completed. In an emergency, however, a manual override can be activated to evacuate the tank.

Another feature of the delivery system is a manual override that enables the drop to be suspended. To complete a selected drop configuration the pilot must activate the appropriate sequence and then maintain pressure on a switch. If the drop must be suspended or stopped for some reason, such as when an overrun may result, release of the switch will automatically suspend the preselected drop and conserve fire retardant[12].

[12] Personal communication - Eric van de Walker, Erickson Air-Crane (1998).

Preparedness

Awareness of the capabilities of the Aircrane

Fire managers, firefighters, media organisations and members of the public in 1997–98 regarded the addition of the Aircrane Helitanker to the established fleet of specialist firefighting aircraft to be a significant event. But the majority of personnel engaged in firefighting at the time had limited knowledge about the helitanker and its unique abilities. Detailed information was required to supplement the promotional brochures and videos provided by Erickson Air-crane Inc.

During the contract period both Erickson Air-crane Inc. and the Department conducted briefing and information sessions about the operation of the Aircrane Helitanker. The sessions involved employees of the Department and the Country Fire Authority (CFA) and brigades from both the CFA and the Melbourne Fire and Emergency Services Board. Interested school groups also attended information sessions.

Standard information and specification sheets (Appendix A) were prepared and distributed during the briefings and information sessions. Where possible, the information sheets were updated with any new data that was collated after deployments of the aircraft to wildfires. Relevant information was also released on request to the media and the public.

More technical data on specifications, operational requirements and logistical information about the Aircrane Helitanker were provided to personnel engaged in firefighting to assist effective operational planning in wildfire suppression. (For example, the Fire Management memo – Operational Information Erickson Aircrane S-64F Helitanker – included in Appendix D.) In addition to the information sheets routinely produced during the fire season, reports were prepared on case studies of particular wildfire suppression operations undertaken by the Aircrane in Victoria to demonstrate its abilities (for example, Appendix B).

Several demonstrations and media days were planned so that fire managers and the media could see the unique capabilities of the Aircrane Helitanker. Some planned demonstrations could not proceed, however, because of the forecast fire danger for the scheduled days and deployments of the Aircrane to wildfires. One exception occurred on 25 February 1998 when a demonstration was planned for representatives of fire authorities from interstate. When the Aircrane and other firebombing aircraft from the fleet present on the day were deployed to a fire at Macedon, arrangements were made to transport the representatives to where they could see both fixed-wing and rotary-wing firebombing aircraft, including the Aircrane, operate together in an effective and efficient wildfire suppression operation (Figures 8 & 9).

Figure 8 Delivering a full-salvo drop (Macedon, 25 February 1998)

Figure 9 A Bell 212 helicopter hover-filling (Nursery Dam, Macedon, 25 February 1998)

Planning

Landing areas

The design and layout of a landing area for the Aircrane requires careful consideration. The cleared area should have a minimum diameter of 150 metres as the helicopter produces significant rotor wash that can raise considerable amounts of dust and dislodge loose items on the ground, vehicles and structures. Access for heavy vehicles is also required so that the ground support crews can service and refuel the aircraft and refill the foam concentrate reservoir.

The Aircrane is stationed at Essendon Airport – the nominated operational base pending dispatch of the helitanker to a fire. Because its primary response zone is the within 100 kilometres of Melbourne, sites identified as suitable landing areas for the aircraft within 80 kilometres of the metropolitan area were nominated as *goto helipads*. These were generally large sports ovals that had limited development around the perimeter. This information was also relayed to the operators of other helitankers.

The arrival of firebombing aircraft at the landing areas attracts the attention of the media and general public. Standard Departmental security and marshalling procedures were implemented to manage employees engaged in the air operations and associated duties, public safety and landing area security.

Fuel

A primary planning issue was the availability of fuel to support the operation of the Aircrane. This included consideration of both the location of fuel reserves and the volume that could be supplied. While the contract for the Aircrane included the provision of a refuelling tanker, there was potential for the aircraft to be redeployed to a wildfire remote from where the tanker was stationed. Accordingly, alternative arrangements were made with organisations that had bulk refuelling facilities. On several occasions during the 1997–98 season these alternative resources were engaged to support the Aircrane as well as other aircraft from the aerial firefighting fleet.

Hover-fill water points

The availability of suitable water sources also required attention. Large domestic water supply reservoirs were abundant in much of the identified primary response zone. However, several areas were deficient of *fill-points* and/or the capacity to sustain hover-fill operations. The lack of available fill-points was compounded by Victoria's extended dry period. Reconnaissance flights were conducted to locate suitable fill-points in the deficient areas and record them for future use in wildfire suppression operations.

Foam concentrate support units

The foam concentrate reservoir of the Aircrane holds 290 litres. If the concentrate is injected into each load of water at 0.5% by volume, a maximum of six 9000-litre loads of water can be injected with foam after each fill of the reservoir.

To maintain a supply of foam concentrate for both the Aircrane and the rest of the aircraft fleet, four 'foam support units'—consisting of three mobile units (Figure 10) and one fixed unit—were built and strategically located around the outer-metropolitan area.

Figure 10 Mobile foam support unit

Each mobile foam support unit comprised a 1500-litre tank, pump and connecting hoses and safety equipment mounted on a trailer towed by a four-wheel-drive vehicle. Each was manned by trained staff from the Department and Parks Victoria.

The units were designed to supply all rotary- and fixed-wing firebombing aircraft and were refilled from bulk supplies from the Department's Fire Equipment Development Centre in Altona.

Preparedness statements

To ensure rapid deployment of the helitanker and associated essential resources, a preparedness statement (Appendix C) was developed for the aircrew and support crews. The statement specified the required levels of preparedness in accordance with the level of fire danger forecast for the day.

Individual action statements were developed for each resource associated with the helitanker to ensure that awareness was maintained and that essential duties were undertaken. Standard *go-kits* for the Air Attack Supervisor were also maintained (Appendix D).

Training

Erickson Air-crane Inc. resources

The 1997–98 fire season in southern Australia was the first time the Aircrane Helitanker had been engaged in a firefighting contract outside the United States of America. Accordingly, its aircrew and support crews were given a formal induction briefing about Victorian fire authorities and their respective responsibilities. Subsequent less-formal sessions were conducted covering subjects similar to those for the Air Attack Supervisors.

Agency resources

Air Attack Supervisors were nominated from both the Department—including representatives from Parks Victoria—and the Country Fire Authority.

The nominated Air Attack Supervisors attended formal training sessions covering subjects relating to the efficient and safe management of firebombing aircraft generally and the Aircrane Helitanker specifically.

Following an introduction to the project and a briefing on their requirements, the training sessions included refreshers on:

- air attack principles to reinforce prior learning
- air attack strategies and tactics to demonstrate the versatility of firebombing aircraft and their various applications in air attack operations
- air attack terminology including the terms frequently used by the Erickson aircrew.

A detailed session covered the operational performance and the specifications of the Aircrane Helitanker, its capabilities and what was required to support a sustained operation.

The training concluded with a session on the responsibilities of the Air Attack Supervisors for monitoring and recording the activities of the helitanker to enable evaluation of its operational performance.

Operational requirements

Operational airbase

Essendon Airport is the nominated operational airbase pending repositioning, if necessary, of the Aircrane Helitanker to a site closer to the fire. For fires within the primary response zone, if it was repositioned, the appropriate goto helipad became the operational airbase.

When the aircraft was deployed to a fire outside the primary response zone, a large cleared area with access for heavy vehicles and as close as reasonable to the *fire ground* was established as the operational airbase. (Not all of the helipads established in State forests and parks around the State are large enough or have suitable access for the Aircrane's requirements.) Although it is only a temporary landing site, the design, layout and security of an operational airbase still require careful attention as the hazards of operation of the Aircrane and other helicopters remain.

Foam concentrate support units

The three mobile foam support units were strategically located around the outer-metropolitan area at the Department's Bacchus Marsh, Plenty Gorge Park and Cardinia work centres. The fourth (fixed) support unit, which contained 1000 litres of concentrate, was located at Essendon Airport and maintained by Erickson Air-Crane Inc. On deployment of the Aircrane, the nearest foam support unit was dispatched to the nominated operational airbase.

Fill-points

Natural or man-made water sources can be utilised as fill-points. During wildfire operations in 1997–98 the Aircrane Helitanker hover-filled from a range of water sources including shallow irrigation channels, alpine soaks, farm dams, narrow creeks, major rivers and domestic water-supply reservoirs.

During wildfire suppression operations at the Alpine National Park fire in 1998, several fill-points along the Macalister River (Figure 11) were modified to allow access to water and reduce turn-around times.

Hazards such as trees or cliffs near remote natural water sources potentially restrict access to fill-points and therefore reduce productivity for the helitanker.

Figure 11 Hover-filling from the Macalister River (Caledonia fire 1998)

Access to and the volume of water available from a water source are major considerations when operating the Aircrane Helitanker. Extracting 9000 litres with each hover-fill would impact adversely on many of the small rural water sources. Accordingly, the Department and Erickson Air-Crane Inc. implemented a Good Neighbour Policy. The intent of the policy is to consider the integrity of water sources in rainfall-deficient periods when not working in life-threatening situations. Consideration was given to identifying large capacity water sources in the vicinity of the wildfire to minimise the impact on small water sources.

Operational hover-fill points for the Aircrane require a minimum of 70 metres diameter free of vertical obstructions (Figure 12). Beyond this range, however, the height of surrounding objects does not restrict its operation. Smaller-diameter fill-points were used on occasions because these were the only water sources available in potentially life-threatening situations.

Figure 12 A minimum clearance of 70 metres diameter is required (Wonnangatta River – Caledonia fire 1998)

As the snorkel pump cage must be submerged to operate efficiently, a water depth of 0.5 metres is specified as a minimum. On several occasions, however, a full load of water was successfully drafted with the snorkel cage on its side and less than two-thirds immersed. On one occasion the fill-point was too shallow for the snorkel to submerge. So the pilot manoeuvred the helitanker backwards and forwards, dragging the pump cage along the gravel bed of the river to excavate a trench sufficiently deep to allow the pick up of water.

Because drought conditions during the 1997–98 fire season limited the availability of fill-points and obstructions (such as powerlines, trees etc) restricted access to others, the possibility of supplementary water supplies was raised. Serviced filling points or floating-collar tanks or other portable water storage facilities were considered as alternatives to natural and permanent man-made water sources.

The ability of ground resources to replenish portable water storage facilities for hover-filling operations must be considered. The largest floating-collar tank available to the Department contains 25 000 litres. If the Aircrane and other firebombing helitankers operate together at less than a five-minute turn-around, a production rate of 150 000 litres per hour would be required to maintain the fill-point. Further, the snorkel pump cage of the hover-fill system has the potential to split or puncture the walls of a floating-collar tank or the rapid extraction of water may cause the tank to cavitate and collapse. Because natural and man-made water resources were available near the areas of operation, neither serviced filling points nor pre-positioned floating collar tanks or other portable storage facilities were required during the 1997–98 Victorian wildfires.

Fuel

The Aircrane is a high-performance heavy-lift aircraft that consumes more than 2080 litres of fuel every hour of operation (Table 1). Its three fuel tanks have a total capacity of 4900 litres. (Of the two options for refuelling the Aircrane, the most efficient is the *under the wing* pressurised refuelling system. An *over the wing* facility is available but not recommended because of the extended time required to complete the operation.)

The contract arrangements for the Aircrane included the provision of a dedicated 30 000-litre pressurised refuelling tanker (Figure 13) to support the helitanker during wildfire suppression operations. The fuel tanker also provided refuelling facilities for other contracted aircraft.

Figure 13 The 30 000-litre pressurised refuelling tanker

The fuel tanker was automatically dispatched when the Aircrane was activated. On days of high fire danger priority escort was provided.

Routes to each goto helipad were pre-planned to minimise travel times. The selected routes were called *transit routes* and had provision for alternative en-route refuelling points. Called *transit goto helipads*, these alternative refuelling points were to be used when the Aircrane was deployed to a wildfire requiring greater than 1.5 hours travel time for the fuel tanker. Rather than being stood down to await the arrival of refuelling resources at the nominated goto helipad, the Aircrane could refuel at a transit goto helipad, thereby reducing its period of absence from the wildfire.

On initial deployment from the operational airbase, the aircraft carried its maximum capacity of fuel to allow for the ferry time to the wildfire and the delay for the refuelling tanker to arrive at the designated goto or transit goto helipad.

Deployment

Protocol

All specialised firefighting aircraft used in Victoria by the Department and the CFA are managed as a single fleet. One Coordinator manages the fleet under an agreement called the Integrated Firefighting Aircraft Resource (*IFAR*).

The IFAR Coordinator is located at the Department's Emergency Coordination Centre. The Coordinator arranges allocation of all IFAR aircraft on behalf of both agencies and maintains a register of the operational status and location of each aircraft.

Standard management practices and support arrangements for all aircraft engaged in wildfire suppression operations are implemented under IFAR.

As a contract aircraft, the Aircrane is subject to the IFAR agreement and is assigned to either the Departmental or CFA Incident Controller (depending on which organisation has the lead role at the particular fire) for fire suppression operations.

When the Aircrane was dispatched to a going fire, essential ground resources—the refuelling tanker, a mobile foam support unit and an engineering maintenance team—were also despatched as support (Appendix C).

In addition, a dedicated Air Attack Supervisor in an air-attack platform (usually a contract light helicopter) was dispatched to supervise the helitanker in firebombing operations.

Deployment in Victoria

During the 1997–98 fire season, the Aircrane was successfully deployed a total of nine times to wildfires in a variety of topographic and vegetation types within the State (Table 3 and Appendix E). It was used for direct attack on wildfires in highly-flammable coastal vegetation, various classes of eucalypt forest and in pine plantations and for the protection of assets at the rural–urban interface. It was effective in direct attack on the edges of going fires, hot spots and spot fires, providing valuable support to the firefighting resources on the ground, and in working with both the fixed-wing and other rotary-wing firebombers from the IFAR fleet.

Interstate enquiries

During the fire season the Department received enquires from fire authorities in Tasmania and New South Wales regarding the availability of the Aircrane Helitanker to assist in wildfire suppression. Although no enquiry resulted in an interstate deployment for the Aircrane, a planning process and exercise were undertaken to determine the practicality of deploying it to assist other States. In all cases it was determined that arrival at the identified wildfire with an adequate minimum operating period could be guaranteed.

Table 3 Deployments of the S-64F Aircrane Helitanker, 1997–98

Dates (1998)	Fire location	Vegetation type	Total hours	Retardant delivered		Tasking
				Loads (No.)	Volume (Litres)	
2 January	Commencement of contract					
5–14 Jan.	Caledonia - Alpine National Park	Native eucalypt	24.95	94	811 471	Line construction; spot fire knockdown; crew protection; lightning strike containment
14 Jan.	freeway near Wondong	Pine plantation and grassland.	3.1	30	263 466	Line construction; asset protection; spot fire knockdown
16–17 Jan.	Caledonia - Alpine National Park	Native eucalypt	3.59	7	15 700	Spot fire knockdown
17 Jan.	Pines - Frankston	Native heathland.	0.67	5	453 600	Asset protection; line construction; spot fire knockdown; crew protection
18 Feb.	Jancourt - Colac	Native eucalypt	2.5	10	68 040	Line construction
25 Feb.	Macedon – Mt. Macedon	Pine plantation and native eucalypt.	6.44	81	612 398	Line construction; asset protection
26 Feb.	Cherokee – Mt. Macedon	Native eucalypt.	1.12	1	7560	Lightning strike containment
12 March	Kalorama – Mt Dandenong	Native eucalypt	2.51	14	113 400	Asset protection; line construction
22 March	Spring Hill - Trentham	Native eucalypt and grassland.	4.93	58	375 921	Asset protection
27 March	Completion of contract					

See also Appendix E

Operational performance

The large volume of retardant carried and the variable door options enable the Aircrane Helitanker to be used on remote fires, individual spot fires and for the effective containment of going fire edges.

Load capacity

The availability of 9000 litres from a single firebombing aircraft enables combinations of tactics to be employed in fire suppression.

The most obvious advantages of the Aircrane Helitanker over other firebombing aircraft are its abilities to lay down longer lengths of a fire retardant line during a drop and to deliver a variety of drops—such as one large-volume drop and then a series of additional drops of smaller volume—within a short period of time. (The ability to split the load numerous times leaves open the opportunity to develop the uneconomical practice of *heli-mopping*. Alternative resources and tactics will usually be more cost effective for mopping up.)

The large volume carried allows the helitanker to effectively attack many aspects of a wildfire, to remain at the fire ground longer and to provide valuable support to ground resources at going fires.

The combination of the aircraft drop height, the concentrated drop pattern and the volume delivered makes it possible to directly attack the edges of high-intensity fires.

Because the helitanker must carry its maximum capacity of fuel on departure from the operational base—to allow for ferry time to the wildfire and the delay for the refuelling tanker to arrive at the designated goto or operational helipad—the volumes of water that can picked up during the initial loads at a fire are reduced to compensate for the extra fuel load and to offer the maximum flight time at the fire ground.

Delivery of retardant

The Aircrane Helitanker usually delivers a load of fire retardant at a speed of 45 knots. This slow speed allows the retardant to be applied directly onto the fire edge.

The design of the helitanker's delivery system is such that it produces its maximum effect from the optimum height of 150 feet above ground level (*AGL*). Initial observations suggested that the drop height was too great compared to drop heights from other firebombing aircraft. However, the design of the delivery system and the specified drop height ensure that the rotor wash from the Aircrane does not adversely affect the activity of the fire edge, the delivery of fire retardant or the vegetation within the drop zone.

It is not common practice to deliver full salvo drops. Disposal of the full load in one drop gives no allowance for miscalculation of delivery, incorrect directions from the Air Attack Supervisor or the effect of the retardant on wildfire intensity. Nevertheless, full salvo drops were used successfully under certain circumstances, such as on a high-intensity fire burning in large-diameter native eucalypt fuel (Spring Hill Fire, Trentham) and in *Pinus radiata* thinning residue (freeway Fire near Wandong).

Splitting the load to deliver a minimum of 25% of the total volume carried allows the helitanker to attack the fire from various angles, eliminating the *shadowing effect* as can occur with a single load applied from smaller aircraft.

The ability to split the load and to deliver variable levels of coverage provide the opportunity to select multiple targets in a range of wildfire scenarios, such as:

- asset protection
- containment of spot fires
- containment of low-intensity fire in areas of broken or scattered fuel types.

The concentrated uniform drop pattern showed no evidence of *massing* or *pillars* of unmixed water and foam concentrate. Further, there appeared to be no evidence of *pulsing* of the drop or *gaps* in the *footprint* on the ground in the drop zone.

Drop options

The basic characteristics of the Aircrane Helitanker's fire retardant delivery system are similar to those of the belly-tanks carried by the medium helicopters—Bell 205 and 212 (see Biggs 2004). The large volume carried by the helitanker, however, and the ability to control the number of drops as well as the aperture of the drop-doors (enabling control of the coverage level of retardant) mean that it provides more firefighting options.

Splitting the load allows the effectiveness of the first drop to be evaluated and the opportunity to reinforce the drop or to select another target.

Experience with the helitanker's split-load system indicates that, in practice, a maximum of four workable drops can be delivered in a wildfire scenario. If further division of the load is sought, experience indicates that other resources may be more appropriate for the task and the helitanker be employed more appropriately.

Evaluating drops during the early deployments of the helitanker indicated the coverage level of retardant required to treat a fire in a particular vegetation type. As a general guide, coverage levels 1 to 3 (as indicated on the control panel of the Aircrane delivery system's microprocessor) are appropriate for light fuels such as grasslands, levels 4 to 6 for eucalypt forests and coverage levels 7, 8 and full salvos are appropriate for high-intensity fires and fires in areas with high fuel loads.

Drop pattern

The footprint of the drops of retardant delivered by the Aircrane Helitanker's delivery system are concentrated and elongated, whereas that delivered by fixed-wing firebombers is elliptical. The footprint patterns of retardant delivered by other helicopter belly-tanks are described in Biggs (2004).

Because of the constant delivery speed of the Aircrane, there is no break-up of the load. Variations in delivery speed from fixed-wing firebombing aircraft and medium helicopters have resulted in a break-up of the load and gaps in the footprint on the ground.

The most significant features commented on by firefighters were the distances covered by individual drops and their extended duration (Figure 14).

One recorded full salvo drop of 7600 litres applied at a coverage level of 3 in grassland achieved a distance of 1700 metres.

Figure 14 Aircrane delivering an extended drop of retardant

Tactical operations

The majority of firebombing aircraft rely on their forward movement to assist with the delivery of fire retardant. Using the flight characteristics of the aircraft and the physical form and volume of the load, the drops can be *pitched* into the drop zone. Pitching is a tactic employed when access to the drop zone is restricted by topography or fire behaviour.

The power and manoeuvrability of the Aircrane and its ability to reduce its speed of forward movement to a minimum enable the helitanker to deliver retardant directly onto the edge of a fire with greater accuracy than other aircraft.

In very steep terrain, however, the approach and orientation of the helitanker to the drop zone require monitoring. On one occasion, the rotor wash adversely affected the behaviour of a section of a fire contained within a retardant line. The section of the fire was on the uphill side of the helitanker, close to the rotor wash effect area. The subsequent drops were successfully pitched into the drop zone.

The Aircrane is able to conduct controlled turns almost under its own rotor disc diameter, allowing it to reinforce a previous drop of retardant or extend it at an angle. This tactic requires careful orientation as the drop can be misaligned or the target missed. This manoeuvre was successfully executed several times in situations of potential entrapment of ground crews and in the containment of high-intensity spot fires.

Using a preselected coverage level during a 50% split-load drop or a full-salvo drop the pilot is able to adjust the helitanker's direction of flight during a tactical run to apply fire retardant on variable or disjunct edges of a fire.

On several occasions the helitanker was specifically tasked to work with ground firefighters to contain spot fires and the edges of going fire. Drops were placed in strategic locations at the request of the on-ground firefighters, providing valuable support to assist in the containment of the wildfires. On one occasion the Aircrane Helitanker delivered four split-load drops from the one load to contain a going fire edge, providing assistance to the ground resources and allowing them to exit a potential entrapment situation.

A critical factor in aerial firefighting is the turn-around time between successive loads of retardant. If a large amount of going fire or a number of hot spots can be contained with one load, this may allow or compensate for extended turn-around times. The degree of compensation is subject to a combination of the wildfire intensity, accuracy of the aircraft, the type of retardant being delivered and the turn-around time.

Operational limitations

The Aircrane is certified to take off and land up to 12 500 feet and to operate to a height of 16 000 feet AMSL. The helitanker's areas of operation in Victoria during the 1997–98 season did not exceed 7000 feet AMSL.

All tactical aircraft engaged in firebombing operations are subject to the requirements of the Visual Flight Rules (*VFR*). These restrict firebombing operations to daylight hours only and to periods of suitable visibility. The operation of the helitanker was restricted on only two occasions during fire suppression operations in 1997–98. Neither was specific to the Aircrane. On the first occasion the onset of adverse weather conditions with low cloud and fog restricted the ability of all aircraft to undertake bombing operations. The second occasion occurred when visibility on a section of fire was restricted because of smoke. Other firebombing aircraft engaged in the operation had earlier cancelled operations for the same reason.

The following points did not impact on the operational performance of the Aircrane Helitanker during the 1997–98 fire season but they do have the potential to restrict its performance and that of other types of firebombing aircraft.

Salt-water sources were not considered for filling points and are not recommended because the significant blast from the rotor wash produces airborne salt particles that will enter the airframe and cause corrosion. In addition, salt adhering to the cockpit would result in restricted visibility for flight operations despite the use, in the helitanker, of an on-board wash and wipe facility.

Availability, accessibility and capacity of water sources within the area of operation and, importantly, the impact that the distance from filling point to drop zone will have on turn-around times restrict the ability of firebombing aircraft to operate successfully.

Heli-mopping is an uneconomical practice that reduces the ability of the helitanker to successfully suppress going fire elsewhere in the fire ground. The rotor wash can produce *dirty air* and would most likely rekindle and fan fire edges and hotspots before the load is delivered. This will result in the continued use of the helitanker on inappropriate tasking, which could more successfully be achieved by another resource. In this situation a medium helicopter would be more suitable because it is able to deliver a drop from a lower height with minimal disturbance from its rotor wash.

Enhanced operational performance

The power and vertical lift capacity of the Aircrane allows it to work in steep rugged terrain and narrow valleys with few obvious restrictions. It has demonstrated its ability to work in narrow sections of gullies and in tight corners on steep slopes.

Unlike fixed-wing firebombers, the flight characteristics of the helitanker allow it to deliver fire retardant up-slope on wildfire edges. It is also able to hold its position in unstable fire weather conditions to deliver a drop.

Its unique vertical-lift capability enables the Aircrane Helitanker to carry large volumes of fire retardant directly between the fill-point and the target area with limited non-productive flight time, reducing the all-important turn-around time. Another factor contributing to its short turn-around times is its quick-fill system.

Operational safety

Operational air base

Standard Departmental management, security and marshalling procedures were implemented for the on-ground resources and employees engaged in the air operations and associated duties, public safety and landing area security.

Drop zone

Ground firefighting resources working in conjunction with Aircrane Helitanker were advised to observe and maintain awareness of the drop zone safety procedures set out in the Aircraft Safety booklet (see, for example State Aircraft Unit 2002).

Additional information was relayed to ground crews if they were caught in a drop zone. The Air Attack Supervisor advised ground crews of imminent firebombing drops and a siren fitted on the Aircrane was used to warn when the drop was about to occur.

Ground crews were advised that the drops from the helitanker would be for an extended period of time and would cover a greater distance compared to other IFAR aircraft. They were also warned that the Aircrane Helitanker is able to provide multiple high-volume drops from one load. After a large-volume drop from the Aircrane, ground crews in the drop zone reported that the vegetation and the ground became extremely wet and the relative humidity within the area increased dramatically. Several reported that the drop zone became very slippery and small erosion rills developed on sloping surfaces.

The concentrated drop pattern from a full-salvo dump or multiple loads delivered by the helitanker will damage vegetation and it is highly probable that branches will be broken off or dislodged. On two occasions during the Aircrane's operations in 1997–98, in a remote location with no ground crews were present, large branches were broken off trees. One such incident was a result of several drops being delivered to the same fire edge.

Air operations safety

The Aircrane was not always the first tactical aircraft at a wildfire. Often, both fixed-wing and rotary-wing firebombers would already be engaged in firefighting operations upon its arrival.

Despite its size, the Aircrane's performance and operation are generally no different to those of the medium helicopters engaged by the Department for firebombing operations. Its power, speed and manoeuvrability allowed it to work effectively and safely with both the fixed-wing and the smaller rotary-wing firebombers.

During the 1997–98 fire season, the Air Attack Supervisor recognised and was able to utilise the respective attributes and capabilities of fixed-wing and rotary-wing aircraft and, by applying the established communication procedures, all the tactical aircraft were assimilated into the fire operation safely and effectively.

Effectiveness and evaluation

Effectiveness

Where adequate filling points are close by, the availability of the large capacity helitanker has enabled effective, aggressive direct attack on the head fires of high-intensity wildfires where such attack would otherwise prove impracticable. The large volume of retardant available from the Aircrane Helitanker is able to check a going wildfire, allowing aggressive attack by ground crews to complete the task of bringing the fire under control.

The Aircrane demonstrated its ability to quickly deliver fire retardant in potentially threatening situations under extreme fire danger conditions. The large volume it carries also allows it to deliver drops to several locations from the one load, reducing some of the urgency and pressure in the decision-making processes and enhancing the safety and effectiveness of firebombing operations.

By directly attacking high-intensity fires the Aircrane Helitanker was credited with several significant saves where high-value assets were under threat.

The enhanced flight characteristics of the Aircrane combined with its power and manoeuvrability permit the speed of delivery to be slow and the orientation of the aircraft in relation to the target area to be maintained, resulting in more accurate drops of retardant.

The design of the firebombing tank produces a concentrated drop pattern (Figure 15) with a higher volume along its centre line, maximising the effect of the retardant on a fire. Together with the large volume the Aircrane Helitanker can carry, this enables greater lengths of fireline to be treated, reducing the time required to achieve effective line work. Other firebombing aircraft would have had difficulty checking the lengths of fireline equivalent to that achieved by the Aircrane because of the volume of fire retardant required.

Figure 15 A concentrated drop from the helitanker

The vertical lift capability of the Aircrane enables it to fill from water sources that are not accessible to other helicopters. Many fill-points had no horizontal approach or departure paths and the surrounding vegetation was higher than 30 metres, requiring the Aircrane to depart vertically while fully loaded.

The Aircrane Helitanker can provide effective rapid first attack on wildfires in remote locations or where access for ground resources is restricted by distance, topography or cultural development.

The large volume it carries and the concentrated drop pattern it achieves enable the Aircrane to be highly productive when working on a fire edge. In high-intensity fire scenarios the Aircrane has delivered retardant drops in excess of 350 metres long, resulting in successful containment of the going fire edge.

The availability of an effective large-capacity firebomber for direct attack on wildfires has allowed the fixed- and rotary-wing firebombers of the fleet to undertake their primary roles. The medium helicopters work most effectively in fire bombing, rappelling, cargo and crew transport and the fixed-wing aircraft are highly effective and efficient with indirect fire bombing using long-term retardant.

Evaluation

Table 4 illustrates the effectiveness of Erickson's Aircrane Helitanker in delivering large volumes of retardant compared to that of a medium helicopter and a fixed-wing firebomber. In a one-hour period during the fire in the Alpine National Park the Aircrane delivered 126 000 litres of water injected with foam concentrate; 10 medium helicopters would have been required to deliver an equivalent volume in the same time (at a higher total cost).

Table 4 Comparative effectiveness of firebombing aircraft in delivering 126 000 Litres of retardant in one hour

Comparison	Aircraft type		
	Aircrane S-64F	Bell B212 (helicopter)	PZL Dromader (fixed-wing)
Maximum possible volume **(Litres)** carried in a single load	9500	1400	2400
Total volume **(Litres)** of retardant to deliver in one hour	126 000[1]	126 000	126 000
Total number of loads required to deliver 126 000 L	14	90	53
Average drop rate required **(number of drops per hour)**	14	90	53
Number of aircraft required to achieve the desired drop rate[2]	1	10	6

Notes: **1.** Actual volume delivered by the Aircrane in one hour at the Caledonia fire – Alpine National Park (6 January 1998)—Source - Hayden Biggs, Air Attack Supervisor.

2. The turn-around times factored in here assume that a suitable fill-point was available for all types of aircraft. (In fact fixed-wing aircraft could not operate in this situation.)

Another example of the comparative effectiveness of the Aircrane Helitanker could be drawn from the Wondong fire (14 January 1998) where the helitanker delivered 263 466 litres in 1.55 hours; to achieve a similar production rate would have required eight Dromader fixed-wing firebombers (Table 5).

Table 5 Comparative effectiveness of firebombing aircraft in delivering 263 466 Litres of retardant in 1.55 hours

Comparison	Aircraft type		
	Aircrane S-64F	Bell B212 (helicopter)	PZL Dromader (fixed-wing)
Maximum possible volume **(Litres)** carried in a single load	9500	1400	2400
Total volume **(Litres)** of retardant to deliver in 1.55 hours	263 466[1]	263 466	263 466
Total number of loads required to deliver 263 466 L	29	188	110
Average drop rate required **(number of drops per hour)**	19	121	71
Number of aircraft required to achieve the desired drop rate[2]	1	14	8

Notes: **1.** Actual volume delivered by the Aircrane in 1.55 hours at the freeway fire – Wandong (14 January 1998)—Source - Hayden Biggs, Air Attack Supervisor.

2. The turn-around times factored in here assume that a suitable fill-point was available for all types of aircraft.

Recommendations

The Department

Recommendation 1. A project manager be appointed to implement the addition of a supplementary firebombing aircraft equal to the capabilities and operating requirements of the Aircrane Helitanker.

Recommendation 2. The operational base for a firebombing aircraft similar to the Aircrane Helitanker remain at a central location within the primary response zone.
(The Essendon facility enabled the Aircrane to be deployed rapidly to wildfires and provided the necessary infrastructure to support the operation.)

Recommendation 3. A dedicated Air Attack Supervisor in a suitable air-attack platform be provided during wildfire suppression operations to maximise the effectiveness of a helicopter that has the ability to deliver large volumes of fire retardant in short turn-around times.

Recommendation 4. The tactical supervision of an aircraft with capabilities and operational requirements similar to the Aircrane Helitanker be managed by Air Attack Supervisors experienced in the use of both rotary- and fixed-wing firebombing aircraft in fire suppression operations.

The project manager

Recommendation 5. The project manager be responsible for determining the requirements for preparedness, training and accreditation of suitable persons engaged in air operations and ensure adequate resource management and logistical infrastructure is maintained.

Recommendation 6. A preparedness program be implemented to identify additional facilities and resources needed to supplement a firebombing operation using large-capacity firebombing aircraft.

Recommendation 7. The project manager monitor the performance and operation of the firebomber during the availability period.

Erickson Air-Crane INC.

Recommendation 8. Salt-water sources be not used for filling points.
(Salt particles airborne by the rotor wash blast will enter the airframe and cause corrosion. In addition, the drying of salt water on the cockpit results in restricted visibility for the pilot despite the use of the on-board wash and wipe facility.)

Recommendation 9. Future contractors supplying large capacity firebombing helicopters equal to the capabilities and operation requirements of the Aircrane Helitanker explore the use of supplementary water-supply facilities similar to the mobile dip tanks utilised by Erickson Air-crane Inc. in the USA.

Glossary of terms and acronyms

AGL – above ground level

AMSL – above mean sea level

bambi bucket – a collapsible bucket slung below a helicopter; usually used to dip water from a variety of sources for use in fire suppression

coverage level – the volume or depth of fire retardant delivered to a specified area on the ground

dirty air – air that has been disturbed by the effects of a helicopter rotor down-wash

fill-point – a natural or man-made water source where rotary-wing firebombing aircraft can reload by hover-filling

fire ground – the area in the vicinity of the wildfire and fire suppression operations, and the area immediately threatened by the fire. It includes burning and burnt areas; constructed and proposed fire control lines; the area where firefighters, vehicles, machinery and equipment are located when deployed; roads and access points under traffic management control; tracks and facilities in the area surrounding the actual fire; and may extend to adjoining area directly threatened by the fire.

fire retardant – a substance that, by chemical or physical action, reduces the flammability of fuels or slows their rate of combustion. May be water or water injected with a foam concentrate or a long-term retardant chemical.

footprint – the coverage pattern (length, width and depth) of fire retardant on the ground after being delivered

full salvo – rapid release of the total volume of retardant from the firebombing tank

gaps – breaks in the drop footprint of the fire retardant on the ground; the result of pulsing

go-kit – maps, lists of contacts, resources, statements of protocols and procedures and etc. (see Appendix D)

goto helipad – a site identified by the aircrew of the helitanker, the Air Attack Supervisor and the refuelling truck operator as being suitable for the landing and refuelling of the helitanker deployed to a wildfire operation

heli-mopping – the use of a helitanker to black out fire (an uneconomical and unsafe practice)

helitanker – a rotary-wing aircraft fitted with a purpose-built tank attached under the fuselage and capable of dropping a liquid fire retardant

IFAR – Integrated Firefighting Aircraft Resource

IFR – Instrument Flight Rules

massing – large masses or pillars of water mixed with foam concentrate, but which have not mixed effectively before delivery into the drop zone

over-wing refuelling – where a hand-held hose is used to fuel the aircraft by gravity or pump

pillars – see massing

pitching – delivery of a drop using the forward movement of a firebombing aircraft before it changes the direction of flight. Pitching is a tactic employed when access to the drop zone is restricted by topography or fire behaviour.

primary response zone – area identified as a significant fire threat

pulsing – occurs when inadequate venting of a drop from a firebomber restricts the flow of fire retardant through the drop-doors

serviced filling point – a manned facility that has logistical support to conduct refilling of firebombing aircraft

shadowing effect – when the forward motion of the mass of retardant dropped from an aircraft is intercepted by an obstruction, such as a dense stand of trees, the area on the lee side of the obstruction receives little or no retardant

split; split-load drop – part of the load is released at a time from the firebombing tank to achieve two or more drops of retardant

transit goto helipad – alternative helitanker refuelling points along transit routes (qv)

transit route – one of a number of public access roads identified to allow rapid deployment of a support vehicle in emergency operations

under-wing refuelling – where a pressurised flow system with airtight connections is used

VFR – Visual Flight Rules

wildfire – an unplanned grass, scrub or forest fire

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Appendices

Appendix A Public Information Sheet: Erickson Aircrane S64F Helitanker

Natural Resources and Environment

AVIATION SERVICES - FIRE MANAGEMENT

FIRE BOMBING AIRCRAFT
FIRE SEASON 1997/1998

ERICKSON S-64F AIR -CRANE HELITANKER

The Erickson S-64F Air-crane Helitanker is heavy vertical lift helicopter with a 9000 litre fire bombing tank attached to the under body of the helicopter's fuselage.

The helitanker with it's specifically designed high volume tank provides in wildfire suppression a combination of a large capacity fixed wing fire bombing aircraft with important short turn around capability and the versatility, performance and manoeuvrability of a helicopter.

The helitanker's full-length constant flow microprocessor controlled tank doors are designed to be used with long term retardant, water injected with foam concentrate and water. Foam concentrate is injected into the water from a separate internal foam storage tank.

The helitanker is capable of making multiple drops where the pilot can select the volume and coverage level of each drop providing a variety of options for suppressing wildfire. The helitanker is fitted with a fast self-fill snorkel that allows it to hover fill from a variety of water sources. The hover fill system can draw 9000 litres in 38 seconds.

Appendix B

Public Information Sheet: Air attack operation using the S64F Erickson Aircrane

Natural Resources and Environment

CALEDONIA FIRE 9 / 01 / 1998

SPOT FIRE MOROKA RIVER SECTOR

AIR ATTACK OPERATION USING THE S-64F ERICKSON AIR-CRANE

The Caledonia fire started on Wednesday December 31st. 1997 and was located approximately 28 kilometres north of Licola. The suspected cause of the fire was an escape from a campfire. A total of 32,000 hectares was burnt. Areas affected included the Alpine National Park and the Carey River State Forest. Natural Resources and Environment firefighters from across the State battled the blaze along with 31 dozers, 80 tankers and 25 aircraft including the Erickson Air-crane Helitanker.

During the wildfire a section of fire line being indirectly attacked by ground firefighters using hand tools requested aerial support. The line was being constructed along a spur line running east - west to the north of the rapidly advancing fire front. The fire front was running up slope to the north. Ground fire fighters were back burning from a rakehoe line. The depth of the back burn was shallow and the intensity was similar to the main fire front. A spot fire was reported approximately 90 metres north of the intended control line, it was up slope to the northwest in unburned vegetation.

An escape at this point would have required falling back to control lines a considerable distance away, resulting in greater areas of public land being burnt, additional resources to assist suppression activities and additional expenditure. If the Air-crane was to be deployed to the hot spot an immediate concern for the success of the operation was the availability of water fill points. The most serviceable fill point was a natural lake called Tali Karng which was enroute to the hot spot area and located approximately 20 kilometres to the south west of the reported spot fire. After an initial load being delivered to the spot fire the turn around time to Tali Karng would have been in excess of 15 minutes.
The Moroka River was not suitable for hover filling by the Air-crane. Access to suitable water was not possible. The only alternative would be to determine a fill point along the Wonnangatta River.

The ground fire fighters were fully committed to establishing the control line and were reluctant to suppress the spot fire because of the potential of spot fires developing in the area creating entrapment scenarios. Visibility was limited because of smoke. In addition the terrain was very steep with narrow valleys. The use of fixed wing fire bombers and multiple helicopter attack would have been unsafe.

Appendix B (cont). Public Information Sheet: Air attack operation using the S64F Erickson Aircrane (cont.)

The potential of the spot fire was discussed between the Air Attack Supervisor and the Operations Officer on the fire line. The ground fire fighters remained on the fire line to continue the back burning operation and would attempt follow up work on the spot fire. It was earlier proposed to withdraw all ground fire fighters from the sector and forfeit the control strategy. The air attack strategy employed was first to restrict the advance of the going spot fire up slope using an arrow head attack. Once achieved, the remaining two drops would be placed along the spot fire flanks and backing fire. The target area was identified by the air attack platform for the Air-crane, which then departed the target area to provide adequate separation.

A single load, split into four drops, on the going spot fire edges using direct attack was effective enough to suppress the going fire edges and contain the fire. The load of water was injected with foam concentrate at a rate of 0.5 %. All four drops were successful in extinguishing going fire edges. Small hot spots continued to burn inside the spot fire perimeter. Ground fire fighting crews were advised of the actions taken and were directed to the spot fire area and employed dry fire fighting techniques to control the spot fire. No further aerial assistance was required on the spot fire.

Additional loads were picked up from the Wonnangatta River and were placed strategically within the going fire to cool off the advancing fire front and the back burn buying time for the reduced number of ground crews who remained on the control line. The advancing fire front was contained within the hand line and back burn that was implemented.

The Air-crane delivered 9,000 litres of fire suppressant that was split into four drops on the spot fire in a recorded time of 47 seconds. The subsequent five drops delivered to the fire line achieved six-minute turn-arounds from a fill point established on the Wonnangatta River. The high performance manoeuvrability and power of the Air-crane enabled it to operate in an area where it was not suitable for a light helicopter to continue operations or to allow fixed wing fire bombers to operate because of the terrain and wildfire conditions.

The ability to provide uniform concentrated drop patterns combined with the extreme manoeuvrability of the Air-crane allows for accurate delivery of fire suppressant. The option of manual over ride on the bombing system allows the pilot the ability to drop fire suppressant directly on the fire edge without extending drops outside target area.

Appendix C Project heavy helicopter preparedness statement

Summary of preparedness levels

Resource	Low Fire Danger	Moderate Fire Danger	High Fire Danger	Extreme Fire Danger
Erickson Aircrane	Stand-by 15 Minute availability	Stand-by 15 Minute availability	Stand-by 15 Minute availability Duty IFAR Coordinator Requirement	Duty IFAR Coordinator Requirement
Erickson Duty Pilots	Stand-by 15 Minute availability Core time 1000-1800	Stand-by 15 Minute availability Core time 1000-1800	Stand-by 15 Minute availability Duty IFAR Coordinator Requirement	Duty IFAR Coordinator Requirement
Erickson Duty Engineers	Erickson management Core time 1000-1800	Erickson management Core time 1000-1800	Erickson management Duty IFAR Coordinator Requirement	Duty Erickson management
Erickson Duty Refueller / Refuelling truck	Stand-by 15 Minute availability Core time 1000-1800	Stand-by 15 Minute availability Core time 1000-1800	Stand-by 15 Minute availability Duty IFAR Coordinator Requirement	Duty - IFAR Coordinator Requirement
Victoria Police Escort	Standard operations	Standard operations	Standard operations	IFAR Coordinator Requirement Displan
Air Attack Platform	15 minute availability	15 minute availability	Firebird 10 Notionally committed Duty, IFAR Coordinator requirement.	Firebird 10 Located with Erickson 43 immediate deployment Duty IFAR Coordinator requirement
Duty Air Attack Supervisor	15 minute availability Core time 1000-1800	15 minute availability Core time 1000-1800	Duty IFAR Coordinator requirement Located with Erickson 43 immediate deployment.	Duty IFAR Coordinator requirement Located with Erickson 43 immediate deployment
Aircraft Officer	Normal work duties	Normal work duties	Normal preparedness requirements	Duty - IFAR Coordinator Requirement
Foam Support Trailers 3 x 1500 Lt Foam Support Permanent 1 x 1000 Lt	Located at Nominated Base X 3 Fully Equipped and maintained, inspected daily	Located at Nominated Base X 3 Fully Equipped and maintained, inspected daily	Located at Nominated Base X 3 Fully Equipped and maintained, inspected daily	Located at Nominated Base. Fully Equipped and maintained, inspected daily attached to manned dispatch vehicle, two persons.
Duty Foam Support Crew	Normal work duties	Normal work duties	Normal preparedness requirements	Duty - IFAR Coordinator Requirement
Bulk Foam Support	IFAR Coordinator - Equipment and Development Centre	IFAR Coordinator - Equipment and Development Centre	IFAR Coordinator - Equipment and Development Centre	IFAR Coordinator - Equipment and Development Centre

Appendix D

Go-kit - Air Attack Supervisor Flight Kit Requirements

The Air Attack Supervisor must be reasonably prepared for unexpected and dramatic changes in the flight program, once in flight. The following is a suggested kit only. An Air Attack Supervisor kit is a personal item and as such should be personalised to the individuals needs.

Basic and Essential Equipment

Complete set of maps - prepared and organised to be readily useable and adequate to reasonably cover every area of operation. AAS may have different preferences, but each should have a complete set of maps at a working scale.

Note: WAC charts (1:1,000,000) are useful for long distance navigating and pilot briefing; AAS in state border regions should have maps for interstate flying.

Clothing Requirements

Personal Protective Equipment

protective helmet	one piece flying suit	safety boots
nomex gloves	cotton underclothing	

Personal Clothing

overnight kit comprising tooth brush, socks, jocks etc

Operational Requirements

Operational Equipment

knee clipboard	binoculars	camera and spare film
watch	compass	audio recorder
GPS	spare batteries/charger	electret/dynamic microphone
nre flight operations checklist	navigation protractor	McArthur Meter
portable radio 12 dc charger		

Stationary

pencils	full circle/square protractor	ruler/scale ruler
eraser	sharpener	AAS log sheet
radio call signs	radio frequencies	area estimator

Welfare Requirements

Personal

drinking water	sunglasses	urine bottle
money	food	small first aid kit
air sickness tablets	air sickness bag	

Appendix D (cont). Go-kit - Air Attack Supervisor Flight Kit Requirements (cont.)

Mapping Requirements

World Aeronautical Chart ICAO 1:1,000,000

Adelaide	Armidale	Bourke
Brisbane	Canberra	Hamilton
Melbourne	Sydney	Tasmania

Visual Navigation Chart – Melbourne 1: 500 000

Australian Map Grid 1 : 100,000 Series

Primary Response Zone Deployment Heavy Helicopter Project

Bacchus Marsh	Geelong	Healesville
Melbourne	Ringwood	Sorrento
Warragul	Western Port	

Australian Map Grid 1 : 250,000 Series

State Wide Deployment Heavy Helicopter

Bairnsdale	Ballarat	Bega
Bendigo	Colac	Deniliquin
Hamilton	Horsham	Mallacoota
Melbourne	Mildura	Naracoorte
Ouyen	Penola	Portland
Port Phillip	St Arnaud	Swan Hill
Tallangatta	Warburton	Wangaratta

Commercial and/or Agency Map Books(Current Editions)

ESMAP Outer Melbourne Directory

Airfield Almanac

Melway Greater Melbourne

VICROADS Country Street Directory of Victoria

Vic/Tas Country Airstrip Guide

Melbourne Water's Asset Exclusion Zones

Beaconsfield Reservoir	Cardina Reservoir	Devils Bend Reservoir
Frankston Reservoir	Greenvale Reservoir	Maroondah Reservoir
O'Shannassy Reservoir	Running Creek Reservoir	Silvan Reservoir
Sugarloaf Reservoir	Tarago Reservoir	Thompson Reservoir
Toorourong Reservoir	Upper Yarra Reservoir	Yan Yean Reservoir

Appendix D (cont). *Go-kit - Air Attack Supervisor Flight Kit Requirements (cont.)*

Natural Resources and Environment
AGRICULTURE
RESOURCES
CONSERVATION
LAND MANAGEMENT

Fire Management

"Protecting your forests, parks and reserves from wildfire"

P.O. Box 41, East Melbourne, Victoria, Australia, 3002
Telephone: *(03) 9412 4777* ***Facsimile:*** *(03) 9412 4750*

Operational Information Erickson Air-crane S-64F Helitanker

1.0. Introduction

An Erickson S-64F Air-crane Helitanker has been added to the fleet of aerial fire fighting aircraft. The Air-crane is a heavy vertical lift helicopter with a 9000 litre fire-bombing tank. The tank is fitted with a fast self-fill snorkel that allows it to hover-fill from a variety of water sources. The microprocessor controlled tank system is capable of delivering multiple drops, where the pilot can select the volume and coverage level of each drop.

The principal area of operation identified for the helitanker is in a *primary response zone*[13] ***with significant high fire threat areas of forested public lands and the urban/semi urban interface within a 100-kilometre radius of Melbourne.***

2.0. Erickson S-64F Air-crane Helitanker

2.1 Quick facts.

Max. Speed.	100 Knots	Length.	27.3m
Fuel Capacity	4900 lt	Main Rotor Dia	22.0m.
Fuel Con	2080 lt/hr.	Height.	7.82m
Tank Capacity	9000 lt.	Foam Capacity	290 lt
Hover Fill Time	40 sec		

When the Air-crane is flying a flight crew of two pilots operates it and the lead pilot flies the aircraft from the left-hand side.

2.2 Delivery Systems.

2.2.1 Fire Bombing Tank.

The Air -crane is fitted with a 9000 litre tank designed for the delivery of long term retardant, water injected with foam concentrate and water. The tank has been designed to deliver a concentrated drop pattern. The tank is fitted with a fast self-fill flexible snorkel, has the ability to hover fill 9000 litres in 38 seconds from a variety of water sources. Filling points require a minimum overall diameter of 70 metres and a minimum depth in clean water of one metre.

2.2.2 Pressurised Water Cannon.

The helitanker has an experimental delivery system, which is a forward mounted water cannon. The cannon is located on the left-hand side of the helitanker forward of the lead pilot. The cannon has the ability to direct fire suppressant up to fifty metres with a constant flow of 1100 litres per minute.

[13] Area identified as a significant fire threat.

Appendix D (cont). Go-kit - Air Attack Supervisor Flight Kit Requirements (cont.)

The ability to control the direction of the cannon is restricted to a vertical adjustment of 15 degrees using a hydraulic ram mounted on the side of the aircraft, the horizontal directional control is provided by the ability of the aircraft to turn.

2.2.3 Delivery Control.
The tank doors are controlled by a microprocessor. The flight crew can pre-select the volume and coverage level of each drop. The minimum volume available to be delivered is 25 % of the volume available in the tank. The other volume options available to be selected and delivered are 50 %, 75 % or 100 %.

The microprocessor also controls the** coverage level [14]**of suppressant to be delivered to the ground. This is achieved by regulating the flow of suppressant through the tank doors. A Global Positing System receiver monitors the delivery speed of the helitanker and has the ability to adjust and modify the flow rates from the doors if the delivery speed is too fast or slow.

Coverage levels available are:

Coverage Level Per 10m^2	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Volume Litres	3.78	7.56	11.3	15.1	18.9	22.6	26.4	29.9

As a general guide coverage levels 1 to 3 are used in light fuels similar to grasslands, 4 to 6 for eucalypt vegetation and coverage levels 7, 8 and full salvos are used on high fire intensities and in high fuel load areas.

Foam concentrate is injected into the tank from a separate 290 litre internal foam storage tank, the injection rates that can be selected range from are 0.1% to 0.5%.

3.0 Preparedness

3.1 Planning
A preparedness statement has been developed to manage the Air-crane and essential resources to ensure rapid deployment. The document specifies the requirement for a resource according to the fire danger level determined for each day.

3.2 Preparedness
It is acknowledged that an accredited and experienced Air Attack Supervisor with knowledge and awareness of specific details of the helitanker's attributes and operation have the ability to supervise the aircraft in a fire bombing operation.
(This document is acknowledged as providing adequate information for air attack supervisors.).

Air Attack Supervisors are to recognise their limitations and operational experience in complex wildfire scenarios and are reminded that Incident Controllers will appoint additional resources during forecast periods of Very High to Extreme Fire Danger and complex wildfire scenarios combined with additional aircraft resources. In addition Air Attack Supervisors are advised that in a complex wildfire scenario with multiple aircraft operating, the helitanker will require dedicated supervision to maintain effectiveness.

4.0 Operational Requirements

4.1 Operational Air Base
The Air-crane has a significant rotor wash, which has the ability to dislodge loose items on vehicles or structures.

[14] The volume of fire suppressant delivered to a specified area on the ground after a drop.

Appendix D (cont). Go-kit - Air Attack Supervisor Flight Kit Requirements (cont.)

Consideration is to be given to the landing area design and layout.

- Landing areas equal to 150 metres by 150 metres are required.
- Heavy vehicle access is required to allow for refuelling.
- Landing areas in the urban interface fire situation will be sports ovals.
- Aircraft management and marshalling is required to provide public safety and landing area security.

4.2 Fuel

The Air crane is a high performance fire bombing aircraft and requires substantial quantities of fuel.

- The Air-crane has a fuel tank capacity of 4900 litres
- It consumes 2080 litres per hour.
- A 30,000 litre refuelling truck is despatched with the Air-crane to provide hot refuelling capability.
- The refuelling truck will supply all Jet A1 powered IFAR aircraft during wildfire operations.

If the Air-crane is deployed to a wildfire greater than 1.5 hours travel time for the refuelling truck consideration will be given to the provision of a **goto-helipad** [15] for refuelling. The goto-helipad is a site identified by the Air-crane and refuelling truck, which is on-route to the wildfire. The goto-helipad will be located at an established sports oval in consultation with the incident management team.

4.3 Foam

The fixed tank of the air-crane has an internal tank fitted, which holds 290 litres of foam concentrate.

- If foam is injected to the load at 0.5 % the maximum number of loads available is ten.
- Foam support units have been produced and are located at strategic locations in the metropolitan area.
- Bacchus Marsh (1500 lts.), Westerfold Park (1500lts.) and Cardina Reservoir Park (1500 lts.).
- If the Air crane is deployed to a wildfire the nearest foam support unit will be dispatched.
- The Equipment Development Centre Altona will refill foam support units.
- The foam support units will supply all IFAR aircraft.

4.4 Fill Points

The Air-crane is similar to the contract medium helicopters and can utilise natural or man made bodies of water. Suitable fill points should have

- A minimum diameter of 70 metres.
- A minium depth in clear water of 1.0 metres.
- A large capacity.

The Department of Natural Resources and Environment has implemented a Good Neighbour Policy. The intent of the policy is to consider the integrity of water sources in rainfall deficient periods (W*hen not working in life threatening situations.).*

[15] Sites identified by the aircrew of the helitanker, air attack supervisor and refueling truck at a wildfire operation suitable to land and refuel the helitanker.

Appendix D (cont). Go-kit - Air Attack Supervisor Flight Kit Requirements (cont.)

4.5 Operational Support

General maintenance of the Air-crane and other IFAR aircraft at the end of a day's operation will require:

- A wash-down/wash-out to remove suppressant residues.
- The provision of mobile lighting units to assist with overnight maintenance.

5.0 Deployment

5.1 Deployment

The Air-crane is a contract aircraft subject to the IFAR agreement and is assigned to Incident Controllers, either NRE or CFA, for fire suppression operations.

Air Attack Supervisors are reminded that the IFAR Coordinator may appoint additional resources during forecast periods of Very High to Extreme fire danger and complex wildfire scenarios.

6.0 Operational Performance

6.1 Load Capacity

The availability of 9000 litres from one aircraft provides the ability to produce longer lengths of line and the ability to deliver a single high volume drop and then provide additional drops of similar capacity within a short period of time. However the ability to split the load numerous times has the potential to develop the uneconomical practice of **heli-mopping** [16]. If this situation develops then alternative resources and tactics should be employed.

6.2 Delivery

The helitanker normally drops its load of fire suppressant at a speed of 45 knots. The optimum height of a drop to be delivered is 150 feet AGL. The design of the tank delivery system and the drop height ensures that the rotor wash from the Air-crane has no adverse effect on the fire edge activity, delivery of fire suppressant or vegetation within the drop zone.

The use of full salvo drops is not common practice. Delivery of a full salvo does not allow for miscalculation of delivery, incorrect direction from the air attack supervisor or the effect of the suppressant on the wildfire intensity.

6.3 Drop Options

The helitanker's delivery system is very similar to the medium helicopters (Bell 205 and 212). The medium helicopters have the ability to split their loads and restrict the rate of flow. The Air-crane is similar but provides more options with the large volume available and restricted door control options.

The practical number of workable drops is a maximum of four. It is possible that the further division of the load indicates that other resources would be more appropriate for the tasking and the helitanker be redeployed to a more appropriate tasking.

6.4 Drop Pattern

The drops delivered by the Air-crane result in a concentrated elongated **footprint**[17] in the drop zone. The pattern is elongated in shape compared to an elliptical shape from fixed wing fire bombers. Because of the constant delivery flow there is no break up of the load.

[16] Uneconomical practice of using a helitanker to black out fire.
[17] The coverage pattern on the ground of fire suppressant after being delivered.

Appendix D (cont). Go-kit - Air Attack Supervisor Flight Kit Requirements (cont.)

6.5 Operational Limitations

The operational endurance of the Air-crane is limited to 1.5 to 2.0 hours subject to transit times.

- The use of salt-water sources will not be considered because of the significant rotor wash blast producing airborne salt particles that will enter the airframe and cause corrosion.
- The Air-crane operates under Visual Flight Rules (VFR) and is restricted to daylight hours for flying operations.
- The availability, accessibility and capacity of water sources within the area of operation.
- The impact of the distance from filling point to drop zone will have on turn around times.

The potential use of the uneconomical practice of heli-mopping will restrict the ability of the helitanker to successfully suppress going fire in the drop zone. The rotor wash has the potential to produce dirty air and most likely rekindle fire edges and hotspots before the load is delivered. This will result in the continued use of the helitanker on inappropriate tasking, which could be successfully attacked by another resource.

7.0 Operational Safety

7.1 Drop Zone

Advice to ground crews of fire bombing drops will be provided by the Air Attack Supervisor. The Air-crane is fitted with a siren to advise of fire bombing drops.

If ground crews are caught in a drop zone they are to employ the standard drop zone safety procedures as set out in the Aircraft Safety Handbook.
The additional factors to consider if ground crews are caught in a drop zone are:

- The drop will be for a extended period of time
- The drop will cover a greater distance in length as compared to other IFAR aircraft.

7.2 Air Operations Safety

Despite the physical size of Air-crane, the performance and operation of the aircraft is no different to the medium helicopters currently engaged for fire bombing operations. The speed and manoeuvrability of the Air-crane allows it to work with fixed wing fire bombers and other rotary wing fire bombers.

A factor to consider is the potential effect of the significant rotor wash effect on other aircraft in the operating environment. The flight path taken by the Air-crane will result in residual dirty air, which will produce turbulence activity for any aircraft that passes through the flight path immediately after the Air-crane.

Further information can be obtained by contacting Hayden Biggs Fire Management Branch, telephone 03 0412 4777.

Additional information appended to the Go-kit:

PREPAREDNESS STATEMENT LARGE INCIDENT DEPLOYMENT AIRCRAFT PROJECT
SUMMARY OF PREPAREDNESS LEVELS

(Reproduced as Appendix C above)

MAPS

Melbourne Water's Asset Exclusion Zones

(A series of maps depicting available water sources in the primary response zone)

Contract Aircraft for 1997/98

Category	Callsign	Type	Operator	NOB	Bomb capacity (litres)	Fuel Type	Trunk Radio 2001-	Simplex home channel
Light Helicopter 15 min call	Firebird 1 Firebird 2 Firebird 3 Firebird 4	Bell 206 Jetranger AS350 Squirrel Bell 206 Jetranger Bell 206 Jetranger	Jayrow Jayrow Jayrow Jayrow	Horsham Moorabbin Myrtleford Bairnsdale	400 Bucket 600 Bucket 400 Bucket 400 Bucket	Jet A1 Jet A1 Jet A1 Jet A1	701 702 703 704	143 131 149 155
Medium Helicopter 15 min call 15 min call	Helitack 1 Helitack 2 Helitack 3 Helitack 4	Bell 212 Bell 205 Bell 212 Bell 205	Lloyd Jayrow Lloyd Jayrow	Moorabbin Benalla Heyfield Bacchus Marsh	1400 Belly tank 1400 Belly tank 1400 Belly tank 1400 Belly tank	Jet A1 Jet A1 Jet A1 Jet A1	721 722 723 724	131 149 155 131
Fixed Wing Firebombers Absolute 15 min call	Firebomber 1 Firebomber 2 Firebomber 3 Firebomber 4 Firebomber 5	Turbine Thrush Turbine Thrush PZL Dromader Air Tractor 802 PZL Dromader	A.G. Airwork Western Aerial Woorayl Pay's Air Service Woorayl	Stawell Portland Lilydale Albury Bairnsdale	1900 hopper 1900 hopper 2850 hopper 3200 hopper 2850 hopper	Jet A1 Jet A1 Avgas Jet A1 Avgas	751 752 753 754 755	143 143 131 149 155
Fixed Wing Firebombers Partial 2hrs/15 min call	Firebomber 6 Firebomber 7 Firebomber 8 Firebomber 9 Firebomber 10	TBA PZL Dromader PZL Dromader PZL Dromader Turbine Thrush	TBA Superspread Woorayl Alpine Airwork A.G. Airwork	TBA Deniliquin Leongatha Benambra	TBA 2500 hopper 2850 hopper 2850 hopper 1900 hopper	TBA Avgas Avgas Avgas Jet A1	TBA 757 758 759 760	TBA 137 155 155 TBA
I R Linescanner	Firescan 02	Cessna 404 Titan	Australasian Jet	Essendon	not applicable	Avgas	750	131
Reconnaissance	Birddog 37	Cessna 337	Australasian Jet	Essendon	not applicable	Avgas	776	131
Heavy Helicopter	Erickson 46	Aircrane S64F	Heavy Lift PNG	Essendon	9000 Belly tank	Jet A1	775	131

Appendix E

Operational deployments – Erickson Aircrane S-64F Helitanker

OPERATIONAL DEPLOYMENTS ERICKSON AIR-CRANE JANUARY 1998

Day	Date	Location	Loads	Drops	US Gallons	Litres	Total Hours	Station Time	Refuel Time	Ferry Time	Turn Arounds Decimal Minutes
Thursday	1/01/1998	NOB	0	0	0	0	0	0	0	0	0
Friday	2/01/1998	NOB	0	0	0	0	0	0	0	0	0
Saturday	3/01/1998	NOB	0	0	0	0	0	0	0	0	0
Sunday	4/01/1998	NOB	0	0	0	0	0	0	0	0	0
Monday	5/01/1998	Ferry	0	0	0	0	1.07	0	0	1.07	0
Monday	5/01/1998	Caledonia	33	105	72,250	273,105	5.07	5.07	0.8	0	3.51 Min.
Tuesday	6/01/1998	Caledonia	22	73	63,100	238,518	6.5	5.83	0.67	0	5.34 Min.
Wednesday	7/01/1998	Caledonia	13	52	27,275	103,099	2.45	2.45	0	0	2.82 Min.
Thursday	8/01/1998	Caledonia	8	25	16,700	63,126	3.27	3.27	0	0	7.84 Min.
Friday	9/01/1998	Caledonia	0	0	0	0	0	0	0	0	0
Saturday	10/01/1998	Caledonia	0	0	0	0	0	0	0	0	0
Sunday	11/01/1998	Caledonia	0	0	0	0	0	0	0	0	0
Monday	12/01/1998	Caledonia	11	50	21,550	81,459	3.05	3.05	0	0	3.66 Min.
Tuesday	13/01/1998	Briagalong	7	48	13,800	52,164	2.44	2.44	0	0	3.04 Min.
Wednesday	14/01/1998	Ferry	0	0	0	0	1.1	0	0	1.1	0
Wednesday	14/01/1998	Wondong	30	57	69,700	263,466	3.1	1.55	0.12	1.43	3.26 Min.
Thursday	15/01/1998	NOB	0	0	0	0	0	0	0	0	0
Friday	16/01/1998	Caledonia	3	6	6,100	23,058	1.72	0.64	0	1.08	17.16 Min.
Saturday	17/01/1998	Caledonia	4	15	9,600	36,288	0.97	0.97	0	0	7.86 Min.
Saturday	17/01/1998	Ferry	0	0	0	0	1	0	0	0	0
Saturday	17/01/1998	Frankston	5	11	12000	45,360	0.67	0.35	0	0.32	3.63 Min.
Sunday	18/01/1998	NOB	0	0	0	0	0	0	0	0	0
Monday	19/01/1998	NOB	0	0	0	0	0	0	0	0	0
Tuesday	20/01/1998	NOB	0	0	0	0	0	0	0	0	0
Wednesday	21/01/1998	NOB	0	0	0	0	0	0	0	0	0
Thursday	22/01/1998	NOB	0	0	0	0	0	0	0	0	0
Friday	23/01/1998	NOB	0	0	0	0	0	0	0	0	0
Saturday	24/01/1998	NOB	0	0	0	0	0	0	0	0	0
Sunday	25/01/1998	NOB	0	0	0	0	0	0	0	0	0
Monday	26/01/1998	NOB	0	0	0	0	0	0	0	0	0
Tuesday	27/01/1998	NOB	0	0	0	0	0	0	0	0	0
Wednesday	28/01/1998	NOB	0	0	0	0	0	0	0	0	0
Thursday	29/01/1998	NOB	0	0	0	0	0	0	0	0	0
Friday	30/01/1998	NOB	0	0	0	0	0	0	0	0	0
Saturday	31/01/1998	NOB	0	0	0	0	0	0	0	0	0
		Totals	136	442	312,075	1,179,643	32.41	25.62	1.59	5	

Notes: 1. All times are recorded in Decimal Time
2. Turn around times are recorded in Decimal minutes.
3. Turn-around times are calculated on the total period of the operational deployment, not just the time in the target area.

Appendix E (cont). *Operational deployments – Erickson Aircrane S-64F Helitanker (cont.)*

OPERATIONAL DEPLOYMENTS ERICKSON AIR-CRANE FEBRUARY 1998

Day	Date	Location	Loads	Drops	US Gallons	Litres	Total Hours	Station Time	Refuel Time	Ferry Time	Turn Arounds Decimal Minutes
Sunday	1/02/1998		0	0	0	0	0	0	0	0	0
Monday	2/02/1998		0	0	0	0	0	0	0	0	0
Tuesday	3/02/1998		0	0	0	0	0	0	0	0	0
Wednesday	4/02/1998		0	0	0	0	0	0	0	0	0
Thursday	5/02/1998		0	0	0	0	0	0	0	0	0
Friday	6/02/1998		0	0	0	0	0	0	0	0	0
Saturday	7/02/1998		0	0	0	0	0	0	0	0	0
Sunday	8/02/1998		0	0	0	0	0	0	0	0	0
Monday	9/02/1998		0	0	0	0	0	0	0	0	0
Tuesday	10/02/1998		0	0	0	0	0	0	0	0	0
Wednesday	11/02/1998		0	0	0	0	0	0	0	0	0
Thursday	12/02/1998		0	0	0	0	0	0	0	0	0
Friday	13/02/1998		0	0	0	0	0	0	0	0	0
Saturday	14/02/1998		0	0	0	0	0	0	0	0	0
Sunday	15/02/1998		0	0	0	0	0	0	0	0	0
Monday	16/02/1998		0	0	0	0	0	0	0	0	0
Tuesday	17/02/1998		0	0	0	0	0	0	0	0	0
Wednesday	18/02/1998	Jancourt	10	20	18,200	68,796	2.07	0.74	0	1.33	6.05
Thursday	19/02/1998	Ferry flight	0	0	0	0	0.88	0	0	0	0
Friday	20/02/1998		0	0	0	0	0	0	0	0	0
Saturday	21/02/1998		0	0	0	0	0	0	0	0	0
Sunday	22/02/1998		0	0	0	0	0	0	0	0	0
Monday	23/02/1998		0	0	0	0	0	0	0	0	0
Tuesday	24/02/1998		0	0	0	0	0	0	0	0	0
Wednesday	25/02/1998	Macedon	81	175	162,010	612,398	6.44	5.44	0.67	0.33	2.2
Thursday	26/02/1998	Cherokee	1	3	2,000	7,560	1.12	0	0	0	22.33
Friday	27/02/1998		0	0	0	0	0	0	0	0	0
Saturday	28/02/1998		0	0	0	0	0	0	0	0	0
		Totals	92	198	182,210	688,754	10.51	6.18	0.67	1.66	

Notes: 1. All times are recorded in Decimal Time
2. Turn around times are recorded in Decimal minutes.
3. Turn-around times are calculated on the total period of the operational deployment, not just the time in the target area.

Appendix E (cont). *Operational deployments – Erickson Aircrane S-64F Helitanker (cont.)*

OPERATIONAL DEPLOYMENTS ERICKSON AIR-CRANE MARCH 1998

Day	Date	Location	Loads	Drops	US Gallons	Litres	Total Hours	Station Time	Refuel Time	Ferry Time	Turn Arounds Decimal Minutes
Sunday	1/03/1998		0	0	0	0	0	0	0	0	0
Monday	2/03/1998		0	0	0	0	0	0	0	0	0
Tuesday	3/03/1998		0	0	0	0	0	0	0	0	0
Wednesday	4/03/1998		0	0	0	0	0	0	0	0	0
Thursday	5/03/1998		0	0	0	0	0	0	0	0	0
Friday	6/03/1998		0	0	0	0	0	0	0	0	0
Saturday	7/03/1998		0	0	0	0	0	0	0	0	0
Sunday	8/03/1998		0	0	0	0	0	0	0	0	0
Monday	9/03/1998		0	0	0	0	0	0	0	0	0
Tuesday	10/03/1998		0	0	0	0	0	0	0	0	0
Wednesday	11/03/1998		0	0	0	0	0	0	0	0	0
Thursday	12/03/1998	Kalorama	14	36	30,000	113,400	2.51	2	0	0.51	4.16
Friday	13/03/1998		0	0	0	0	0	0	0	0	0
Saturday	14/03/1998		0	0	0	0	0	0	0	0	0
Sunday	15/03/1998		0	0	0	0	0	0	0	0	0
Monday	16/03/1998		0	0	0	0	0	0	0	0	0
Tuesday	17/03/1998		0	0	0	0	0	0	0	0	0
Wednesday	18/03/1998		0	0	0	0	0	0	0	0	0
Thursday	19/03/1998		0	0	0	0	0	0	0	0	0
Friday	20/03/1998		0	0	0	0	0	0	0	0	0
Saturday	21/03/1998		0	0	0	0	0	0	0	0	0
Sunday	22/03/1998	Trentham	58	118	99450	375921	4.93	4.16	0.37	0.4	2.5
Monday	23/03/1998	Ferry	0	0	0	0	0.68	0	0	0	0
Tuesday	24/03/1998		0	0	0	0	0	0	0	0	0
Wednesday	25/03/1998		0	0	0	0	0	0	0	0	0
Thursday	26/03/1998		0	0	0	0	0	0	0	0	0
Friday	27/03/1998		0	0	0	0	0	0	0	0	0
Saturday	28/03/1998		0	0	0	0	0	0	0	0	0
Sunday	29/03/1998		0	0	0	0	0	0	0	0	0
Monday	30/03/1998		0	0	0	0	0	0	0	0	0
Tuesday	31/03/1998		0	0	0	0	0	0	0	0	0
		Totals	72	154	129,450	489,321	8.12	6.16	0.37	0.91	

Notes: 1. All times are recorded in Decimal Time
2. Turn around times are recorded in Decimal minutes.
3. Turn-around times are calculated on the total period of the operational deployment, not just the time in the target area.

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