AIRCRAFT OPERATIONS MANUAL DISTRIBUTION

Manual No.	Manual Holder
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3	T Maher, CALMfire Bunbury
4	CALMfire Como
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1.0 CIVIL AVIATION REGULATIONS AND CIVIL AVIATION ORDERS

1.1 Dropping of Incendiaries from Aircraft for the Ignition and Controlled Burning of Forest Undergrowth:

1.1.1 DROPPING APPROVAL

CIVIL AVIATION ORDERS SECTION 29-5

Incendiaries may be carried in aircraft on bush fire control subject to the following conditions:

[a] Operator hold's an aerial work licence.

[b] Operation is authorised by state forest authority.

[c] Incendiaries type and arming device and dropping equipment be approved by C.A.A. officers.

1.1.2 CIVIL AVIATION REGULATION 150A(IV)

Incendiaries may be dropped from aircraft subject to the following conditions:

DROPPING SITE

[a] Dropping site clearly defined by state forest authorities using terrain features, ground signals, markers etc.

[b] The pilot shall make one preliminary run over the site and obtain confirmation he is over the site.

1.1.3 DROPPING REQUIREMENTS

[a] Site must be clear of persons and stock.
[b] Incendiaries shall be dropped by an Incendiary Machine Operator.
[c] Effective communications shall be maintained between the crew.
[d] The pilot shall at all times be in VHF contact with a responsible forest officer on the drop site.
[e] The pilot shall be personally briefed on the location of the drop area and other matters prior to departure.
[f] The pilot shall ensure that the load is within the limits - both regarding centre of gravity and weight.

1.1.4 INCENDIARY MACHINE OPERATOR QUALIFICATIONS

[a] Shall be trained and qualified in the use of the incendiary equipment and dropping operations.

1.1.5 CARRIAGE OF ARTICLES AND PERSONS

[a] The carriage of incendiaries shall be in accordance with Section 20.16.2 CAO's.
[b] For safety reasons, no persons other than those having duties relating to the operation shall be carried in the aircraft.
[c] Each person shall occupy a separate seat equipped with an approved safety belt or harness. Safety belts/harness shall be worn at all times during take-off, flight and landing.

1.1.6 OPERATING CONDITIONS

[a] Under CAR 157(4)(b) approval may be given for the aircraft to descend to, but not below, 46 metres (150 feet) above tree-top level during dropping operations.

[b] However, an aircraft shall not be flown below 155 metres (500 feet) above terrain within 610 metres (2000 feet) over any built-up area.

[c] During dropping operations the aircraft shall not fly below 465 metres (1500 feet) above terrain, over any populous area.

[d] Dropping operations shall be in accordance with the Visual Flight Rules.

Flight visibility - better than 4.8 kilometres (3 miles).

Distance from cloud - 620 metres (2000 feet) horizontal and 155 metres (500 feet) vertical, when flying below 1550 metres (5000 feet).

[e] The aircraft shall be flown straight and level while incendiaries are being dropped.

[f] The approach to and climb away path from the dropping area shall not involve abrupt manoeuvres, the climb away shall be clear of obstacles.

1.1.7 EMERGENCY EQUIPMENT

The aircraft shall be equipped with:

(a) A wool or similar flexible sheet; and

(b) CO2 or BCF fire extinguisher readily available to the Incendiary Machine Operator.

1.1.8 ADDITIONAL EQUIPMENT

In addition to the instruments required by CAO 20.18 for VFR operations, the aircraft shall be fitted with a gyroscopic horizon indicator.

1.1.9 OPERATIONS MANUAL

An operator carrying out dropping operations shall be required to list the terms of the permission in the aircraft's operation manual.

Reference: Operational Standards - Civil Aviation Authority - Commonwealth of Australia.

1.2 Pilot Flight Time Limitations:

1.2.1 CIVIL AVIATION ORDER 48.1

Pilot flight times are limited to prevent fatique and avoid accidents from happening. The maximum times should not exceed:

8	hours in one day;
6	consecutive days of work;
30	hours in 7 consecutive days;
100	hours in 30 consecutive days;
900	hours in 365 consecutive days.

1.2.2 MEDICAL STANDARDS

Civil Aviation Regulation 5.04(1); and
CAR Schedule 1.

An aircrew member may not consume alcohol 8 hours prior to flying CAR 256.

Aircrew shall not be under the influence of alcohol or drugs. Caution should be exercised if taking any drugs in conjunction with alcohol prior to flying.

Other factors to watch are:

- fatique
- dehydration
- effects of caffeine
- colds or flu
- earache
- hangovers

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2.0 SAFETY ASPECTS, AERODROMES AND AIRCRAFT

2.1 PARKING VEHICLES AT AERODROMES

It is permissible to drive onto the aerodrome at the following locations:

[a] Bunbury
[b] Manjimup
[c] Collie
[d] All CALM controlled ALAs (Authorised Landing Areas) such as Dwellingup, Mundaring, Nannup, Grimwade etc).

It is permissible to drive onto the apron at Jandakot but permission must first be obtained from the Surface Movement Controller in the Control Tower.

Points to observe when driving onto an apron area:

[a] The area must be free of manoeuvring aircraft.
[b] You must not enter onto or obstruct a taxiway.
[c] Park close to the aircraft to be loaded, ensuring that the vehicle cannot damage the aircraft.
[d] Once loading has been completed, drive your vehicle off the apron and park in a suitable spot.

2.2 APPROACHING THE AIRCRAFT

When approaching a fixed wing aircraft always ensure:

[a] You are aware of the propeller(s), particularly when engine(s) are idling during warm up and brief stops to load or unload passengers, materials or equipment.
[b] Do not lean on the propeller of a reciprocal engine aircraft as the engine can turn over if the ignition switches are left on, or the engine is at the bottom of the compression stroke.
[c] Do not handle control surfaces such as ailerons, elevators, rudders, flaps or trim tabs.
[d] Do not handle aerials as they are easily bent.

[e] Do not handle pitot tubes, they can be bent and could be hot.

[f] When boarding and leaving aircraft, be careful to avoid using panel areas marked "no step".

When approaching a rotary wing aircraft (helicopter) please refer to Section 2.8 of "Helicopter".

2.3 BOARDING A FIXED WIND AIRCRAFT

When boarding a fixed wing aircraft always ensure that:

[a] the pilot is aware of and concurs with your intentions;

[b] you are wearing appropriate clothing and footwear;

[c] you are equipped with air sick bags.

2.4 SEATING IN AIRCRAFT

When becoming seated in the aircraft, always ensure that:

[a] you are in correct seat for your task;

[b] the pilot concurs with your seating position;

[c] you have the seatbelt correctly fitted.

2.5 DISEMBARKING FROM THE AIRCRAFT

When disembarking from the aircraft always ensure that:

[a] the aircraft engines are shut down;

[b] the pilot is aware of your intentions;

[c] you are on the look out for other aircraft taxing on the apron.

2.6 LOADING OF THE AIRCRAFT

When loading the aircraft always ensure that:

[a] Equipment and cargo is to be loaded only under the supervision of the Pilot or Flightcrew who are responsible for keeping the aircraft within its weight and balance limit;

[b] Equipment and cargo must be unloaded under the supervision of the Pilot and Flightcrew with the same care as loading.

2.7 CARRIAGE OF DANGEROUS GOODS

When boarding an aircraft you must ensure that you are not carrying goods which could pose a threat to the safety of the aircraft.

2.8 HELICOPTER GROUND SAFETY

- If working on or near airstrip/helipad always wear goggles and ear protection.

- Carry all hats, including hard hats, unless chin straps are secured. Particularly watch for persons wearing soft peaked (baseball type) caps.

- Don't leave loose objects near aircraft or landing areas where they may be blown about.

- Remain well clear of landing and take off areas when aircraft are operating unless a specific task requires you to be in the area.

- Don't smoke within 30m of an aircraft, fuel dump or refuelling equipment.

- Ensure that campfires are at least 100m away from aircraft.

- Stay away from any moving parts.

- Always follow the directions given by the Pilot, Flightcrew or Aircraft Marshall.

- If moving large crews, conduct a safety brief.

- Keep them together to one side of the landing area. Instruct them to face away during take off or landings.

- Have each person responsible for their own gear and be ready to board as soon as pilot signals.

- Stay in the Pilot's field of view at all times.

- Stay away from spinning main and tail rotor blades. They are not readily visible.

- Stand outside the main rotor disc and enter in a crouch only when the Pilot signals, ie' gives the thumbs up sign. Look out for aerials and pitot tubes which are easily damaged.

- Don't approach the helicopter until the rotors have completely stopped or started. A slowing main rotor can tilt downwards, especially in windy weather.

- Be aware of ground irregularities on uneven, sloping terrain. Approach and leave on the lowest, downslope side to give yourself maximum clearance.

- Carry stretchers, tools and other objects horizontally, firmly held below the waist. Never carry equipment upright or over the shoulder.

  Carry long objects between two people.

- If blinded by dust, cover eyes and crouch down with your back to the helicopter.

- Don't rush, take time to think and observe. Remember a helicopter can move in all directions.

2.9 IN-FLIGHT SAFETY

- Carefully and gently close and latch doors. They are easily damaged.

- Fasten seatbelts and keep them fastened at all times unless the Pilot directs otherwise.

- Sit where instructed by the Pilot or Flightcrew.

- Don't distract the Pilot, especially during take off and landing. Signal an intention to speak, and wait for response. Inform the Pilot of any possible hazard he or she may not be aware of.

- Don't smoke unless the Pilot indicates it is safe to do so.

- Don't place loose objects indiscriminately in the cockpit; they may move about and affect the controls.

- Don't throw objects from the helicopter.

- Don't open doors in flight unless instructed to by the Pilot.

2.10 EMERGENCY PROCEDURES

If you are travelling in an aircraft for the first time, have the Pilot or Flightcrew member brief you on the procedure for opening the doors and fastening seatbelts. There are many varied combinations even amongst aircraft of the same type.

Look for the location of the:

[a] Fire extinguisher
[b] First Aid Kit
[c] Electronic locator beacon (ELB)

If in doubt, ask the Pilot or Flightcrew member.

On large helicopters the sliding doors are fitted with emergency exits. Many fixed wing aircraft have pop out windows that are also emergency exists. Look at the instructions for opening them.

If an emergency should occur, follow the Pilot or crew members' directions immediately.

* Don't panic
* Fasten seatbelts or harnesses
* Secure any loose objects
* Brace for impact

After landing:

- WAIT FOR ALL MOVEMENT TO STOP
- Leave the aircraft in an orderly manner in the Pilot's sight or as directed by the Pilot or Flightcrew
- When out of the aircraft, move clear in an upwind direction, as a fire risk always exists.

2.11 HELICOPTER MARSHALLING SIGNALS

The Helipad Marshall or Aircraft Operations Officer is responsible for ensuring the area is clear of personnel and equipment during landings and take offs.

The Helipad Marshall or Officer in Charge is to use the following correct signals as specified by the Civil Aviation Authority in CAO 20.3.

Helicopter Marshalling Signals .... conti.

When marshalling, stand with back to wind with both arms outstretched to indicate landing area. Indicate wind direction with a flag or visual indicator.

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3.0 EQUIPMENT CAPABILITIES AND LIMITATION

3.1 INCENDIARY MACHINE CAPABILITIES AND OPERATIONAL LIMITATIONS

3.1.1 INTRODUCTION

Prescribed burning using aerial ignition was first developed as a joint project between the Commonwealth and Scientific Industrial Research Organization (CSIRO) and the Forests Department of Western Australia in 1965. (Baxter et al: 1966)

This section describes the development of incendiary machines used for aerial burning in Western Australia (W.A.), from the original hand-operated machine to the most recent machine developed by the Forest Department (FD) of Western Australia, (renamed since 22 March 1985 as the Department of Conservation and Land Management). (van Didden, 1983)

3.1.2 HISTORICAL BACKGROUND

Since the earliest days of colonization in W.A., periodic summer wildfires have ravaged the forests. Early foresters were alarmed by the damage caused and after 1918 pursued a policy of almost complete fire exclusion. However, by 1953 heavy accumulation of forest fuels or debris in the protected areas had resulted in many wildfires which caused serious damage to the forest. It became apparent that complete protection of the forest could not be maintained with the limited manpower and equipment available, especially in the presence of heavy forest fuels.

As a result, a complete review of the fire policy took place in 1954. Prescribed burning over large areas to reduce fuel hazards was introduced. (Peet, 1967)

Early programmes of "hand burning" were carried out by gangs of men of foot. This method was slow, expensive and risky in dense, inaccessible areas. Consequently, alternative methods of lighting up large areas of forest were sought, and ignition from aircraft was an obvious choice. However, there were many technical problems to overcome, the most important being the development of a suitable and safe incendiary machine to be used in the aircraft.

The first incendiary machine was developed in 1965 by the CSIRO. In December of that year, this machine was used on the first large-scale aerial burn, on the Pingerup Plains near Walpole in Western Australia.

Despite a number of initial problems, in the summer of 1965/66 over 20 000 ha of forest was prescribe burnt using the incendiary machine. The use of aircraft and the new incendiary equipment enabled large areas of forest to be covered in a short time. This was a major step forward in fire control, as greater areas could be lit for hazard reduction burning, under ideal weather conditions and at relatively low costs. (Baxter et al, 1966)

The success of the first venture led to 180 000 ha of forest being prescribed burnt in the spring of 1967. By 1968 the aerial burning programme was operational in Western Australia and has since played an increasingly important role in fire protection of State forest.

3.2 WESTERN AUSTRALIAN MACHINE BACKGROUND WAM 1982

3.2.1 DESCRIPTION

The basic function of the equipment is to inject small plastic capsules with a measured quantity of glycol, thereby initiating the exothermic reaction, and to eject the primed capsules from the aircraft at precisely timed intervals. The capsules are loaded into the turntable by hand. It has been designed to accomplish this with the highest degree of reliability and safety.

3.2.2 MODE OF OPERATION

A 24-28 volt D.C. motor is connected by belt drive to a worm gear speed reducer to obtain a final drive speed of 10 to 55 r.p.m.

The power take-off shaft from the gearbox is directly coupled to the axial cam to continuously control the injector mechanism. The cam has five different functions to perform during each rotation, they are: dwell, pierce, inject, dwell and strip, for each cycle. During part of the dwell period at the beginning of each cycle, the geneva mechanism is activated and rotates the turntable holding the capsules in position.

While the turntable is stationary, the cam activates the injector pump to pierce the capsule top, then injects 1.3 ml of glycol, dwells for 10o, then strips or removes the needles from the cap. As soon as the needles return to their original "up" position, the turntable is again moved by the action of the geneva cam. The primed capsule them moves one position and is ejected from the aircraft.

The incendiary capsules are fed by hand from a storage tray into the turntable on the machine, where they are automatically injected and ejected when the machine is in operation.

3.2.3 MECHANICAL DRIVE SYSTEM

Power for the WAM'82 machine is supplied by a .25kw - 24 Volt Direct Current (VDC) shuntwound electric motor - operating at 833 to 5000 rpm. The speed for the motor is controlled through an electronic motor speed control board in the Electronic Control box. The board controls motor speed by feeding a field winding with pulses of constant voltage but variable width. The motor stop/start function utilizes a silicon controlled rectifier, which ensure the machine stops in the safe "rest" position.

The electric motor is connected to a Richardson Radicon wormdrive gear reduction box of 25:1 ratio, to give a calculated output of 10 to 60 rpm.

The output shaft from the gearbox drives both the injector cam and the geneva mechanism. The geneva cam mechanism is an intermittent-motion device allowing power to be periodically transferred from the gearbox output shaft to the geneva cam.

The gearbox output shaft rotates continuously to drive the injector cam, which sets the injection cycle in motion. During each injection cycle the geneva cam remains stationary, until the cycle is complete, and is then reactivated.

A 28 teeth gear underneath the geneva cam drives the larger 84 teeth idler gear which is then connected to a 28 teeth gear to move the turntable. The intermittent motion of the geneva cam is thereby synchronised to the movement of the turntable.

3.2.4 CAPSULE TRANSPORT SYSTEM

Turntable

The six station turntable is designed to move the capsule from the loading stage to the injection and ejection positions. The turntable is designed to withstand any primed capsule from igniting the next capsule in the event of a misfire in the aircraft due to a system malfunction.

Manual Release Overdrive (Hdg)

In the event of a power failure the turntable can be manually released from the drive shaft by pulling up the release pin and rotating the turntable by hand. In the event that the turntable drive shaft becomes unsynchronised from the geneva cam the needles will not be damaged because of the hollow groove in the top of the turntable.

Glycol System

Glycol Tank

Injector

Glycol is stored in a 6.7 litre capacity stainless steel tank. Fitted with a sight gauge and graduated scale to determine the glycol level. Glycol is fed by gravity to the injector.

The modified injector is based on the original 1968 CSIRO design with slight modifications to reduce the number of parts.

3.3 EJECTION RATE

The ejection rate of the incendiary machine can be varied from a maximum rate of 54 capsules per minute or 1.2 second interval down to 13 capsules per minute or 4.6 second interval. Changes in speed are made by turning the motor speed control knob to the desired drop rate setting on the digital indicator.

To obtain correct ground spacing check table below.

IGNITION SPACING AS A FUNCTION OF TIMING AND GROUNDSPEED

Capsules per min Interval	Ground Speed (knots) 70	80	90	100	110	120
	Approximate Distance Between Ignition Points Metres					
13	166	190	213	237	261	285
16.5	131	149	168	187	205	224
23.5	92	105	118	131	144	157
27	80	91	102	114	125	137
31	70	79	89	99	109	119
35	62	70	79	88	97	106
37	58	66	75	83	91	100
40	54	62	69	77	85	93
42	51	58	66	73	81	88
43	50	57	64	72	79	86
45	48	54	61	68	75	82
47	46	52	59	65	72	79
50	43	49	55	61	67	74

3.4 CHEMICALS USED

The chemicals used to start the fires are potassium permanganate and mono-ethylene glycol mixed at the ratio of 1:4 (1 part glycol to 4 parts permanganate). Insufficient glycol will prevent ignition taking place, from the mixture being too dry. While excessive glycol will drown the mixture and make it ineffective.

Testing of Incendiaries

Reaction Time

The reaction between potassium permanganate and ethylene glycol depends upon temperature and particle size of the permanganate - if the temperature is high or the particles are fine the reaction time will be short.

To test the reaction time a capsule should be run through the machine, and should be timed from the instant of injection to the first appearance of flame. The temperature of the glycol should be taken and recorded together with the reaction time.

Reaction time should exceed 30 seconds at 20oC. Capsules should be stored in a cool place away from direct sunlight and high temperatures, to avoid the lids loosing their plasticity and coming off.

Quantity of Glycol

The quantity of glycol injected is important for the proper functioning of the reaction. At the beginning of each day after priming the injector - check that the quantity is satisfactory. Do this by injecting 5 times into a single capsule and then measuring the amount in a small measuring flask. The correct quantity is 1.3 ml per injection.

At the end of each day it is recommended that the quantity of glycol used is recorded, and divided by the number of capsules ejected to give an average volume per capsule used.

3.5 INCENDIARY SPECIFICATIONS:

Incendiary Capsule

Container: Size: 38 mm x 21 mm diameter
Material: Styrene acrylan nitrol
Mass: (Empty) 2.52 gms
Cap: Size: 11.5 mm x 21 mm diameter
Material: Low density virgin polythene
Mass: 1.31 gms
Contents: Material: Potassium permanganate $KMnO_4$
Mass: 4.0 + 0.5 gms
Mass Total: 7.83 + 0.5 gms
Size Total: 45 mm x 21 mm diameter.
Reagent
Mass: 1.3 gms + 0.2 gms
Material: Mono ethylene glycol $C_2H_6O_2$

3.6 CAPSULE LOAD - GLYCOL CAPACITY

Capsule Load

The metal cabinet in the Britten Norman Islander carries 11 trays of 324 capsules totalling 3 564 capsules.

This quantity should be sufficient for most large burns. However if there is a need to carry additional supplies they should be carried in the rear cargo compartment. Restrained by an approved cargo net. Incendiary capsules come packed in boxes containing 4 trays, holding a total of 1 296 incendiary capsules.

Glycol Capacity

The glycol tank when fully loaded has a capacity of 6.9 litres, however for planning purposes only count on 6.5 litres useable. This should give an endurance of 4 333 capsules based on 1.5 ml per injection.

Additional glycol may be carried in a suitable container, anchored to the floor with cargo tie points. The 'esky' box is installed for this purpose.

For security reasons this additional glycol should not be left in the aircraft overnight or during the weekends.

At the end of each dropping operation the aircraft must be cleaned inside to ensure that any loose articles are stowed. Any potassium permanganate or ethylene glycol that may have been spilt must be cleaned to avoid the inadvertent mixing of any spilt portions.

3.7 EQUIPMENT WEIGHTS

Incendiary Machine

Main frame mass, glycol tank empty		47 kg
Glycol tank full, capacity 6.7 litres		55 kg
Overall dimensions	length	51 cm
	height	70 cm
	width	35 cm

Subframe Assembly		Britten Norman Islander	Partenavia
Mass		3.75 kg	1.9 kg
Overall dimensions,	length	84 cm	40 cm
	height	21 cm	21 cm
	width	30 cm	35 cm

Incendiary Storage Cabinet

		Britten Norman Islander	Partenavia
Mass, empty		37 kg	32 kg
Mass, fully loaded		73 kg	54 kg
Contents, 11 trays @ 324 ea			8 trays
number of incendiaries		3 564	2 592
Overall dimensions,	depth	43 cm	42 cm
	height	61 cm	51 cm
	width	42 cm	43 cm

Additional Equipment

Operators seat	9.3 kg	-
Seat-rail	5.9 kg	-
Firemat	5.4 kg	-
Esky for glycol	5.4 kg	-
5 litres glycol	11.3 kg	_____
Total equipment weight	169.0 kg	110.9 kg

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4.0 PREPARING AERIAL BURN FLIGHT PLANS

Preparation of flight plans are one of the basic requirements of successful burns. Along with other aspects of Aerial Burning Technology, flight plans have developed into the specialized document in use today.

4.1 Early Plans:

These were essentially jottings on a 1:40,000 API, and were derived during telephone conservations. They invariably suffered the inherent faults caused by misinterpretation. The system adopted in 1966 used a transparency of the relevant section of the 1:40,000 API sheet to produce dyeline prints, showing boundaries and flight lines.

4.2 Current Plans:

Under the current system, plans of the specific burn area are produced by Mapping Branch and are available at the relevant District before the commencement of the burning season. This provides the same base plan data so that everyone starts from a common point with the same information.

4.3 Features of Current Flight Plans:

[a] Job No.;

[b] Scale - 1:25000;

[c] Area in hectares;

[d] A clearly defined boundary (only one job is indicated on any one sheet);

[e] Departmental or Australian mapping grids are indicated for orientation;

[f] Date of photography (from which the plan was derived);

[g] Cleared areas and plantations are marked;

[h] Data panel.

4.4 Acquiring Information:

Whenever possible - derive base information from the District Office concerned - preferably the Controller or his deputy (usually the Burn Boss).

If the information has been passed on or received second hand it is a good general rule to confirm the data with the particular office. Do not assume that the District concerned will automatically advise you of last minute changes.

4.5 Essential Data:

[a] Flight line one: axis co-ordinates,
e.g., x axis north
y axis south

[b] Stripwidth and spot distance;

[c] Time required over job/or start time;

[d] Communications, callsigns, channel;

[e] Check:

- marking method and details, flares etc;
- boundary modifications;
- unidentified obstacles (radio masts etc);
- sensitive or excluded areas - within burn.

4.6 Method of Preparation:

(a) Locate and place line 1 from reference data.

(b) According to stripwidth dimension measure off each progressive line as a scaled increment - AT RIGHT ANGLES TO LINE NO. 1.

(c) Number and mark each line consecutively. Use two colours to indicate alternate lines.

- even/uneven numbers;
- flight line transparencies of differing spacings are available at District offices.

(d) Highlight - control point and areas of concern - e.g., obstacles, plantations - and "no-burn" areas. Every uncleared private property boundaries which may cause confusion or required special marking.

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Introduction:

The aim of this operation is to provide a suitably fitted out aircraft and well trained crew to carry out incendiary dropping operations for fire management purposes. The purpose of this lesson is to further develop the students knowledge of the basic operational and planning requirements for aerial prescribed burning.

5.1 Briefing:

The morning of the proposed burn the duty operations office or delegate navigator should personally (or by phone) contact the burn boss or District protection officer and discussed the following points:

Burn number and location (distance and bearing from DHQ)

Objective of burn, or for part of the burn.

Features - topography, shape, area.

Boundary location and last minute changes.

Weather - wind direction and possible changes.

Forest Types - fuel types and variations. Location of heavy fuel pockets.

Fuel details - SMC's and FDI's, actual rate of spread expected.

Co-ordinates of flight lines, strip widths.

Lighting patterns.

Previous trouble spots (unburnt creeks, plots, poor boundary access, poor edging).

Adjoining fuel types and ages.

Private property to avoid (no overfly permission), pine, eucalypt or research plots, etc.

Staff at burn - names and call signs. Position around boundary. Control point location.

Beacon vehicle - are they required, if so location. Access problems with beacons, long travel times between individual lines, etc.

Public check - campers, fishermen, recreationists - along rivers or picnic spots.

Special instructions - areas to avoid (dunes, swamps, creek systems, ridge top lightings. Radio towers or SEC ines to avoid.

Communications - VHF channel, simplex/duplex.

Spot fires - if required.

Expected start time.

Day's program - prior and later burn lightings.

Contingency plans - alterations.

5.2 Planning Measure Distance, Direction, Calculate Time

1:1,000,000 Scale Plan - World Aeronautical Chart check position of Burn - Direction from Base Airstrip .... Magn. Distance .... nm. E.T.I. .... Min.

From stripwidth and spotdistance calculate capsule requirements - see Table 1. From required spotdistance, work out most satisfactory ejection rate and flying speed. See Table 2.

Measuring Distance

The Nautical Mile:

For air navigation the N.M. is the most convenient unit as it is taken to be the average length of one minute of latitude (this average being 6,080 feet).

Measurement of the Track

When it is intended that an aircraft be flown from A to B, a straight line or "track" is drawn joining them and the direction is read off with a protractor placed on the mid-meridian.

The track so measured is true. Isogonals (lines of equal Magnetic Variation) which on the WAC chart take the form of a blue dotted line, this indicates the variation in that locality. The variation when applied to the track measured, or the Heading, converts them from True to Magnetic.

From strip width and spot distance calculate capsule requirements.

TABLE 1
Number of Capsules Required per Hectare
Ignition Grid Pattern in Metres
Spot distance x Stripwidth

Area in Hectares	75 x 150	80 x 175	100 x 200	125 x 250	150 x 300	200 x 400
	Number of Capsules Required					
1000	889	715	500	320	222	125
2000	1778	1429	1000	641	445	250
3000	2667	2143	1500	962	667	375
4000	3556	2858	2000	1282	889	500
5000	4444	3572	2500	1603	1112	625
6000	-	4286	3000	1923	1334	750
7000	-	-	3500	2244	1556	875
8000	-	- 4000	2564	1778	1000	
9000	-	-	-	2885	2000	1125
10000	-	-	-	3205	2223	1250
12000	-	-	-	3846	2667	1500
14000	-	-	-	4487	3111	1750
16000	-	-	-	-	3556	2000
18000	-	-	-	-	4000	2250
20000	-	-	-	-	4445	2500

From required spotdistance work out most satisfactory ejection rate and flying speed.

TABLE 2
Ejection Interval
Spotdistance and Flying Speed

To determine the speed the aircraft should be flown in nautical miles (knots) in conjunction with the ejection interval rate of the incendiary machine to obtain the required spotdistance on the ground.

Ejection Drop Rate in Capsules per Minute	Aircraft Speed in Knots 60	70	80	90	100	110	120	130
	Spot Distance Spacing in Metres							
65	29	33	38	43	48	52	57	62
60	31	36	41	46	51	57	62	67
55	34	39	45	51	56	62	67	73

50	37	43	49	56	62	68	74	80
45	41	48	55	62	69	76	82	89
40	46	54	62	70	77	85	93	100
35	53	62	71	79	88	97	105	115
30	62	72	82	93	103	113	124	134
25	74	87	99	111	124	136	148	161
20	93	108	123	139	154	170	185	201
15	124	144	165	185	206	226	247	268
10	185	216	247	278	309	340	370	402

5.3 Estimating Departure Times and Flight Duration

The following guideline is drawn up to estimate the time that the aircraft can be expected to complete a job, and allow programming for a days work. These times are a guide only.

Other factors, will affect the time the aircraft can be expected over a job:

Estimate Departure Time

Work out the departure time take into account the following factors:

Time to get to the airstrip
Note: Lodgement of Flight Plan at Primary and Secondary Airports required

Daily the aircraft, check incendiary machine	(20 min)
Warmup and Taxi	(5 to 8 min)
Flying to the job	(2nm/minute)
Job reconnaissance	(10 min to 20 min)
Dummy flight line to establish drift	(5 min to 10 min)

Advise the pilot of the area to be burned, what time the aircraft is required over the job, time required to commence dropping capsules.

Point out boundary difficulties.

TABLE 3

Production rate over job assumes airspeed 100 knots, and flightline spacing 200 metres apart.

Job Size Ha	Time Hrs	Job Size Ha	Time Hrs
500	60	4 000	1.4
1 000	75	5 000	1.8
1 500	90	6 000	2.1
2 000	1.0	7 000	2.4
2 500	1.1	8 000	2.8
3 000	1.2	9 000	3.2
3 500	1.3	10 000	3.4

5.4 Suitable Clothing and Aircrew Punctuality

Navigators are to promote an image of responsibility and authority to preserve and enhance the image of the Department. Aircrew should wear clothing and footwear that is appropriate to the task and climate while bearing in mind safety at all times.

Punctuality is needed to ensure a smooth operation when a number of Districts are involved in the days burning program.

5.5 Pre-Flight Briefing to Pilot

The following points should be covered in your pre-flight briefing. To ensure that the aircraft arrives on time and can be programmed for other burns during that day. The pilot and incendiary machine operator should be briefed as early as possible after the decision is made to burn to involve them in the planning process and make them feel part of the team.

The following timetable should be observed by disticts in scheduling their daily burning program.

0745 hrs - Districts to obtain weather forecast

0820 hrs - District Controller to advise Regional co-ordinator prior to 0820 hours of proposed burn and required start time.

0830 hrs - Regional co-ordinators to advise Senior Fire Operations Officer Bunbury of requests.

0845 hrs - Approved programme notified to region with Beacon arrangements.

0900 hrs - Navigators to be advised of flight plan details.

0900 hrs - Bunbury Protection Branch to advise ABC and commercial stations burns proposed for the day.

1000 hrs - Controller to check the weather forecast to confirm conditions remain suitable.

5.6 Pre-Flight Arrangements for Aircrew and Supply Requirements

Navigator to advise incendiary machine operator of the jobs to be completed for the day; to allow the incendiary machine operator to plan his capsule and glycol or anti-freeze requirements.

NOTE: keep a check of supplies and advise Regional Fire Protection Officer Leader if stocks are running low and require replacement.

5.7 Arrangements, when Reaching Target Area:

On the way to the job the navigator should contact the controller re any last minutes changes, confirms boundary changes or areas to be left unburnt, eg regeneration areas. Asks for advice on difficult boundaries.

Establish contact with beacon vehicles at least 15 kilometres from the job. Determine if beacons are functioning.

On arrival over the area to be burnt, request marker fires to be lit on difficult corners projecting into the burn.

Boundary definition can be improved by lighting marker fires at intervals along the boundary.

The pilot is legally required to do at least one circuit of the boundary to identify ground points on the map, establish he is in the correct area and establish that the area is free of people, stock and vehicles.

The first flightline should be a dummy line to establish wind drift. The track error should be less than 100 metres before lighting can be commenced.

The navigator must obtain clearance from operations officer before commencing on a live dropping run to ensure authority is granted to commence lighting.

5.8 Flight Patterns

Parallel Method

Consists of marking every line with beacons and Verey piston flares used early in the season when percentage take is low.

Aircraft approaches point A and beacon is put on - the moment the aircraft goes over point A the navigator requests "East beacon on, West beacon off, East fire flare".

It is understood West beacon automatically moves to point D and waits and advises ready in position on line 2.

As soon as the aircraft flies over the East beacon, it is turned off and shifts to position C. Driver advises when ready in position "East beacon on in position line 2". This procedure is repeated as often as necessary until the job is completed.

The aircraft turning time outside the burn area has to be co-ordinated with the time it takes the beacons to shift.

Corridor Method

Consists of marking only every second line with the beacon, i.e. the beacon has too move 400 metres if flight lines are 200 metres apart. The initial three or four lines are slow as the aircraft waits for the smoke to show up, when this occurs the aircraft flies back through the previous flight lines.

When filling in between the lines it is easier to see the smoke if looking into the sun, ie: if lines are East to West and the burn is in the afternoon, then all flying onto the beacon should be done on East edge and flying in Westerly direction when filling in.

The above method of marking is particularly successful under conditions where smoke shows up very rapidly i.e. within 15 minutes. If smoke shows up slowly, then as many as 5 or 6 lines have to be flown at double spacing before anything shows up.

Racecourse Method

Consists of marking the first and fifth line and every fourth line from there on with beacons or other navigational device.

The method relies heavily on pilot technique, ability and boundary definition.

First line flown from marker fires, the aircraft then flies over beacons on line 5 then to line 3 by optically dividing the area in half.

The area is again optically divided and line 2 then line 4 flown. The whole method can be repeated with the beacon moving to line 9.

5.9 Capsule Flight Path

Showing the theoretical time it takes before a capsule strikes the ground (in seconds) and the horizontal distance (in metres) before the target, that the capsule has to be released.

It is assumed that the aircraft is in level flight 90 kts and neglects the effect of air resistance mass and inertia on the capsule.

Dropping Height Feet	Time Capsule takes to fall and Strike the Ground Seconds	Distance Capsule Travels Horizontally After Being Released Metres
1000	7.9	366
900	7.4	342
800	7.0	324
700	6.6	305
600	6.1	282
500	5.6	259
400	4.9	226
300	4.3	199
200	3.5	162
100	2.5	115

Note the actual time taken for the fall will be longer, but the horizontal distance the capsule travels will be shorter.

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6.0 LATITUDE AND LONGITUDE

A convenient way of specifying the POSITION of any point on earth is to relate it to the imaginary lines that form the latitude and longitude graticule (or grid).

- Latitude

The reference for latitude is the EQUATOR, the great circle whose plane is perpendicular (at right angles, 90 degrees) to the polar axis.

FIGS 2a, b, & c LATITUDE.

* The LATITUDE of a place is its angular distance in degrees from the equator, measured at the centre of the earth and designated either north or south.

* A PARALLEL OF LATITUDE joins all points of the same latitude and is a small circle (except for the equator).

* Parallels of latitude are parallel to the equator and to each other.

* The longest parallel of latitude is the equator (Latitude 0 degrees) and the parallels of latitude progressively decrease in size until the 90 degrees parallels of latitude become just points at the N and S geographic poles.

FIG. 3. THE FURTHER FROM THE EQUATOR THE SMALLER THE PARALLEL OF LATITUDE

- Longitude

The basic reference for longitude is the GREENWICH MERIDIAN - also known as the PRIME MERIDIAN. It is that branch (half) of the great circle that contains the polar axes (N and S geographic poles) and passes through the Greenwich Observatory which is situated near London.

The prime meridian is designated as "longitude 0 degrees".

FIGS 4 a & b, THE PRIME MERIDIAN

The other branch of the same great circle that contains the prime meridian runs from the north geographic pole to the south geographic pole on the other side of the earth to Greenwich (roughly down the west side of the Pacific Ocean).

It is called "longitude 180 degrees" and it can be reached by travelling either East from the prime meridian or by travelling the same angular distance (180 degrees) West from the prime meridian. Therefore it can be called both "180E" or "180W". It is also called the anti-meridian of Greenwich.

* All of the great circles containing the polar axis (therefore passing through the N and S geographic poles) are called MERIDIANS OF LONGITUDE.

* Meridians of longitude are specified by their angular difference in degrees EAST or WEST from the prime meridian.

FIG. 5. THE LONGITUDE OF A PLACE IS THE ANGLE BETWEEN ITS MERIDIAN OF LONGITUDE AND THE PRIME (GREENWICH) MERIDIAN MEASURED EASTWARD OR WESTWARD.

6.1 POSITION ON EARTH

The position of any point on the earth can be specified by:

* its LATITUDE - its angular position N or S of the plane of the equator;

together with:

* its LONGITUDE - its angular position E or W of the prime meridian.

The "parallels of latitude" and "meridians of longitude" form an imaginary graticule or grid over the surface of the earth.

The position of any point on earth can be specified by its LATITUDE and LONGITUDE. It is usually sufficiently accurate to specify the latitude and longitude of a place in degrees and minutes only (although for extreme accuracy each minute can be divided into 60 seconds of arc).

FIG. 6. THE POSITION OF BIRDSVILLE IN QUEENSLAND IS (25o 54'S, 139o 21'E)

Latitude and longitude is the normal method of specifying position on earth and is the one that pilot/navigators most commonly use at the flight planning stage when they are preparing their maps and flight plan. Once in flight, however, there are other means of specifying the position of the aircraft:

* by position over a landmark or radio beacon, e.g. "over the Harbour Bridge";

* by range (distance and bearing from a landmark or radio beacon, e.g. 10 nm on a bearing of 290 M from Melville Island".

6.2 DISTANCE ON EARTH

The standard unit of distance in navigation is the NAUTICAL MILE - the length of 1 minute of arc of any great circle on the earth (assuming the earth to be a perfect sphere).

There are 360 degrees in a circle and 60 minutes in a degree. This makes (60 x 360 =) 21,600 minutes of arc - which makes the distance right around the circumference of the earth on a great circle 21,600 NM.

FIG. 7. I NM = THE LENGTH OF 1 MINUTE OF ARC OF A GREAT CIRCLE ON THE EARTH

* LATITUDE (the angular distance north or south of the equator) is measured up and down a meridian of longitude (which is a great circle) and therefore:

1 MINUTE OF LATITUDE AT ANY POINT ON EARTH = 1 NM.

FIGS 8 a & b
1 MINUTE OF LATITUDE = 1NM/1 MINUTE OF LONGITUDE
VARIES IN LENGTH

---

1 DEGREE OF LATITUDE AT ANY POINT ON EARTH = 60 NM

---

* LONGITUDE is measured around the parallels of latitude (small circles except for the equator) and so 1 minute of longitude varies in length depending upon where it is on the earth's surface.

The only place where 1 minute of longitude is equal to 1 NM is around the equator.

Do not be confused by the fact that:

WE MEASURE 1 MINUTE OF LATITUDE (ALWAYS 1 NM) UP OR DOWN
THE SIDE OF THE CHART ALONG A MERIDIAN OF LONGITUDE;

- it is logical when you think about it.

FIG 9: 1 MIN LAT = 1NM

FOR CONVERSIONS:

1 NM = 1852 METRES = 6076 FEET = 1.15 SM.

6.3 CHART PROJECTIONS

The original problem in map-making is still with us - how can you represent the curved surface of a earth on the flat surface of a map without distortion?

The answer is still the same - it cannot be done!

"A spherical orange peel cannot be flattened out perfectly."

Some property will always be distorted to a greater or lesser extent depending upon how you transfer the points on the surface of the spherical earth onto the flat chart.

Some curved surfaces such as a cylinder or a cone can be cut and laid out flat - or, in the opposite sense, you can make a cylinder or a cone out of a flat piece of paper. This is not possible with a spherical surface - try it with an orange peel.

Chart-making involves the PROJECTION of the points on the surface of a sphere onto either a conical or cylindrical surface that can then be flattened out to form a plane.

A simple view of map projections is to think of a light projecting the shadows of the latitude-longitude graticule of the sphere onto a cone (Lambert's projection) or onto a cylinder (Mercator's projection), which is then laid out flat.

6.4 SCALE

Unlike Spike Milligan we cannot carry full-scale maps of the earth in our nav bags. Our charts have to be scaled down and this is done by "reducing the earth" to a fraction of its size, and then doing the projection.

There are numerous ways of describing just how much the earth is scaled down on a particular map.

SCALE IS DEFINED AS THE RATIO OF THE CHART LENGTH
COMPARED TO THE EARTH DISTANCE THAT IT REPRESENTS

$$\text{SCALE} = \frac{\text{CHART LENGTH}}{\text{EARTH LENGTH}}$$

THE LARGER THE CHART LENGTH FOR A GIVEN EARTH LENGTH,
THE LARGER THE SCALE AND THE MORE DETAIL
THAT CAN BE SHOWN

This means that large scale charts cover small areas in detail. For example, a Visual Terminal Chart (VTC) has a larger scale and can show more detail than a Visual En-route Chart (VEC).

- SCALE CAN BE EXPRESSED IN VARIOUS WAYS;

* as a REPRESENTATIVE FRACTION, e.g. the WAC series are 1/1,000,000 charts (one to a million), where 1 centimetre on the chart will represent 1,000,000 cm or 10 kilometres on the earth, or where 1 NM on earth is represented by 1 millionth of a NM on the chart.

* as a GRADUATED SCALE LINE - usually situated at the bottom of the chart. A graduated scale line allows you to measure-off the distance between two points on the chart and match it against the scale line.

FIG 12: A SCALE LINE OFF A CHART

* in WORDS - e.g. "1 cm equals 10 NM", which obviously means that 10 NM on the earth's surface is represented by 1 cm on the chart.

Even if you can find no reference to scale on the chart you can always measure-off the distance between two points against the latitude scale which runs down the side of the chart (1' of latitude = 1 NM).

A point to remember here is to use the latitude scale at about the mid-latitude between the two points because on some charts scale may vary slightly depending upon where you are (top, middle or bottom) of the chart.

There are three main types of chart that every visual pilot in Australia should be familiar with:

* the WORLD AERONAUTICAL CHART (WAC) series - used mainly for en route topographical and cultural information.

* the VISUAL EN ROUTE CHART (VEC) series - used mainly for en route aeronautical information.

* the VISUAL TERMINAL CHART (VTC) series - used for all topographical, cultural and aeronautical information around major terminal areas.

6.5 THE WORLD AERONAUTICAL CHARTS (WACs)- INTERNATIONAL CIVIL AVIATION ORGANISATION (ICAO), 1:1ÿ000ÿ000 SERIES.

We use WACs to provide us mainly with TOPOGRAPHICAL information (mountains, lakes, rivers, deserts, coastlines etc.) and CULTURAL information (cities, towns, freeways, country roads, railway lines, etc.) for visual en-route navigation.

All WACs have the same "one to a million" scale and the same symbols.

WACs are based on the Lambert Conformal Conic projection, so that angular relationships and shapes are preserved and so that there is a reasonably constant scale over the whole of the chart. Straight Lines closely represent the Great Circle track between two points.

Each country is responsible for producing the WACs covering its own area, and they are generally available for all parts of the world (one exception at the moment being Papua New Guinea where Tactical Pilotage Charts known as TPCs are used).

Each WAC chart has a number which is displayed at the top beside the name of that particular chart. The number of the adjoining WAC chart is also labelled around the edge of the chart.

Things such as radio towers, irrigation channels, railway lines and roads change from time to time, and so WAC charts are continually up-dated by:

* re-prints at convenient intervals (so ensure you have the current edition, as specified in NOTAM's NOTAMs class 2);

* NOTAM (NOTices to AirMen) amendments which you should make by hand on your WAC's. These are called "Manuscript Amendments".

The WAC is the primary chart used by visual pilots in Australia to plot positions and tracks when well away from busy terminal areas. Aeronautical information (e.g. controlled airspace, restricted areas) will then be cross-checked off the VEC.

It is possible to plot on the VEC as well as the WAC if you want to.

The TOPOGRAPHIC information shown on a WAC chart is that which is considered to be of most use to the pilot/navigator.

It is of course impossible to show absolutely everything on a chart, so there may be some details on the ground not shown - conversely anything shown on the chart you can reasonably expect to exist on the ground. For example, an isolated rock may not be considered significant by the map-maker and therefore will not be shown on the map. You might spot it on the ground yet not find it depicted on the map. If however there is an isolated rock depicted on the map, you can be certain that it does exist on the ground.

* DRAINAGE AND WATER FEATURES (hydrographic features) are usually depicted on the map in blue. This includes creeks, streams, rivers, canals, lakes, swamps, waterholes, wells and bores, shorelines, tidal flats, dry lakes, etc. Just how they are depicted on the map is explained by the legend - but bear in mind that after a flood, for instance what might be shown as a dry river bed on the map might in fact be a raging torrent, etc. Right throughout aviation, common sense is

necessary. One drainage feature not depicted by blue is the mangrove swamp, which is usually near a coastline, and which is depicted in green.

*   RELIEF. There are various ways of bringing ground contours into relief, so that an impression of hills, mountains, valleys, etc. is obtained when you look at the map.

The WAC chart uses CONTOURS, which are lines joining places of equal height above sea level, and the closer the contour lines are together on the map the steeper the hill on the ground.

COLOUR or layer tinting is used in conjunction with the contour lines to give even more relief. The colours or tints used for the various ground elevations are shown on a "hypsometric tint" table at the side of the WAC chart. ("Hypsometric" means "establishment of vertical heights or elevations".) The shades of colour on the WAC chart start with green for low land, then goes through yellow and into brown, gradually darkening the higher the ground is.

HACHURING and HILL SHADING are used to give a three dimensional effect. Hachuring consists of very short lines radiating from high ground and is commonly used to portray bluffs, cliffs and escarpments. Hill shading shows darkened areas on the low side of high ground where you would expect to see shadows at certain times of the day.

SPOT ELEVATIONS (or spot heights) are also shown using a black spot with an adjacent number to indicate height AMSL (Above Mean Sea Level) in FEET. These heights can be assumed to be accurately measured (unless amended by NOTAM). Spot Heights are normally used to show local peaks and other critical elevations that are significantly higher than the surrounding terrain.

*   CULTURAL FEATURES are of great help to the pilot/navigator. It is not possible to show every town or every house on the map. so a choice is made to show what is significant and of value for visual air navigation.

A group of say 100 houses is of little significance if it lies in the middle of a city the size of Sydney and so will not be specifically depicted on the map, yet in the outback it is extremely significant and will certainly be shown. In remote areas the map will even show isolated homesteads, out-stations and water tanks.

ROADS and RAILWAYS can be of great assistance to the visual pilot/navigator. Those that will be most significant for air navigation will be clearly shown. Distinctive patterns such as curves, roads running parallel to railway lines and then crossing over, junctions, forks, overpasses, tunnels, etc. are especially useful.

Many other useful cultural features may also be shown such as wheat silos, telegraph lines, etc. Read the legend carefully and become familiar with the symbols.

*   Limited AERONAUTICAL information is also shown on WAC charts, such as aerodromes (civil, military, or joint use), aerodrome beacons and landing grounds. The date at which this aeronautical information was still considered to be current is specified on the chart.

The division of airspace is not shown on WAC charts - this information is shown on VEC and VTC charts.

The LATITUDE-LONGITUDE graticule is clearly marked on WAC charts:

* the east-west parallels of latitude indicating degrees north or south of the Equator (south in Australia of course) are labelled at either side of the chart;

* the north-south meridians of longitude gradually converging as they near the south pole are labelled at the top and bottom of the map in degrees East or West of the Prime Meridian (in Australia, Longitudes are East).

This makes the WAC chart ideal for measuring the latitude and longitude of a position.

Figure 13 below is a photographic excerpt from the top right hand corner of a WAC chart and clearly shows the latitude and longitude indications.

To measure the latitude and longitude of a place on a WAC chart:

6.6 Measuring Latitude and Longitude of a Position.

6.6.1 Latitude:

- Place a straight-edge east-west through the place parallel to the parallels of latitude.

- From the latitude scales running north-south down the page you can read-off the exact latitude. (It should be the same latitude on the scale either side of the place - this ensures that the straight-edge is placed correctly on the map.)

Note: that in the Southern Hemisphere the latitude increases towards the south and bottom of the chart, and that the scale lines break up each degree of latitude into 60 minutes, with large marks each 10 minutes. (Make sure that you count from the top down the page.)

6.6.2 Longitude:

Place a straight-edge north-south through the place parallel to the closest meridians of longitude.

From the longitude scales running

east-west across the page you can
read-off the exact longitude.
(It should read the same on the
scales above and below the place
this checks that the straight-edge
is placed correctly on the chart).

Figure 14. Finding the latitude - longitude of a known place.

6.7 PLOTTING ON A CHART

The reverse problem of plotting a given latitude and longitude on the chart is just as easy:

1. Find the approximate position of the place on the chart.

2. Mark the latitude given on the two nearest latitude scales either side of the position.

3. Mark the longitude given on the two nearest longitude scales north and south of the position.

4. Join the latitude marks and then join the longitude marks - their point of intersection being the the desired position.

Note: You are required to be able to specify or mark a position to an accuracy of 1 minute of arc.

Fig.15. Plotting a Known Latitude - Longitude

ISOGONALS (lines joining places of equal magnetic variation) are indicated on the WAC chart by dashed purple-coloured lines. The Eastern States of Australia experience "variation east-magnetic least", whilst in W.A. there is "variation-west - magnetic best".

The AGONIC LINE (where True North and Magnetic North are the same direction, with variation zero) lies inbetween. Because the magnetic poles are gradually moving, the amount of variation at a particular place will also gradually change over a period of years.

Every few years the isogonic information on the charts is up-dated, and the year of the isogonic information is shown on the chart.

6.8 Measuring Direction with a PROTRACTOR.

The best way to measure

direction with a protractor is to align its north-south axis with True North along the mid-meridian and then to read-off the direction on the outer scale.

(You can also measure the direction by aligning the axis of the pro-tractor with the track and measuring the direction against the inner scale.)

Once again it is vital that you have an approximate value in mind prior to using the protractor so that you avoid any gross errors, such as being out by 90ø or 180ø.

Fig.16. the Square Protractor is the type of protractor commonly used.

Fig.17. Measuring Direction with a Protractor.

6.9 MEASUREMENT OF DISTANCE ON CHARTS

Distance may be measured by various methods and you should be able to achieve an accuracy to within 1 NM by using one of the following methods:

* The GRADUATED SCALE LINE at the bottom of most charts. Using dividers or some other means transfer the distance between the two positions on the chart down onto the scale line.

* The LATITUDE SCALE down the side of the chart. At all points on earth for all practical purposes, 1 minute of latitude = 1 NM. Using dividers or some other means, transfer the distance between the two positions on the chart across onto the latitude scale. (Because the scale over the whole chart may vary slightly from latitude to latitude,

use that part of the latitude scale which is about the same as the mid-latitude of the track that you are considering.)

* A correctly graduated SCALE RULE. Most navigation plotters have graduations suitable for 1:1,000,000 maps such as the WAC charts, which are all 1 to a million. On the back of the Australian D of A Domestic Flight Plan Form is a similar 1:1,000,000 graduated scale line suitable for WAC charts. (Some plotters also have a 1:250,000 scale line useful for VTC charts, which are all 1 to a quarter million. The scale on VEC charts however varies from chart to chart and so we cannot use this method for them.)

Fig.18. Measuring the Distance Between Mount Garnet and Cairns on the WAC using time 1:1 000 000 Distance Scales on the Plotter

6.10 MAP READING

There is often confusion about the difference between a Map and a Chart.

A Map is a representation on a flat surface of some part of the earth's curved surface, whereas a Chart is a map (possible even just an outline map) showing special conditions or information.

Since most of our aeronautical charts show specific aeronautical and navigational data, they are therefore "charts" rather than "maps".

The ability to read a map well - the chart that we have discussed, the topographical variety, in the hands of a navigator becomes a Map - is very valuable and cannot be over-emphasized. That is true all over the world, but in the less inhabited areas it is doubly true. Skill in the art of map reading varies according to natural aptitude and the amount of practice experienced. Good map reading depends upon being able to visualize the ground features as portrayed on the map, knowing the navigational value of the prominent features, the estimation of distance and bearings, and finally memory of how it has all looked before under similar circumstances.

The ability to distinguish the more significant features and not be confused with irrelevant detail is an important aspect of map reading. Features mentioned here which have great length, are generally known as "Line Features", e.g. Railroads. These are most important, because an interception is almost impossible to be missed.

Coastlines

The dividing line between land and sea takes priority in aerial navigation. The shape and bearing of a stretch of coastline quickly limits the area within which an aircraft is flying.

Railways

Railways are of great importance and are given considerable prominence on I.C.A.O. charts. They are reasonably easy to see especially in open country and are easily identified by their bearing. Traffic on them makes them more obvious. Their value and identification in built-up areas is slight and difficult. The presence of a railroad is often masked by a road running parallel to it. Tunnels and bridges when marked on the chart are especially useful in fixing position.

Roads

The value of roads in map reading varies considerably. Generally they are confusing and misleading.

Many more roads are on the earth's surface than are printed on the chart. Main highways are always useful. In the outback a mere track could have the same value.

Rivers and Canals

Rapid and positive indication of position is provided by major waterways. They show up well and can be seen from considerable distances. Even dry rivers generally have a tell-tale line of green vegetation along their banks which shows from a considerable distance. The dry sandy bed of a river without the accompanying line of trees can still be identified when overhead.

Lakes

Shape is the most important aspect in identification of lakes of comparable size. They are easily seen from great distances, even dry lakes.

Mountains and Hills

The navigational value of mountains and hills varies with the height from which they are seen and to a certain extent the light that is experienced.

The country appears to flatten out as height is gained and only the very prominent hills will stand out. If flying at about the same height as the hill-tops they are most prominent. In mountainous country it is difficult to differentiate between the various valley and peaks. The lone mountain, however, is very useful.

Towns and Settlements

Towns can sometimes be recognized by their shape as depicted on the chart, but generally they are identified by their size or position in relation to other features. Careful scrutiny of the number and direction of railways and main roads, entering and leaving or near the town, will usually dispel ambiguity. In large industrial regions towns tend to merge into each other making accurate pin-pointing difficult. In less densely populated areas, confusion can also exist between villages in a particular area. In such areas three or four houses might well be marked on a chart as a village.

Forest and Tree Plantations

These show up well from the air and if marked on the map can be very useful, if their shape is accurately portrayed. In country which is mostly forest or bush the clearings (often indicating a valley) are most important.

Airfields

Airports with sealed runways are quite easily seen. Disused airfields, or those with a graded strip or two generally of the same colour as the surrounding country, are extremely hard to see. Be prepared to observe private strips which are not marked on the map.

Culture

Minor culture, e.g., factories, radio masts, windmills, etc. are very difficult to find without first getting a lead from some other nearby feature more easily seen. Isolated forms of culture have slight value in positioning the aircraft.

Seasonal Changes

Landmarks and their appearance and, therefore, their prominence change considerably during the seasons of the year. Some areas of Australia are comparatively unaffected by seasonal changes. Those areas which experience heavy falls of snow are, of course, most affected. A covering of snow can obliterate those landmarks normally most prominent and give to lesser landmarks a considerable prominence for the period.

Floods, or course, will considerably change the formation and appearance of rivers. Unmapped rivers exist and rivers that previously existed are swallowed and lost amongst sheets of water. The shape and size of lakes are similarly affected. Drought and normal summer dryness change not only the waterways, but the general colour of the terrain. The associated covering of dust makes everything blend and become inconspicious.

Visibility and the Sun

During periods of reduced visibility map reading is made so much more difficult mainly because the area of ground that can be observed is considerably reduced. If it is possible to pass within two miles of a landmark without it being seen, the chances of flying a considerable distance before a Fix is obtained are extremely high. Looking up sun in hazy conditions due to the diffused light severely restricts visibility in that direction. In practice, it is best to fly up sun of the track and observe down sun.

Importance of Features

Prominent landmarks, especially line features are what we base our map reading on. But the really significant feature, the one that dispels all doubt, is the unusual or singular feature. When map reading over a flat and arid expanse, tracks if not easily seen because of their infrequent sighting are useful, and because the terrain is otherwise devoid of detail they could be called prominent. However, doubt can arise, if not confusion. But if in this arid and monotonous area stands one mountain and this can be sighted all doubts are reduced. It cannot be confused, there is only one, and it is doubly prominent because of its unusualness. In a mountainous area, a wide and defined valley would command our attention. The water reservoir in the midst of a rambling built-up area serves the same purpose. The twenty or so railway lines running in all directions which have been confusing can now be ignored.

COMBINATION OF FEATURES

One feature by itself is rarely sufficient for the pilot/ navigator to fix his position. A fix is made easier and perhaps only possible when several features are present. If a straight railway line is crossed, it doesn't tell much. The crossing could conceivably have been made anywhere along a thirty mile stretch of straight rail. But if the crossing is made near where a main road bridges the railroad then a Fix is possible. A bend in the railroad would, of course, be just as useful. If, when endeavouring to decide which of three towns is which, the problem will not be made easier to find that each town has a road running through the centre. But if only two of the towns has a railway passing through and only one of these has a river, the problem is solved. In this example, the fact that the bearings of the railways and roads would surely be different helps identification.

Therefore, when map reading, check carefully the inter-relationship between the various features. The inter- relationship is more important than the features themselves.

Bearings and Distances

The bearing of landmarks from the aircraft is widely used in fixing position by map reading. They can only give an approximate pinpoint because the bearing is only a guess without the aid of a bearing compass. However, the fairly accurate guess is most useful in establishing an area of probability.

The estimation of distance from the air is quite difficult.

The difficulty is not made any easier by the fact that the height at which we will map read varies from trip to trip. Experience and practice does, of course, help. But if the estimation of distances can be avoided do so. If when passing well to the side of, say, a lake instead of trying firstly to guess how far to the side, look in the other direction for some other landmark be observed it should be possible to decide more accurately which is the nearer and the proportion of nearness.

Hills observed on Port beam, position uncertain, somewhere along line A.B.

Lake appears 45ø to the Starboard position along line A.B. can now be fixed with a fair amount of certainty. Bearings from aircraft.

Orientation of Map

For map reading, the map is best held with the North of the map pointing in the direction of North. This is carried out when the map is held so that the track line on the map lies along the actual track of the aircraft which is approximately (unless severe drift is experienced) along the fore and aft axis of the aircraft. For example, when the track on the map runs North to South, the North side of the map would be held to your chest and the South side farthest away from you. The aircraft would be headed approximately South and, therefore, features shown on the map to be left of the track would be expected to appear to the left of the nose and vice versa. With the map so held, less difficulty will be found in comparing what is on the map with the features they represent on the ground.

Anticipation

When the approximate position is known map reading is carried out from the map to the ground. You know your position, you know in which direction you are travelling, it is an easy matter to look ahead on the map to see what can be expected to show up in the next few minutes. Because the anticipation of features before they show up is so important to success, careful study of the track before departure is recommended. To enable the pilot/ navigator to anticipate correctly, it is necessary for him to know his ground speed or rate of travel over the map. This rate of travel depends on the wind, the speed of the aircraft and the scale of the map. If the rate of travel over the map is approximately one inch every five minutes, the finger can follow the progress, pointing to the position, and to look ahead of the finger is to anticipate correctly. If a fast aircraft was flown by a pilot with a large scale map, the rate of travel over the map would be so rapid, that useful anticipation would perhaps be necessary on the adjoining map sheet. Rate of travel or the time factor is all important.

Timing

If the ground speed is reckoned to be 120 k, two nautical miles will be covered in every minute. Therefore, five minutes after the aerodrome or some other recognized landmark has been flown over, the aircraft will have travelled ten nautical miles. By looking at the map, ten miles along the track from the landmark, it is possible to see what other landmarks, if any, are now to be seen and by looking a further ten miles along the track on the map, landmarks can be expected to be seen in the next five minutes. If the track is crossed by a railroad 40 nautical miles from the departure point, it is useless to worry about finding it, and, of course, eventually about not having found it, until some 30 nautical miles and, therefore, 15 minutes have passed. It is most likely impossible to see if regardless of experience, etc., before this time. So for those 15 minutes, relax or busy yourself with closer landmarks even though they are of less importance.

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SECTION: CONTENTS

Civil Aviation Regulations and Orders Relating to the Dropping of Incendiaries: Page

1.0 CIVIL AVIATION REGULATIONS AND CIVIL AVIATION ORDERS

1.1 Dropping of Incendiaries from Aircraft for the Ignition and Controlled Burning of Forest Undergrowth:

1.1.1 DROPPING APPROVAL

CIVIL AVIATION REGULATION 120

Incendiaries may be carried in aircraft on bush fire control subject to the following conditions:

[a] Operator hold's an aerial work licence.

[b] Operation is authorised by state forest authority.

[c] Incendiaries type and arming device and dropping equipment be approved by C.A.A. officers.

1.1.2 CIVIL AVIATION REGULATION 126 (2) (a)

Incendiaries may be dropped from aircraft subject to the following conditions:

DROPPING SITE

[a] Dropping site clearly defined by state forest authorities using terrain features, ground signals, markers etc.

[b] The pilot shall make one preliminary run over the site and obtain confirmation he is over the site.

1.1.3 DROPPING REQUIREMENTS

[a] Site must be clear of persons and stock.
[b] Incendiaries shall be dropped by an Incendiary Machine Operator.
[c] Effective communications shall be maintained between the crew.
[d] The pilot shall at all times be in VHF contact with a responsible forest officer on the drop site.
[e] The pilot shall be personally briefed on the location of the drop area and other matters prior to departure.
[f] The pilot shall ensure that the load is within the limits - both regarding centre of gravity and weight.

1.1.4 INCENDIARY MACHINE OPERATOR QUALIFICATIONS

[a] Shall be trained and qualified in the use of the incendiary equipment and dropping operations.

1.1.5 CARRIAGE OF ARTICLES AND PERSONS

[a] The carriage of incendiaries shall be in accordance with Section 20.16.2 CAO's.
[b] For safety reasons, no persons other than those having duties relating to the operation shall be carried in the aircraft.
[c] Each person shall occupy a separate seat equipped with an approved safety belt or harness, which shall be worn as follows:

- During take-off and landing;
- During an instrument approach;
- When flying less than 1000 feet above terrain;
- In turbulent conditions; and
- During dropping operations.

1.1.6 OPERATING CONDITIONS

[a] Under CAO 133(3) approval may be given for the aircraft to descend to, but not below, 46 metres (150 feet) above tree-top level during dropping operations.

[b] However, an aircraft shall not be flown below 155 metres (500 feet) above terrain within 610 metres (2000 feet) over any built-up area.

[c] During dropping operations the aircraft shall not fly below 465 metres (1500 feet) above terrain, over any populous area.

[d] Dropping operations shall be in accordance with the Visual Flight Rules.

Flight visibility - better than 4.8 kilometres (3 miles).

Distance from cloud - 620 metres (2000 feet) horizontal and 155 metres (500 feet) vertical, when flying below 1550 metres (5000 feet).

[e] The aircraft shall be flown straight and level while incendiaries are being dropped.

[f] The approach to and climb away path from the dropping area shall not involve abrupt manoeuvres, the climb away shall be clear of obstacles.

1.1.7 EMERGENCY EQUIPMENT

The aircraft shall be equipped with:

(a) A wool or similar flexible sheet; and

(b) CO_2 or BCF fire extinguisher readily available to the Incendiary Machine Operator.

1.1.8 ADDITIONAL EQUIPMENT

In addition to the instruments required by CAO 20.18 for VFR operations, the aircraft shall be fitted with a gyroscopic horizon indicator.

1.1.9 OPERATIONS MANUAL

An operator carrying out dropping operations shall be required to list the terms of the permission in the aircraft's operation manual.

Reference: Operational Standards - Civil Aviation Authority - Commonwealth of Australia.

1.2 Pilot Flight Time Limitations:

1.2.1 CIVIL AVIATION ORDER 48.1

Pilot flight times are limited to prevent fatique and avoid accidents from happening. The maximum times should not exceed:

8	hours in one day;
6	consecutive days of work;
30	hours in 7 consecutive days;
100	hours in 30 consecutive days;
900	hours in 365 consecutive days.

1.2.2 MEDICAL STANDARDS

Civil Aviation Regulation 57; and
Civil Aviation Order 47 Standards.

An aircrew member may not consume alcohol 8 hours prior to flying CAR 247.

Aircrew shall not be under the influence of alcohol or drugs. Caution should be exercised if taking any drugs in conjunction with alcohol prior to flying.

Other factors to watch are:

- fatique
- dehydration
- effects of caffeine
- colds or flu
- earache
- hangovers

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3.0 EQUIPMENT CAPABILITIES AND LIMITATION

3.1 INCENDIARY MACHINE CAPABILITIES AND OPERATIONAL LIMITATIONS

3.1.1 INTRODUCTION

Prescribed burning using aerial ignition was first developed as a joint project between the Commonwealth and Scientific Industrial Research Organization (CSIRO) and the Forests Department of Western Australia in 1965. (Baxter et al: 1966)

This section describes the development of incendiary machines used for aerial burning in Western Australia (W.A.), from the original hand-operated machine to the most recent machine developed by the Forest Department (FD) of Western Australia, (renamed since 22 March 1985 as the Department of Conservation and Land Management). (van Didden, 1983)

3.1.2 HISTORICAL BACKGROUND

Since the earliest days of colonization in W.A., periodic summer wildfires have ravaged the forests. Early foresters were alarmed by the damage caused and after 1918 pursued a policy of almost complete fire exclusion. However, by 1953 heavy accumulation of forest fuels or debris in the protected areas had resulted in many wildfires which caused serious damage to the forest. It became apparent that complete protection of the forest could not be maintained with the limited manpower and equipment available, especially in the presence of heavy forest fuels.

As a result, a complete review of the fire policy took place in 1954. Prescribed burning over large areas to reduce fuel hazards was introduced. (Peet, 1967)

Early programmes of "hand burning" were carried out by gangs of men of foot. This method was slow, expensive and risky in dense, inaccessible areas. Consequently, alternative methods of lighting up large areas of forest were sought, and ignition from aircraft was an obvious choice. However, there were many technical problems to overcome, the most important being the development of a suitable and safe incendiary machine to be used in the aircraft.

The first incendiary machine was developed in 1965 by the CSIRO. In December of that year, this machine was used on the first large-scale aerial burn, on the Pingerup Plains near Walpole in Western Australia.

Despite a number of initial problems, in the summer of 1965/66 over 20 000 ha of forest was prescribe burnt using the incendiary machine. The use of aircraft and the new incendiary equipment enabled large areas of forest to be covered in a short time. This was a major step forward in fire control, as greater areas could be lit for hazard reduction burning, under ideal weather conditions and at relatively low costs. (Baxter et al, 1966)

The success of the first venture led to 180 000 ha of forest being prescribed burnt in the spring of 1967. By 1968 the aerial burning programme was operational in Western Australia and has since played an increasingly important role in fire protection of State forest.

3.2 WESTERN AUSTRALIAN MACHINE BACKGROUND WAM 1982

3.2.1 DESCRIPTION

The basic function of the equipment is to inject small plastic capsules with a measured quantity of glycol, thereby initiating the exothermic reaction, and to eject the primed capsules from the aircraft at precisely timed intervals. The capsules are loaded into the turntable by hand. It has been designed to accomplish this with the highest degree of reliability and safety.

3.2.2 MODE OF OPERATION

A 24-28 volt D.C. motor is connected by belt drive to a worm gear speed reducer to obtain a final drive speed of 10 to 55 r.p.m.

The power take-off shaft from the gearbox is directly coupled to the axial cam to continuously control the injector mechanism. The cam has five different functions to perform during each rotation, they are: dwell, pierce, inject, dwell and strip, for each cycle. During part of the dwell period at the beginning of each cycle, the geneva mechanism is activated and rotates the turntable holding the capsules in position.

While the turntable is stationary, the cam activates the injector pump to pierce the capsule top, then injects 1.3 ml of glycol, dwells for 10o, then strips or removes the needles from the cap. As soon as the needles return to their original "up" position, the turntable is again moved by the action of the geneva cam. The primed capsule them moves one position and is ejected from the aircraft.

The incendiary capsules are fed by hand from a storage tray into the turntable on the machine, where they are automatically injected and ejected when the machine is in operation.

3.2.3 MECHANICAL DRIVE SYSTEM

Power for the WAM'82 machine is supplied by a .25kw - 24 Volt Direct Current (VDC) shuntwound electric motor - operating at 833 to 5000 rpm. The speed for the motor is controlled through an electronic motor speed control board in the Electronic Control box. The board controls motor speed by feeding a field winding with pulses of constant voltage but variable width. The motor stop/start function utilizes a silicon controlled rectifier, which ensure the machine stops in the safe "rest" position.

The electric motor is connected to a Richardson Radicon wormdrive gear reduction box of 25:1 ratio, to give a calculated output of 10 to 60 rpm.

The output shaft from the gearbox drives both the injector cam and the geneva mechanism. The geneva cam mechanism is an intermittent-motion device allowing power to be periodically transferred from the gearbox output shaft to the geneva cam.

The gearbox output shaft rotates continuously to drive the injector cam, which sets the injection cycle in motion. During each injection cycle the geneva cam remains stationary, until the cycle is complete, and is then reactivated.

A 28 teeth gear underneath the geneva cam drives the larger 84 teeth idler gear which is then connected to a 28 teeth gear to move the turntable. The intermittent motion of the geneva cam is thereby synchronised to the movement of the turntable.

3.2.4 CAPSULE TRANSPORT SYSTEM

Turntable

The six station turntable is designed to move the capsule from the loading stage to the injection and ejection positions. The turntable is designed to withstand any primed capsule from igniting the next capsule in the event of a misfire in the aircraft due to a system malfunction.

Manual Release Overdrive (Hdg)

In the event of a power failure the turntable can be manually released from the drive shaft by pulling up the release pin and rotating the turntable by hand. In the event that the turntable drive shaft becomes unsynchronised from the geneva cam the needles will not be damaged because of the hollow groove in the top of the turntable.

Glycol System

Glycol Tank

Injector

Glycol is stored in a 6.7 litre capacity stainless steel tank. Fitted with a sight gauge and graduated scale to determine the glycol level. Glycol is fed by gravity to the injector.

The modified injector is based on the original 1968 CSIRO design with slight modifications to reduce the number of parts.

3.3 EJECTION RATE

The ejection rate of the incendiary machine can be varied from a maximum rate of 54 capsules per minute or 1.2 second interval down to 13 capsules per minute or 4.6 second interval. Changes in speed are made by turning the motor speed control knob to the desired drop rate setting on the digital indicator.

To obtain correct ground spacing check table below.

IGNITION SPACING AS A FUNCTION OF TIMING AND GROUNDSPEED

Capsules per min	Ground Speed (knots) 70	80	90	100	110	120
Interval	Approximate Distance Between Ignition Points Metres					
13	166	190	213	237	261	285
16.5	131	149	168	187	205	224
23.5	92	105	118	131	144	157
27	80	91	102	114	125	137
31	70	79	89	99	109	119
35	62	70	79	88	97	106
37	58	66	75	83	91	100
40	54	62	69	77	85	93
42	51	58	66	73	81	88
43	50	57	64	72	79	86
45	48	54	61	68	75	82
47	46	52	59	65	72	79
50	43	49	55	61	67	74

3.4 CHEMICALS USED

The chemicals used to start the fires are potassium permanganate and mono-ethylene glycol mixed at the ratio of 1:4 (1 part glycol to 4 parts permanganate). Insufficient glycol will prevent ignition taking place, from the mixture being too dry. While excessive glycol will drown the mixture and make it ineffective.

Testing of Incendiaries

Reaction Time

The reaction between potassium permanganate and ethylene glycol depends upon temperature and particle size of the permanganate - if the temperature is high or the particles are fine the reaction time will be short.

To test the reaction time a capsule should be run through the machine, and should be timed from the instant of injection to the first appearance of flame. The temperature of the glycol should be taken and recorded together with the reaction time.

Reaction time should exceed 30 seconds at 20oC. Capsules should be stored in a cool place away from direct sunlight and high temperatures, to avoid the lids loosing their plasticity and coming off.

Quantity of Glycol

The quantity of glycol injected is important for the proper functioning of the reaction. At the beginning of each day after priming the injector - check that the quantity is satisfactory. Do this by injecting 5 times into a single capsule and then measuring the amount in a small measuring flask. The correct quantity is 1.3 ml per injection.

At the end of each day it is recommended that the quantity of glycol used is recorded, and divided by the number of capsules ejected to give an average volume per capsule used.

3.5 INCENDIARY SPECIFICATIONS:

Incendiary Capsule

Container: Size: 38 mm x 21 mm diameter
Material: Styrene acrylan nitrol
Mass: (Empty) 2.52 gms
Cap: Size: 11.5 mm x 21 mm diameter
Material: Low density virgin polythene
Mass: 1.31 gms
Contents: Material: Potassium permanganate $KMnO_4$
Mass: 4.0 + 0.5 gms
Mass Total: 7.83 + 0.5 gms
Size Total: 45 mm x 21 mm diameter.
Reagent
Mass: 1.3 gms + 0.2 gms
Material: Mono ethylene glycol $C_2H_6O_2$

3.6 CAPSULE LOAD - GLYCOL CAPACITY

Capsule Load

The metal cabinet in the Britten Norman Islander carries 11 trays of 324 capsules totalling 3 564 capsules.

This quantity should be sufficient for most large burns. However if there is a need to carry additional supplies they should be carried in the rear cargo compartment. Restrained by an approved cargo net. Incendiary capsules come packed in boxes containing 4 trays, holding a total of 1 296 incendiary capsules.

Glycol Capacity

The glycol tank when fully loaded has a capacity of 6.9 litres, however for planning purposes only count on 6.5 litres useable. This should give an endurance of 4 333 capsules based on 1.5 ml per injection.

Additional glycol may be carried in a suitable container, anchored to the floor with cargo tie points. The 'esky' box is installed for this purpose.

For security reasons this additional glycol should not be left in the aircraft overnight or during the weekends.

At the end of each dropping operation the aircraft must be cleaned inside to ensure that any loose articles are stowed. Any potassium permanganate or ethylene glycol that may have been spilt must be cleaned to avoid the inadvertent mixing of any spilt portions.

3.7 EQUIPMENT WEIGHTS

Incendiary Machine
Main frame mass, glycol tank empty 47 kg
Glycol tank full, capacity 6.7 litres 55 kg
Overall dimensions length 51 cm
height 70 cm
width 35 cm

Subframe Assembly Britten Norman Islander Partenavia
Mass 3.75 kg 1.9 kg
Overall dimensions, length 84 cm 40 cm
height 21 cm 21 cm
width 30 cm 35 cm

Incendiary Storage Cabinet

Britten Norman Islander Partenavia
Mass, empty 37 kg 32 kg
Mass, fully loaded 73 kg 54 kg
Contents, 11 trays @ 324 ea 8 trays
number of incendiaries 3 564 2 592
Overall dimensions, depth 43 cm 42 cm
height 61 cm 51 cm
width 42 cm 43 cm

Additional Equipment

Operators seat 9.3 kg -
Seat-rail 5.9 kg -
Firemat 5.4 kg -
Esky for glycol 5.4 kg -
5 litres glycol 11.3 kg _____
Total equipment weight 169.0 kg 110.9 kg

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4.6 Method of Preparation 2

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4.0 PREPARING AERIAL BURN FLIGHT PLANS

Preparation of flight plans are one of the basic requirements of successful burns. Along with other aspects of Aerial Burning Technology, flight plans have developed into the specialized document in use today.

4.1 Early Plans:

These were essentially jottings on a 1:40,000 API, and were derived during telephone conservations. They invariably suffered the inherent faults caused by misinterpretation. The system adopted in 1966 used a transparency of the relevant section of the 1:40,000 API sheet to produce dyeline prints, showing boundaries and flight lines.

4.2 Current Plans:

Under the current system, plans of the specific burn area are produced by Mapping Branch and are available at the relevant District before the commencement of the burning season. This provides the same base plan data so that everyone starts from a common point with the same information.

4.3 Features of Current Flight Plans:

[a] Job No.;

[b] Scale - 1:25000;

[c] Area in hectares;

[d] A clearly defined boundary (only one job is indicated on any one sheet);

[e] Departmental or Australian mapping grids are indicated for orientation;

[f] Date of photography (from which the plan was derived);

[g] Cleared areas and plantations are marked;

[h] Data panel.

4.4 Acquiring Information:

Whenever possible - derive base information from the District Office concerned - preferably the Controller or his deputy (usually the Burn Boss).

If the information has been passed on or received second hand it is a good general rule to confirm the data with the particular office. Do not assume that the District concerned will automatically advise you of last minute changes.

4.5 Essential Data:

[a] Flight time one: axis co-ordinates,
e.g., x axis north
y axis south

[b] Stripwidth and spot distance;

[c] Time required over job/or start time;

[d] Communications, callsigns, channel;

[e] Check:

- marking method and details, flares etc;
- boundary modifications;
- unidentified obstacles (radio masts etc);
- sensitive or excluded areas - within burn.

4.6 Method of Preparation:

(a) Locate and place line 1 from reference data.

(b) According to stripwidth dimension measure off each progressive line as a scaled increment - AT RIGHT ANGLES TO LINE NO. 1.

(c) Number and mark each line consecutively. Use two colours to indicate alternate lines.

- even/uneven numbers;
- flight line transparencies of differing spacings are available at District offices.

(d) Highlight - control point and areas of concern - e.g., obstacles, plantations - and "no-burn" areas. Every uncleared private property boundaries which may cause confusion or required special marking.

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Introduction:

The aim of this operation is to provide a suitably fitted out aircraft and well trained crew to carry out incendiary dropping operations for fire management purposes. The purpose of this lesson is to further develop the students knowledge of the basic operational and planning requirements for aerial prescribed burning.

5.1 Briefing:

The morning of the proposed burn the duty operations office or delegate navigator should personally (or by phone) contact the burn boss or District protection officer and discussed the following points:

Burn number and location (distance and bearing from DHQ)

Objective of burn, or for part of the burn.

Features - topography, shape, area.

Boundary location and last minute changes.

Weather - wind direction and possible changes.

Forest Types - fuel types and variations. Location of heavy fuel pockets.

Fuel details - SMC's and FDI's, actual rate of spread expected.

Co-ordinates of flight lines, strip widths.

Lighting patterns.

Previous trouble spots (unburnt creeks, plots, poor boundary access, poor edging).

Adjoining fuel types and ages.

Private property to avoid (no overfly permission), pine, eucalypt or research plots, etc.

Staff at burn - names and call signs. Position around boundary. Control point location.

Beacon vehicle - are they required, if so location. Access problems with beacons, long travel times between individual lines, etc.

Public check - campers, fishermen, recreationists - along rivers or picnic spots.

Special instructions - areas to avoid (dunes, swamps, creek systems, ridge top lightings. Radio towers or SEC ines to avoid.

Communications - VHF channel, simplex/duplex.

Spot fires - if required.

Expected start time.

Day's program - prior and later burn lightings.

Contingency plans - alterations.

5.2 Planning Measure Distance, Direction, Calculate Time

1:1,000,000 Scale Plan - World Aeronautical Chart check position of Burn - Direction from Base Airstrip .... Magn. Distance .... nm. E.T.I. .... Min.

From stripwidth and spotdistance calculate capsule requirements - see Table 1. From required spotdistance, work out most satisfactory ejection rate and flying speed. See Table 2.

Measuring Distance

The Nautical Mile:

For air navigation the N.M. is the most convenient unit as it is taken to be the average length of one minute of latitude (this average being 6,080 feet).

Measurement of the Track

When it is intended that an aircraft be flown from A to B, a straight line or "track" is drawn joining them and the direction is read off with a protractor placed on the mid-meridian.

The track so measured is true. Isogonals (lines of equal Magnetic Variation) which on the WAC chart take the form of a blue dotted line, this indicates the variation in that locality. The variation when applied to the track measured, or the Heading, converts them from True to Magnetic.

From strip width and spot distance calculate capsule requirements.

TABLE 1
Number of Capsules Required per Hectare
Ignition Grid Pattern in Metres
Spot distance x Stripwidth

Area in Hectares	75 x 150	80 x 175	100 x 200	125 x 250	150 x 300	200 x 400
	Number of Capsules Required					
1000	889	715	500	320	222	125
2000	1778	1429	1000	641	445	250
3000	2667	2143	1500	962	667	375
4000	3556	2858	2000	1282	889	500
5000	4444	3572	2500	1603	1112	625
6000	-	4286	3000	1923	1334	750
7000	-	-	3500	2244	1556	875
8000	-	- 4000	2564	1778	1000	
9000	-	-	-	2885	2000	1125
10000	-	-	-	3205	2223	1250
12000	-	-	-	3846	2667	1500
14000	-	-	-	4487	3111	1750
16000	-	-	-	-	3556	2000
18000	-	-	-	-	4000	2250
20000	-	-	-	-	4445	2500

From required spotdistance work out most satisfactory ejection rate and flying speed.

TABLE 2
Ejection Interval
Spotdistance and Flying Speed

To determine the speed the aircraft should be flown in nautical miles (knots) in conjunction with the ejection interval rate of the incendiary machine to obtain the required spotdistance on the ground.

Ejection Drop Rate in Capsules per Minute	Aircraft Speed in Knots							
	60	70	80	90	100	110	120	130
	Spot Distance Spacing in Metres							
65	29	33	38	43	48	52	57	62

60	31	36	41	46	51	57	62	67
55	34	39	45	51	56	62	67	73
50	37	43	49	56	62	68	74	80
45	41	48	55	62	69	76	82	89
40	46	54	62	70	77	85	93	100
35	53	62	71	79	88	97	105	115
30	62	72	82	93	103	113	124	134
25	74	87	99	111	124	136	148	161
20	93	108	123	139	154	170	185	201
15	124	144	165	185	206	226	247	268
10	185	216	247	278	309	340	370	402

5.3 Estimating Departure Times and Flight Duration

The following guideline is drawn up to estimate the time that the aircraft can be expected to complete a job, and allow programming for a days work. These times are a guide only.

Other factors, will affect the time the aircraft can be expected over a job:

Estimate Departure Time

Work out the departure time take into account the following factors:

Time to get to the airstrip
Note: Lodgement of Flight Plan at Primary and Secondary Airports required
Daily the aircraft, check incendiary machine (20 min)
Warmup and Taxi (5 to 8 min)
Flying to the job (2nm/minute)
Job reconnaissance (10 min to 20 min)
Dummy flight line to establish drift (5 min to 10 min)

Advise the pilot of the area to be burned, what time the aircraft is required over the job, time required to commence dropping capsules.

Point out boundary difficulties.

TABLE 3

Production rate over job assumes airspeed 100 knots, and flightline spacing 200 metres apart.

Job Size Ha	Time Hrs	Job Size Ha	Time Hrs
500	.6	4 000	1.4
1 000	.75	5 000	1.8
1 500	.9	6 000	2.1
2 000	1.0	7 000	2.4
2 500	1.1	8 000	2.8
3 000	1.2	9 000	3.2
3 500	1.3	10 000	3.4

5.4 Suitable Clothing and Aircrew Punctuality

Navigators are to promote an image of responsibility and authority to preserve and enhance the image of the Department. Aircrew should wear clothing and footwear that is appropriate to the task and climate while bearing in mind safety at all times.

Punctuality is needed to ensure a smooth operation when a number of Districts are involved in the days burning program.

5.5 Pre-Flight Briefing to Pilot

The following points should be covered in your pre-flight briefing. To ensure that the aircraft arrives on time and can be programmed for other burns during that day. The pilot and incendiary machine operator should be briefed as early as possible after the decision is made to burn to involve them in the planning process and make them feel part of the team.

The following timetable should be observed by distiсts in scheduling their daily burning program.

0745 hrs - Districts to obtain weather forecast

0820 hrs - District Controller to advise Regional co-ordinator prior to 0820 hours of proposed burn and required start time.

0830 hrs - Regional co-ordinators to advise Senior Fire Operations Officer Bunbury of requests.

0845 hrs - Approved programme notified to region with Beacon arrangements.

0900 hrs - Navigators to be advised of flight plan details.

0900 hrs - Bunbury Protection Branch to advise ABC and commercial stations burns proposed for the day.

1000 hrs - Controller to check the weather forecast to confirm conditions remain suitable.

5.6 Pre-Flight Arrangements for Aircrew and Supply Requirements

Navigator to advise incendiary machine operator of the jobs to be completed for the day; to allow the incendiary machine operator to plan his capsule and glycol or anti-freeze requirements.

NOTE: keep a check of supplies and advise Regional Fire Protection Officer Leader if stocks are running low and require replacement.

5.7 Arrangements, when Reaching Target Area:

On the way to the job the navigator should contact the controller re any last minutes changes, confirms boundary changes or areas to be left unburnt, eg regeneration areas. Asks for advice on difficult boundaries.

Establish contact with beacon vehicles at least 15 kilometres from the job. Determine if beacons are functioning.

On arrival over the area to be burnt, request marker fires to be lit on difficult corners projecting into the burn.

Boundary definition can be improved by lighting marker fires at intervals along the boundary.

The pilot is legally required to do at least one circuit of the boundary to identify ground points on the map, establish he is in the correct area and establish that the area is free of people, stock and vehicles.

The first flightline should be a dummy line to establish wind drift. The track error should be less than 100 metres before lighting can be commenced.

The navigator must obtain clearance from operations officer before commencing on a live dropping run to ensure authority is granted to commence lighting.

5.8   Flight Patterns

Parallel Method

Consists of marking every line with beacons and Verey piston flares used early in the season when percentage take is low.

Aircraft approaches point A and beacon is put on - the moment the aircraft goes over point A the navigator requests "East beacon on, West beacon off, East fire flare".

It is understood West beacon automatically moves to point D and waits and advises ready in position on line 2.

As soon as the aircraft flies over the East beacon, it is turned off and shifts to position C. Driver advises when ready in position "East beacon on in position line 2". This procedure is repeated as often as necessary until the job is completed.

The aircraft turning time outside the burn area has to be co-ordinated with the time it takes the beacons to shift.

Corridor Method

Consists of marking only every second line with the beacon, i.e. the beacon has too move 400 metres if flight lines are 200 metres apart. The initial three or four lines are slow as the aircraft waits for the smoke to show up, when this occurs the aircraft flies back through the previous flight lines.

When filling in between the lines it is easier to see the smoke if looking into the sun, ie: if lines are East to West and the burn is in the afternoon, then all flying onto the beacon should be done on East edge and flying in Westerly direction when filling in.

The above method of marking is particularly successful under conditions where smoke shows up very rapidly i.e. within 15 minutes. If smoke shows up slowly, then as many as 5 or 6 lines have to be flown at double spacing before anything shows up.

Racecourse Method

Consists of marking the first and fifth line and every fourth line from there on with beacons or other navigational device.

The method relies heavily on pilot technique, ability and boundary definition.

First line flown from marker fires, the aircraft then flies over beacons on line 5 then to line 3 by optically dividing the area in half.

The area is again optically divided and line 2 then line 4 flown. The whole method can be repeated with the beacon moving to line 9.

5.9 Capsule Flight Path

Showing the theoretical time it takes before a capsule strikes the ground (in seconds) and the horizontal distance (in metres) before the target, that the capsule has to be released.

It is assumed that the aircraft is in level flight 90 kts and neglects the effect of air resistance mass and inertia on the capsule.

Dropping Height Feet	Time Capsule takes to fall and Strike the Ground Seconds	Distance Capsule Travels Horizontally After Being Released Metres
1000	7.9	366
900	7.4	342
800	7.0	324
700	6.6	305
600	6.1	282
500	5.6	259
400	4.9	226
300	4.3	199
200	3.5	162
100	2.5	115

Note the actual time taken for the fall will be longer, but the horizontal distance the capsule travels will be shorter.

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6.0 LATITUDE AND LONGITUDE

A convenient way of specifying the POSITION of any point on earth is to relate it to the imaginary lines that form the latitude and longitude graticule (or grid).

- Latitude

The reference for latitude is the EQUATOR, the great circle whose plane is perpendicular (at right angles, 90 degrees) to the polar axis.

FIGS 2a, b, & c LATITUDE.

* The LATITUDE of a place is its angular distance in degrees from the equator, measured at the centre of the earth and designated either north or south.

* A PARALLEL OF LATITUDE joins all points of the same latitude and is a small circle (except for the equator).

* Parallels of latitude are parallel to the equator and to each other.

* The longest parallel of latitude is the equator (Latitude 0 degrees) and the parallels of latitude progressively decrease in size until the 90 degrees parallels of latitude become just points at the N and S geographic poles.

FIG. 3. THE FURTHER FROM THE EQUATOR THE SMALLER THE PARALLEL OF LATITUDE

- Longitude

The basic reference for longitude is the GREENWICH MERIDIAN - also known as the PRIME MERIDIAN. It is that branch (half) of the great circle that contains the polar axes (N and S geographic poles) and passes through the Greenwich Observatory which is situated near London.

The prime meridian is designated as "longitude 0 degrees".

FIGS 4 a & b, THE PRIME MERIDIAN

The other branch of the same great circle that contains the prime meridian runs from the north geographic pole to the south geographic pole on the other side of the earth to Greenwich (roughly down the west side of the Pacific Ocean).

It is called "longitude 180 degrees" and it can be reached by travelling either East from the prime meridian or by travelling the same angular distance (180 degrees) West from the prime meridian. Therefore it can be called both "180E" or "180W". It is also called the anti-meridian of Greenwich.

* All of the great circles containing the polar axis (therefore passing through the N and S geographic poles) are called MERIDIANS OF LONGITUDE.

* Meridians of longitude are specified by their angular difference in degrees EAST or WEST from the prime meridian.

FIG. 5. THE LONGITUDE OF A PLACE IS THE ANGLE BETWEEN ITS MERIDIAN OF LONGITUDE AND THE PRIME (GREENWICH) MERIDIAN MEASURED EASTWARD OR WESTWARD.

6.1 POSITION ON EARTH

The position of any point on the earth can be specified by:

* its LATITUDE - its angular position N or S of the plane of the equator;

together with:

* its LONGITUDE - its angular position E or W of the prime meridian.

The "parallels of latitude" and "meridians of longitude" form an imaginary graticule or grid over the surface of the earth.

The position of any point on earth can be specified by its LATITUDE and LONGITUDE. It is usually sufficiently accurate to specify the latitude and longitude of a place in degrees and minutes only (although for extreme accuracy each minute can be divided into 60 seconds of arc).

FIG. 6. THE POSITION OF BIRDSVILLE IN QUEENSLAND IS (25o 54'S, 139o 21'E)

Latitude and longitude is the normal method of specifying position on earth and is the one that pilot/navigators most commonly use at the flight planning stage when they are preparing their maps and flight plan. Once in flight, however, there are other means of specifying the position of the aircraft:

* by position over a landmark or radio beacon, e.g. "over the Harbour Bridge";

* by range (distance and bearing from a landmark or radio beacon, e.g. 10 nm on a bearing of 290 M from Melville Island".

6.2 DISTANCE ON EARTH

The standard unit of distance in navigation is the NAUTICAL MILE - the length of 1 minute of arc of any great circle on the earth (assuming the earth to be a perfect sphere).

There are 360 degrees in a circle and 60 minutes in a degree. This makes (60 x 360 =) 21,600 minutes of arc - which makes the distance right around the circumference of the earth on a great circle 21,600 NM.

FIG. 7. I NM = THE LENGTH OF 1 MINUTE OF ARC OF A GREAT CIRCLE ON THE EARTH

* LATITUDE (the angular distance north or south of the equator) is measured up and down a meridian of longitude (which is a great circle) and therefore:

1 MINUTE OF LATITUDE AT ANY POINT ON EARTH = 1 NM.

FIGS 8 a & b
1 MINUTE OF LATITUDE = 1NM/1 MINUTE OF LONGITUDE
VARIES IN LENGTH

1 DEGREE OF LATITUDE AT ANY POINT ON EARTH = 60 NM

* LONGITUDE is measured around the parallels of latitude (small circles except for the equator) and so 1 minute of longitude varies in length depending upon where it is on the earth's surface.

The only place where 1 minute of longitude is equal to 1 NM is around the equator.

Do not be confused by the fact that:

WE MEASURE 1 MINUTE OF LATITUDE (ALWAYS 1 NM) UP OR DOWN
THE SIDE OF THE CHART ALONG A MERIDIAN OF LONGITUDE;

- it is logical when you think about it.

FIG 9: 1 MIN LAT = 1NM

FOR CONVERSIONS:

1 NM = 1852 METRES = 6076 FEET = 1.15 SM.

6.3 CHART PROJECTIONS

The original problem in map-making is still with us - how can you represent the curved surface of a earth on the flat surface of a map without distortion?

The answer is still the same - it cannot be done!

"A spherical orange peel cannot be flattened out perfectly."

Some property will always be distorted to a greater or lesser extent depending upon how you transfer the points on the surface of the spherical earth onto the flat chart.

Some curved surfaces such as a cylinder or a cone can be cut and laid out flat - or, in the opposite sense, you can make a cylinder or a cone out of a flat piece of paper. This is not possible with a spherical surface - try it with an orange peel.

Chart-making involves the PROJECTION of the points on the surface of a sphere onto either a conical or cylindrical surface that can then be flattened out to form a plane.

A simple view of map projections is to think of a light projecting the shadows of the latitude-longitude graticule of the sphere onto a cone (Lambert's projection) or onto a cylinder (Mercator's projection), which is then laid out flat.

6.4 SCALE

Unlike Spike Milligan we cannot carry full-scale maps of the earth in our nav bags. Our charts have to be scaled down and this is done by "reducing the earth" to a fraction of its size, and then doing the projection.

There are numerous ways of describing just how much the earth is scaled down on a particular map.

SCALE IS DEFINED AS THE RATIO OF THE CHART LENGTH
COMPARED TO THE EARTH DISTANCE THAT IT REPRESENTS

$$\text{SCALE} = \frac{\text{CHART LENGTH}}{\text{EARTH LENGTH}}$$

THE LARGER THE CHART LENGTH FOR A GIVEN EARTH LENGTH,
THE LARGER THE SCALE AND THE MORE DETAIL

THAT CAN BE SHOWN

This means that large scale charts cover small areas in detail. For example, a Visual Terminal Chart (VTC) has a larger scale and can show more detail than a Visual En-route Chart (VEC).

- SCALE CAN BE EXPRESSED IN VARIOUS WAYS;

* as a REPRESENTATIVE FRACTION, e.g. the WAC series are 1/1,000,000 charts (one to a million), where 1 centimetre on the chart will represent 1,000,000 cm or 10 kilometres on the earth, or where 1 NM on earth is represented by 1 millionth of a NM on the chart.

* as a GRADUATED SCALE LINE - usually situated at the bottom of the chart. A graduated scale line allows you to measure-off the distance between two points on the chart and match it against the scale line.

FIG 12: A SCALE LINE OFF A CHART

* in WORDS - e.g. "1 cm equals 10 NM", which obviously means that 10 NM on the earth's surface is represented by 1 cm on the chart.

Even if you can find no reference to scale on the chart you can always measure-off the distance between two points against the latitude scale which runs down the side of the chart (1' of latitude = 1 NM).

A point to remember here is to use the latitude scale at about the mid-latitude between the two points because on some charts scale may vary slightly depending upon where you are (top, middle or bottom) of the chart.

There are three main types of chart that every visual pilot in Australia should be familiar with:

* the WORLD AERONAUTICAL CHART (WAC) series - used mainly for en route topographical and cultural information.

* the VISUAL EN ROUTE CHART (VEC) series - used mainly for en route aeronautical information.

* the VISUAL TERMINAL CHART (VTC) series - used for all topographical, cultural and aeronautical information around major terminal areas.

6.5 THE WORLD AERONAUTICAL CHARTS (WACs)- INTERNATIONAL CIVIL AVIATION ORGANISATION (ICAO), 1:1ÿ000ÿ000 SERIES.

We use WACs to provide us mainly with TOPOGRAPHICAL information (mountains, lakes, rivers, deserts, coastlines etc.) and CULTURAL information (cities, towns, freeways, country roads, railway lines, etc.) for visual en-route navigation.

All WACs have the same "one to a million" scale and the same symbols.

WACs are based on the Lambert Conformal Conic projection, so that angular relationships and shapes are preserved and so that there is a reasonably constant scale over the whole of the chart. Straight Lines closely represent the Great Circle track between two points.

Each country is responsible for producing the WACs covering its own area, and they are generally available for all parts of the world (one exception at the moment being Papua New Guinea where Tactical Pilotage Charts known as TPCs are used).

Each WAC chart has a number which is displayed at the top beside the name of that particular chart. The number of the adjoining WAC chart is also labelled around the edge of the chart.

Things such as radio towers, irrigation channels, railway lines and roads change from time to time, and so WAC charts are continually up-dated by:

* re-prints at convenient intervals (so ensure you have the current edition, as specified in NOTAM's NOTAMs class 2);

* NOTAM (NOTices to AirMen) amendments which you should make by hand on your WAC's. These are called "Manuscript Amendments".

The WAC is the primary chart used by visual pilots in Australia to plot positions and tracks when well away from busy terminal areas. Aeronautical information (e.g. controlled airspace, restricted areas) will then be cross-checked off the VEC.

It is possible to plot on the VEC as well as the WAC if you want to.

The TOPOGRAPHIC information shown on a WAC chart is that which is considered to be of most use to the pilot/navigator.

It is of course impossible to show absolutely everything on a chart, so there may be some details on the ground not shown - conversely anything shown on the chart you can reasonably expect to exist on the ground. For example, an isolated rock may not be considered significant by the map-maker and therefore will not be shown on the map. You might spot it on the ground yet not find it depicted on the map. If however there is an isolated rock depicted on the map, you can be certain that it does exist on the ground.

* DRAINAGE AND WATER FEATURES (hydrographic features) are usually depicted on the map in blue. This includes creeks, streams, rivers, canals, lakes, swamps, waterholes, wells and bores, shorelines, tidal flats, dry lakes, etc. Just how they are depicted on the map is explained by the legend - but bear in mind that after a flood, for

instance what might be shown as a dry river bed on the map might in fact be a raging torrent, etc. Right throughout aviation, common sense is necessary. One drainage feature not depicted by blue is the mangrove swamp, which is usually near a coastline, and which is depicted in green.

* RELIEF. There are various ways of bringing ground contours into relief, so that an impression of hills, mountains, valleys, etc. is obtained when you look at the map.

The WAC chart uses CONTOURS, which are lines joining places of equal height above sea level, and the closer the contour lines are together on the map the steeper the hill on the ground.

COLOUR or layer tinting is used in conjunction with the contour lines to give even more relief. The colours or tints used for the various ground elevations are shown on a "hypsometric tint" table at the side of the WAC chart. ("Hypsometric" means "establishment of vertical heights or elevations".) The shades of colour on the WAC chart start with green for low land, then goes through yellow and into brown, gradually darkening the higher the ground is.

HACHURING and HILL SHADING are used to give a three dimensional effect. Hachuring consists of very short lines radiating from high ground and is commonly used to portray bluffs, cliffs and escarpments. Hill shading shows darkened areas on the low side of high ground where you would expect to see shadows at certain times of the day.

SPOT ELEVATIONS (or spot heights) are also shown using a black spot with an adjacent number to indicate height AMSL (Above Mean Sea Level) in FEET. These heights can be assumed to be accurately measured (unless amended by NOTAM). Spot Heights are normally used to show local peaks and other critical elevations that are significantly higher than the surrounding terrain.

* CULTURAL FEATURES are of great help to the pilot/navigator. It is not possible to show every town or every house on the map. so a choice is made to show what is significant and of value for visual air navigation.

A group of say 100 houses is of little significance if it lies in the middle of a city the size of Sydney and so will not be specifically depicted on the map, yet in the outback it is extremely significant and will certainly be shown. In remote areas the map will even show isolated homesteads, out-stations and water tanks.

ROADS and RAILWAYS can be of great assistance to the visual pilot/navigator. Those that will be most significant for air navigation will be clearly shown. Distinctive patterns such as curves, roads running parallel to railway lines and then crossing over, junctions, forks, overpasses, tunnels, etc. are especially useful.

Many other useful cultural features may also be shown such as wheat silos, telegraph lines, etc. Read the legend carefully and become familiar with the symbols.

* Limited AERONAUTICAL information is also shown on WAC charts, such as aerodromes (civil, military, or joint use), aerodrome beacons and landing grounds. The date at which this aeronautical information was still considered to be current is specified on the chart.

The division of airspace is not shown on WAC charts - this information is shown on VEC and VTC charts.

The LATITUDE-LONGITUDE graticule is clearly marked on WAC charts:

* the east-west parallels of latitude indicating degrees north or south of the Equator (south in Australia of course) are labelled at either side of the chart;

* the north-south meridians of longitude gradually converging as they near the south pole are labelled at the top and bottom of the map in degrees East or West of the Prime Meridian (in Australia, Longitudes are East).

This makes the WAC chart ideal for measuring the latitude and longitude of a position.

Figure 13 below is a photographic excerpt from the top right hand corner of a WAC chart and clearly shows the latitude and longitude indications.

To measure the latitude and longitude of a place on a WAC chart:

6.6 Measuring Latitude and Longitude of a Position.

6.6.1 Latitude:

- Place a straight-edge east-west through the place parallel to the parallels of latitude.

- From the latitude scales running north-south down the page you can read-off the exact latitude. (It should be the same latitude on the scale either side of the place - this ensures that the straight-edge is placed correctly on the map.)

Note: that in the Southern Hemisphere the latitude increases towards the south and bottom of the chart, and that the scale lines break up each degree of latitude into 60 minutes, with large marks each 10 minutes. (Make sure that you count from the top down the page.)

6.6.2 Longitude:

Place a straight-edge north-south through the place parallel to the closest meridians of longitude.

From the longitude scales running east-west across the page you can read-off the exact longitude. (It should read the same on the scales above and below the place this checks that the straight-edge is placed correctly on the chart).

Figure 14. Finding the latitude - longitude of a known place.

6.7 PLOTTING ON A CHART

The reverse problem of plotting a given latitude and longitude on the chart is just as easy:

1. Find the approximate position of the place on the chart.

2. Mark the latitude given on the two nearest latitude scales either side of the position.

3. Mark the longitude given on the two nearest longitude scales north and south of the position.

4. Join the latitude marks and then join the longitude marks - their point of intersection being the the desired position.

Note: You are required to be able to specify or mark a position to an accuracy of 1 minute of arc.

Fig.15. Plotting a Known Latitude - Longitude

ISOGONALS (lines joining places of equal magnetic variation) are indicated on the WAC chart by dashed purple-coloured lines. The Eastern States of Australia experience "variation east-magnetic least", whilst in W.A. there is "variation-west - magnetic best".

The AGONIC LINE (where True North and Magnetic North are the same direction, with variation zero) lies inbetween. Because the magnetic poles are gradually moving, the amount of variation at a particular place will also gradually change over a period of years.

Every few years the isogonic information on the charts is up-dated, and the year of the isogonic information is shown on the chart.

6.8 Measuring Direction with a PROTRACTOR.

The best way to measure direction with a protractor is to align its north-south axis with True North along the mid-meridian and then to read-off the direction on the outer scale.

(You can also measure the direction by aligning the axis of the pro-tractor with the track and measuring the direction against the inner scale.)

Once again it is vital that you have an approximate value in mind prior to using the protractor so that you avoid any gross errors, such as being out by 90ø or 180ø.

Fig.16. the Square Protractor is the type of protractor commonly used.

Fig.17. Measuring Direction with a Protractor.

6.9 MEASUREMENT OF DISTANCE ON CHARTS

Distance may be measured by various methods and you should be able to achieve an accuracy to within 1 NM by using one of the following methods:

* The GRADUATED SCALE LINE at the bottom of most charts. Using dividers or some other means transfer the distance between the two positions on the chart down onto the scale line.

* The LATITUDE SCALE down the side of the chart. At all points on earth for all practical purposes, 1 minute of latitude = 1 NM. Using dividers or some other means, transfer the distance between the two positions on the chart across onto the latitude scale. (Because the scale over the whole chart may vary slightly from latitude to latitude,

use that part of the latitude scale which is about the same as the mid-latitude of the track that you are considering.)

* A correctly graduated SCALE RULE. Most navigation plotters have graduations suitable for 1:1,000,000 maps such as the WAC charts, which are all 1 to a million. On the back of the Australian D of A Domestic Flight Plan Form is a similar 1:1,000,000 graduated scale line suitable for WAC charts. (Some plotters also have a 1:250,000 scale line useful for VTC charts, which are all 1 to a quarter million. The scale on VEC charts however varies from chart to chart and so we cannot use this method for them.)

Fig.18. Measuring the Distance Between Mount Garnet and Cairns on the WAC using time 1:1 000 000 Distance Scales on the Plotter

6.10 MAP READING

There is often confusion about the difference between a Map and a Chart.

A Map is a representation on a flat surface of some part of the earth's curved surface, whereas a Chart is a map (possible even just an outline map) showing special conditions or information.

Since most of our aeronautical charts show specific aeronautical and navigational data, they are therefore "charts" rather than "maps".

The ability to read a map well - the chart that we have discussed, the topographical variety, in the hands of a navigator becomes a Map - is very valuable and cannot be over-emphasized. That is true all over the world, but in the less inhabited areas it is doubly true. Skill in the art of map reading varies according to natural aptitude and the amount of practice experienced. Good map reading depends upon being able to visualize the ground features as portrayed on the map, knowing the navigational value of the prominent features, the estimation of distance and bearings, and finally memory of how it has all looked before under similar circumstances.

The ability to distinguish the more significant features and not be confused with irrelevant detail is an important aspect of map reading. Features mentioned here which have great length, are generally known as "Line Features", e.g. Railroads. These are most important, because an interception is almost impossible to be missed.

Coastlines

The dividing line between land and sea takes priority in aerial navigation. The shape and bearing of a stretch of coastline quickly limits the area within which an aircraft is flying.

Railways

Railways are of great importance and are given considerable prominence on I.C.A.O. charts. They are reasonably easy to see especially in open country and are easily identified by their bearing. Traffic on them makes them more obvious. Their value and identification in built-up areas is slight and difficult. The presence of a railroad is often masked by a road running parallel to it. Tunnels and bridges when marked on the chart are especially useful in fixing position.

Roads

The value of roads in map reading varies considerably. Generally they are confusing and misleading.

Many more roads are on the earth's surface than are printed on the chart. Main highways are always useful. In the outback a mere track could have the same value.

Rivers and Canals

Rapid and positive indication of position is provided by major waterways. They show up well and can be seen from considerable distances. Even dry rivers generally have a tell-tale line of green vegetation along their banks which shows from a considerable distance. The dry sandy bed of a river without the accompanying line of trees can still be identified when overhead.

Lakes

Shape is the most important aspect in identification of lakes of comparable size. They are easily seen from great distances, even dry lakes.

Mountains and Hills

The navigational value of mountains and hills varies with the height from which they are seen and to a certain extent the light that is experienced.

The country appears to flatten out as height is gained and only the very prominent hills will stand out. If flying at about the same height as the hill-tops they are most prominent. In mountainous country it is difficult to differentiate between the various valley and peaks. The lone mountain, however, is very useful.

Towns and Settlements

Towns can sometimes be recognized by their shape as depicted on the chart, but generally they are identified by their size or position in relation to other features. Careful scrutiny of the number and direction of railways and main roads, entering and leaving or near the town, will usually dispel ambiguity. In large industrial regions towns tend to merge into each other making accurate pin-pointing difficult. In less densely populated areas, confusion can also exist between villages in a particular area. In such areas three or four houses might well be marked on a chart as a village.

Forest and Tree Plantations

These show up well from the air and if marked on the map can be very useful, if their shape is accurately portrayed. In country which is mostly forest or bush the clearings (often indicating a valley) are most important.

Airfields

Airports with sealed runways are quite easily seen. Disused airfields, or those with a graded strip or two generally of the same colour as the surrounding country, are extremely hard to see. Be prepared to observe private strips which are not marked on the map.

Culture

Minor culture, e.g., factories, radio masts, windmills, etc. are very difficult to find without first getting a lead from some other nearby feature more easily seen. Isolated forms of culture have slight value in positioning the aircraft.

Seasonal Changes

Landmarks and their appearance and, therefore, their prominence change considerably during the seasons of the year. Some areas of Australia are comparatively unaffected by seasonal changes. Those areas which experience heavy falls of snow are, of course, most affected. A covering of snow can obliterate those landmarks normally most prominent and give to lesser landmarks a considerable prominence for the period.

Floods, or course, will considerably change the formation and appearance of rivers. Unmapped rivers exist and rivers that previously existed are swallowed and lost amongst sheets of water. The shape and size of lakes are similarly affected. Drought and normal summer dryness change not only the waterways, but the general colour of the terrain. The associated covering of dust makes everything blend and become inconspicious.

Visibility and the Sun

During periods of reduced visibility map reading is made so much more difficult mainly because the area of ground that can be observed is considerably reduced. If it is possible to pass within two miles of a landmark without it being seen, the chances of flying a considerable distance before a Fix is obtained are extremely high. Looking up sun in hazy conditions due to the diffused light severely restricts visibility in that direction. In practice, it is best to fly up sun of the track and observe down sun.

Importance of Features

Prominent landmarks, especially line features are what we base our map reading on. But the really significant feature, the one that dispels all doubt, is the unusual or singular feature. When map reading over a flat and arid expanse, tracks if not easily seen because of their infrequent sighting are useful, and because the terrain is otherwise devoid of detail they could be called prominent. However, doubt can arise, if not confusion. But if in this arid and monotonous area stands one mountain and this can be sighted all doubts are reduced. It cannot be confused, there is only one, and it is doubly prominent because of its unusualness. In a mountainous area, a wide and defined valley would command our attention. The water reservoir in the midst of a rambling built-up area serves the same purpose. The twenty or so railway lines running in all directions which have been confusing can now be ignored.

COMBINATION OF FEATURES

One feature by itself is rarely sufficient for the pilot/ navigator to fix his position. A fix is made easier and perhaps only possible when several features are present. If a straight railway line is crossed, it doesn't tell much. The crossing could conceivably have been made anywhere along a thirty mile stretch of straight rail. But if the crossing is made near where a main road bridges the railroad then a Fix is possible. A bend in the railroad would, of course, be just as useful. If, when endeavouring to decide which of three towns is which, the problem will not be made easier to find that each town has a road running through the centre. But if only two of the towns has a railway passing through and only one of these has a river, the problem is solved. In this example, the fact that the bearings of the railways and roads would surely be different helps identification.

Therefore, when map reading, check carefully the inter-relationship between the various features. The inter- relationship is more important than the features themselves.

Bearings and Distances

The bearing of landmarks from the aircraft is widely used in fixing position by map reading. They can only give an approximate pinpoint because the bearing is only a guess without the aid of a bearing compass. However, the fairly accurate guess is most useful in establishing an area of probability.

The estimation of distance from the air is quite difficult.

The difficulty is not made any easier by the fact that the height at which we will map read varies from trip to trip. Experience and practice does, of course, help. But if the estimation of distances can be avoided do so. If when passing well to the side of, say, a lake instead of trying firstly to guess how far to the side, look in the other direction for some other landmark be observed it should be possible to decide more accurately which is the nearer and the proportion of nearness.

Hills observed on Port beam, position uncertain, somewhere along line A.B.

Lake appears 45ø to the Starboard position along line A.B. can now be fixed with a fair amount of certainty. Bearings from aircraft.

Orientation of Map

For map reading, the map is best held with the North of the map pointing in the direction of North. This is carried out when the map is held so that the track line on the map lies along the actual track of the aircraft which is approximately (unless severe drift is experienced) along the fore and aft axis of the aircraft. For example, when the track on the map runs North to South, the North side of the map would be held to your chest and the South side farthest away from you. The aircraft would be headed approximately South and, therefore, features shown on the map to be left of the track would be expected to appear to the left of the nose and vice versa. With the map so held, less difficulty will be found in comparing what is on the map with the features they represent on the ground.

Anticipation

When the approximate position is known map reading is carried out from the map to the ground. You know your position, you know in which direction you are travelling, it is an easy matter to look ahead on the map to see what can be expected to show up in the next few minutes. Because the anticipation of features before they show up is so important to success, careful study of the track before departure is recommended. To enable the pilot/ navigator to anticipate correctly, it is necessary for him to know his ground speed or rate of travel over the map. This rate of travel depends on the wind, the speed of the aircraft and the scale of the map. If the rate of travel over the map is approximately one inch every five minutes, the finger can follow the progress, pointing to the position, and to look ahead of the finger is to anticipate correctly. If a fast aircraft was flown by a pilot with a large scale map, the rate of travel over the map would be so rapid, that useful anticipation would perhaps be necessary on the adjoining map sheet. Rate of travel or the time factor is all important.

Timing

If the ground speed is reckoned to be 120 k, two nautical miles will be covered in every minute. Therefore, five minutes after the aerodrome or some other recognized landmark has been flown over, the aircraft will have travelled ten nautical miles. By looking at the map, ten miles along the track from the landmark, it is possible to see what other landmarks, if any, are now to be seen and by looking a further ten miles along the track on the map, landmarks can be expected to be seen in the next five minutes. If the track is crossed by a railroad 40 nautical miles from the departure point, it is useless to worry about finding it, and, of course, eventually about not having found it, until some 30 nautical miles and, therefore, 15 minutes have passed. It is most likely impossible to see if regardless of experience, etc., before this time. So for those 15 minutes, relax or busy yourself with closer landmarks even though they are of less importance.

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7.0 EFFICIENT COMMUNICATIONS:

Excessive radio traffic can generally be traced to poor organisation management or radio discipline. It is a joint responsibility of the navigator on one hand to ensure that he is fully conversant with all aspects of the proposed ACB (see 1.1 below) before take-off to the burn, and the burn boss (or District protection officer) on the other hand ensuring that he is fully familiar with the details of the burn and that this information and burning method is clearly and accurately passed to the navigator.

A relatively inexperienced navigator may need a significant amount of discussion with the burn boss to discuss expected fire behaviour, possible lighting pattern changes, etc. An experienced navigator however need only to know the basics of the burn and would be quite comfortable should changes become necessary because he will anticipate and even recommend these if required.

Experience develops confidence.

To be entirely confident it is necessary for you to know your own and other people's RESPONSIBILITIES during the burn.

7.1.1 PILOT:

Has absolute authority with aircraft safety. Decides the minimum safe flying height. May abort the operation at any time for safety reasons. Responsible for safe stowage of equipment within aircraft.

7.1.2 NAVIGATOR:

Acts on the burn boss's instructions (is the burn boss's eyes).

Reports all relative data on fire behaviour, (changes, potential changes, fire behaviour in various fuel types, potential problem spots, wind changes - at the burn and at a distance - and anything that differs from the prescription. Reports when conditions are becoming unsuitable for lighting (turbulence,smoke, poor light, etc).

7.1.3 IMO:

Acts on navigator's instruction. Responsible for on-ground maintenance and preparedness of incendiary machine and in air operations.

7.1.4 BURN BOSS (Operations Officer):

Responsible to controller at DHQ. Makes all decisions relating to the burn, (lighting patterns, method, start and stop times, suppression/patrol requirements, etc). ie makes necessary modifications to operations as required, based on reports to navigator, field personnel, or changes due to weather, weather forecast amendments, fuel dryness, etc.

7.1.5 FIRE EXPERIENCE:

Navigators generally have a fair amount of fire experience. However there are some northern forest navigators who will be expected to fly southern forest (karri) type burns. It is most desirable if they have not experienced this type of burning to request a mentor to spend some time with them

7.1.6 FAMILIARITY:

In addition to understanding fire behaviour in the karri forest there are two other important aspects with which to improve his confidence. Both can be covered during a familiarisation tour if this is possible.

Personnel:

Getting to know people with whom you will be communicating on a first name basis. District staff (burn boss and sector bosses, overseers, beacon operators) will also welcome your interest.

Ground Inspection:

A ground inspection, especially in the company of the prescribing or protection officer, would be most beneficial. In addition to becoming familiar with the country and its forests, fuel types, roading system, topography etc., discussions on burn objectives, possible problems and even past burning or fire history may be discussed.

Where possible a talk with a person directly associated with the same burn last time would be beneficial. They can usually remember problem areas, such as dense, damp gullies, or capsules dropped too far from the top of a steep hill, causing scorch from increased fire behaviour.

Failing a ground inspection an aerial inspection whilst consulting the flight plan and burn prescription would be in order. Experienced spotter pilots, particularly the Regional chief spotter pilots have extensive knowledge of each proposed burn and can point out potential problem spots as well as boundaries, etc.

All of the above will allow a navigator to become familiar with the task ahead and build his CONFIDENCE. This should then lead to a reduction in radio traffic on the day of the burn.

The above is the ideal situation and mostly will not be able to be achieved. There is still a chance that another navigator may fly the burn anyway but this is no excuse for not pre-planning as described.

7.2 BRIEFING

7.2.1 VHF CHANNEL/MODE SELECTION:

Simplex channels should be used around the burn boundary where possible to allow normal district communications to continue without restriction whilst lighting is continuing.

The Aircraft/Burn Boss will need to use a duplex channel (1-10). Other personnel (sector bosses, suppression crews) should use a simplex channel if possible (with the Burn Boss scanning this channel).

7.2.2 CONTINGENCY PLANS:

Remember Murphy's Law: If it can go wrong it will go wrong. Aircraft will often arrive late at a burn because of mechanical or previous burn problems or other reasons. Because of this plans may need to be changed, however if contingency plans have been discussed and agreed, alterations should be able to be made to the proceedings with a minimum of radio traffic.

7.2.3 INITIAL CONTACT:

Once the aircraft has made initial radio contact and is over the burn (guided there be beacon, spot fires or navigation) the navigator will proceed to make an inspection and become conversant with the burn and its boundaries. Points covered in the briefing will be identified from the air, by the navigator (potential trouble spots, campers, etc).

7.2.4 COMMENCEMENT:

The navigator should not commence lighting until:

- he fully understands all instructions;
- he is fully coversant with the burn shape and boundaries;
- all personnel and units are in position;
- the flight crew are ready to commence;
- he has been instructed by the Burn Boss to commence.

7.2.5 OPERATION:

Once lighting has commenced the lighting pattern will not be varied unless instructed to do so by the Burn Boss. Radio transmissions will be kept brief, to the point, and as infrequent as possible. Only Burn Boss, Navigator and Markers should communicate direct to each other (on their own duplex channel if possible). Other personnel (preferably on VHF simplex) will talk only amongst themselves when necessary.

Burn Boss is to pre-arrange a time for the first fire report, and no other report will be required unless navigator sees fit because of change to expected fire behaviour, etc. No other requests for fire reports from outside personnel will be considered, ie: District office. Pre-arranging a time for reports say every 20 minutes from the commencement time will allow Controller or other involved staff to listen at that time to save duplication of transmissions.

Report format should be as per standard reports. Keep comments to a clear and concise minimum without leaving the Burn Boss in the dark. Remember you are his eyes. He may be in a situation at the control point that has poor visibility over the burn.

Burn Bosses or other staff should avoid calling aircraft near the end of flight lines when contact with beacon vehicles is imminent or concentration is required to avoid overshooting the boundary.

Navigators should firmly request stations to "stand by" should this happen.

It must be remembered that it is essential for the burn to be lit effectively in the shortest time possible to reduce aircraft hire rates, and ensure its availability for other burns the same day if arranged.

Steps are underway to reduce radio traffic. Mobile Data Systems (radio transmitted word printers) are being purchased for evaluation trials. Correct radio procedure starts with the individual - what are you doing to improve your radio technique?

7.2.6 SAR WATCH:

Unless other arrangements have been made navigators are required to advise the District in which they are working in of their position every 30 minutes. The navigator must also advise the office when leaving one District and passing into another.

7.2.7 FLIGHT RADIO:

Most aeroplanes are equipped with at least one high quality Communications set. It will operate in the Very High Frequency (VHF) radio band. Such a set (known as a VHF-COM) is both a transmitter and a receiver and is simple to operate.

VHF refers to a specific group of radio frequencies. The characteristics of VHF transmissions are such that communication systems operating in the VHF band are able to provide high quality "line-of-sight" communications between aircraft and ground stations.

eg:

HEIGHT OF AEROPLANE ABOVE STATION	EXPECTED VHF RANGE
500 ft	27 nm, say 30 nm
1 000 ft	39 nm, say 40 nm
5 000 ft	87 nm, say 90 nm
10 000 ft	122 nm, say 120 nm

Local conditions, such as mountainous terrain, may reduce this range.

Improved COMMUNICATIONS can be achieved by having repeater stations, ie: aerial at locations remote from the source of the radio message. Repeater Station improve "DIRECT WAVE" communications.

VHF is the most common form of radio communication in aviation. It gives good clear communication with little distortion and interference under most conditions.

7.3 FLIGHT RADIO

Each radio communication set will consist of:

* a transmitter;
* a receiver; and
* an aerial.

For the set to function it must be connected to an electrical power supply. The power is supplied to the radios via the master switch and in most cases is protected by a circuitbreaker. The navigator will become familiar with the radio equipment very quickly and, in the case of the VHF-COM, little is required except to switch the set on, ensure the headset is plugged in and that the correct radio and frequency is selected.

7.3.1 RADIO SET-UP IN THE COCKPIT:

Connected to the radio sets in the aircraft cabin are:

* A remote audio selector panel to connect the two VHF radios on the Low and High frequency bands. Allow for channel changing and selection for each radio.

* Headphones, for listening to the reception.

* A boom microphone attached to the headphones for transmitting, activated by a press to talk switch.

* Remote connection points fitted with individual volume control to plug headphones into.

7.3.2 USE OF THE VHF-COM:

To obtain maximum benefit from using a VHF-COM system the navigator must understand:

* how to switch the set on;
* how to use the remote audio selector panel;
* correct microphone technique;
* correct phraseology, pronunciation, voice control; and
* fault finding procedures if the radio does not work properly.

7.3.3 SWITCHING THE VHF-COM RADIO ON:

1. Check the mast switch on and circuitbreaker in.

2. Switch the radio on.

3. Select the desired radio and frequency.

4. Adjust volume to desired level and adjust "squelch" control to cut out undesired background noise, if fitted.

5. Check headset is plugged in correctly.

7.4 SEARCH AND RESCUE (SAR) ORGANISATION:

The purpose of the Department of Conservation and Land Management's (CALM) Search and Rescue (SAR) procedure is to provide assistance to any aircraft in distress who is operating on the departmental frequencies.

SAR action is usually coordinated by the District Manager or the most senior person in charge of the district and authorised landing area at the time.

The navigator can request different levels of SAR watch on his particular flight when he submits his flight details, or at any other time.

The various classifications are:

7.4.1 FULLSAR: in which a continuous SAR watch is maintained on the flight, with full reporting from the navigator being required, including taxiing, departure, en route position reports, etc. A two minute delay on any position reporting time or estimate is allowed before a radio call sign is made from the base station who is keeping the watch on the aircraft. Good communiations throughout the flight is important for a FULLSAR flight. These facilities may not necessarily be available unless previously arranged with the District Manager.

7.4.2 SARTIME: in which SAR action is commenced at the SARTIME nominated by the navigator in consultation with the pilot in command. He has nominated that he will contact a particular base station prior to this time to advise them of the safe conclusion of his flight, and to "CANCEL SARWATCH". It is usual to allow yourself a time buffer in nominating a SARTIME to allow for unforeseen delays. If en route you become aware that your nominated SARTIME is too early then you should amend it. Communications throughout a SARTIME flight is not a requirement as it is for a FULLSAR flight.

7.4.3 NOSAR: an aircraft may submit flight details but nominate NOSAR, or not even submit flight details (called a NOSAR NO DETAILS flight). Of course, if anything unfortunate has happended and the SAR organisation becomes aware of it, they will initiate SAR action immediately irrespective of what SAR coverage on the flight had previously been requested by the crew.

7.5 OPERATIONAL CALLS:

Communications Air to Ground

Radio Calls:

Navigator should notify departure base the following details:

When taxiing during engine warm-up to establish radio contact, and provide SARTIME details.

Taxi Call:

(Base station) THIS IS ..... (aircraft call sign) TAXIING AT ..... (airstrip) FOR ..... (District) ON ..... (type of operation) (job number if applicable) ENDURANCE ..... (minutes) ETA ..... (hours and minutes), SARTIME ..... (24 hour clock hours and minutes) FOR ARRIVAL AT ..... (destination).

Immediately after departure and when aircraft has established a heading for the job.

Advise the frequency changing to after departure.

Departure Report:

(Base station) THIS IS ..... (aircraft call sign) DEPARTED AT ..... (hours, minutes) FOR ..... (District) TRACKING ..... (direction in degrees) CHANGING TO CHANNEL ..... (number).

Contacting Area Control:

CONTROL THIS IS ..... (aircraft call sign) ETA OVER YOUR AREA ..... (minutes).

ARE THERE ANY CHANGES TO THE FLIGHT PLAN ..... OR SPECIAL REMARKS .....

CONFIRM MARKERS IN POSITION

Establish radio contact with beacon vehicles at least 15 kilometres from the job when flying at 3,000 feet above ground level (AGL). Determine if beacons are operating, although the range and ADF contact may not actually be established until much closer.

AIRCRAFT TO ..... (direction) MARKER TURN ON YOUR BEACON FOR A.D.F. SIGNAL CHECK

On arrival over the area to be burnt, request marker fires to be lit.

Marker Fires:

CONTROL THIS IS ..... (aircraft call sign) APPROACHING YOUR AREA LIGHT MARKER FIRES ON FLIGHTLINE ..... (number) ..... (cardinal direction) MARKER ON ..... (cardinal direction) MARKER STANDBY

First flightline should be a dummy line to establish wind drift over the area and actual headings to be flown. Track error should be less than 100 metres before lighting can be commenced.

Dummy Flight Line:

..... (direction/direction) MARKER THIS WILL BE A DUMMY FLIGHTLINE. HOLD YOUR POSITION AFTER WE FLY OVER YOUR POSITION

Discuss lighting pattern to be used; and Beacon vehicles, shifts that will take place.

Navigator must obtain clearance from controller before commencing on a live dropping run to ensure everything is satisfactory.

Dropping Approval:

..... (aircraft call sign) TO CONTROL HAVE INSPECTED THE AREA AND AM SATISFIED WITH THE BOUNDARIES. REQUEST PERMISSION TO START ON FLIGHTLINE ..... (number)

Starting Burn:

..... (cardinal direction) MARKER BEACON ON STANDBY WITH FLARE, RUNNING FROM ..... (direction) TO ..... (direction) MARKER STANDBY WITH FLARE

Approaching First Flightline:

..... (direction) MARKER FIRE FLARE

Over Boundary Inside Burn Area:

..... (direction) MARKER BEACON OFF. SHIFT TO NEXT POSITION. ..... (direction) MARKER BEACON ON FIRE FLARE

FLARE SIGHTED OR NOT SIGHTED

Over Boundary Outside Burn Area:

..... (direction) MARKER BEACON OFF. SHIFT TO NEXT POSITION. ADVISE WHEN IN POSITION WITH BEACON ON

Navigator should give advice to the Burn Boss in the early stages of a burn re the fire behaviour, in particular if the strip width should be increased to prevent scorch from high intensity fire or decreased to allow fires to join or alterntively spots appear to be behaving satisfactorily no action required.

It is preferable that all radio transmissions to the ground and not relating to the actual operations should be made only when the aircraft is outside the job and during the turning period. That is reports on fire behaviour or request of any other nature.

Normal fire behaviour report should give:

(a) Percentage of capsule ignition and fuel type.

(b) Flame height ..... metres - rate of spread ..... metres/hr.

(c) Fire intensity ..... Smoke behaviour ....

(d) Fire shape ....

Fire Behaviour Report:

..... (aircraft call sign) TO CONTROL I HAVE A FIRE BEHAVIOUR REPORT ARE YOU READY?

PERCENTAGE TAKE .... (number) TO ..... (number)

FLAME HEIGHT .... (number) METRES IN ..... (tree type)

RATE OF SPREAD ..... (number) METRES PER HOUR

Additional Information:

FIRE BEHAVIOUR ..... (quite, normal, strong)

SMOKE BEHAVIOUR ..... (weak, quiet, medium, strong)

FIRE SHAPE ..... (round, oval, 1:1 or 1:3)

On completing a burn or when beacons are no longer required the navigator should advise both beacon operators to report to the controller for further instructions. Obtain acknowledgement, message received.

Dismissing Beacon Operators:

..... (aircraft call sign) TO ..... (cardinal direction) MARKER BEACON WE HAVE COMPLETED WITH YOUR SERVICES. THANK YOU FOR YOUR ASSISTANCE. HOW MANY FLARES DID YOU USE? REPORT TO THE CONTROLLER FOR FURTHER INSTRUCTIONS.

Navigator must advise controller before departing burn area of his intentions, where he is proceeding to and of any frequency change he is going to make.

If direct radio contact cannot be made with the base station while the aircraft is departing from the burn area, the navigator must go immediately back to the last frequency on which he made contact and ask to have the relevant details passed by telephone.

Departure Advise:

..... (aircraft call sign) TO CONTROL IF YOU HAVE NO FURTHER REQUIREMENTS FOR US WE WILL DEPART FOR ..... (destination)

Await acknowledgement from controller then advise,

CONTROL THIS IS ..... (aircraft call sign) DEPARTED FROM ..... (job no) AT ..... (time hours and minutes) FOR ..... (destination), ETA ..... (estimated time of arrival)

When direct radio contact is made with the destination base; give the required details, advise estimated arrival time, and whether supplies need to be organised and brought out to the airstrip for the next flight.

Notifying Return to Destination:

..... (base station) THIS IS ..... (aircraft call sign) DEPARTED JOB NO ..... AT ..... (time hours and minutes) HEADING FOR ..... (destination) ETA ..... (hours and minutes)

Required Supplies:

REQUIRE FLIGHTPLANS AND CAPSULES TO BE BROUGHT TO AIRSTRIP AT ..... (hour and minutes)

Circuit Area Call:

..... (base station) THIS IS ..... (aircraft call sign) CIRCUIT AREA ..... (airstrip name) WILL CALL WHEN ON THE GROUND

Call when safely on the ground and advise time landed, cancel SARTIME if activated.

..... (base station) ..... (aircraft call sign) LANDED ..... (time) CANCEL SARWATCH

Section Subject Page No.

Civil Aviation Regulations and Orders Relating to the Dropping of Incendiaries: Page

1.0 CIVIL AVIATION REGULATIONS AND CIVIL AVIATION ORDERS

1.1 Dropping of Incendiaries from Aircraft for the Ignition and Controlled Burning of Forest Undergrowth:

1.1.1 DROPPING APPROVAL

CIVIL AVIATION REGULATION 120

Incendiaries may be carried in aircraft on bush fire control subject to the following conditions:

[a] Operator hold's an aerial work licence.

[b] Operation is authorised by state forest authority.

[c] Incendiaries type and arming device and dropping equipment be approved by C.A.A. officers.

1.1.2 CIVIL AVIATION REGULATION 126 (2) (a)

Incendiaries may be dropped from aircraft subject to the following conditions:

DROPPING SITE

[a] Dropping site clearly defined by state forest authorities using terrain features, ground signals, markers etc.

[b] The pilot shall make one preliminary run over the site and obtain confirmation he is over the site.

1.1.3 DROPPING REQUIREMENTS

[a] Site must be clear of persons and stock.
[b] Incendiaries shall be dropped by an Incendiary Machine Operator.
[c] Effective communications shall be maintained between the crew.
[d] The pilot shall at all times be in VHF contact with a responsible forest officer on the drop site.
[e] The pilot shall be personally briefed on the location of the drop area and other matters prior to departure.
[f] The pilot shall ensure that the load is within the limits - both regarding centre of gravity and weight.

1.1.4 INCENDIARY MACHINE OPERATOR QUALIFICATIONS

[a] Shall be trained and qualified in the use of the incendiary equipment and dropping operations.

1.1.5 CARRIAGE OF ARTICLES AND PERSONS

[a] The carriage of incendiaries shall be in accordance with Section 20.16.2 CAO's.
[b] For safety reasons, no persons other than those having duties relating to the operation shall be carried in the aircraft.
[c] Each person shall occupy a separate seat equipped with an approved safety belt or harness, which shall be worn as follows:

- During take-off and landing;
- During an instrument approach;
- When flying less than 1000 feet above terrain;
- In turbulent conditions; and
- During dropping operations.

1.1.6 OPERATING CONDITIONS

[a] Under CAO 133(3) approval may be given for the aircraft to descend to, but not below, 46 metres (150 feet) above tree-top level during dropping operations.

[b] However, an aircraft shall not be flown below 155 metres (500 feet) above terrain within 610 metres (2000 feet) over any built-up area.

[c] During dropping operations the aircraft shall not fly below 465 metres (1500 feet) above terrain, over any populous area.

[d] Dropping operations shall be in accordance with the Visual Flight Rules.

Flight visibility - better than 4.8 kilometres (3 miles).

Distance from cloud - 620 metres (2000 feet) horizontal and 155 metres (500 feet) vertical, when flying below 1550 metres (5000 feet).

[e] The aircraft shall be flown straight and level while incendiaries are being dropped.

[f] The approach to and climb away path from the dropping area shall not involve abrupt manoeuvres, the climb away shall be clear of obstacles.

1.1.7 EMERGENCY EQUIPMENT

The aircraft shall be equipped with:

(a) A wool or similar flexible sheet; and

(b) CO2 or BCF fire extinguisher readily available to the Incendiary Machine Operator.

1.1.8 ADDITIONAL EQUIPMENT

In addition to the instruments required by CAO 20.18 for VFR operations, the aircraft shall be fitted with a gyroscopic horizon indicator.

1.1.9 OPERATIONS MANUAL

An operator carrying out dropping operations shall be required to list the terms of the permission in the aircraft's operation manual.

Reference: Operational Standards - Civil Aviation Authority - Commonwealth of Australia.

1.2 Pilot Flight Time Limitations:

1.2.1 CIVIL AVIATION ORDER 48.1

Pilot flight times are limited to prevent fatique and avoid accidents from happening. The maximum times should not exceed:

- 8 hours in one day;
- 6 consecutive days of work;
- 30 hours in 7 consecutive days;
- 100 hours in 30 consecutive days;
- 900 hours in 365 consecutive days.

1.2.2 MEDICAL STANDARDS

Civil Aviation Regulation 57; and
Civil Aviation Order 47 Standards.

An aircrew member may not consume alcohol 8 hours prior to flying CAR 247.

Aircrew shall not be under the influence of alcohol or drugs. Caution should be exercised if taking any drugs in conjunction with alcohol prior to flying.

Other factors to watch are:

- fatique
- dehydration
- effects of caffeine
- colds or flu
- earache

hangovers

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3.0 EQUIPMENT CAPABILITIES AND LIMITATION

3.1 INCENDIARY MACHINE CAPABILITIES AND OPERATIONAL LIMITATIONS

3.1.1 INTRODUCTION

Prescribed burning using aerial ignition was first developed as a joint project between the Commonwealth and Scientific Industrial Research Organization (CSIRO) and the Forests Department of Western Australia in 1965. (Baxter et al: 1966)

This section describes the development of incendiary machines used for aerial burning in Western Australia (W.A.), from the original hand-operated machine to the most recent machine developed by the Forest Department (FD) of Western Australia, (renamed since 22 March 1985 as the Department of Conservation and Land Management). (van Didden, 1983)

3.1.2 HISTORICAL BACKGROUND

Since the earliest days of colonization in W.A., periodic summer wildfires have ravaged the forests. Early foresters were alarmed by the damage caused and after 1918 pursued a policy of almost complete fire exclusion. However, by 1953 heavy accumulation of forest fuels or debris in the protected areas had resulted in many wildfires which caused serious damage to the forest. It became apparent that complete protection of the forest could not be maintained with the limited manpower and equipment available, especially in the presence of heavy forest fuels.

As a result, a complete review of the fire policy took place in 1954. Prescribed burning over large areas to reduce fuel hazards was introduced. (Peet, 1967)

Early programmes of "hand burning" were carried out by gangs of men of foot. This method was slow, expensive and risky in dense, inaccessible areas. Consequently, alternative methods of lighting up large areas of forest were sought, and ignition from aircraft was an obvious choice. However, there were many technical problems to overcome, the most important being the development of a suitable and safe incendiary machine to be used in the aircraft.

The first incendiary machine was developed in 1965 by the CSIRO. In December of that year, this machine was used on the first large-scale aerial burn, on the Pingerup Plains near Walpole in Western Australia.

Despite a number of initial problems, in the summer of 1965/66 over 20 000 ha of forest was prescribe burnt using the incendiary machine. The use of aircraft and the new incendiary equipment enabled large areas of forest to be covered in a short time. This was a major step forward in fire control, as greater areas could be lit for hazard reduction burning, under ideal weather conditions and at relatively low costs. (Baxter et al, 1966)

The success of the first venture led to 180 000 ha of forest being prescribed burnt in the spring of 1967. By 1968 the aerial burning programme was operational in Western Australia and has since played an increasingly important role in fire protection of State forest.

3.2 WESTERN AUSTRALIAN MACHINE BACKGROUND WAM 1982

3.2.1 DESCRIPTION

The basic function of the equipment is to inject small plastic capsules with a measured quantity of glycol, thereby initiating the exothermic reaction, and to eject the primed capsules from the aircraft at precisely timed intervals. The capsules are loaded into the turntable by hand. It has been designed to accomplish this with the highest degree of reliability and safety.

3.2.2 MODE OF OPERATION

A 24-28 volt D.C. motor is connected by belt drive to a worm gear speed reducer to obtain a final drive speed of 10 to 55 r.p.m.

The power take-off shaft from the gearbox is directly coupled to the axial cam to continuously control the injector mechanism. The cam has five different functions to perform during each rotation, they are: dwell, pierce, inject, dwell and strip, for each cycle. During part of the dwell period at the beginning of each cycle, the geneva mechanism is activated and rotates the turntable holding the capsules in position.

While the turntable is stationary, the cam activates the injector pump to pierce the capsule top, then injects 1.3 ml of glycol, dwells for 10o, then strips or removes the needles from the cap. As soon as the needles return to their original "up" position, the turntable is again moved by the action of the geneva cam. The primed capsule them moves one position and is ejected from the aircraft.

The incendiary capsules are fed by hand from a storage tray into the turntable on the machine, where they are automatically injected and ejected when the machine is in operation.

3.2.3 MECHANICAL DRIVE SYSTEM

Power for the WAM'82 machine is supplied by a .25kw - 24 Volt Direct Current (VDC) shuntwound electric motor - operating at 833 to 5000 rpm. The speed for the motor is controlled through an electronic motor speed control board in the Electronic Control box. The board controls motor speed by feeding a field winding with pulses of constant voltage but variable width. The motor stop/start function utilizes a silicon controlled rectifier, which ensure the machine stops in the safe "rest" position.

The electric motor is connected to a Richardson Radicon wormdrive gear reduction box of 25:1 ratio, to give a calculated output of 10 to 60 rpm.

The output shaft from the gearbox drives both the injector cam and the geneva mechanism. The geneva cam mechanism is an intermittent-motion device allowing power to be periodically transferred from the gearbox output shaft to the geneva cam.

The gearbox output shaft rotates continuously to drive the injector cam, which sets the injection cycle in motion. During each injection cycle the geneva cam remains stationary, until the cycle is complete, and is then reactivated.

A 28 teeth gear underneath the geneva cam drives the larger 84 teeth idler gear which is then connected to a 28 teeth gear to move the turntable. The intermittent motion of the geneva cam is thereby synchronised to the movement of the turntable.

3.2.4 CAPSULE TRANSPORT SYSTEM

Turntable

The six station turntable is designed to move the capsule from the loading stage to the injection and ejection positions. The turntable is designed to withstand any primed capsule from igniting the next capsule in the event of a misfire in the aircraft due to a system malfunction.

Manual Release Overdrive (Hdg)

In the event of a power failure the turntable can be manually released from the drive shaft by pulling up the release pin and rotating the turntable by hand. In the event that the turntable drive shaft becomes unsynchronised from the geneva cam the needles will not be damaged because of the hollow groove in the top of the turntable.

Glycol System

Glycol Tank

Injector

Glycol is stored in a 6.7 litre capacity stainless steel tank. Fitted with a sight gauge and graduated scale to determine the glycol level. Glycol is fed by gravity to the injector.

The modified injector is based on the original 1968 CSIRO design with slight modifications to reduce the number of parts.

3.3 EJECTION RATE

The ejection rate of the incendiary machine can be varied from a maximum rate of 54 capsules per minute or 1.2 second interval down to 13 capsules per minute or 4.6 second interval. Changes in speed are made by turning the motor speed control knob to the desired drop rate setting on the digital indicator.

To obtain correct ground spacing check table below.

IGNITION SPACING AS A FUNCTION OF TIMING AND GROUNDSPEED

Capsules per min	Interval	Ground Speed (knots) 70	80	90	100	110	120
		Approximate Distance Between Ignition Points Metres					
13	166	190	213	237	261	285	
16.5	131	149	168	187	205	224	
23.5	92	105	118	131	144	157	
27	80	91	102	114	125	137	
31	70	79	89	99	109	119	
35	62	70	79	88	97	106	
37	58	66	75	83	91	100	
40	54	62	69	77	85	93	
42	51	58	66	73	81	88	
43	50	57	64	72	79	86	
45	48	54	61	68	75	82	
47	46	52	59	65	72	79	
50	43	49	55	61	67	74	

3.4 CHEMICALS USED

The chemicals used to start the fires are potassium permanganate and mono-ethylene glycol mixed at the ratio of 1:4 (1 part glycol to 4 parts permanganate). Insufficient glycol will prevent ignition taking place, from the mixture being too dry. While excessive glycol will drown the mixture and make it ineffective.

Testing of Incendiaries

Reaction Time

The reaction between potassium permanganate and ethylene glycol depends upon temperature and particle size of the permanganate - if the temperature is high or the particles are fine the reaction time will be short.

To test the reaction time a capsule should be run through the machine, and should be timed from the instant of injection to the first appearance of flame. The temperature of the glycol should be taken and recorded together with the reaction time.

Reaction time should exceed 30 seconds at 20oC. Capsules should be stored in a cool place away from direct sunlight and high temperatures, to avoid the lids loosing their plasticity and coming off.

Quantity of Glycol

The quantity of glycol injected is important for the proper functioning of the reaction. At the beginning of each day after priming the injector - check that the quantity is satisfactory. Do this by injecting 5 times into a single capsule and then measuring the amount in a small measuring flask. The correct quantity is 1.3 ml per injection.

At the end of each day it is recommended that the quantity of glycol used is recorded, and divided by the number of capsules ejected to give an average volume per capsule used.

3.5 INCENDIARY SPECIFICATIONS:

Incendiary Capsule

Container: Size: 38 mm x 21 mm diameter
Material: Styrene acrylan nitrol
Mass: (Empty) 2.52 gms
Cap: Size: 11.5 mm x 21 mm diameter
Material: Low density virgin polythene
Mass: 1.31 gms
Contents: Material: Potassium permanganate $KMn04$
Mass: 4.0 + 0.5 gms
Mass Total: 7.83 + 0.5 gms
Size Total: 45 mm x 21 mm diameter.
Reagent
Mass: 1.3 gms + 0.2 gms
Material: Mono ethylene glycol $C2H6O2$

3.6 CAPSULE LOAD - GLYCOL CAPACITY

Capsule Load

The metal cabinet in the Britten Norman Islander carries 11 trays of 324 capsules totalling 3 564 capsules.

This quantity should be sufficient for most large burns. However if there is a need to carry additional supplies they should be carried in the rear cargo compartment. Restrained by an approved cargo net. Incendiary capsules come packed in boxes containing 4 trays, holding a total of 1 296 incendiary capsules.

Glycol Capacity

The glycol tank when fully loaded has a capacity of 6.9 litres, however for planning purposes only count on 6.5 litres useable. This should give an endurance of 4 333 capsules based on 1.5 ml per injection.

Additional glycol may be carried in a suitable container, anchored to the floor with cargo tie points. The 'esky' box is installed for this purpose.

For security reasons this additional glycol should not be left in the aircraft overnight or during the weekends.

At the end of each dropping operation the aircraft must be cleaned inside to ensure that any loose articles are stowed. Any potassium permanganate or ethylene glycol that may have been spilt must be cleaned to avoid the inadvertent mixing of any spilt portions.

3.7 EQUIPMENT WEIGHTS

Incendiary Machine
Main frame mass, glycol tank empty 47 kg
Glycol tank full, capacity 6.7 litres 55 kg
Overall dimensions length 51 cm
height 70 cm
width 35 cm

Subframe Assembly		Britten Norman Islander	Partenavia
Mass		3.75 kg	1.9 kg
Overall dimensions,	length	84 cm	40 cm
	height	21 cm	21 cm
	width	30 cm	35 cm

Incendiary Storage Cabinet

		Britten Norman Islander	Partenavia
Mass, empty		37 kg	32 kg
Mass, fully loaded		73 kg	54 kg
Contents,		11 trays @ 324 ea	8 trays
number of incendiaries		3 564	2 592
Overall dimensions,	depth	43 cm	42 cm
	height	61 cm	51 cm
	width	42 cm	43 cm

Additional Equipment

Operators seat	9.3 kg	-

Seat-rail	5.9 kg	-
Firemat	5.4 kg	-
Esky for glycol	5.4 kg	-
5 litres glycol	11.3 kg	_____
Total equipment weight	169.0 kg	110.9 kg

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4.0 PREPARING AERIAL BURN FLIGHT PLANS

Preparation of flight plans are one of the basic requirements of successful burns. Along with other aspects of Aerial Burning Technology, flight plans have developed into the specialized document in use today.

4.1 Early Plans:

These were essentially jottings on a 1:40,000 API, and were derived during telephone conservations. They invariably suffered the inherent faults caused by misinterpretation. The system adopted in 1966 used a transparency of the relevant section of the 1:40,000 API sheet to produce dyeline prints, showing boundaries and flight lines.

4.2 Current Plans:

Under the current system, plans of the specific burn area are produced by Mapping Branch and are available at the relevant District before the commencement of the burning season. This provides the same base plan data so that everyone starts from a common point with the same information.

4.3 Features of Current Flight Plans:

[a] Job No.;

[b] Scale - 1:25000;

[c] Area in hectares;

[d] A clearly defined boundary (only one job is indicated on any one sheet);

[e] Departmental or Australian mapping grids are indicated for orientation;

[f] Date of photography (from which the plan was derived);

[g] Cleared areas and plantations are marked;

[h] Data panel.

4.4 Acquiring Information:

Whenever possible - derive base information from the District Office concerned - preferably the Controller or his deputy (usually the Burn Boss).

If the information has been passed on or received second hand it is a good general rule to confirm the data with the particular office. Do not assume that the District concerned will automatically advise you of last minute changes.

4.5 Essential Data:

[a] Flight time one: axis co-ordinates,
e.g., x axis north
y axis south

[b] Stripwidth and spot distance;

[c] Time required over job/or start time;

[d] Communications, callsigns, channel;

[e] Check:

- marking method and details, flares etc;
- boundary modifications;
- unidentified obstacles (radio masts etc);
- sensitive or excluded areas - within burn.

4.6 Method of Preparation:

(a) Locate and place line 1 from reference data.

(b) According to stripwidth dimension measure off each progressive line as a scaled increment - AT RIGHT ANGLES TO LINE NO. 1.

(c) Number and mark each line consecutively. Use two colours to indicate alternate lines.

- even/uneven numbers;
- flight line transparencies of differing spacings are available at District offices.

(d) Highlight - control point and areas of concern - e.g., obstacles, plantations - and "no-burn" areas. Every uncleared private property boundaries which may cause confusion or required special marking.

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CHAPTER: PRE-FLIGHT PLANNING DISTANCE, TIME DIRECTION NO: 5

SECTION: CONTENTS

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Introduction:

The aim of this operation is to provide a suitably fitted out aircraft and well trained crew to carry out incendiary dropping operations for fire management purposes. The purpose of this lesson is to further develop the students knowledge of the basic operational and planning requirements for aerial prescribed burning.

5.1 Briefing:

The morning of the proposed burn the duty operations office or delegate navigator should personally (or by phone) contact the burn boss or District protection officer and discussed the following points:

Burn number and location (distance and bearing from DHQ)

Objective of burn, or for part of the burn.

Features - topography, shape, area.

Boundary location and last minute changes.

Weather - wind direction and possible changes.

Forest Types - fuel types and variations. Location of heavy fuel pockets.

Fuel details - SMC's and FDI's, actual rate of spread expected.

Co-ordinates of flight lines, strip widths.

Lighting patterns.

Previous trouble spots (unburnt creeks, plots, poor boundary access, poor edging).

Adjoining fuel types and ages.

Private property to avoid (no overfly permission), pine, eucalypt or research plots, etc.

Staff at burn - names and call signs. Position around boundary. Control point location.

Beacon vehicle - are they required, if so location. Access problems with beacons, long travel times between individual lines, etc.

Public check - campers, fishermen, recreationists - along rivers or picnic spots.

Special instructions - areas to avoid (dunes, swamps, creek systems, ridge top lightings. Radio towers or SEC ines to avoid.

Communications - VHF channel, simplex/duplex.

Spot fires - if required.

Expected start time.

Day's program - prior and later burn lightings.

Contingency plans - alterations.

5.2 Planning Measure Distance, Direction, Calculate Time

1:1,000,000 Scale Plan - World Aeronautical Chart check position of Burn - Direction from Base Airstrip .... Magn. Distance .... nm. E.T.I. .... Min.

From stripwidth and spotdistance calculate capsule requirements - see Table 1. From required spotdistance, work out most satisfactory ejection rate and flying speed. See Table 2.

Measuring Distance

The Nautical Mile:

For air navigation the N.M. is the most convenient unit as it is taken to be the average length of one minute of latitude (this average being 6,080 feet).

Measurement of the Track

When it is intended that an aircraft be flown from A to B, a straight line or "track" is drawn joining them and the direction is read off with a protractor placed on the mid-meridian.

The track so measured is true. Isogonals (lines of equal Magnetic Variation) which on the WAC chart take the form of a blue dotted line, this indicates the variation in that locality. The variation when applied to the track measured, or the Heading, converts them from True to Magnetic.

From strip width and spot distance calculate capsule requirements.

TABLE 1
Number of Capsules Required per Hectare
Ignition Grid Pattern in Metres
Spot distance x Stripwidth

Area in Hectares	75 x 150	80 x 175	100 x 200	125 x 250	150 x 300	200 x 400
	Number of Capsules Required					
1000	889	715	500	320	222	125
2000	1778	1429	1000	641	445	250
3000	2667	2143	1500	962	667	375
4000	3556	2858	2000	1282	889	500
5000	4444	3572	2500	1603	1112	625

6000	-	4286	3000	1923	1334	750
7000	-	-	3500	2244	1556	875
8000	-	- 4000	2564	1778	1000	
9000	-	-	-	2885	2000	1125
10000	-	-	-	3205	2223	1250
12000	-	-	-	3846	2667	1500
14000	-	-	-	4487	3111	1750
16000	-	-	-	-	3556	2000
18000	-	-	-	-	4000	2250
20000	-	-	-	-	4445	2500

From required spotdistance work out most satisfactory ejection rate and flying speed.

TABLE 2
Ejection Interval
Spotdistance and Flying Speed

To determine the speed the aircraft should be flown in nautical miles (knots) in conjunction with the ejection interval rate of the incendiary machine to obtain the required spotdistance on the ground.

Ejection Drop Rate in Capsules per Minute	Aircraft Speed in Knots 60	70	80	90	100	110	120	130
	Spot Distance Spacing in Metres							
65	29	33	38	43	48	52	57	62
60	31	36	41	46	51	57	62	67
55	34	39	45	51	56	62	67	73
50	37	43	49	56	62	68	74	80
45	41	48	55	62	69	76	82	89
40	46	54	62	70	77	85	93	100
35	53	62	71	79	88	97	105	115
30	62	72	82	93	103	113	124	134
25	74	87	99	111	124	136	148	161
20	93	108	123	139	154	170	185	201
15	124	144	165	185	206	226	247	268
10	185	216	247	278	309	340	370	402

5.3 Estimating Departure Times and Flight Duration

The following guideline is drawn up to estimate the time that the aircraft can be expected to complete a job, and allow programming for a days work. These times are a guide only.

Other factors, will affect the time the aircraft can be expected over a job:

Estimate Departure Time

Work out the departure time take into account the following factors:

Time to get to the airstrip
Note: Lodgement of Flight Plan at Primary and Secondary Airports required
Daily the aircraft, check incendiary machine (20 min)
Warmup and Taxi (5 to 8 min)

Flying to the job	(2nm/minute)
Job reconnaissance	(10 min to 20 min)
Dummy flight line to establish drift	(5 min to 10 min)

Advise the pilot of the area to be burned, what time the aircraft is required over the job, time required to commence dropping capsules.

Point out boundary difficulties.

TABLE 3

Production rate over job assumes airspeed 100 knots, and flightline spacing 200 metres apart.

Job Size Ha	Time Hrs	Job Size Ha	Time Hrs
500	.6	4 000	1.4
1 000	.75	5 000	1.8
1 500	.9	6 000	2.1
2 000	1.0	7 000	2.4
2 500	1.1	8 000	2.8
3 000	1.2	9 000	3.2
3 500	1.3	10 000	3.4

5.4 Suitable Clothing and Aircrew Punctuality

Navigators are to promote an image of responsibility and authority to preserve and enhance the image of the Department. Aircrew should wear clothing and footwear that is appropriate to the task and climate while bearing in mind safety at all times.

Punctuality is needed to ensure a smooth operation when a number of Districts are involved in the days burning program.

5.5 Pre-Flight Briefing to Pilot

The following points should be covered in your pre-flight briefing. To ensure that the aircraft arrives on time and can be programmed for other burns during that day. The pilot and incendiary machine operator should be briefed as early as possible after the decision is made to burn to involve them in the planning process and make them feel part of the team.

The following timetable should be observed by disticts in scheduling their daily burning program.

0745 hrs - Districts to obtain weather forecast

0820 hrs - District Controller to advise Regional co-ordinator prior to 0820 hours of proposed burn and required start time.

0830 hrs - Regional co-ordinators to advise Senior Fire Operations Officer Bunbury of requests.

0845 hrs - Approved programme notified to region with Beacon arrangements.

0900 hrs - Navigators to be advised of flight plan details.

0900 hrs - Bunbury Protection Branch to advise ABC and commercial stations burns proposed for the day.

1000 hrs - Controller to check the weather forecast to confirm conditions remain suitable.

5.6 Pre-Flight Arrangements for Aircrew and Supply Requirements

Navigator to advise incendiary machine operator of the jobs to be completed for the day; to allow the incendiary machine operator to plan his capsule and glycol or anti-freeze requirements.

NOTE: keep a check of supplies and advise Regional Fire Protection Officer Leader if stocks are running low and require replacement.

5.7 Arrangements, when Reaching Target Area:

On the way to the job the navigator should contact the controller re any last minutes changes, confirms boundary changes or areas to be left unburnt, eg regeneration areas. Asks for advice on difficult boundaries.

Establish contact with beacon vehicles at least 15 kilometres from the job. Determine if beacons are functioning.

On arrival over the area to be burnt, request marker fires to be lit on difficult corners projecting into the burn.

Boundary definition can be improved by lighting marker fires at intervals along the boundary.

The pilot is legally required to do at least one circuit of the boundary to identify ground points on the map, establish he is in the correct area and establish that the area is free of people, stock and vehicles.

The first flightline should be a dummy line to establish wind drift. The track error should be less than 100 metres before lighting can be commenced.

The navigator must obtain clearance from operations officer before commencing on a live dropping run to ensure authority is granted to commence lighting.

5.8 Flight Patterns

Parallel Method

Consists of marking every line with beacons and Verey piston flares used early in the season when percentage take is low.

Aircraft approaches point A and beacon is put on - the moment the aircraft goes over point A the navigator requests "East beacon on, West beacon off, East fire flare".

It is understood West beacon automatically moves to point D and waits and advises ready in position on line 2.

As soon as the aircraft flies over the East beacon, it is turned off and shifts to position C. Driver advises when ready in position "East beacon on in position line 2". This procedure is repeated as often as necessary until the job is completed.

The aircraft turning time outside the burn area has to be co-ordinated with the time it takes the beacons to shift.

Corridor Method

Consists of marking only every second line with the beacon, i.e. the beacon has too move 400 metres if flight lines are 200 metres apart. The initial three or four lines are slow as the aircraft waits for the smoke to show up, when this occurs the aircraft flies back through the previous flight lines.

When filling in between the lines it is easier to see the smoke if looking into the sun, ie: if lines are East to West and the burn is in the afternoon, then all flying onto the beacon should be done on East edge and flying in Westerly direction when filling in.

The above method of marking is particularly successful under conditions where smoke shows up very rapidly i.e. within 15 minutes. If smoke shows up slowly, then as many as 5 or 6 lines have to be flown at double spacing before anything shows up.

Racecourse Method

Consists of marking the first and fifth line and every fourth line from there on with beacons or other navigational device.

The method relies heavily on pilot technique, ability and boundary definition.

First line flown from marker fires, the aircraft then flies over beacons on line 5 then to line 3 by optically dividing the area in half.

The area is again optically divided and line 2 then line 4 flown. The whole method can be repeated with the beacon moving to line 9.

5.9 Capsule Flight Path

Showing the theoretical time it takes before a capsule strikes the ground (in seconds) and the horizontal distance (in metres) before the target, that the capsule has to be released.

It is assumed that the aircraft is in level flight 90 kts and neglects the effect of air resistance mass and inertia on the capsule.

Dropping Height Feet	Time Capsule takes to fall and Strike the Ground Seconds	Distance Capsule Travels Horizontally After Being Released Metres
1000	7.9	366
900	7.4	342
800	7.0	324
700	6.6	305
600	6.1	282
500	5.6	259
400	4.9	226
300	4.3	199
200	3.5	162
100	2.5	115

Note the actual time taken for the fall will be longer, but the horizontal distance the capsule travels will be shorter.

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6.0 LATITUDE AND LONGITUDE

A convenient way of specifying the POSITION of any point on earth is to relate it to the imaginary lines that form the latitude and longitude graticule (or grid).

- Latitude

The reference for latitude is the EQUATOR, the great circle whose plane is perpendicular (at right angles, 90 degrees) to the polar axis.

FIGS 2a, b, & c LATITUDE.

* The LATITUDE of a place is its angular distance in degrees from the equator, measured at the centre of the earth and designated either north or south.

* A PARALLEL OF LATITUDE joins all points of the same latitude and is a small circle (except for the equator).

* Parallels of latitude are parallel to the equator and to each other.

* The longest parallel of latitude is the equator (Latitude 0 degrees) and the parallels of latitude progressively decrease in size until the 90 degrees parallels of latitude become just points at the N and S geographic poles.

FIG. 3. THE FURTHER FROM THE EQUATOR
THE SMALLER THE PARALLEL OF LATITUDE

- Longitude

The basic reference for longitude is the GREENWICH MERIDIAN - also known as the PRIME MERIDIAN. It is that branch (half) of the great circle that contains the polar axes (N and S geographic poles) and passes through the Greenwich Observatory which is situated near London.

The prime meridian is designated as "longitude 0 degrees".

FIGS 4 a & b, THE PRIME MERIDIAN

The other branch of the same great circle that contains the prime meridian runs from the north geographic pole to the south geographic pole on the other side of the earth to Greenwich (roughly down the west side of the Pacific Ocean).

It is called "longitude 180 degrees" and it can be reached by travelling either East from the prime meridian or by travelling the same angular distance (180 degrees) West from the prime meridian. Therefore it can be called both "180E" or "180W". It is also called the anti-meridian of Greenwich.

* All of the great circles containing the polar axis (therefore passing through the N and S geographic poles) are called MERIDIANS OF LONGITUDE.

* Meridians of longitude are specified by their angular difference in degrees EAST or WEST from the prime meridian.

FIG. 5. THE LONGITUDE OF A PLACE IS THE ANGLE BETWEEN ITS MERIDIAN OF LONGITUDE AND THE PRIME (GREENWICH) MERIDIAN MEASURED EASTWARD OR WESTWARD.

6.1 POSITION ON EARTH

The position of any point on the earth can be specified by:

* its LATITUDE - its angular position N or S of the plane of the equator;

together with:

* its LONGITUDE - its angular position E or W of the prime meridian.

The "parallels of latitude" and "meridians of longitude" form an imaginary graticule or grid over the surface of the earth.

The position of any point on earth can be specified by its LATITUDE and LONGITUDE. It is usually sufficiently accurate to specify the latitude and longitude of a place in degrees and minutes only (although for extreme accuracy each minute can be divided into 60 seconds of arc).

FIG. 6. THE POSITION OF BIRDSVILLE IN QUEENSLAND IS (25o 54'S, 139o 21'E)

Latitude and longitude is the normal method of specifying position on earth and is the one that pilot/navigators most commonly use at the flight planning stage when they are preparing their maps and flight plan. Once in flight, however, there are other means of specifying the position of the aircraft:

* by position over a landmark or radio beacon, e.g. "over the Harbour Bridge";

* by range (distance and bearing from a landmark or radio beacon, e.g. 10 nm on a bearing of 290 M from Melville Island".

6.2 DISTANCE ON EARTH

The standard unit of distance in navigation is the NAUTICAL MILE - the length of 1 minute of arc of any great circle on the earth (assuming the earth to be a perfect sphere).

There are 360 degrees in a circle and 60 minutes in a degree. This makes (60 x 360 =) 21,600 minutes of arc - which makes the distance right around the circumference of the earth on a great circle 21,600 NM.

FIG. 7. I NM = THE LENGTH OF 1 MINUTE OF ARC OF A GREAT CIRCLE ON THE EARTH

* LATITUDE (the angular distance north or south of the equator) is measured up and down a meridian of longitude (which is a great circle) and therefore:

1 MINUTE OF LATITUDE AT ANY POINT ON EARTH = 1 NM.

FIGS 8 a & b
1 MINUTE OF LATITUDE = 1NM/1 MINUTE OF LONGITUDE VARIES IN LENGTH

1 DEGREE OF LATITUDE AT ANY POINT ON EARTH = 60 NM

* LONGITUDE is measured around the parallels of latitude (small circles except for the equator) and so 1 minute of longitude varies in length depending upon where it is on the earth's surface.

The only place where 1 minute of longitude is equal to 1 NM is around the equator.

Do not be confused by the fact that:

WE MEASURE 1 MINUTE OF LATITUDE (ALWAYS 1 NM) UP OR DOWN
THE SIDE OF THE CHART ALONG A MERIDIAN OF LONGITUDE;

- it is logical when you think about it.

FIG 9: 1 MIN LAT = 1NM

FOR CONVERSIONS:

1 NM = 1852 METRES = 6076 FEET = 1.15 SM.

6.3 CHART PROJECTIONS

The original problem in map-making is still with us - how can you represent the curved surface of a earth on the flat surface of a map without distortion?

The answer is still the same - it cannot be done!

"A spherical orange peel cannot be flattened out perfectly."

Some property will always be distorted to a greater or lesser extent depending upon how you transfer the points on the surface of the spherical earth onto the flat chart.

Some curved surfaces such as a cylinder or a cone can be cut and laid out flat - or, in the opposite sense, you can make a cylinder or a cone out of a flat piece of paper. This is not possible with a spherical surface - try it with an orange peel.

Chart-making involves the PROJECTION of the points on the surface of a sphere onto either a conical or cylindrical surface that can then be flattened out to form a plane.

A simple view of map projections is to think of a light projecting the shadows of the latitude-longitude graticule of the sphere onto a cone

(Lambert's projection) or onto a cylinder (Mercator's projection), which is then laid out flat.

6.4 SCALE

Unlike Spike Milligan we cannot carry full-scale maps of the earth in our nav bags. Our charts have to be scaled down and this is done by "reducing the earth" to a fraction of its size, and then doing the projection.

There are numerous ways of describing just how much the earth is scaled down on a particular map.

SCALE IS DEFINED AS THE RATIO OF THE CHART LENGTH
COMPARED TO THE EARTH DISTANCE THAT IT REPRESENTS

$$\text{SCALE} = \frac{\text{CHART LENGTH}}{\text{EARTH LENGTH}}$$

THE LARGER THE CHART LENGTH FOR A GIVEN EARTH LENGTH,
THE LARGER THE SCALE AND THE MORE DETAIL
THAT CAN BE SHOWN

This means that large scale charts cover small areas in detail. For example, a Visual Terminal Chart (VTC) has a larger scale and can show more detail than a Visual En-route Chart (VEC).

- SCALE CAN BE EXPRESSED IN VARIOUS WAYS;

* as a REPRESENTATIVE FRACTION, e.g. the WAC series are 1/1,000,000 charts (one to a million), where 1 centimetre on the chart will represent 1,000,000 cm or 10 kilometres on the earth, or where 1 NM on earth is represented by 1 millionth of a NM on the chart.

* as a GRADUATED SCALE LINE - usually situated at the bottom of the chart. A graduated scale line allows you to measure-off the distance between two points on the chart and match it against the scale line.

FIG 12: A SCALE LINE OFF A CHART

* in WORDS - e.g. "1 cm equals 10 NM", which obviously means that 10 NM on the earth's surface is represented by 1 cm on the chart.

Even if you can find no reference to scale on the chart you can always measure-off the distance between two points against the latitude scale which runs down the side of the chart (1' of latitude = 1 NM).

A point to remember here is to use the latitude scale at about the mid-latitude between the two points because on some charts scale may vary slightly depending upon where you are (top, middle or bottom) of the chart.

There are three main types of chart that every visual pilot in Australia should be familiar with:

* the WORLD AERONAUTICAL CHART (WAC) series - used mainly for en route topographical and cultural information.

* the VISUAL EN ROUTE CHART (VEC) series - used mainly for en route aeronautical information.

* the VISUAL TERMINAL CHART (VTC) series - used for all topographical, cultural and aeronautical information around major terminal areas.

6.5 THE WORLD AERONAUTICAL CHARTS (WACs)- INTERNATIONAL CIVIL AVIATION ORGANISATION (ICAO), 1:1ÿ000ÿ000 SERIES.

We use WACs to provide us mainly with TOPOGRAPHICAL information (mountains, lakes, rivers, deserts, coastlines etc.) and CULTURAL information (cities, towns, freeways, country roads, railway lines, etc.) for visual en-route navigation.

All WACs have the same "one to a million" scale and the same symbols.

WACs are based on the Lambert Conformal Conic projection, so that angular relationships and shapes are preserved and so that there is a reasonably constant scale over the whole of the chart. Straight Lines closely represent the Great Circle track between two points.

Each country is responsible for producing the WACs covering its own area, and they are generally available for all parts of the world (one exception at the moment being Papua New Guinea where Tactical Pilotage Charts known as TPCs are used).

Each WAC chart has a number which is displayed at the top beside the name of that particular chart. The number of the adjoining WAC chart is also labelled around the edge of the chart.

Things such as radio towers, irrigation channels, railway lines and roads change from time to time, and so WAC charts are continually up-dated by:

* re-prints at convenient intervals (so ensure you have the current edition, as specified in NOTAM's NOTAMs class 2);

*   NOTAM (NOTices to AirMen) amendments which you should make by hand on your WAC's. These are called "Manuscript Amendments".

The WAC is the primary chart used by visual pilots in Australia to plot positions and tracks when well away from busy terminal areas. Aeronautical information (e.g. controlled airspace, restricted areas) will then be cross-checked off the VEC.

It is possible to plot on the VEC as well as the WAC if you want to.

The TOPOGRAPHIC information shown on a WAC chart is that which is considered to be of most use to the pilot/navigator.

It is of course impossible to show absolutely everything on a chart, so there may be some details on the ground not shown - conversely anything shown on the chart you can reasonably expect to exist on the ground. For example, an isolated rock may not be considered significant by the map-maker and therefore will not be shown on the map. You might spot it on the ground yet not find it depicted on the map. If however there is an isolated rock depicted on the map, you can be certain that it does exist on the ground.

*   DRAINAGE AND WATER FEATURES (hydrographic features) are usually depicted on the map in blue. This includes creeks, streams, rivers, canals, lakes, swamps, waterholes, wells and bores, shorelines, tidal flats, dry lakes, etc. Just how they are depicted on the map is explained by the legend - but bear in mind that after a flood, for instance what might be shown as a dry river bed on the map might in fact be a raging torrent, etc. Right throughout aviation, common sense is necessary. One drainage feature not depicted by blue is the mangrove swamp, which is usually near a coastline, and which is depicted in green.

*   RELIEF. There are various ways of bringing ground contours into relief, so that an impression of hills, mountains, valleys, etc. is obtained when you look at the map.

The WAC chart uses CONTOURS, which are lines joining places of equal height above sea level, and the closer the contour lines are together on the map the steeper the hill on the ground.

COLOUR or layer tinting is used in conjunction with the contour lines to give even more relief. The colours or tints used for the various ground elevations are shown on a "hypsometric tint" table at the side of the WAC chart. ("Hypsometric" means "establishment of vertical heights or elevations".) The shades of colour on the WAC chart start with green for low land, then goes through yellow and into brown, gradually darkening the higher the ground is.

HACHURING and HILL SHADING are used to give a three dimensional effect. Hachuring consists of very short lines radiating from high ground and is commonly used to portray bluffs, cliffs and escarpments. Hill shading shows darkened areas on the low side of high ground where you would expect to see shadows at certain times of the day.

SPOT ELEVATIONS (or spot heights) are also shown using a black spot with an adjacent number to indicate height AMSL (Above Mean Sea Level) in

FEET. These heights can be assumed to be accurately measured (unless amended by NOTAM). Spot Heights are normally used to show local peaks and other critical elevations that are significantly higher than the surrounding terrain.

* CULTURAL FEATURES are of great help to the pilot/navigator. It is not possible to show every town or every house on the map. so a choice is made to show what is significant and of value for visual air navigation.

A group of say 100 houses is of little significance if it lies in the middle of a city the size of Sydney and so will not be specifically depicted on the map, yet in the outback it is extremely significant and will certainly be shown. In remote areas the map will even show isolated homesteads, out-stations and water tanks.

ROADS and RAILWAYS can be of great assistance to the visual pilot/navigator. Those that will be most significant for air navigation will be clearly shown. Distinctive patterns such as curves, roads running parallel to railway lines and then crossing over, junctions, forks, overpasses, tunnels, etc. are especially useful.

Many other useful cultural features may also be shown such as wheat silos, telegraph lines, etc. Read the legend carefully and become familiar with the symbols.

* Limited AERONAUTICAL information is also shown on WAC charts, such as aerodromes (civil, military, or joint use), aerodrome beacons and landing grounds. The date at which this aeronautical information was still considered to be current is specified on the chart.

The division of airspace is not shown on WAC charts - this information is shown on VEC and VTC charts.

The LATITUDE-LONGITUDE graticule is clearly marked on WAC charts:

* the east-west parallels of latitude indicating degrees north or south of the Equator (south in Australia of course) are labelled at either side of the chart;

* the north-south meridians of longitude gradually converging as they near the south pole are labelled at the top and bottom of the map in degrees East or West of the Prime Meridian (in Australia, Longitudes are East).

This makes the WAC chart ideal for measuring the latitude and longitude of a position.

Figure 13 below is a photographic excerpt from the top right hand corner of a WAC chart and clearly shows the latitude and longitude indications.

To measure the latitude and longitude of a place on a WAC chart:

6.6 Measuring Latitude and Longitude of a Position.

6.6.1 Latitude:

- Place a straight-edge east-west through the place parallel to the parallels of latitude.

- From the latitude scales running north-south down the page you can read-off the exact latitude. (It should be the same latitude on the scale either side of the place - this ensures that the straight-edge is placed correctly on the map.)

Note: that in the Southern Hemisphere the latitude increases towards the south and bottom of the chart, and that the scale lines break up each degree of latitude into 60 minutes, with large marks each 10 minutes. (Make sure that you count from the top down the page.)

6.6.2 Longitude:

Place a straight-edge north-south through the place parallel to the closest meridians of longitude.

From the longitude scales running east-west across the page you can read-off the exact longitude. (It should read the same on the scales above and below the place this checks that the straight-edge is placed correctly on the chart).

Figure 14. Finding the latitude - longitude of a known place.

6.7 PLOTTING ON A CHART

The reverse problem of plotting a given latitude and longitude on the chart is just as easy:

1. Find the approximate position of the place on the chart.

2. Mark the latitude given on the two nearest latitude scales either side of the position.

3. Mark the longitude given on the two nearest longitude scales north and south of the position.

4. Join the latitude marks and then

join the longitude marks - their point of intersection being the the desired position.

Note: You are required to be able to specify or mark a position to an accuracy of 1 minute of arc.

Fig.15. Plotting a Known Latitude - Longitude

ISOGONALS (lines joining places of equal magnetic variation) are indicated on the WAC chart by dashed purple-coloured lines. The Eastern States of Australia experience "variation east-magnetic least", whilst in W.A. there is "variation-west - magnetic best".

The AGONIC LINE (where True North and Magnetic North are the same direction, with variation zero) lies inbetween. Because the magnetic poles are gradually moving, the amount of variation at a particular place will also gradually change over a period of years.

Every few years the isogonic information on the charts is up-dated, and the year of the isogonic information is shown on the chart.

6.8 Measuring Direction with a PROTRACTOR.

The best way to measure direction with a protractor is to align its north-south axis with True North along the mid-meridian and then to read-off the direction on the outer scale.

(You can also measure the direct-ion by aligning the axis of the pro-tractor with the track and measuring the direction against the inner scale.)

Once again it is vital that you have an approximate value in mind prior to using the protractor so that you avoid any gross errors, such as being out by 90ø or 180ø.

Fig.16. the Square Protractor is the type of protractor commonly used.

Fig.17. Measuring Direction with a Protractor.

6.9 MEASUREMENT OF DISTANCE ON CHARTS

Distance may be measured by various methods and you should be able to achieve an accuracy to within 1 NM by using one of the following methods:

* The GRADUATED SCALE LINE at the bottom of most charts. Using dividers or some other means transfer the distance between the two positions on the chart down onto the scale line.

* The LATITUDE SCALE down the side of the chart. At all points on earth for all practical purposes, 1 minute of latitude = 1 NM. Using dividers or some other means, transfer the distance between the two positions on the chart across onto the latitude scale. (Because the scale over the whole chart may vary slightly from latitude to latitude, use that part of the latitude scale which is about the same as the mid-latitude of the track that you are considering.)

* A correctly graduated SCALE RULE. Most navigation plotters have graduations suitable for 1:1,000,000 maps such as the WAC charts, which are all 1 to a million. On the back of the Australian D of A Domestic Flight Plan Form is a similar 1:1,000,000 graduated scale line suitable for WAC charts. (Some plotters also have a 1:250,000 scale line useful for VTC charts, which are all 1 to a quarter million. The scale on VEC charts however varies from chart to chart and so we cannot use this method for them.)

Fig.18. Measuring the Distance Between Mount Garnet and Cairns on the WAC using time 1:1 000 000 Distance Scales on the Plotter

6.10 MAP READING

There is often confusion about the difference between a Map and a Chart.

A Map is a representation on a flat surface of some part of the earth's curved surface, whereas a Chart is a map (possible even just an outline map) showing special conditions or information.

Since most of our aeronautical charts show specific aeronautical and navigational data, they are therefore "charts" rather than "maps".

The ability to read a map well - the chart that we have discussed, the topographical variety, in the hands of a navigator becomes a Map - is very valuable and cannot be over-emphasized. That is true all over the world, but in the less inhabited areas it is doubly true. Skill in the art of map reading varies according to natural aptitude and the amount of practice experienced. Good map reading depends upon being able to visualize the ground features as portrayed on the map, knowing the navigational value of the prominent features, the estimation of distance and bearings, and finally memory of how it has all looked before under similar circumstances.

The ability to distinguish the more significant features and not be confused with irrelevant detail is an important aspect of map reading. Features mentioned here which have great length, are generally known as "Line Features", e.g. Railroads. These are most important, because an interception is almost impossible to be missed.

Coastlines

The dividing line between land and sea takes priority in aerial navigation. The shape and bearing of a stretch of coastline quickly limits the area within which an aircraft is flying.

Railways

Railways are of great importance and are given considerable prominence on I.C.A.O. charts. They are reasonably easy to see especially in open country and are easily identified by their bearing. Traffic on them makes them more obvious. Their value and identification in built-up areas is slight and difficult. The presence of a railroad is often masked by a road running parallel to it. Tunnels and bridges when marked on the chart are especially useful in fixing position.

Roads

The value of roads in map reading varies considerably. Generally they are confusing and misleading.

Many more roads are on the earth's surface than are printed on the chart. Main highways are always useful. In the outback a mere track could have the same value.

Rivers and Canals

Rapid and positive indication of position is provided by major waterways. They show up well and can be seen from considerable distances. Even dry rivers generally have a tell-tale line of green vegetation along their banks which shows from a considerable distance. The dry sandy bed of a river without the accompanying line of trees can still be identified when overhead.

Lakes

Shape is the most important aspect in identification of lakes of comparable size. They are easily seen from great distances, even dry lakes.

Mountains and Hills

The navigational value of mountains and hills varies with the height from which they are seen and to a certain extent the light that is experienced.

The country appears to flatten out as height is gained and only the very prominent hills will stand out. If flying at about the same height as the hill-tops they are most prominent. In mountainous country it is difficult to differentiate between the various valley and peaks. The lone mountain, however, is very useful.

Towns and Settlements

Towns can sometimes be recognized by their shape as depicted on the chart, but generally they are identified by their size or position in relation to other features. Careful scrutiny of the number and direction of railways and main roads, entering and leaving or near the town, will usually dispel ambiguity. In large industrial regions towns tend to merge into each other making accurate pin-pointing difficult. In less densely populated areas, confusion can also exist between villages in a particular area. In such areas three or four houses might well be marked on a chart as a village.

Forest and Tree Plantations

These show up well from the air and if marked on the map can be very useful, if their shape is accurately portrayed. In country which is mostly forest or bush the clearings (often indicating a valley) are most important.

Airfields

Airports with sealed runways are quite easily seen. Disused airfields, or those with a graded strip or two generally of the same colour as the surrounding country, are extremely hard to see. Be prepared to observe private strips which are not marked on the map.

Culture

Minor culture, e.g., factories, radio masts, windmills, etc. are very difficult to find without first getting a lead from some other nearby feature more easily seen. Isolated forms of culture have slight value in positioning the aircraft.

Seasonal Changes

Landmarks and their appearance and, therefore, their prominence change considerably during the seasons of the year. Some areas of Australia are comparatively unaffected by seasonal changes. Those areas which experience heavy falls of snow are, of course, most affected. A covering of snow can obliterate those landmarks normally most prominent and give to lesser landmarks a considerable prominence for the period.

Floods, or course, will considerably change the formation and appearance of rivers. Unmapped rivers exist and rivers that previously existed are swallowed and lost amongst sheets of water. The shape and size of lakes are similarly affected. Drought and normal summer dryness change not only the waterways, but the general colour of the terrain. The associated covering of dust makes everything blend and become inconspicious.

Visibility and the Sun

During periods of reduced visibility map reading is made so much more difficult mainly because the area of ground that can be observed is considerably reduced. If it is possible to pass within two miles of a landmark without it being seen, the chances of flying a considerable distance before a Fix is obtained are extremely high. Looking up sun in hazy conditions due to the diffused light severely restricts visibility in that direction. In practice, it is best to fly up sun of the track and observe down sun.

Importance of Features

Prominent landmarks, especially line features are what we base our map reading on. But the really significant feature, the one that dispels all doubt, is the unusual or singular feature. When map reading over a flat and arid expanse, tracks if not easily seen because of their infrequent sighting are useful, and because the terrain is otherwise devoid of detail they could be called prominent. However, doubt can arise, if not confusion. But if in this arid and monotonous area stands one mountain and this can be sighted all doubts are reduced. It cannot be confused, there is only one, and it is doubly prominent because of its unusualness. In a mountainous area, a wide and defined valley would command our attention. The water reservoir in the midst of a rambling built-up area serves the same purpose. The twenty or so railway lines running in all directions which have been confusing can now be ignored.

COMBINATION OF FEATURES

One feature by itself is rarely sufficient for the pilot/ navigator to fix his position. A fix is made easier and perhaps only possible when several features are present. If a straight railway line is crossed, it doesn't tell much. The crossing could conceivably have been made anywhere along a thirty mile stretch of straight rail. But if the crossing is made near where a main road bridges the railroad then a Fix is possible. A bend in the railroad would, of course, be just as useful. If, when endeavouring to decide which of three towns is which, the problem will not be made easier to find that each town has a road running through the centre. But if only two of the towns has a railway passing through and only one of these has a river, the problem is solved. In this example, the fact that the bearings of the railways and roads would surely be different helps identification.

Therefore, when map reading, check carefully the inter-relationship between the various features. The inter- relationship is more important than the features themselves.

Bearings and Distances

The bearing of landmarks from the aircraft is widely used in fixing position by map reading. They can only give an approximate pinpoint because the bearing is only a guess without the aid of a bearing compass. However, the fairly accurate guess is most useful in establishing an area of probability.

The estimation of distance from the air is quite difficult.

The difficulty is not made any easier by the fact that the height at which we will map read varies from trip to trip. Experience and practice does, of course, help. But if the estimation of distances can be avoided do so. If when passing well to the side of, say, a lake instead of trying firstly to guess how far to the side, look in the other direction for some other landmark be observed it should be possible to decide more accurately which is the nearer and the proportion of nearness.

Hills abserved on Port beam, position uncertain, somewhere along line A.B.

Lake appears 45ø to the Starboard position along line A.B. can now be fixed with a fair amount of certainty. Bearings from aircraft.

Orientation of Map

For map reading, the map is best held with the North of the map pointing in the direction of North. This is carried out when the map is held so that the track line on the map lies along the actual track of the aircraft which is approximately (unless severe drift is experienced) along the fore and aft axis of the aircraft. For example, when the track on the map runs North to South, the North side of the map would be held to your chest and the South side farthest away from you. The aircraft would be headed approximately South and, therefore, features shown on the map to be left of the track would be expected to appear to the left of the nose and vice versa. With the map so held, less difficulty will be found in comparing what is on the map with the features they represent on the ground.

Anticipation

When the approximate position is known map reading is carried out from the map to the ground. You know your position, you know in which direction you are travelling, it is an easy matter to look ahead on the map to see what can be expected to show up in the next few minutes. Because the anticipation of features before they show up is so important to success, careful study of the track before departure is recommended. To enable the pilot/ navigator to anticipate correctly, it is necessary for him to know his ground speed or rate of travel over the map. This rate of travel depends on the wind, the speed of the aircraft and the scale of the map. If the rate of travel over the map is approximately one inch every five minutes, the finger can follow the progress, pointing to the position, and to look ahead of the finger is to anticipate correctly. If a fast aircraft was flown by a pilot with a large scale map, the rate of travel over the map would be so rapid, that useful anticipation would perhaps be necessary on the adjoining map sheet. Rate of travel or the time factor is all important.

Timing

If the ground speed is reckoned to be 120 k, two nautical miles will be covered in every minute. Therefore, five minutes after the aerodrome or some other recognized landmark has been flown over, the aircraft will have travelled ten nautical miles. By looking at the map, ten miles along the track from the landmark, it is possible to see what other landmarks, if any, are now to be seen and by looking a further ten miles along the track on the map, landmarks can be expected to be seen in the next five minutes. If the track is crossed by a railroad 40 nautical miles from the departure point, it is useless to worry about finding it, and, of course, eventually about not having found it, until some 30 nautical miles and, therefore, 15 minutes have passed. It is most likely impossible to see if regardless of experience, etc., before this time. So for those 15 minutes, relax or busy yourself with closer landmarks even though they are of less importance.

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Civil Aviation Regulations and Orders Relating to the Dropping of Incendiaries: Page

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1.0 CIVIL AVIATION REGULATIONS AND CIVIL AVIATION ORDERS

1.1 Dropping of Incendiaries from Aircraft for the Ignition and Controlled Burning of Forest Undergrowth:

1.1.1 DROPPING APPROVAL

CIVIL AVIATION ORDERS SECTION 29-5

Incendiaries may be carried in aircraft on bush fire control subject to the following conditions:

[a] Operator hold's an aerial work licence.

[b] Operation is authorised by state forest authority.

[c] Incendiaries type and arming device and dropping equipment be approved by C.A.A. officers.

1.1.2 CIVIL AVIATION REGULATION 150A (IV)

Incendiaries may be dropped from aircraft subject to the following conditions:

DROPPING SITE

[a] Dropping site clearly defined by state forest authorities using terrain features, ground signals, markers etc.

[b] The pilot shall make one preliminary run over the site and obtain confirmation he is over the site.

1.1.3 DROPPING REQUIREMENTS

[a] Site must be clear of persons and stock.
[b] Incendiaries shall be dropped by an Incendiary Machine Operator.
[c] Effective communications shall be maintained between the crew.
[d] The pilot shall at all times be in VHF contact with a responsible forest officer on the drop site.
[e] The pilot shall be personally briefed on the location of the drop area and other matters prior to departure.
[f] The pilot shall ensure that the load is within the limits - both regarding centre of gravity and weight.

1.1.4 INCENDIARY MACHINE OPERATOR QUALIFICATIONS

[a] Shall be trained and qualified in the use of the incendiary equipment and dropping operations.

1.1.5 CARRIAGE OF ARTICLES AND PERSONS

[a] The carriage of incendiaries shall be in accordance with Section 20.16.2 CAO's.

[b] For safety reasons, no persons other than those having duties relating to the operation shall be carried in the aircraft.

[c] Each person shall occupy a separate seat equipped with an approved safety belt or harness. Safety belts/harness shall be worn at all times during take-off, flight and landing.

1.1.6 OPERATING CONDITIONS

[a] Under CAR 157(4)(b) approval may be given for the aircraft to descend to, but not below, 46 metres (150 feet) above tree-top level during dropping operations.

[b] However, an aircraft shall not be flown below 155 metres (500 feet) above terrain within 610 metres (2000 feet) over any built-up area.

[c] During dropping operations the aircraft shall not fly below 465 metres (1500 feet) above terrain, over any populous area.

[d] Dropping operations shall be in accordance with the Visual Flight Rules.

Flight visibility - better than 4.8 kilometres (3 miles).

Distance from cloud - 620 metres (2000 feet) horizontal and 155 metres (500 feet) vertical, when flying below 1550 metres (5000 feet).

[e] The aircraft shall be flown straight and level while incendiaries are being dropped.

[f] The approach to and climb away path from the dropping area shall not involve abrupt manoeuvres, the climb away shall be clear of obstacles.

1.1.7 EMERGENCY EQUIPMENT

The aircraft shall be equipped with:

(a) A wool or similar flexible sheet; and

(b) CO_2 or BCF fire extinguisher readily available to the Incendiary Machine Operator.

1.1.8 ADDITIONAL EQUIPMENT

In addition to the instruments required by CAO 20.18 for VFR operations, the aircraft shall be fitted with a gyroscopic horizon indicator.

1.1.9 OPERATIONS MANUAL

An operator carrying out dropping operations shall be required to list the terms of the permission in the aircraft's operation manual.

Reference: Operational Standards - Civil Aviation Authority - Commonwealth of Australia.

1.2 Pilot Flight Time Limitations:

1.2.1 CIVIL AVIATION ORDER 48.1

Pilot flight times are limited to prevent fatique and avoid accidents from happening. The maximum times should not exceed:

8 hours in one day;
6 consecutive days of work;
30 hours in 7 consecutive days;
100 hours in 30 consecutive days;
900 hours in 365 consecutive days.

1.2.2 MEDICAL STANDARDS

Civil Aviation Regulation 5.04(1); and
CAR Schedule 1.

An aircrew member may not consume alcohol 8 hours prior to flying CAR 256.

Aircrew shall not be under the influence of alcohol or drugs. Caution should be exercised if taking any drugs in conjunction with alcohol prior to flying.

Other factors to watch are:

- fatique
- dehydration
- effects of caffeine
- colds or flu
- earache
- hangovers

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3.0 EQUIPMENT CAPABILITIES AND LIMITATION

3.1 INCENDIARY MACHINE CAPABILITIES AND OPERATIONAL LIMITATIONS

3.1.1 INTRODUCTION

Prescribed burning using aerial ignition was first developed as a joint project between the Commonwealth and Scientific Industrial Research Organization (CSIRO) and the Forests Department of Western Australia in 1965. (Baxter et al: 1966)

This section describes the development of incendiary machines used for aerial burning in Western Australia (W.A.), from the original hand-operated machine to the most recent machine developed by the Forest Department (FD) of Western Australia, (renamed since 22 March 1985 as the Department of Conservation and Land Management). (van Didden, 1983)

3.1.2 HISTORICAL BACKGROUND

Since the earliest days of colonization in W.A., periodic summer wildfires have ravaged the forests. Early foresters were alarmed by the damage caused and after 1918 pursued a policy of almost complete fire exclusion. However, by 1953 heavy accumulation of forest fuels or debris in the protected areas had resulted in many wildfires which caused serious damage to the forest. It became apparent that complete protection of the forest could not be maintained with the limited manpower and equipment available, especially in the presence of heavy forest fuels.

As a result, a complete review of the fire policy took place in 1954. Prescribed burning over large areas to reduce fuel hazards was introduced. (Peet, 1967)

Early programmes of "hand burning" were carried out by gangs of men of foot. This method was slow, expensive and risky in dense, inaccessible areas. Consequently, alternative methods of lighting up large areas of forest were sought, and ignition from aircraft was an obvious choice. However, there were many technical problems to overcome, the most important being the development of a suitable and safe incendiary machine to be used in the aircraft.

The first incendiary machine was developed in 1965 by the CSIRO. In December of that year, this machine was used on the first large-scale aerial burn, on the Pingerup Plains near Walpole in Western Australia.

Despite a number of initial problems, in the summer of 1965/66 over 20 000 ha of forest was prescribe burnt using the incendiary machine. The use of aircraft and the new incendiary equipment enabled large areas of forest to be covered in a short time. This was a major step forward in fire control, as greater areas could be lit for hazard reduction burning, under ideal weather conditions and at relatively low costs. (Baxter et al, 1966)

The success of the first venture led to 180 000 ha of forest being prescribed burnt in the spring of 1967. By 1968 the aerial burning programme was operational in Western Australia and has since played an increasingly important role in fire protection of State forest.

3.2 WESTERN AUSTRALIAN MACHINE BACKGROUND WAM 1982

3.2.1 DESCRIPTION

The basic function of the equipment is to inject small plastic capsules with a measured quantity of glycol, thereby initiating the exothermic reaction, and to eject the primed capsules from the aircraft at precisely timed intervals. The capsules are loaded into the turntable by hand. It has been designed to accomplish this with the highest degree of reliability and safety.

3.2.2 MODE OF OPERATION

A 24-28 volt D.C. motor is connected by belt drive to a worm gear speed reducer to obtain a final drive speed of 10 to 55 r.p.m.

The power take-off shaft from the gearbox is directly coupled to the axial cam to continuously control the injector mechanism. The cam has five different functions to perform during each rotation, they are: dwell, pierce, inject, dwell and strip, for each cycle. During part of the dwell period at the beginning of each cycle, the geneva mechanism is activated and rotates the turntable holding the capsules in position.

While the turntable is stationary, the cam activates the injector pump to pierce the capsule top, then injects 1.3 ml of glycol, dwells for 10o, then strips or removes the needles from the cap. As soon as the needles return to their original "up" position, the turntable is again moved by the action of the geneva cam. The primed capsule them moves one position and is ejected from the aircraft.

The incendiary capsules are fed by hand from a storage tray into the turntable on the machine, where they are automatically injected and ejected when the machine is in operation.

3.2.3 MECHANICAL DRIVE SYSTEM

Power for the WAM'82 machine is supplied by a .25kw - 24 Volt Direct Current (VDC) shuntwound electric motor - operating at 833 to 5000 rpm. The speed for the motor is controlled through an electronic motor speed control board in the Electronic Control box. The board controls motor speed by feeding a field winding with pulses of constant voltage but variable width. The motor stop/start function utilizes a silicon controlled rectifier, which ensure the machine stops in the safe "rest" position.

The electric motor is connected to a Richardson Radicon wormdrive gear reduction box of 25:1 ratio, to give a calculated output of 10 to 60 rpm.

The output shaft from the gearbox drives both the injector cam and the geneva mechanism. The geneva cam mechanism is an intermittent-motion device allowing power to be periodically transferred from the gearbox output shaft to the geneva cam.

The gearbox output shaft rotates continuously to drive the injector cam, which sets the injection cycle in motion. During each injection cycle the geneva cam remains stationary, until the cycle is complete, and is then reactivated.

A 28 teeth gear underneath the geneva cam drives the larger 84 teeth idler gear which is then connected to a 28 teeth gear to move the turntable. The intermittent motion of the geneva cam is thereby synchronised to the movement of the turntable.

3.2.4 CAPSULE TRANSPORT SYSTEM

Turntable

The six station turntable is designed to move the capsule from the loading stage to the injection and ejection positions. The turntable is designed to withstand any primed capsule from igniting the next capsule in the event of a misfire in the aircraft due to a system malfunction.

Manual Release Overdrive (Hdg)

In the event of a power failure the turntable can be manually released from the drive shaft by pulling up the release pin and rotating the turntable by hand. In the event that the turntable drive shaft becomes unsynchronised from the geneva cam the needles will not be damaged because of the hollow groove in the top of the turntable.

Glycol System

Glycol Tank

Injector

Glycol is stored in a 6.7 litre capacity stainless steel tank. Fitted with a sight gauge and graduated scale to determine the glycol level. Glycol is fed by gravity to the injector.

The modified injector is based on the original 1968 CSIRO design with slight modifications to reduce the number of parts.

3.3 EJECTION RATE

The ejection rate of the incendiary machine can be varied from a maximum rate of 54 capsules per minute or 1.2 second interval down to 13 capsules per minute or 4.6 second interval. Changes in speed are made by turning the motor speed control knob to the desired drop rate setting on the digital indicator.

To obtain correct ground spacing check table below.

IGNITION SPACING AS A FUNCTION OF TIMING AND GROUNDSPEED

Capsules per min	Ground Speed (knots) 70	80	90	100	110	120
	Approximate Distance Between Ignition Points Interval Metres					
13	166	190	213	237	261	285
16.5	131	149	168	187	205	224
23.5	92	105	118	131	144	157
27	80	91	102	114	125	137
31	70	79	89	99	109	119
35	62	70	79	88	97	106
37	58	66	75	83	91	100
40	54	62	69	77	85	93
42	51	58	66	73	81	88
43	50	57	64	72	79	86
45	48	54	61	68	75	82
47	46	52	59	65	72	79
50	43	49	55	61	67	74

3.4 CHEMICALS USED

The chemicals used to start the fires are potassium permanganate and mono-ethylene glycol mixed at the ratio of 1:4 (1 part glycol to 4 parts permanganate). Insufficient glycol will prevent ignition taking place, from the mixture being too dry. While excessive glycol will drown the mixture and make it ineffective.

Testing of Incendiaries

Reaction Time

The reaction between potassium permanganate and ethylene glycol depends upon temperature and particle size of the permanganate - if the temperature is high or the particles are fine the reaction time will be short.

To test the reaction time a capsule should be run through the machine, and should be timed from the instant of injection to the first appearance of flame. The temperature of the glycol should be taken and recorded together with the reaction time.

Reaction time should exceed 30 seconds at 20oC. Capsules should be stored in a cool place away from direct sunlight and high temperatures, to avoid the lids loosing their plasticity and coming off.

Quantity of Glycol

The quantity of glycol injected is important for the proper functioning of the reaction. At the beginning of each day after priming the injector - check that the quantity is satisfactory. Do this by injecting 5 times into a single capsule and then measuring the amount in a small measuring flask. The correct quantity is 1.3 ml per injection.

At the end of each day it is recommended that the quantity of glycol used is recorded, and divided by the number of capsules ejected to give an average volume per capsule used.

3.5 INCENDIARY SPECIFICATIONS:

Incendiary Capsule

Container: Size: 38 mm x 21 mm diameter
Material: Styrene acrylan nitrol
Mass: (Empty) 2.52 gms
Cap: Size: 11.5 mm x 21 mm diameter
Material: Low density virgin polythene
Mass: 1.31 gms
Contents: Material: Potassium permanganate $KMn04$
Mass: 4.0 + 0.5 gms
Mass Total: 7.83 + 0.5 gms
Size Total: 45 mm x 21 mm diameter.
Reagent
Mass: 1.3 gms + 0.2 gms
Material: Mono ethylene glycol $C2H6O2$

3.6 CAPSULE LOAD - GLYCOL CAPACITY

Capsule Load

The metal cabinet in the Britten Norman Islander carries 11 trays of 324 capsules totalling 3 564 capsules.

This quantity should be sufficient for most large burns. However if there is a need to carry additional supplies they should be carried in the rear cargo compartment. Restrained by an approved cargo net. Incendiary capsules come packed in boxes containing 4 trays, holding a total of 1 296 incendiary capsules.

Glycol Capacity

The glycol tank when fully loaded has a capacity of 6.9 litres, however for planning purposes only count on 6.5 litres useable. This should give an endurance of 4 333 capsules based on 1.5 ml per injection.

Additional glycol may be carried in a suitable container, anchored to the floor with cargo tie points. The 'esky' box is installed for this purpose.

For security reasons this additional glycol should not be left in the aircraft overnight or during the weekends.

At the end of each dropping operation the aircraft must be cleaned inside to ensure that any loose articles are stowed. Any potassium permanganate or ethylene glycol that may have been spilt must be cleaned to avoid the inadvertent mixing of any spilt portions.

3.7 EQUIPMENT WEIGHTS

Incendiary Machine

Main frame mass, glycol tank empty		47 kg
Glycol tank full, capacity 6.7 litres		55 kg
Overall dimensions	length	51 cm
	height	70 cm
	width	35 cm

Subframe Assembly		Britten Norman Islander	Partenavia
Mass		3.75 kg	1.9 kg
Overall dimensions,	length	84 cm	40 cm
	height	21 cm	21 cm
	width	30 cm	35 cm

Incendiary Storage Cabinet

		Britten Norman Islander	Partenavia
Mass, empty		37 kg	32 kg
Mass, fully loaded		73 kg	54 kg
Contents,		11 trays @ 324 ea	8 trays
	number of incendiaries	3 564	2 592
Overall dimensions,	depth	43 cm	42 cm
	height	61 cm	51 cm
	width	42 cm	43 cm

Additional Equipment

Operators seat	9.3 kg	-
Seat-rail	5.9 kg	-
Firemat	5.4 kg	-
Esky for glycol	5.4 kg	-

5 litres glycol	11.3 kg		_____
Total equipment weight		169.0 kg	110.9 kg

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4.0 PREPARING AERIAL BURN FLIGHT PLANS

Preparation of flight plans are one of the basic requirements of successful burns. Along with other aspects of Aerial Burning Technology, flight plans have developed into the specialized document in use today.

4.1 Early Plans:

These were essentially jottings on a 1:40,000 API, and were derived during telephone conservations. They invariably suffered the inherent faults caused by misinterpretation. The system adopted in 1966 used a transparency of the relevant section of the 1:40,000 API sheet to produce dyeline prints, showing boundaries and flight lines.

4.2 Current Plans:

Under the current system, plans of the specific burn area are produced by Mapping Branch and are available at the relevant District before the commencement of the burning season. This provides the same base plan data so that everyone starts from a common point with the same information.

4.3 Features of Current Flight Plans:

[a] Job No.;

[b] Scale - 1:25000;

[c] Area in hectares;

[d] A clearly defined boundary (only one job is indicated on any one sheet);

[e] Departmental or Australian mapping grids are indicated for orientation;

[f] Date of photography (from which the plan was derived);

[g] Cleared areas and plantations are marked;

[h] Data panel.

4.4 Acquiring Information:

Whenever possible - derive base information from the District Office concerned - preferably the Controller or his deputy (usually the Burn Boss).

If the information has been passed on or received second hand it is a good general rule to confirm the data with the particular office. Do not assume that the District concerned will automatically advise you of last minute changes.

4.5 Essential Data:

[a] Flight line one: axis co-ordinates,
e.g., x axis north
y axis south

[b] Stripwidth and spot distance;

[c] Time required over job/or start time;

[d] Communications, callsigns, channel;

[e] Check:

- marking method and details, flares etc;
- boundary modifications;
- unidentified obstacles (radio masts etc);
- sensitive or excluded areas - within burn.

4.6 Method of Preparation:

(a) Locate and place line 1 from reference data.

(b) According to stripwidth dimension measure off each progressive line as a scaled increment - AT RIGHT ANGLES TO LINE NO. 1.

(c) Number and mark each line consecutively. Use two colours to indicate alternate lines.

- even/uneven numbers;
- flight line transparencies of differing spacings are available at District offices.

(d) Highlight - control point and areas of concern - e.g., obstacles, plantations - and "no-burn" areas. Every uncleared private property boundaries which may cause confusion or required special marking.

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Chapter 5 Aircrew Training Manual of 9

Introduction:

The aim of this operation is to provide a suitably fitted out aircraft and well trained crew to carry out incendiary dropping operations for fire management purposes. The purpose of this lesson is to further develop the students knowledge of the basic operational and planning requirements for aerial prescribed burning.

5.1 Briefing:

The morning of the proposed burn the duty operations office or delegate navigator should personally (or by phone) contact the burn boss or District protection officer and discussed the following points:

Burn number and location (distance and bearing from DHQ)

Objective of burn, or for part of the burn.

Features - topography, shape, area.

Boundary location and last minute changes.

Weather - wind direction and possible changes.

Forest Types - fuel types and variations. Location of heavy fuel pockets.

Fuel details - SMC's and FDI's, actual rate of spread expected.

Co-ordinates of flight lines, strip widths.

Lighting patterns.

Previous trouble spots (unburnt creeks, plots, poor boundary access, poor edging).

Adjoining fuel types and ages.

Private property to avoid (no overfly permission), pine, eucalypt or research plots, etc.

Staff at burn - names and call signs. Position around boundary. Control point location.

Beacon vehicle - are they required, if so location. Access problems with beacons, long travel times between individual lines, etc.

Public check - campers, fishermen, recreationists - along rivers or picnic spots.

Special instructions - areas to avoid (dunes, swamps, creek systems, ridge top lightings. Radio towers or SEC ines to avoid.

Communications - VHF channel, simplex/duplex.

Spot fires - if required.

Expected start time.

Day's program - prior and later burn lightings.

Contingency plans - alterations.

5.2 Planning Measure Distance, Direction, Calculate Time

1:1,000,000 Scale Plan - World Aeronautical Chart check position of Burn - Direction from Base Airstrip .... Magn. Distance .... nm. E.T.I. .... Min.

From stripwidth and spotdistance calculate capsule requirements - see Table 1. From required spotdistance, work out most satisfactory ejection rate and flying speed. See Table 2.

Measuring Distance

The Nautical Mile:

For air navigation the N.M. is the most convenient unit as it is taken to be the average length of one minute of latitude (this average being 6,080 feet).

Measurement of the Track

When it is intended that an aircraft be flown from A to B, a straight line or "track" is drawn joining them and the direction is read off with a protractor placed on the mid-meridian.

The track so measured is true. Isogonals (lines of equal Magnetic Variation) which on the WAC chart take the form of a blue dotted line, this indicates the variation in that locality. The variation when applied to the track measured, or the Heading, converts them from True to Magnetic.

From strip width and spot distance calculate capsule requirements.

TABLE 1
Number of Capsules Required per Hectare
Ignition Grid Pattern in Metres
Spot distance x Stripwidth

Area in Hectares	75 x 150	80 x 175	100 x 200	125 x 250	150 x 300	200 x 400
	Number of Capsules Required					
1000	889	715	500	320	222	125
2000	1778	1429	1000	641	445	250
3000	2667	2143	1500	962	667	375
4000	3556	2858	2000	1282	889	500
5000	4444	3572	2500	1603	1112	625
6000	-	4286	3000	1923	1334	750
7000	-	-	3500	2244	1556	875
8000	-	-	4000	2564	1778	1000

9000	-	-	-	2885	2000	1125
10000	-	-	-	3205	2223	1250
12000	-	-	-	3846	2667	1500
14000	-	-	-	4487	3111	1750
16000	-	-	-	-	3556	2000
18000	-	-	-	-	4000	2250
20000	-	-	-	-	4445	2500

From required spotdistance work out most satisfactory ejection rate and flying speed.

TABLE 2
Ejection Interval
Spotdistance and Flying Speed

To determine the speed the aircraft should be flown in nautical miles (knots) in conjunction with the ejection interval rate of the incendiary machine to obtain the required spotdistance on the ground.

Ejection Drop Rate in Capsules per Minute	Aircraft Speed in Knots 60	70	80	90	100	110	120	130
	Spot Distance Spacing in Metres							
65	29	33	38	43	48	52	57	62
60	31	36	41	46	51	57	62	67
55	34	39	45	51	56	62	67	73
50	37	43	49	56	62	68	74	80
45	41	48	55	62	69	76	82	89
40	46	54	62	70	77	85	93	100
35	53	62	71	79	88	97	105	115
30	62	72	82	93	103	113	124	134
25	74	87	99	111	124	136	148	161
20	93	108	123	139	154	170	185	201
15	124	144	165	185	206	226	247	268
10	185	216	247	278	309	340	370	402

5.3 Estimating Departure Times and Flight Duration

The following guideline is drawn up to estimate the time that the aircraft can be expected to complete a job, and allow programming for a days work. These times are a guide only.

Other factors, will affect the time the aircraft can be expected over a job:

Estimate Departure Time

Work out the departure time take into account the following factors:

Time to get to the airstrip
Note: Lodgement of Flight Plan at Primary and Secondary Airports required
Daily the aircraft, check incendiary machine (20 min)
Warmup and Taxi (5 to 8 min)
Flying to the job (2nm/minute)
Job reconnaissance (10 min to 20 min)
Dummy flight line to establish drift (5 min to 10 min)

Advise the pilot of the area to be burned, what time the aircraft is required over the job, time required to commence dropping capsules.

Point out boundary difficulties.

TABLE 3

Production rate over job assumes airspeed 100 knots, and flightline spacing 200 metres apart.

Job Size Ha	Time Hrs	Job Size Ha	Time Hrs
500	60	4 000	1.4
1 000	75	5 000	1.8
1 500	90	6 000	2.1
2 000	1.0	7 000	2.4
2 500	1.1	8 000	2.8
3 000	1.2	9 000	3.2
3 500	1.3	10 000	3.4

5.4 Suitable Clothing and Aircrew Punctuality

Navigators are to promote an image of responsibility and authority to preserve and enhance the image of the Department. Aircrew should wear clothing and footwear that is appropriate to the task and climate while bearing in mind safety at all times.

Punctuality is needed to ensure a smooth operation when a number of Districts are involved in the days burning program.

5.5 Pre-Flight Briefing to Pilot

The following points should be covered in your pre-flight briefing. To ensure that the aircraft arrives on time and can be programmed for other burns during that day. The pilot and incendiary machine operator should be briefed as early as possible after the decision is made to burn to involve them in the planning process and make them feel part of the team.

The following timetable should be observed by disticts in scheduling their daily burning program.

0745 hrs - Districts to obtain weather forecast

0820 hrs - District Controller to advise Regional co-ordinator prior to 0820 hours of proposed burn and required start time.

0830 hrs - Regional co-ordinators to advise Senior Fire Operations Officer Bunbury of requests.

0845 hrs - Approved programme notified to region with Beacon arrangements.

0900 hrs - Navigators to be advised of flight plan details.

0900 hrs - Bunbury Protection Branch to advise ABC and commercial stations burns proposed for the day.

1000 hrs - Controller to check the weather forecast to confirm conditions remain suitable.

5.6 Pre-Flight Arrangements for Aircrew and Supply Requirements

Navigator to advise incendiary machine operator of the jobs to be completed for the day; to allow the incendiary machine operator to plan his capsule and glycol or anti-freeze requirements.

NOTE: keep a check of supplies and advise Regional Fire Protection Officer Leader if stocks are running low and require replacement.

5.7 Arrangements, when Reaching Target Area:

On the way to the job the navigator should contact the controller re any last minutes changes, confirms boundary changes or areas to be left unburnt, eg regeneration areas. Asks for advice on difficult boundaries.

Establish contact with beacon vehicles at least 15 kilometres from the job. Determine if beacons are functioning.

On arrival over the area to be burnt, request marker fires to be lit on difficult corners projecting into the burn.

Boundary definition can be improved by lighting marker fires at intervals along the boundary.

The pilot is legally required to do at least one circuit of the boundary to identify ground points on the map, establish he is in the correct area and establish that the area is free of people, stock and vehicles.

The first flightline should be a dummy line to establish wind drift. The track error should be less than 100 metres before lighting can be commenced.

The navigator must obtain clearance from operations officer before commencing on a live dropping run to ensure authority is granted to commence lighting.

5.8 Flight Patterns

Parallel Method

Consists of marking every line with beacons and Verey piston flares used early in the season when percentage take is low.

Aircraft approaches point A and beacon is put on - the moment the aircraft goes over point A the navigator requests "East beacon on, West beacon off, East fire flare".

It is understood West beacon automatically moves to point D and waits and advises ready in position on line 2.

As soon as the aircraft flies over the East beacon, it is turned off and shifts to position C. Driver advises when ready in position "East beacon on in position line 2". This procedure is repeated as often as necessary until the job is completed.

The aircraft turning time outside the burn area has to be co-ordinated with the time it takes the beacons to shift.

Corridor Method

Consists of marking only every second line with the beacon, i.e. the beacon has too move 400 metres if flight lines are 200 metres apart. The initial three or four lines are slow as the aircraft waits for the smoke to show up, when this occurs the aircraft flies back through the previous flight lines.

When filling in between the lines it is easier to see the smoke if looking into the sun, ie: if lines are East to West and the burn is in the afternoon, then all flying onto the beacon should be done on East edge and flying in Westerly direction when filling in.

The above method of marking is particularly successful under conditions where smoke shows up very rapidly i.e. within 15 minutes. If smoke shows up slowly, then as many as 5 or 6 lines have to be flown at double spacing before anything shows up.

Racecourse Method

Consists of marking the first and fifth line and every fourth line from there on with beacons or other navigational device.

The method relies heavily on pilot technique, ability and boundary definition.

First line flown from marker fires, the aircraft then flies over beacons on line 5 then to line 3 by optically dividing the area in half.

The area is again optically divided and line 2 then line 4 flown. The whole method can be repeated with the beacon moving to line 9.

5.9 Capsule Flight Path

Showing the theoretical time it takes before a capsule strikes the ground (in seconds) and the horizontal distance (in metres) before the target, that the capsule has to be released.

It is assumed that the aircraft is in level flight 90 kts and neglects the effect of air resistance mass and inertia on the capsule.

Dropping Height Feet	Time Capsule takes to fall and Strike the Ground Seconds	Distance Capsule Travels Horizontally After Being Released Metres
1000	7.9	366
900	7.4	342
800	7.0	324
700	6.6	305
600	6.1	282
500	5.6	259
400	4.9	226
300	4.3	199
200	3.5	162
100	2.5	115

Note the actual time taken for the fall will be longer, but the horizontal distance the capsule travels will be shorter.

Section Subject Page No.

6.0 LATITUDE AND LONGITUDE

A convenient way of specifying the POSITION of any point on earth is to relate it to the imaginary lines that form the latitude and longitude graticule (or grid).

- Latitude

The reference for latitude is the EQUATOR, the great circle whose plane is perpendicular (at right angles, 90 degrees) to the polar axis.

FIGS 2a, b, & c LATITUDE.

* The LATITUDE of a place is its angular distance in degrees from the equator, measured at the centre of the earth and designated either north or south.

* A PARALLEL OF LATITUDE joins all points of the same latitude and is a small circle (except for the equator).

* Parallels of latitude are parallel to the equator and to each other.

* The longest parallel of latitude is the equator (Latitude 0 degrees) and the parallels of latitude progressively decrease in size until the 90 degrees parallels of latitude become just points at the N and S geographic poles.

FIG. 3. THE FURTHER FROM THE EQUATOR
THE SMALLER THE PARALLEL OF LATITUDE

- Longitude

The basic reference for longitude is the GREENWICH MERIDIAN - also known as the PRIME MERIDIAN. It is that branch (half) of the great circle that contains the polar axes (N and S geographic poles) and passes through the Greenwich Observatory which is situated near London.

The prime meridian is designated as "longitude 0 degrees".

FIGS 4 a & b, THE PRIME MERIDIAN

The other branch of the same great circle that contains the prime meridian runs from the north geographic pole to the south geographic pole on the other side of the earth to Greenwich (roughly down the west side of the Pacific Ocean).

It is called "longitude 180 degrees" and it can be reached by travelling either East from the prime meridian or by travelling the same angular distance (180 degrees) West from the prime meridian. Therefore it can be called both "180E" or "180W". It is also called the anti-meridian of Greenwich.

* All of the great circles containing the polar axis (therefore passing through the N and S geographic poles) are called MERIDIANS OF LONGITUDE.

* Meridians of longitude are specified by their angular difference in degrees EAST or WEST from the prime meridian.

FIG. 5. THE LONGITUDE OF A PLACE IS THE ANGLE BETWEEN ITS MERIDIAN OF LONGITUDE AND THE PRIME (GREENWICH) MERIDIAN MEASURED EASTWARD OR WESTWARD.

6.1 POSITION ON EARTH

The position of any point on the earth can be specified by:

* its LATITUDE - its angular position N or S of the plane of the equator;

together with:

* its LONGITUDE - its angular position E or W of the prime meridian.

The "parallels of latitude" and "meridians of longitude" form an imaginary graticule or grid over the surface of the earth.

The position of any point on earth can be specified by its LATITUDE and LONGITUDE. It is usually sufficiently accurate to specify the latitude and longitude of a place in degrees and minutes only (although for extreme accuracy each minute can be divided into 60 seconds of arc).

FIG. 6. THE POSITION OF BIRDSVILLE IN QUEENSLAND IS (25o 54'S, 139o 21'E)

Latitude and longitude is the normal method of specifying position on earth and is the one that pilot/navigators most commonly use at the flight planning stage when they are preparing their maps and flight plan. Once in flight, however, there are other means of specifying the position of the aircraft:

* by position over a landmark or radio beacon, e.g. "over the Harbour Bridge";

* by range (distance and bearing from a landmark or radio beacon, e.g. 10 nm on a bearing of 290 M from Melville Island".

6.2 DISTANCE ON EARTH

The standard unit of distance in navigation is the NAUTICAL MILE - the length of 1 minute of arc of any great circle on the earth (assuming the earth to be a perfect sphere).

There are 360 degrees in a circle and 60 minutes in a degree. This makes (60 x 360 =) 21,600 minutes of arc - which makes the distance right around the circumference of the earth on a great circle 21,600 NM.

FIG. 7. I NM = THE LENGTH OF 1 MINUTE OF ARC OF A GREAT CIRCLE ON THE EARTH

* LATITUDE (the angular distance north or south of the equator) is measured up and down a meridian of longitude (which is a great circle) and therefore:

1 MINUTE OF LATITUDE AT ANY POINT ON EARTH = 1 NM.

FIGS 8 a & b
1 MINUTE OF LATITUDE = 1NM/1 MINUTE OF LONGITUDE
VARIES IN LENGTH

1 DEGREE OF LATITUDE AT ANY POINT ON EARTH = 60 NM

* LONGITUDE is measured around the parallels of latitude (small circles except for the equator) and so 1 minute of longitude varies in length depending upon where it is on the earth's surface.

The only place where 1 minute of longitude is equal to 1 NM is around the equator.

Do not be confused by the fact that:

WE MEASURE 1 MINUTE OF LATITUDE (ALWAYS 1 NM) UP OR DOWN THE SIDE OF THE CHART ALONG A MERIDIAN OF LONGITUDE;

- it is logical when you think about it.

FIG 9: 1 MIN LAT = 1NM

FOR CONVERSIONS:

1 NM = 1852 METRES = 6076 FEET = 1.15 SM.

6.3 CHART PROJECTIONS

The original problem in map-making is still with us - how can you represent the curved surface of a earth on the flat surface of a map without distortion?

The answer is still the same - it cannot be done!

"A spherical orange peel cannot be flattened out perfectly."

Some property will always be distorted to a greater or lesser extent depending upon how you transfer the points on the surface of the spherical earth onto the flat chart.

Some curved surfaces such as a cylinder or a cone can be cut and laid out flat - or, in the opposite sense, you can make a cylinder or a cone out of a flat piece of paper. This is not possible with a spherical surface - try it with an orange peel.

Chart-making involves the PROJECTION of the points on the surface of a sphere onto either a conical or cylindrical surface that can then be flattened out to form a plane.

A simple view of map projections is to think of a light projecting the shadows of the latitude-longitude graticule of the sphere onto a cone

(Lambert's projection) or onto a cylinder (Mercator's projection), which is then laid out flat.

6.4 SCALE

Unlike Spike Milligan we cannot carry full-scale maps of the earth in our nav bags. Our charts have to be scaled down and this is done by "reducing the earth" to a fraction of its size, and then doing the projection.

There are numerous ways of describing just how much the earth is scaled down on a particular map.

SCALE IS DEFINED AS THE RATIO OF THE CHART LENGTH
COMPARED TO THE EARTH DISTANCE THAT IT REPRESENTS

$$\text{SCALE} = \frac{\text{CHART LENGTH}}{\text{EARTH LENGTH}}$$

THE LARGER THE CHART LENGTH FOR A GIVEN EARTH LENGTH,
THE LARGER THE SCALE AND THE MORE DETAIL
THAT CAN BE SHOWN

This means that large scale charts cover small areas in detail. For example, a Visual Terminal Chart (VTC) has a larger scale and can show more detail than a Visual En-route Chart (VEC).

- SCALE CAN BE EXPRESSED IN VARIOUS WAYS;

* as a REPRESENTATIVE FRACTION, e.g. the WAC series are 1/1,000,000 charts (one to a million), where 1 centimetre on the chart will represent 1,000,000 cm or 10 kilometres on the earth, or where 1 NM on earth is represented by 1 millionth of a NM on the chart.

* as a GRADUATED SCALE LINE - usually situated at the bottom of the chart. A graduated scale line allows you to measure-off the distance between two points on the chart and match it against the scale line.

FIG 12: A SCALE LINE OFF A CHART

* in WORDS - e.g. "1 cm equals 10 NM", which obviously means that 10 NM on the earth's surface is represented by 1 cm on the chart.

Even if you can find no reference to scale on the chart you can always measure-off the distance between two points against the latitude scale which runs down the side of the chart (1' of latitude = 1 NM).

A point to remember here is to use the latitude scale at about the mid-latitude between the two points because on some charts scale may vary slightly depending upon where you are (top, middle or bottom) of the chart.

There are three main types of chart that every visual pilot in Australia should be familiar with:

* the WORLD AERONAUTICAL CHART (WAC) series - used mainly for en route topographical and cultural information.

* the VISUAL EN ROUTE CHART (VEC) series - used mainly for en route aeronautical information.

* the VISUAL TERMINAL CHART (VTC) series - used for all topographical, cultural and aeronautical information around major terminal areas.

6.5 THE WORLD AERONAUTICAL CHARTS (WACs)- INTERNATIONAL CIVIL AVIATION ORGANISATION (ICAO), 1:1ÿ000ÿ000 SERIES.

We use WACs to provide us mainly with TOPOGRAPHICAL information (mountains, lakes, rivers, deserts, coastlines etc.) and CULTURAL information (cities, towns, freeways, country roads, railway lines, etc.) for visual en-route navigation.

All WACs have the same "one to a million" scale and the same symbols.

WACs are based on the Lambert Conformal Conic projection, so that angular relationships and shapes are preserved and so that there is a reasonably constant scale over the whole of the chart. Straight Lines closely represent the Great Circle track between two points.

Each country is responsible for producing the WACs covering its own area, and they are generally available for all parts of the world (one exception at the moment being Papua New Guinea where Tactical Pilotage Charts known as TPCs are used).

Each WAC chart has a number which is displayed at the top beside the name of that particular chart. The number of the adjoining WAC chart is also labelled around the edge of the chart.

Things such as radio towers, irrigation channels, railway lines and roads change from time to time, and so WAC charts are continually up-dated by:

* re-prints at convenient intervals (so ensure you have the current edition, as specified in NOTAM's NOTAMs class 2);

*   NOTAM (NOTices to AirMen) amendments which you should make by hand on your WAC's. These are called "Manuscript Amendments".

The WAC is the primary chart used by visual pilots in Australia to plot positions and tracks when well away from busy terminal areas. Aeronautical information (e.g. controlled airspace, restricted areas) will then be cross-checked off the VEC.

It is possible to plot on the VEC as well as the WAC if you want to.

The TOPOGRAPHIC information shown on a WAC chart is that which is considered to be of most use to the pilot/navigator.

It is of course impossible to show absolutely everything on a chart, so there may be some details on the ground not shown - conversely anything shown on the chart you can reasonably expect to exist on the ground. For example, an isolated rock may not be considered significant by the map-maker and therefore will not be shown on the map. You might spot it on the ground yet not find it depicted on the map. If however there is an isolated rock depicted on the map, you can be certain that it does exist on the ground.

*   DRAINAGE AND WATER FEATURES (hydrographic features) are usually depicted on the map in blue. This includes creeks, streams, rivers, canals, lakes, swamps, waterholes, wells and bores, shorelines, tidal flats, dry lakes, etc. Just how they are depicted on the map is explained by the legend - but bear in mind that after a flood, for instance what might be shown as a dry river bed on the map might in fact be a raging torrent, etc. Right throughout aviation, common sense is necessary. One drainage feature not depicted by blue is the mangrove swamp, which is usually near a coastline, and which is depicted in green.

*   RELIEF. There are various ways of bringing ground contours into relief, so that an impression of hills, mountains, valleys, etc. is obtained when you look at the map.

The WAC chart uses CONTOURS, which are lines joining places of equal height above sea level, and the closer the contour lines are together on the map the steeper the hill on the ground.

COLOUR or layer tinting is used in conjunction with the contour lines to give even more relief. The colours or tints used for the various ground elevations are shown on a "hypsometric tint" table at the side of the WAC chart. ("Hypsometric" means "establishment of vertical heights or elevations".) The shades of colour on the WAC chart start with green for low land, then goes through yellow and into brown, gradually darkening the higher the ground is.

HACHURING and HILL SHADING are used to give a three dimensional effect. Hachuring consists of very short lines radiating from high ground and is commonly used to portray bluffs, cliffs and escarpments. Hill shading shows darkened areas on the low side of high ground where you would expect to see shadows at certain times of the day.

SPOT ELEVATIONS (or spot heights) are also shown using a black spot with an adjacent number to indicate height AMSL (Above Mean Sea Level) in

FEET. These heights can be assumed to be accurately measured (unless amended by NOTAM). Spot Heights are normally used to show local peaks and other critical elevations that are significantly higher than the surrounding terrain.

* CULTURAL FEATURES are of great help to the pilot/navigator. It is not possible to show every town or every house on the map. so a choice is made to show what is significant and of value for visual air navigation.

A group of say 100 houses is of little significance if it lies in the middle of a city the size of Sydney and so will not be specifically depicted on the map, yet in the outback it is extremely significant and will certainly be shown. In remote areas the map will even show isolated homesteads, out-stations and water tanks.

ROADS and RAILWAYS can be of great assistance to the visual pilot/navigator. Those that will be most significant for air navigation will be clearly shown. Distinctive patterns such as curves, roads running parallel to railway lines and then crossing over, junctions, forks, overpasses, tunnels, etc. are especially useful.

Many other useful cultural features may also be shown such as wheat silos, telegraph lines, etc. Read the legend carefully and become familiar with the symbols.

* Limited AERONAUTICAL information is also shown on WAC charts, such as aerodromes (civil, military, or joint use), aerodrome beacons and landing grounds. The date at which this aeronautical information was still considered to be current is specified on the chart.

The division of airspace is not shown on WAC charts - this information is shown on VEC and VTC charts.

The LATITUDE-LONGITUDE graticule is clearly marked on WAC charts:

* the east-west parallels of latitude indicating degrees north or south of the Equator (south in Australia of course) are labelled at either side of the chart;

* the north-south meridians of longitude gradually converging as they near the south pole are labelled at the top and bottom of the map in degrees East or West of the Prime Meridian (in Australia, Longitudes are East).

This makes the WAC chart ideal for measuring the latitude and longitude of a position.

Figure 13 below is a photographic excerpt from the top right hand corner of a WAC chart and clearly shows the latitude and longitude indications.

To measure the latitude and longitude of a place on a WAC chart:

6.6 Measuring Latitude and Longitude of a Position.

6.6.1 Latitude:

- Place a straight-edge east-west through the place parallel to the parallels of latitude.

- From the latitude scales running north-south down the page you can read-off the exact latitude. (It should be the same latitude on the scale either side of the place - this ensures that the straight-edge is placed correctly on the map.)

Note: that in the Southern Hemisphere the latitude increases towards the south and bottom of the chart, and that the scale lines break up each degree of latitude into 60 minutes, with large marks each 10 minutes. (Make sure that you count from the top down the page.)

6.6.2 Longitude:

Place a straight-edge north-south through the place parallel to the closest meridians of longitude.

From the longitude scales running east-west across the page you can read-off the exact longitude. (It should read the same on the scales above and below the place this checks that the straight-edge is placed correctly on the chart).

Figure 14. Finding the latitude - longitude of a known place.

6.7 PLOTTING ON A CHART

The reverse problem of plotting a given latitude and longitude on the chart is just as easy:

1. Find the approximate position of the place on the chart.

2. Mark the latitude given on the two nearest latitude scales either side of the position.

3. Mark the longitude given on the two nearest longitude scales north and south of the position.

4. Join the latitude marks and then

join the longitude marks - their point of intersection being the the desired position.

Note: You are required to be able to specify or mark a position to an accuracy of 1 minute of arc.

Fig.15. Plotting a Known Latitude - Longitude

ISOGONALS (lines joining places of equal magnetic variation) are indicated on the WAC chart by dashed purple-coloured lines. The Eastern States of Australia experience "variation east-magnetic least", whilst in W.A. there is "variation-west - magnetic best".

The AGONIC LINE (where True North and Magnetic North are the same direction, with variation zero) lies inbetween. Because the magnetic poles are gradually moving, the amount of variation at a particular place will also gradually change over a period of years.

Every few years the isogonic information on the charts is up-dated, and the year of the isogonic information is shown on the chart.

6.8 Measuring Direction with a PROTRACTOR.

The best way to measure direction with a protractor is to align its north-south axis with True North along the mid-meridian and then to read-off the direction on the outer scale.

(You can also measure the direct-ion by aligning the axis of the pro-tractor with the track and measuring the direction against the inner scale.)

Once again it is vital that you have an approximate value in mind prior to using the protractor so that you avoid any gross errors, such as being out by 90ø or 180ø.

Fig.16. the Square Protractor is the type of protractor commonly used.

Fig.17. Measuring Direction with a Protractor.

6.9 MEASUREMENT OF DISTANCE ON CHARTS

Distance may be measured by various methods and you should be able to achieve an accuracy to within 1 NM by using one of the following methods:

* The GRADUATED SCALE LINE at the bottom of most charts. Using dividers or some other means transfer the distance between the two positions on the chart down onto the scale line.

* The LATITUDE SCALE down the side of the chart. At all points on earth for all practical purposes, 1 minute of latitude = 1 NM. Using dividers or some other means, transfer the distance between the two positions on the chart across onto the latitude scale. (Because the scale over the whole chart may vary slightly from latitude to latitude, use that part of the latitude scale which is about the same as the mid-latitude of the track that you are considering.)

* A correctly graduated SCALE RULE. Most navigation plotters have graduations suitable for 1:1,000,000 maps such as the WAC charts, which are all 1 to a million. On the back of the Australian D of A Domestic Flight Plan Form is a similar 1:1,000,000 graduated scale line suitable for WAC charts. (Some plotters also have a 1:250,000 scale line useful for VTC charts, which are all 1 to a quarter million. The scale on VEC charts however varies from chart to chart and so we cannot use this method for them.)

Fig.18. Measuring the Distance Between Mount Garnet and Cairns on the WAC using time 1:1 000 000 Distance Scales on the Plotter

6.10 MAP READING

There is often confusion about the difference between a Map and a Chart.

A Map is a representation on a flat surface of some part of the earth's curved surface, whereas a Chart is a map (possible even just an outline map) showing special conditions or information.

Since most of our aeronautical charts show specific aeronautical and navigational data, they are therefore "charts" rather than "maps".

The ability to read a map well - the chart that we have discussed, the topographical variety, in the hands of a navigator becomes a Map - is very valuable and cannot be over-emphasized. That is true all over the world, but in the less inhabited areas it is doubly true. Skill in the art of map reading varies according to natural aptitude and the amount of practice experienced. Good map reading depends upon being able to visualize the ground features as portrayed on the map, knowing the navigational value of the prominent features, the estimation of distance and bearings, and finally memory of how it has all looked before under similar circumstances.

The ability to distinguish the more significant features and not be confused with irrelevant detail is an important aspect of map reading. Features mentioned here which have great length, are generally known as "Line Features", e.g. Railroads. These are most important, because an interception is almost impossible to be missed.

Coastlines

The dividing line between land and sea takes priority in aerial navigation. The shape and bearing of a stretch of coastline quickly limits the area within which an aircraft is flying.

Railways

Railways are of great importance and are given considerable prominence on I.C.A.O. charts. They are reasonably easy to see especially in open country and are easily identified by their bearing. Traffic on them makes them more obvious. Their value and identification in built-up areas is slight and difficult. The presence of a railroad is often masked by a road running parallel to it. Tunnels and bridges when marked on the chart are especially useful in fixing position.

Roads

The value of roads in map reading varies considerably. Generally they are confusing and misleading.

Many more roads are on the earth's surface than are printed on the chart. Main highways are always useful. In the outback a mere track could have the same value.

Rivers and Canals

Rapid and positive indication of position is provided by major waterways. They show up well and can be seen from considerable distances. Even dry rivers generally have a tell-tale line of green vegetation along their banks which shows from a considerable distance. The dry sandy bed of a river without the accompanying line of trees can still be identified when overhead.

Lakes

Shape is the most important aspect in identification of lakes of comparable size. They are easily seen from great distances, even dry lakes.

Mountains and Hills

The navigational value of mountains and hills varies with the height from which they are seen and to a certain extent the light that is experienced.

The country appears to flatten out as height is gained and only the very prominent hills will stand out. If flying at about the same height as the hill-tops they are most prominent. In mountainous country it is difficult to differentiate between the various valley and peaks. The lone mountain, however, is very useful.

Towns and Settlements

Towns can sometimes be recognized by their shape as depicted on the chart, but generally they are identified by their size or position in relation to other features. Careful scrutiny of the number and direction of railways and main roads, entering and leaving or near the town, will usually dispel ambiguity. In large industrial regions towns tend to merge into each other making accurate pin-pointing difficult. In less densely populated areas, confusion can also exist between villages in a particular area. In such areas three or four houses might well be marked on a chart as a village.

Forest and Tree Plantations

These show up well from the air and if marked on the map can be very useful, if their shape is accurately portrayed. In country which is mostly forest or bush the clearings (often indicating a valley) are most important.

Airfields

Airports with sealed runways are quite easily seen. Disused airfields, or those with a graded strip or two generally of the same colour as the surrounding country, are extremely hard to see. Be prepared to observe private strips which are not marked on the map.

Culture

Minor culture, e.g., factories, radio masts, windmills, etc. are very difficult to find without first getting a lead from some other nearby feature more easily seen. Isolated forms of culture have slight value in positioning the aircraft.

Seasonal Changes

Landmarks and their appearance and, therefore, their prominence change considerably during the seasons of the year. Some areas of Australia are comparatively unaffected by seasonal changes. Those areas which experience heavy falls of snow are, of course, most affected. A covering of snow can obliterate those landmarks normally most prominent and give to lesser landmarks a considerable prominence for the period.

Floods, or course, will considerably change the formation and appearance of rivers. Unmapped rivers exist and rivers that previously existed are swallowed and lost amongst sheets of water. The shape and size of lakes are similarly affected. Drought and normal summer dryness change not only the waterways, but the general colour of the terrain. The associated covering of dust makes everything blend and become inconspicious.

Visibility and the Sun

During periods of reduced visibility map reading is made so much more difficult mainly because the area of ground that can be observed is considerably reduced. If it is possible to pass within two miles of a landmark without it being seen, the chances of flying a considerable distance before a Fix is obtained are extremely high. Looking up sun in hazy conditions due to the diffused light severely restricts visibility in that direction. In practice, it is best to fly up sun of the track and observe down sun.

Importance of Features

Prominent landmarks, especially line features are what we base our map reading on. But the really significant feature, the one that dispels all doubt, is the unusual or singular feature. When map reading over a flat and arid expanse, tracks if not easily seen because of their infrequent sighting are useful, and because the terrain is otherwise devoid of detail they could be called prominent. However, doubt can arise, if not confusion. But if in this arid and monotonous area stands one mountain and this can be sighted all doubts are reduced. It cannot be confused, there is only one, and it is doubly prominent because of its unusualness. In a mountainous area, a wide and defined valley would command our attention. The water reservoir in the midst of a rambling built-up area serves the same purpose. The twenty or so railway lines running in all directions which have been confusing can now be ignored.

COMBINATION OF FEATURES

One feature by itself is rarely sufficient for the pilot/ navigator to fix his position. A fix is made easier and perhaps only possible when several features are present. If a straight railway line is crossed, it doesn't tell much. The crossing could conceivably have been made anywhere along a thirty mile stretch of straight rail. But if the crossing is made near where a main road bridges the railroad then a Fix is possible. A bend in the railroad would, of course, be just as useful. If, when endeavouring to decide which of three towns is which, the problem will not be made easier to find that each town has a road running through the centre. But if only two of the towns has a railway passing through and only one of these has a river, the problem is solved. In this example, the fact that the bearings of the railways and roads would surely be different helps identification.

Therefore, when map reading, check carefully the inter-relationship between the various features. The inter- relationship is more important than the features themselves.

Bearings and Distances

The bearing of landmarks from the aircraft is widely used in fixing position by map reading. They can only give an approximate pinpoint because the bearing is only a guess without the aid of a bearing compass. However, the fairly accurate guess is most useful in establishing an area of probability.

The estimation of distance from the air is quite difficult.

The difficulty is not made any easier by the fact that the height at which we will map read varies from trip to trip. Experience and practice does, of course, help. But if the estimation of distances can be avoided do so. If when passing well to the side of, say, a lake instead of trying firstly to guess how far to the side, look in the other direction for some other landmark be observed it should be possible to decide more accurately which is the nearer and the proportion of nearness.

Hills abserved on Port beam, position uncertain, somewhere along line A.B.

Lake appears 45ø to the Starboard position along line A.B. can now be fixed with a fair amount of certainty. Bearings from aircraft.

Orientation of Map

For map reading, the map is best held with the North of the map pointing in the direction of North. This is carried out when the map is held so that the track line on the map lies along the actual track of the aircraft which is approximately (unless severe drift is experienced) along the fore and aft axis of the aircraft. For example, when the track on the map runs North to South, the North side of the map would be held to your chest and the South side farthest away from you. The aircraft would be headed approximately South and, therefore, features shown on the map to be left of the track would be expected to appear to the left of the nose and vice versa. With the map so held, less difficulty will be found in comparing what is on the map with the features they represent on the ground.

Anticipation

When the approximate position is known map reading is carried out from the map to the ground. You know your position, you know in which direction you are travelling, it is an easy matter to look ahead on the map to see what can be expected to show up in the next few minutes. Because the anticipation of features before they show up is so important to success, careful study of the track before departure is recommended. To enable the pilot/ navigator to anticipate correctly, it is necessary for him to know his ground speed or rate of travel over the map. This rate of travel depends on the wind, the speed of the aircraft and the scale of the map. If the rate of travel over the map is approximately one inch every five minutes, the finger can follow the progress, pointing to the position, and to look ahead of the finger is to anticipate correctly. If a fast aircraft was flown by a pilot with a large scale map, the rate of travel over the map would be so rapid, that useful anticipation would perhaps be necessary on the adjoining map sheet. Rate of travel or the time factor is all important.

Timing

If the ground speed is reckoned to be 120 k, two nautical miles will be covered in every minute. Therefore, five minutes after the aerodrome or some other recognized landmark has been flown over, the aircraft will have travelled ten nautical miles. By looking at the map, ten miles along the track from the landmark, it is possible to see what other landmarks, if any, are now to be seen and by looking a further ten miles along the track on the map, landmarks can be expected to be seen in the next five minutes. If the track is crossed by a railroad 40 nautical miles from the departure point, it is useless to worry about finding it, and, of course, eventually about not having found it, until some 30 nautical miles and, therefore, 15 minutes have passed. It is most likely impossible to see if regardless of experience, etc., before this time. So for those 15 minutes, relax or busy yourself with closer landmarks even though they are of less importance.

7.0 EFFICIENT COMMUNICATIONS:

Excessive radio traffic can generally be traced to poor organisation management or radio discipline. It is a joint responsibility of the navigator on one hand to ensure that he is fully conversant with all aspects of the proposed ACB before take-off to the burn, and the burn boss (or District protection officer) on the other hand ensuring that he is fully familiar with the details of the burn and that this information and burning method is clearly and accurately passed to the navigator.

A relatively inexperienced navigator may need a significant amount of discussion with the burn boss to discuss expected fire behaviour, possible lighting pattern changes, etc. An experienced navigator however need only to know the basics of the burn and would be quite comfortable should changes become necessary because he will anticipate and even recommend these if required.

Experience develops confidence.

To be entirely confident it is necessary for you to know your own and other people's RESPONSIBILITIES during the burn.

7.1.1 PILOT:

Has absolute authority with aircraft safety. Decides the minimum safe flying height. May abort the operation at any time for safety reasons. Responsible for safe stowage of equipment within aircraft.

7.1.2 NAVIGATOR:

Acts on the burn boss's instructions (is the burn boss's eyes).

Reports all relative data on fire behaviour, (changes, potential changes, fire behaviour in various fuel types, potential problem spots, wind changes - at the burn and at a distance - and anything that differs from the prescription. Reports when conditions are becoming unsuitable for lighting (turbulence,smoke, poor light, etc).

7.1.3 IMO:

Acts on navigator's instruction. Responsible for on-ground maintenance and preparedness of incendiary machine and in air operations.

7.1.4 BURN BOSS (Operations Officer):

Responsible to controller at DHQ. Makes all decisions relating to the burn, (lighting patterns, method, start and stop times, suppression/patrol requirements, etc). ie makes necessary modifications to operations as required, based on reports to navigator, field personnel, or changes due to weather, weather forecast amendments, fuel dryness, etc.

7.1.5 FIRE EXPERIENCE:

Navigators generally have a fair amount of fire experience. However there are some northern forest navigators who will be expected to fly southern forest (karri) type burns. It is most desirable if they have not experienced this type of burning to request a mentor to spend some time with them

7.1.6 FAMILIARITY:

In addition to understanding fire behaviour in the karri forest there are two other important aspects with which to improve his confidence. Both can be covered during a familiarisation tour if this is possible.

Personnel:

Getting to know people with whom you will be communicating on a first name basis. District staff (burn boss and sector bosses, overseers, beacon operators) will also welcome your interest.

Ground Inspection:

A ground inspection, especially in the company of the prescribing or protection officer, would be most beneficial. In addition to becoming familiar with the country and its forests, fuel types, roading system, topography etc., discussions on burn objectives, possible problems and even past burning or fire history may be discussed.

Where possible a talk with a person directly associated with the same burn last time would be beneficial. They can usually remember problem areas, such as dense, damp gullies, or capsules dropped too far from the top of a steep hill, causing scorch from increased fire behaviour.

Failing a ground inspection an aerial inspection whilst consulting the flight plan and burn prescription would be in order. Experienced spotter pilots, particularly the Regional chief spotter pilots have extensive knowledge of each proposed burn and can point out potential problem spots as well as boundaries, etc.

All of the above will allow a navigator to become familiar with the task ahead and build his CONFIDENCE. This should then lead to a reduction in radio traffic on the day of the burn.

The above is the ideal situation and mostly will not be able to be achieved. There is still a chance that another navigator may fly the burn anyway but this is no excuse for not pre-planning as described.

7.2 BRIEFING

7.2.1 VHF CHANNEL/MODE SELECTION:

Simplex channels should be used around the burn boundary where possible to allow normal district communications to continue without restriction whilst lighting is continuing.

The Aircraft/Burn Boss will need to use a duplex channel (1-10). Other personnel (sector bosses, suppression crews) should use a simplex channel if possible (with the Burn Boss scanning this channel).

7.2.2 CONTINGENCY PLANS:

Remember Murphy's Law: If it can go wrong it will go wrong. Aircraft will often arrive late at a burn because of mechanical or previous burn problems or other reasons. Because of this plans may need to be changed, however if contingency plans have been discussed and agreed, alterations should be able to be made to the proceedings with a minimum of radio traffic.

7.2.3 INITIAL CONTACT:

Once the aircraft has made initial radio contact and is over the burn (guided there be beacon, spot fires or navigation) the navigator will proceed to make an inspection and become conversant with the burn and its boundaries. Points covered in the briefing will be identified from the air, by the navigator (potential trouble spots, campers, etc).

7.2.4 COMMENCEMENT:

The navigator should not commence lighting until:

- he fully understands all instructions;
- he is fully coversant with the burn shape and boundaries;
- all personnel and units are in position;
- the flight crew are ready to commence;
- he has been instructed by the Burn Boss to commence.

7.2.5 OPERATION:

Once lighting has commenced the lighting pattern will not be varied unless instructed to do so by the Burn Boss. Radio transmissions will be kept brief, to the point, and as infrequent as possible. Only Burn Boss, Navigator and Markers should communicate direct to each other (on their own duplex channel if possible). Other personnel (preferably on VHF simplex) will talk only amongst themselves when necessary.

Burn Boss is to pre-arrange a time for the first fire report, and no other report will be required unless navigator sees fit because of change to expected fire behaviour, etc. No other requests for fire reports from outside personnel will be considered, ie: District office. Pre-arranging a time for reports say every 20 minutes from the commencement time will allow Controller or other involved staff to listen at that time to save duplication of transmissions.

Report format should be as per standard reports. Keep comments to a clear and concise minimum without leaving the Burn Boss in the dark. Remember you are his eyes. He may be in a situation at the control point that has poor visibility over the burn.

Burn Bosses or other staff should avoid calling aircraft near the end of flight lines when contact with beacon vehicles is imminent or concentration is required to avoid overshooting the boundary.

Navigators should firmly request stations to "stand by" should this happen.

It must be remembered that it is essential for the burn to be lit effectively in the shortest time possible to reduce aircraft hire rates, and ensure its availability for other burns the same day if arranged.

Steps are underway to reduce radio traffic. Mobile Data Systems (radio transmitted word printers) are being purchased for evaluation trials. Correct radio procedure starts with the individual - what are you doing to improve your radio technique?

7.2.6 SAR WATCH:

Unless other arrangements have been made navigators are required to advise the District in which they are working in of their position every 30 minutes. The navigator must also advise the office when leaving one District and passing into another.

7.2.7 FLIGHT RADIO:

Most aircraft are equipped with at least one high quality Communications set. It will operate in the Very High Frequency (VHF) radio band. Such a set (known as a VHF-COM) is both a transmitter and a receiver and is simple to operate.

VHF refers to a specific group of radio frequencies. The characteristics of VHF transmissions are such that communication systems operating in the VHF band are able to provide high quality "line-of-sight" communications between aircraft and ground stations.

eg:

HEIGHT OF AIRCRAFT ABOVE STATION	EXPECTED VHF RANGE
500 ft	27 nm, say 30 nm
1 000 ft	39 nm, say 40 nm
5 000 ft	87 nm, say 90 nm
10 000 ft	122 nm, say 120 nm

Local conditions, such as mountainous terrain, may reduce this range.

Improved COMMUNICATIONS can be achieved by having repeater stations, ie: aerial at locations remote from the source of the radio message. Repeater Station improve "DIRECT WAVE" communications.

VHF is the most common form of radio communication in aviation. It gives good clear communication with little distortion and interference under most conditions.

7.3 FLIGHT RADIO

Each radio communication set will consist of:

* a transmitter;
* a receiver; and
* an aerial.

For the set to function it must be connected to an electrical power supply. The power is supplied to the radios via the master switch and in most cases is protected by a circuitbreaker. The navigator will become familiar with the radio equipment very quickly and, in the case of the VHF-COM, little is required except to switch the set on, ensure the headset is plugged in and that the correct radio and frequency is selected.

7.3.1 RADIO SET-UP IN THE COCKPIT:

Connected to the radio sets in the aircraft cabin are:

* A remote audio selector panel to connect the two VHF radios on the Low and High frequency bands. Allow for channel changing and selection for each radio.

* Headphones, for listening to the reception.

* A boom microphone attached to the headphones for transmitting, activated by a press to talk switch.

* Remote connection points fitted with individual volume control to plug headphones into.

7.3.2 USE OF THE VHF-COM:

To obtain maximum benefit from using a VHF-COM system the navigator must understand:

* how to switch the set on;
* how to use the remote audio selector panel;
* correct microphone technique;
* correct phraseology, pronunciation, voice control; and
* fault finding procedures if the radio does not work properly.

7.3.3 SWITCHING THE VHF-COM RADIO ON:

1. Check the master switch on and circuit breaker in.

2. Switch the radio on.

3. Select the desired radio and frequency.

4. Adjust volume to desired level and adjust "squelch" control to cut out undesired background noise, if fitted.

5. Check headset is plugged in correctly.

7.4 SEARCH AND RESCUE (SAR) ORGANISATION:

The purpose of the Department of Conservation and Land Management's (CALM) Search and Rescue (SAR) procedure is to provide assistance to any aircraft in distress who is operating on the departmental frequencies.

SAR action is usually coordinated by the District Manager or the most senior person in charge of the district and authorised landing area at the time.

The navigator can request different levels of SAR watch on his particular flight when he submits his flight details, or at any other time.

The various classifications are:

7.4.1 FULLSAR: in which a continuous SAR watch is maintained on the flight, with full reporting from the navigator being required, including taxiing, departure, en route position reports, etc. A two minute delay on any position reporting time or estimate is allowed before a radio call sign is made from the base station who is keeping the watch on the aircraft. Good communiations throughout the flight is important for a FULLSAR flight. These facilities may not necessarily be available unless previously arranged with the District Manager.

7.4.2 SARTIME: in which SAR action is commenced at the SARTIME nominated by the navigator in consultation with the pilot in command. He has nominated that he will contact a particular base station prior to this time to advise them of the safe conclusion of his flight, and to "CANCEL SARWATCH". It is usual to allow yourself a time buffer in nominating a SARTIME to allow for unforeseen delays. If en route you become aware that your nominated SARTIME is too early then you should amend it. Communications throughout a SARTIME flight is not a requirement as it is for a FULLSAR flight.

7.4.3 NOSAR: an aircraft may submit flight details but nominate NOSAR, or not even submit flight details (called a NOSAR NO DETAILS flight). Of course, if anything unfortunate has happended and the SAR organisation becomes aware of it, they will initiate SAR action immediately irrespective of what SAR coverage on the flight had previously been requested by the crew.

7.4.4 CALM SAR PROCEDURE LIST

7.5 OPERATIONAL CALLS:

Communications Air to Ground

Radio Calls:

Navigator should notify departure base the following details:

When taxiing during engine warm-up to establish radio contact, and provide SARTIME details.

Taxi Call:

(Base station) THIS IS ..... (aircraft call sign) TAXIING AT ..... (airstrip) FOR ..... (District) ON ..... (type of operation) (job number if applicable) ENDURANCE ..... (minutes) ETA ..... (hours and minutes), SARTIME ..... (24 hour clock hours and minutes) FOR ARRIVAL AT ..... (destination).

Immediately after departure and when aircraft has established a heading for the job.

Advise the frequency changing to after departure.

Departure Report:

(Base station) THIS IS ..... (aircraft call sign) DEPARTED AT ..... (hours, minutes) FOR ..... (District) TRACKING ..... (direction in degrees) CHANGING TO CHANNEL ..... (number).

Contacting Area Control:

CONTROL THIS IS ..... (aircraft call sign) ETA OVER YOUR AREA ..... (minutes).

ARE THERE ANY CHANGES TO THE FLIGHT PLAN ..... OR SPECIAL REMARKS .....

CONFIRM MARKERS IN POSITION

Establish radio contact with beacon vehicles at least 15 kilometres from the job when flying at 3,000 feet above ground level (AGL). Determine if beacons are operating, although the range and ADF contact may not actually be established until much closer.

AIRCRAFT TO ..... (direction) MARKER TURN ON YOUR BEACON FOR A.D.F. SIGNAL CHECK

On arrival over the area to be burnt, request marker fires to be lit.

Marker Fires:

CONTROL THIS IS ..... (aircraft call sign) APPROACHING YOUR AREA LIGHT MARKER FIRES ON FLIGHTLINE ..... (number) ..... (cardinal direction) MARKER ON ..... (cardinal direction) MARKER STANDBY

First flightline should be a dummy line to establish wind drift over the area and actual headings to be flown. Track error should be less than 100 metres before lighting can be commenced.

Dummy Flight Line:

..... (direction/direction) MARKER THIS WILL BE A DUMMY FLIGHTLINE. HOLD YOUR POSITION AFTER WE FLY OVER YOUR POSITION

Discuss lighting pattern to be used; and Beacon vehicles, shifts that will take place.

Navigator must obtain clearance from controller before commencing on a live dropping run to ensure everything is satisfactory.

Dropping Approval:

..... (aircraft call sign) TO CONTROL HAVE INSPECTED THE AREA AND AM SATISFIED WITH THE BOUNDARIES. REQUEST PERMISSION TO START ON FLIGHTLINE ..... (number)

Starting Burn:

..... (cardinal direction) MARKER BEACON ON STANDBY WITH FLARE, RUNNING FROM ..... (direction) TO ..... (direction) MARKER STANDBY WITH FLARE

Approaching First Flightline:

..... (direction) MARKER FIRE FLARE

Over Boundary Inside Burn Area:

..... (direction) MARKER BEACON OFF. SHIFT TO NEXT POSITION. ..... (direction) MARKER BEACON ON FIRE FLARE

FLARE SIGHTED OR NOT SIGHTED

Over Boundary Outside Burn Area:

..... (direction) MARKER BEACON OFF. SHIFT TO NEXT POSITION. ADVISE WHEN IN POSITION WITH BEACON ON

Navigator should give advice to the Burn Boss in the early stages of a burn re the fire behaviour, in particular if the strip width should be increased to prevent scorch from high intensity fire or decreased to allow fires to join or alterntively spots appear to be behaving satisfactorily no action required.

It is preferable that all radio transmissions to the ground and not relating to the actual operations should be made only when the aircraft is outside the job and during the turning period. That is reports on fire behaviour or request of any other nature.

Normal fire behaviour report should give:

(a) Percentage of capsule ignition and fuel type.

(b) Flame height ..... metres - rate of spread ..... metres/hr.

(c) Fire intensity ..... Smoke behaviour ....

(d) Fire shape ....

Fire Behaviour Report:

..... (aircraft call sign) TO CONTROL I HAVE A FIRE BEHAVIOUR REPORT ARE YOU READY?

PERCENTAGE TAKE .... (number) TO ..... (number)

FLAME HEIGHT .... (number) METRES IN ..... (tree type)

RATE OF SPREAD ..... (number) METRES PER HOUR

Additional Information:

FIRE BEHAVIOUR ..... (quite, normal, strong)

SMOKE BEHAVIOUR ..... (weak, quiet, medium, strong)

FIRE SHAPE ..... (round, oval, 1:1 or 1:3)

On completing a burn or when beacons are no longer required the navigator should advise both beacon operators to report to the controller for further instructions. Obtain acknowledgement, message received.

Dismissing Beacon Operators:

..... (aircraft call sign) TO ..... (cardinal direction) MARKER BEACON WE HAVE COMPLETED WITH YOUR SERVICES. THANK YOU FOR YOUR ASSISTANCE. HOW MANY FLARES DID YOU USE? REPORT TO THE CONTROLLER FOR FURTHER INSTRUCTIONS.

Navigator must advise controller before departing burn area of his intentions, where he is proceeding to and of any frequency change he is going to make.

If direct radio contact cannot be made with the base station while the aircraft is departing from the burn area, the navigator must go immediately back to the last frequency on which he made contact and ask to have the relevant details passed by telephone.

Departure Advise:

..... (aircraft call sign) TO CONTROL IF YOU HAVE NO FURTHER REQUIREMENTS FOR US WE WILL DEPART FOR ..... (destination)

Await acknowledgement from controller then advise,

CONTROL THIS IS ..... (aircraft call sign) DEPARTED FROM ..... (job no) AT ..... (time hours and minutes) FOR ..... (destination), ETA ..... (estimated time of arrival)

When direct radio contact is made with the destination base; give the required details, advise estimated arrival time, and whether supplies need to be organised and brought out to the airstrip for the next flight.

Notifying Return to Destination:

..... (base station) THIS IS ..... (aircraft call sign) DEPARTED JOB NO ..... AT ..... (time hours and minutes) HEADING FOR ..... (destination) ETA ..... (hours and minutes)

Required Supplies:

REQUIRE FLIGHTPLANS AND CAPSULES TO BE BROUGHT TO AIRSTRIP AT ..... (hour and minutes)

Circuit Area Call:

..... (base station) THIS IS ..... (aircraft call sign) CIRCUIT AREA ..... (airstrip name) WILL CALL WHEN ON THE GROUND

Call when safely on the ground and advise time landed, cancel SARTIME if activated.

..... (base station) ..... (aircraft call sign) LANDED ..... (time) CANCEL SARWATCH

8.0 CALM ACB AIRCRAFT COMMUNICATION SYSTEM

8.1 Remote Control Box:

The communication system has provision for two remote I/C positions. These remote control boxes contain the following controls:

a. Radio I/C Selector: Selected to "RADIO" allows both radio and I/C communication. Selected to "I/C" allows only I/C communication.

b. PTT Button: Radio Press to Talk button, depress to transmit on selected radio.

c. Volume Control:

d. Indicator Lights: Red light indicates "RADIO" mode selected. Green light indicates "I/C" mode selected.

e. Headset Jack: Located on the side of box below the mode indicator lights.

8.2 Pilot's Control Box:

The communication system has a separate pilot's control box. The unit has provision to plug into the aircraft avionics via the pilot headset jacks position. The pilot's control box contains the following controls:

a. Radio I/C Selector: Selected to "RADIO" allows both CALM radio and I/C communication. Selected to "I/C" allows only I/C communication.

b. DOA CLM Selector: Selected to "DOA" allows DOA communication only. Selected to "CLM" allows DOA, I/C and CALM radio communication. I/C and CALM communication will be dependent on the mode selected by the Radio I/C selector.

c. PTT Button: Radio Press to Talk button, depress to transmit on selected radio.

d. Volume Control:

e. Indicator Lights: Red light indicates "RADIO" mode selected. Green light indicates "I/C" mode selected.

f. Headset Jack: Located on the side of box below the mode indicator lights.

8.3 FRONT PANEL CONTROLS AND FUNCTIONS

FIGURE 1

8.3.1 VOL/SQL/POWER SWITCH:

(a) Turn radio "ON" by depress the inner knob. The radio is switch "OFF" when same knob is depressed a second time.

(b) SQL: This larger outer knob should be turned anti-clockwise until the "BUSY" LED is illuminated.

(c) VOL: Adjust volume control (smaller inner knob) for comfortable level of noise present.

(d) SQL: Turn outer knob clockwise until the noise just stops (Busy LED extinguished).

8.3.2 CHANNEL CHANGE:

The channel LED displays the channel selected. Change channels by keying in the desired channel number.

NOTE: If the number is a 2 digit number, enter the 2 digits within a 3 second period, otherwise the second digit will be neglected.

8.3.3 RECEIVING:

The radio is now ready to receive on the displayed channel.

8.3.4 TRANSMITTING:

The transmitter is engaged when the PTT (Push-to-Talk) button on the joystick or the I/C (Intercom) box is depressed. Visual indication is given by the transmit (TX) LED being illuminated.

NOTE: Noise cancelling microphones are used in all headsets and best results are obtained when microphone is positioned very close to the mouth (almost touching lips).

8.3.5 REMOVAL OF RADIO FROM BRACKET:

(a) Push release button in. It is located at centre of bracket directly above the set.

(b) Gently ease radio out of bracket.

NOTE: Removal greatly eased when "spring-loaded" release button is kept depressed by other hand during removal operation.

(c) Unplug power to radio.

(d) Unplug radio from antenna. The plug and socket are held together by a threaded thumb-nut. Avoid twisting the coax cable.

8.3.6 RE-INSTALLING RADIO:

(a) Connect power plug and socket.

(b) Connect coax plug and socket; finger tight only.

(c) Slide radio gently back into cradle as far as possible. Again this operation is eased if the spring-loaded release button is kept "pushed-in".

(d) Lock the set in its cradle by pulling the release button out.

(e) Tuck excess power cable and coaxial cable above the radio to prevent accidental disconnection and/or damage.

8.4 V.H.F. CHANNELS PROGRAMMED

CHANNEL	APPLICATION
1-10	Used mainly during normal duties. See VHF Channel allocation chart.
11-20	Simplex channels. To be used to communicate with land mobiles who have opted to work on these channels.
21-39	Bush Fire Board, Volunteer Fire Brigade and Shire Channels. See Bush Fires Board/Shire Channel allocation chart.
71-80	Land Mobile channels 1-10, eg: Channel 71 = Land Mobile Channel 1, and so on. Use these channels to communicate with District HQ when out of range with aircraft radio channels 1-10.

9.0 RADIO NAVIGATION EQUIPMENT

9.1 Automatic Direction Finding ADF

ADF enables the pilot of an aircraft to determine the direction from which signals are being received when the equipment is tuned to a known transmitter and to use this information as an aid to navigation.

The non-directional beacon (NDB) is basically a simple transmitter radiating an omni-directional, i.e. all directions, signal which is modulated (interrupted) at intervals with the identification code. NDB's are normally in the 200 to 400 kcs band but aircraft equipment is normally more flexible allowing use of higher frequency broadcast stations.

W.A. Department of Conservation and Land Management beacons operate on 1696 khz.

The NDB and the airborne ADF equipment is primarily a short range navigation aid.

The aircraft equipment normally consists of:

(1) An ADF receiver,

(2) an automatic loop aerial,

(3) a fixed aerial for automatic "sensing",

(4) one or more bearing indicators (radio compasses).

After tuning and identifying a particular NDB the aircraft can be made to "home" to that NDB by turning the aircraft until the bearing indicator or radio compass indicates zero. This means that the station is directly ahead and if this situation is maintained then the aircraft must pass over the NDB. The aircraft will "home" along a straight track only when there is no wind or a head or tail wind.

Passage over the station is seen by a fluctuation of the radio compass needle then a rapid change from an ahead bearing to a behind bearing.

The ADF allows calculation of magnetic or true bearings from the aircraft to the station. (Normally it is more convenient to use magnetic directions.) Over short ranges the reciprocal of these bearings can be plotted on a chart from the NDB to obtain a position line, i.e., a line along which the aircraft is at a certain time.

9.2 Conditions Affecting the Accuracy of ADF Equipment

Radio signals in the NDB range of frequencies are affected by certain phenomena.

(1) Coastal Effect. When ADF equipment is used by an aircraft over the sea, bearings that cross the coast at angles less than 60o are bent towards the coast. Flying at a greater altitude will minimise these errors.

(2) Mountainous Terrain. This affects the bearings in a similar manner to (1).

(3) Thunderstorms. Large errors in bearings occur in the vicinity of thunderstorms. The equipment normally "homes" onto the electrical impulses in the thunderstorm. In thunderstorm conditions the ADF equipment must be used with great care - checking its accuracy with other available aids.

(4) Night Effect. At night the sky wave from the NDB returns to the earth at a steeper angle and this affects the signal from the loop aerial, thus giving erroneous and unsteady indications on the compass. The lower the frequency of the NDB the less the radio compass will be affected.

(5) Mis-tuning. Should the ADF receiver be tuned inaccurately two stations may be received, and the Radio Compass will take up an incorrect bearing somewhere between them, depending on which station has the stronger signal.

(6) Localised Variations: Because this operation uses a short range beacon and low level flight some local structures may cause erroneous indications. For example:

- high voltage powerlines;
- ironstone (laterite) outcrops;
- radio transmission mast antennas;

may cause deflection of the signal transmitted from a beacon (NDB).

The phenomenon may be manifested as:

(a) an apparent bend in a previously straight course track.

(b) an apparent loss of signal; - which means the indicator remains at its previous orientation.

(c) receiver appears to be momentarily attracted towards the object causing variation.

At low level flight in steep topography the beacon signal can also be completely obstructed by a ridgeline - resulting in a lack of response by the ADF indicator until the aircraft is relatively close.

9.3 Track to a Beacon (NDB):

It is possible to use the marker beacon to locate the general position of a boundary when first approaching Aerial burn. In this case the objective is to place the aircraft nose (ie: heading) in the same direction as the beacon indicator so the indicator reads "0". Fore example if the aircraft heading is 045o and the ADF indicator is displaying 45oR a change in aircraft heading to approx 090o will return the ADF indicator to 0o. It is important to remember that the amount of correction in aircraft direction needs to be greater than shown by the ADF Indicator otherwise the aircraft homing on the beacon will follow a curved path.

During incendiary dropping operations and especially at low operation heights always use the beacon indicator judicially. Never rely totally on the beacon (NDB) indicator for flight line direction.

Use beacon (NDB) indicator in conjunction with:

- dead reckoning/anticipative navigation - constantly establish aircraft position by visual reference with known landmarks.
- be aware of aircraft heading in reference to pre-planned flightline direction - either true of magnetic.

Watch for these features in the Beacon (NDB) behaviour:

- pointer swings rapidly through 180o, indicates aircraft has passed over or close to beacon vehicle. Incendiary machine should have ceased operation.
- pointer indicates beacon location significantly different for expected, calculated and present aircraft heading. May indicate that the beacon vehicle is in the wrong position. Stop incendiary machine and verify beacon vehicle location.

10. INTRODUCTION:

The purpose of this section is to advise you of the administration requirements and responsibilities for Aerial prescribed burning.

By making you aware of arrangements and conditions under which you work and the allowances you are entitled to claim.

By requesting you to maintain suitable records of the job, to enable statistical records to be kept for the future.

This section covers:

- Daily Administration requirements. Who does what.
- Aerial Burning Records

10.1 DAILY ADMINISTRATION:

Daily Administration Spring/Summer 1994/95. The following arrangements and information apply to the forthcoming aerial burn season.

10.1.1 Regional Administration:

Regional Fire Control Coordinators - B Harvey or (nominee), K White or (nominee), B Hagan or (nominee) will be responsible for:

(a) Providing navigators and IMO's for the burn programme.

(b) Arranging aircrew rosters and emergency backup crew.

(c) Co-ordinating daily burn requests from Region forwarding requests and nil returns to Bunbury by 0830 hours each day.

(d) Organising daily beacon vehicle requirements between Districts and Regions.

10.1.2 Daily Departmental Administration:

Senior Operations Officer, T Maher (or nominee) will be responsible for:

(a) Book aircraft with Contractor for Departmental use.

(b) Assigning priorities following burn requests from Regions.

(c) Arranging daily burn programmes.

(d) Pilot and aircrew supervision.

(e) Monitoring allocation of aircraft burns.

(f) Radio station notification.

(g) Daily burn information to SOHQ.

(h) Aircrew Training and follow-up performance appraisal.

10.1.3 Equipment and Supplies:

Fire Equipment Officer G Kravainis (or nominee) to arrange:

(a) Fitting and removal of incendiary machines in aircraft.

(b) For maintenance and repairs to machines.

(c) Supply of capsules and glycol to Jandakot, Bunbury and Manjimup.

(d) Stocktake of flare availability in Districts, reserves held at Como, Collie, Manjimup.

(e) Arrange fuel for contract aircraft (contract Helicopter).

10.1.4 Aircraft Contract:

Aircraft Manager M Folks (or nominee) to liaise with Charter Company for:

(a) Aircraft availability.

(b) Pilot availability, qualifications and experience.

(c) Aircraft servicing - timing etc., Departmental aircraft.

(d) Fuelling arrangements.

10.1.5 Navigator Day of Burn Responsibilities:

(a) Assembling aircrew and arranging checking of equipment and materials.

(b) Obtaining burn schedules, priorities etc of daily work program.

(c) Obtaining briefings from Burn Controllers for each burn.

(d) Arranging drawing up of Flight plans or arrange pick up.

(e) Briefing Pilot and IMO on programme, difficulties, constraints.

(f) Arranging Flight Insurance/SAR watch details, destination.

(g) For each burn carry out reconnaissance, confirm target area boundaries identified, clear of people, stock, machinery.

(h) Obtain dropping approval from Operations Officer to start dropping on 1st line.

(i) Instruct IMO to commence and stop dropping.

(j) Provide Operations Officer with regular progress reports on Fire Behaviour.

(k) Notify Operations Officer when departing area time and destination.

(l) Confirm with District office of ETA next job.

(m) For your own sake as well as ours keep good records.

- A Navigators Flight Log - for each sortie.

(n) First thing next morning pass/fax the summarised AFRS information to Departmental Controller at Bunbury.

10.2 AERIAL BURNING RECORDS AND FORMS:

The following Aerial Burning Records/Forms are to be kept by the navigator or Incendiary Machine Operator while seconded to aircrew burning duties.

- Navigators Flight Log - (NFL)
- Public Service Allowances Claim for Payment (PS 10)
- Incendiary Machine Maintenance Release

10.2.1 Navigators Flight Log (NFL):

Purpose: provide all flight details and conditions for each burn for further analysis later, serves as a permanent record of each burn. Validated Aircraft Contract Payment, PS10 Claims.

Contains: Job No. details, Aircraft and Aircrew, Flight Plan details, Flight details, Fire Reports, Aircraft Hours.

Submit: Senior Fire Operations Officer, Fire Protection Branch, Bunbury daily.

10.2.2 Public Service Allowances Claim for Payment (PS10):

Purpose: Prescribed form for claiming flying, travelling allowances, and kilometre allowances.

Contains: Daily departure and arrival times, Claim type details.

Submit: Monthly through District or Regional supervisor.

10.2.3 Incendiary Machine Maintenance Release (IMMR):

Purpose: Keep track of maintenance and service requirements on incendiary machine.

Contains: Part 1 - Maintenance required, Part 2 - Daily Inspection, capsules and glycol usage, time in service, Job no., Part 3 - damage or malfunction report, Part 4 - Service and repairs carried out.

Submit: to G Kravainis, Fire Management Unit, Como at the end of each week or fortnight. Submit photocopy, leave original with aircraft.

Navigator Day of Burn Checklist

DATE: _______________

(1) Assemble aircrew and arrange check of equipment and materials.

(2) Obtain burn schedules, priorities etc of daily work program.

(3) Obtain briefings from Burn Controllers for each burn.

(4) Arrange of draw up Flight Plans or arrange pick up.

(5) Brief Pilot and IMO on programme, difficulties, constraints.

(6) Arrange Flight Insurance/SAR watch details, destination.

(7) For each burn carry out reconnaissance, confirm target area boundaries identified, clear of people, stock, machinery.

(8) Obtain dropping approval from Operations Officer to start dropping on 1st line.

(9) Provide Operations Officer with regular progress reports on Fire Behaviour.

(10) Notify Operations Officer when departing area time and destination.

(11) Confirm with District Officer of ETA next job.
Advise any variations to pre-set schedules.

(12) For your own sake as well as ours, keep good records.
A Navigators Flight Log - for each sortie.

First thing next morning pass/fax the summarised AFRS information to Departmental Controller at Bunbury.

Section Subject Page No.

11. PRE-FLIGHT CHECKS AND OPERATING INSTRUCTIONS

11.1 Pre-Flight Check

A pre-flight check and test of the installed system must be conducted to ensure system performance and pilot familiarity. Problems encountered must be remedied prior to take-off.

The following pre-flight check should be carried out:
*
- Glycol tank FILLED; record quantity
- Capsule load SUFFICIENT; check trays
- Hand extinguishers FULL and CHARGED
- Ejection tube is CLEAR and CLEAN
- Turntable is FREE-RUNNING when release pin is pulled - properly ALIGNED
- Power supply cable CONNECTED
- Circuit breakers - IN
- Switches - OFF
- Navigators remote switch, (if fitted) - ON
- Glycol tap TURN ON
- Injector syringe PRIMEd and moves FREELY
- Check QUANTITY of glycol injected (1.3 mls per injection)

11.2 Pre-Flight Test

CAUTION:

Ignition will be achieved during this test. You must provide a container to catch and remove the primed capsules from the vicinity of the aircraft.

This test is not to be conducted during fuelling operations or where spilled fuels or other fuels or combustible materials can be ignited.

- Advise pilot you are ready for a ground "PRE-FLIGHT TEST", and require the aircraft master switch ON.

- Load four empty capsules, capsules in turntable. To load turntable, lift release pin and rotating turntable by hand until the capsule is under the injector.

- Place metal container under aircraft drop tube to catch capsules.

- On incendiary machine control panel:
  * Power switch - ON
  * Motor switch - ON
  * Speed control to - LOW
  * Start button - PRESS

- Machine will now operate. Switch OFF after last capsule has been injected.

  * Motor switch - OFF
  * Power switch - OFF

- Turn glycol tap - OFF

The incendiary machine has not been checked and if all tests OK it is ready for operation.

Ask pilot to turn aircraft master switch OFF.

11.3 In-Flight Operation

CAUTION:

Preparation and loading of the incendiary machine should only take place after the target area has been positively identified from ground terrain features.

To Start:

- Reset capsule counter to ZERO
- LOAD turntable with capsules
- Turn glycol tap ON
- Adjust speed control to desired setting
- Power switch - ON
- Motor switch - ON
- "Commence" by pressing start button
- Continue loading turntable
- Adjust speed control as required

To Stop:

- Motor switch - OFF

On Completing Burn:

- Note number of capsules and record in log
- Power switch - OFF
- Turn glycol tap - OFF
- Remove unprimed capsules from turntable
- Navigators remote switch (if fitted) - OFF
- Pull OUT circuit breakers on control panel
- Note glycol level and record consumption

11.4 EMERGENCY PROCEDURES

Introduction

Purpose of this instruction is to inform personnel regards emergency measures and procedures to cope with any situation which may arise.

11.4.1 Safety Devices

Safety devices are fitted so as to prevent fire in the aircraft. Whenever the machine is switched off, the machine automatically speeds up, continues to the end of its cycle and ejects any primed capsules.

If there is a power failure with a capsule already primed and with the needles jammed in a capsule, the capsule can be freed by pulling the release pin on the injector cam and turning the hand wheel in an anti-clockwise direction until the syringe needles are clear. The turntable can now be moved to clear the primed capsule by lifting the release pin and rotating the turntable until the capsule falls into the dropping tube.

11.4.2 In Emergency

Apparent power failure:

- Switch motor switch - OFF
- LIFT release pin on injector cam - turn hand wheel anti-clockwise until needles clear of capsule
- LIFT release pin on turntable - turn in a clockwise direction to allow capsule to fall into dropping tube

11.4.3 In Case of Fire

- Motor switch - OFF
- Power switch - OFF
- Direct hand extinguisher on seat of fire

11.4.4 Blocked Ejection Tube

- Motor switch - OFF
- Powre switch - OFF
- Use RAMROD to clear tube

11.4.5 Machine Fails to Stop When Switching Off

- Pull motor circuit breakers OUT
- Pull power circuit breaker OUT
- Use manual overide for cam and turntable to clear any primed capsules

11.4.6 Ditching Procedure

- Switch machine OFF
- Glycol OFF
- Return tray to cabinet and lock
- Spin and unload turntable
- Put protective cover over machine
- Tighten safety belt
- Brace for ditching: Draw feet up
  Use arms to protect face

11.5 MAINTENANCE AND SERVICING - WAM 82 INCENDIARY MACHINE

Introduction

The purpose of this instruction is to make the operator aware of the need for servicing and basic fault finding techniques so that you can keep your equipment running despite setbacks.

Servicing:
as it is normally understood, is a replenishment of lubrication and other fluids and supplies, and cleaning. Equipment servicing is often considered a simple job that requires little skill; but as the equipment technology develops and becomes more complex, even the simple performance of servicing demands an extensive knowledge of the equipment used and the servicing support facilities available.

Inspection:
can be defined as the process of determining the condition of the equipment by examining or operationally checking all of its components or parts before flight and at periodic intervals. Inspection is the core of preventive maintenance, and is the only safe means for telling that a part or component is functioning properly, needs repair, or should be replaced.

Types of Inspection.

Light Inspection:performed daily when incendiary machine is used. Light inspections are limited to visual and operational checks and can be accomplished within a relatively short period. They serve to verify that the machine is ready for operational flight.

Medium Inspection: accomplished at fairly short intervals of accumulated operational time such as 25, 50 or 100 hours. This category can include inspection accomplished at calendar intervals - every week or month period.

Heavy Inspection:performed after the machine has accumulated a large number of operational hours such as 500 or 1000 hours. This category can also include inspections accomplished on a calendar basis - once each year at the end of the burning season.

11.5.1 Daily

- Ejection tube CLEAR and CLEAN
- TURNTABLE is FREE-RUNNING when release pin pulled
- INJECTOR syringe is primed and moves freely
- GLYCOL quantity injected is sufficient
- PRE-FLIGHT TEST of electrical system motor start/stop
- Following each days operation the machine should be thoroughly cleaned

11.5.2 Medium Inspection Weekly or Every 25 Hours

Lubricate the following parts with Selley RP7 or similar lubricant:

- Axial cam and following roller on injector
- Brass follower on the injector syringe
- Slideways on geneva cam and roller on the geneva arm
- Mating gear surfaces

Remove injector then clean underneath the turntable to remove any residuals.
Clean ejection tube with wire brush to remove any residuals.
Service and clean injector as required.

11.5.3 To Service the Injector

NOTE: Turntable release pin must be clear of injector before starting dissembly procedure.

Remove 4 socket head cap screws bolting injector mounting bracket to injector drive bracket.

Slide complete injector in mounting bracket out to the right.
NOTE: ensure that needles clear turntable. If needles contact turntable, lift release pin on turntable and shift turntable as required to clear.

Remove socket head cap screw (8mm), clamping injector in bracket.

Remove grub screw from brass slide follower to stop parts rotating.

Turn injector inlet pipe through 90o to the left - slide whole assembly down and out through slot in base.

Remove brass slide follower by unscrewing from piston shaft.

Remove large outer spring.

Remove top spring nut by unscrewing from piston shaft.

Remove small spring.

Inspect and replace washers and "O" rings as necessary to maintain a perfect seal.

To reassemble, reverse procedure.

11.5.4 Servicing the Turntable

First remove injector; leave attached to glycol supply hose.

Remove turntable by holding firmly, use an open end spanner, turn centre nut anti-clockwise. Considerable force is required initially to break the seal. This action frees the driving sleeve from the drive spindle.

Lift off the turntable and thoroughly clean both turntable and the platform underneath. Glycol has an extremely corrosive effect on aluminium.

Clean centre core and grease lightly before reassembly.

To Reassemble:

Place the turntable over the shaft and slide the driving sleeve into the turntable and over the spindle.

Load an empty capsule in one of the stations in the turntable and rotate clockwise until it is directly underneath and aligned with the centre of the injection position.

NOTE: As the stations in the turntable are of greater diameter than the capsules, the capsules will be dragged back to the trailing side of the stations by the rotation of the turntable. Therefore, it is the capsule, not the station, which must be aligned with the syringe.

When the turntable is correctly positioned, replace the centre locknut and tighten securely.

Slide syringe assembly back into position and replace four socket head cap screws.

Prime syringe to expel all air, until only glycol is ejected.

11.5.5 Re-timing Injection Syringe Operation

Axial cam position and geneva arm position to be aligned as shown. Cam position 0o - geneva arm just leaving slideways.

Turn drive belt by hand in the direction shown on gearbox pulley until the pawl on the geneva arm is just leaving the slideways of the geneva cam.

Release the nut holding the driving sleeve from the drive spindle on the axial cam, moving the cam until the timing mark on the cam lines up with the mark on the injector bracket. Check pawl position and retighten nut.

Check position of micro switch cam under turntable until properly aligned. Make minute adjustments and retighten until the required stopping position is reached.

Release the nut holding driving sleeve on the turntable and reposition until injector and turntable position line up.

11.5.6 Spares to be Carried for Each Machine

1 x complete injector and mounting bracket
2 x ball bearings Part No. 9/3 - 5/16" diam
2 x small springs Part No. 9/4 - Od 7.5
1 x injector piston Part No. 10/1
6 x neoprene washers Part No. 10/4 - Od 15.5 x Id 5.0 x 1mm
6 x neoprene washers Part No. 10/6 - Od19.0 x Id 16 x 1mm
6 x neoprene washers Part No. 10/3 - 0d16.0 x Id 6.5 x 1mm
6 x neoprene washers Part No. 10/7 - Od11.0 x Id 7.0 x 1mm
6 x Viton O rings Part No. 10/5 - Od 15.5 x Id 10.8 x 2.5mm Viton 111
6 x Viton O rings Part No. 12/4 - Od 8.0 x Id 5.0 Viton 008
6 x neoprene O rings Part No. 9/5 - Od 11.9 x Id 6.0 x 24mm
6 x neoprene washers Part No. 9/6 - Od 16.0 x Id 11.0 x 1mm
1 x medium spring Part No. 12/3 (Glycol) - 48mm freelength
1 x large spring Part No. 12/2 (return) - 68mm freelength
4 x ss injector needles Part No. 11/1
1 x brass needle holder Part No. 9/2 and 11/2 complete
4 x polyurethane belts
1 x speed control card
1 x micro switch

11.5.7 Heavy Inspection

Performed at the end of each years burning season.

WAM 82 INCENDIARY MACHINE

Serial No: ____________________ Date Checked: _______________

Signature: ____________________

Checked - Initials

1. Electrical System:

   1.1 Speed control operation
   1.2 Power switch
   1.3 Motor switch
   1.4 Stop/start switch
   1.5 Relay points
   1.6 Micro switch for stop/start
   1.7 Drop rate counter
   1.8 Capsule counter
   1.9 Tachometer
   1.10 Electrical joints
   1.11 Circuit breakers

2. Injector:

   2.1 No hairline cracks on inlet pipe
   2.2 Washers and seals - service
   2.3 Piston and shaft
   2.4 Linearity and wear all threads - replace part if worn
   2.5 Needles tight and shaft springs - tension well compr.
   2.6 Lubrication - smooth action
   2.7 Delivery amount correct

3. Electric Motor:

   3.1 Bearings
   3.2 Brushes
   3.3 Electrical interference
   3.4 Noise suppression
   3.5 Mounting
   3.6 Dribe pulley secure
   3.7 Lockscrew tight

Checked - Initials

4. Glycol System:

4.1 Tank:
- Cap - vent holes open
- Clear of foreign material - flush
- Tap - clear, no obstructions
- Does not leak

4.2 Delivery Hose PVC:
- Flexible
- No leaks at attachment points

5. Capsule Transport System:

5.1 Turntable:
- Rotates freely when released
- Pin used
- Clean thoroughly
- Lubricate
- Lined up properly with injector
- Central locking nut secure

5.2 Ejection:
- Clear and clean
- Fastened securely

6. Manual Overide for Injector Cam System:

6.1 Hand Wheel

6.2 Shaft Locknut Secure

7. Gears:

- Geneva cam gear
- Idler gear

7.1 Geneva Cam:
- Bearings
- Lubrication on pawl and slideway
- No wear in keyway
- Lockscrew tight
- Correct timing

Checked - Initials

7.3 Gearbox:
- Bearings
- Oil level - top up
- Seals - no leaks
- Injector drive shaft secure
- Drive pulley - secure
- Lockscrew tight

7.4 Polyurethane Drive Belt:
- Tension
- Wear

12 AIM 93 INCENDIARY MACHINE

12.1 PRE-FLIGHT CHECK

A pre-flight check and test of the installed machine must be performed to ensure correct operation of all functions occur. Any problems encountered must be remedied prior to takeoff.

The following pre-flight checks must be undertaken:

- Anti-freeze tank full - record quantity
- Water tank full - record quantity
- Tanks connected
- Hand extinguishers charged
- Drop tube connected, secured and clear
- Power supply connected
- Circuit breakers in
- Switches off
- Hopper connected
- Incendiary counter zeroed

12.2 PRE-FLIGHT TEST

CAUTION: Ignition will occur during this test. A metal container must be provided to catch and remove the primed incendiaries from the vicinity of the aircraft.

- Advise Pilot you are ready for a ground pre-flight test and require the aircraft master power switch on.

- Place metal container under aircraft drop tube to catch incendiaries.

- On incendiary control panel:

    * run switch to standby
    * main power switch ON
    * speed select at 40
    * counter reset to zero

Machine is not ready for operation.

* Set run switch to RUN
* Inject predetermined number of incendiaries (use counter - between 4 & 6)
* Run switch OFF after number 6
* Main power switch OFF

Note the time when flaming occurs from injection and the success rate of the test.

If in doubt, repeat the test.

12.3 TO TEST SPEED CONTROL

Do not test with primed incendiaries.

- Ensure that the hopper gate is closed
- Select run switch to RUN
- Rotate speed control through each position, confirming speed increase
- Set run switch to OFF position on completion

12.4 TO TEST MACHINE INTERNAL FIRE EXTINGUISHER

Press extinguisher switch and confirm flow through 3 jets and a flow from the drop tube outside the aircraft. (Power to the water pump is available whenever the power supply lead is connected.

12.5 OPERATIONAL PROCEDURES

CAUTION: Preparation and loading of the incendiary machine hopper should only take place after the burn area has been reached.

12.5.1 When Directed by the Navigator, at The Start of Run, to commence:

- Fill hopper
- Adjust speed control to desired setting
- Main power switch ON
- Run switch on standby
- Commence by switching to RUN

12.5.2 At the End of Each Run:

- Set switch to standby
- Switch water extinguisher on briefly to lubricate slipper block
- Monitor incendiary level

A micro switch on the drive motor parks the chamber in the slipper block over the drop tube when RUN switch is returned to the standby position. This ensure that any primed incendiaries in the slipper block is ejected.

It is essential that the RUN switch is returned to standby before turning off main power switch.

12.5.3 At Completion of Burn:

- Switch water on briefly to lubricate and clean slipper block
- RUN switch in standby position
- Main power switch off
- Note number of incendiaries used and record in log book

12.6 OPERATIONAL EMERGENCY PROCEDURES

12.6.1 Jammed Incendiary:

Jamming of an incendiary in the slipper block may occur if only a few incendiaries remain in the hopper and the feed to the slipper block becomes irregular. Jamming will be indicated if the hand wheel ceases to rotate or the circuit breaker pops.

If the machine jams:

- Advise Navigator/Pilot to remain over burn
- Turn RUN switch to standby position
- Rotate hand wheel to place slipper block in park position
- Engage water extinguisher to flush area
- Reset circuit breaker
- Rectify problem

12.6.2 Electrical Short Circuit:

This will be evident by continual popping of circuit breakers.

- Advise Navigator/Pilot
- Turn RUN switch to standby position
- Turn main power switch OFF
- Disconnect main power lead

12.6.3 Fire in Drop Tube:

- Advise Navigator/Pilot to remain over burn
- Turn water extinguisher on
- Turn main power switch OFF
- Remove hopper from base
- Remove top cover
- Hand rotate slipper to park position
- Use portable Soda Syphon direct to drop tube
- Manually free drop tube of burning incendiary with ram rod
- Clean drop tube before recommencing operation

12.6.4 Fire in Slipper Block Area:

This will occur if:

* Main power failure as incendiary is injected
* Incendiary is crushed due to feed from hopper becoming irregular
* Slipper is not flushed with water on completion of run and particles of Potassium Permanganate are permitted to build up in area.

- Advise Navigator/Pilot to remain over burn
- Turn on water extinguisher
- Return RUN switch to standby position
- Turn main power switch OFF
- Manually eject burning incendiary
- Thoroughly flush slipper block area

12.7 MAINTENANCE

After each day of operation the machine should be thoroughly cleaned. Remove the hopper and the clear cover to gain access to the slipper block. The moving surfaces should be wiped clean and sprayed with lubricant (CRC or similar).

The injection needle should be removed and checked for:

(1) Blockage
(2) Wear

The needle should be cleaned using a fine wire.

The anti-freeze pinch valve tube should be inspected and replaced if faulty.

On completion of the burning season, the machine is to be returned to Fire Management Branch who will arrange for a thorough inspection and servicing of the machine.

AIR NAVIGATION *

An aircraft flight cannot be made without giving some prior concern to the job of navigation. This concern can vary from the simple visual reference during landings to the highly complex job of directing the flight of a long-range aircraft. In any case the airman must have considered, well before wheels-up, certain navigational data designed to make his flight possible, legal and safe. The present chapter will be concerned principally with the knowledge and skills which make a flight navigationally possible.

Air navigation is simply the art of determining the position of an aircraft at any time and directing the aircraft from one position to another. A flight is navigationally possible when these requirements can be met. The precision with which the navigational job need be done is determined by the type of flight and the mission requirements: What is the distance to be travelled? How closely to planned course must the aircraft be kept? What is the en-route weather? The terminal weather? Will there be daylight or darkness? What is the terrain? Such considerations affect the precision with which navigation need be done, but the precision with which the job can be done is solely a function of the equipment available and the knowledge and skill of the navigator

* van Sickle N 1957 Modern Airmanship, D van Nostrand company Inc. 2nd Edition by Maj. James e. Fischer and Capt. Jerome J Rice, Military Airlift Command. Further revision by the Editor.

1. INTRODUCTION TO FLIGHT PLANNING

The aim of FLIGHT PLANNING is to assist in a safe and efficient flight. Good Flight Planning will SIMPLIFY the actual flight.

The more thought and pre-flight preparation given on the ground prior to a cross-country flight, or even a short trip into a primary control zone, the more likely you are to complete the flight with ease, safety, confidence and pleasure.

The scope of the navigational activity is limited by the confined space of the cockpit and the fact that the pilot's attention is divided. Therefore it is vital to keep the navigational activity in the cockpit to a safe minimum.

THE BETTER THE PRE-FLIGHT PREPARATION, THE LESS THE IN-FLIGHT WORKLOAD.

Measuring tracks and distances, track errors, etc., in-flight requires you to be "head-down" - something best avoided as much as possible, especially in single pilot operations without the aid of an autopilot. the navigator needs to be constantly looking out and monitoring the flight path of the aircraft and watching for other traffic.

Flight Planning is pilot-initiated but can be assisted by the navigator. You play the active role. To do this, and to take your proper responsibility, you need to have a sound understanding of the principles involved in good flight planning and also be aware of the legal responsibilities of the pilot-in-command. If you go about learning these skills and responsibilities in a logical way you will see that:

the mental processes required are simple and the methods based on common sense.

Reference: Thom. T. 1983. Private Pilot Navigation 2.
Aviation Theory Centre - Williamstown, Victoria 3106 Australia.

PERSONAL NAVIGATION EQUIPMENT

You should always have a serviceable WATCH and you should build up your own "NAV BAG" to contain at least the following:

* MAPS & CHARTS - WACS and VECS for en-route, VTCs for terminals, the FISCOM/ARFORS map for communications and numbering of area met forecasts;
* a NAVIGATION COMPUTER'
* a PLOTTER or PROTRACTOR (to measure angles);
* a SCALE RULE (often incorporated on plotters);
* PENCILS, PENS;
* the VFG (with LJR and ADDGM);
* spare FLIGHT PLAN FORMS;
* SUN GLASSES.

You should consider carrying a CLIPBOARD to hold your papers together (especially in the cockpit), spare flight plan forms and scribble paper, spare pencils, etc. Judging by some of the computer work that we see from time to time, it might be a good idea to carry the handbook for your computer for occasional reference.

In a typical short-notice navigational exercise, after checking the availability of the aircraft and the contents of your Nav Bag, you would go to the BRIEFING OFFICE where you would :

* obtain the appropriate WEATHER FORECASTS and analyse them;
* obtain the appropriate NOTAMS (Notices to Airmen) and analyse them;
* carry out the ROUTE SELECTION and CHART PREPARATION;
* complete the FLIGHT PLAN form;
* decide the nature of SEARCH AND RESCUE (SAR) protection that you require;
* File the Flight Plan.

If you are unable to attend a Briefing Office in person (you might be at an aerodrome without a Flight Service Unit or you might be departing from an Authorised Landing Area in a farmer's paddock), then you would telephone a nearby suitable Briefing Office to obtain the appropriate forecasts and NOTAMS. Briefing Office locations and telephone numbers can be found in the En Route Supplement (ERS) Com-5.

After completing your flight plan, you would call Flight Service back when you wished to file your flight plan.

Treat briefing seriously and make maximum use of it. Do not be afraid to ask for further details or clarification from the Briefing Officers. It is a legal requirement and a serious responsibility for the pilot in command of any flight away from the vicinity of an aerodrome to ensure that he is briefed adequately on all the available information appropriate to the intended flight and to plan accordingly - Air Navigation Regulation 232 (1).

BRIEFING PRIOR TO FLIGHT:

The Visual Flight Guide (VFG 41.2) lists the information that is available to you at a pre-flight information briefing session. it is quite considerable and you should almost always take advantage of it, even if on a particular flight it is not a requirement. Note that YOU as a pilot have to request it.

When you think about it, almost the whole set-up (the MET Bureau, Flight Service Units, Air Traffic control, etc.) is there to help the pilot.

People involved in these areas are highly trained and are professionals. Even though you might be only at an early stage in your own training, and feeling perhaps a little inadequate due to your lack of knowledge and experience, THE SYSTEM IS THERE TO HELP YOU in the safe and efficient conduct of your flight. therefore your should REQUEST all the information and assistance you require. Do not be embarrassed to do this.

The Departmental Officers are there to assist you, not the other way around.

2. FLIGHT PLANNING

Purpose

1. To familiarize and to exercise. To provide preparation and in doing so relieve navigational pressure during flight.

2. To obtain time intervals for various stages of flight and, therefore, possible E.T.A.'s at various positions and destinations.

3. To anticipate fuel requirements.

4. To enable the maximum load to be carried and the aircraft to be operated as economically as possible.

5. In addition to his own requirements of planning, a Navigator will flight plan in order to provide the pilot with information and a navigational plan and system to be used should the navigation have to be assumed by the pilot.

6. To provide a standard so that the progress of the aircraft when airborne can be compared with the theoretical flight.

7. To provide a standard to enable Air Traffic Control to picture the position of the aircraft at various times in relation to other aircraft and geographical locations. This enables A.T.C. to provide information concerning separation, clearances, warnings, etc.

In extreme cases, only as a result of flight planning is it possible to decide whether or not the flight is possible as envisaged and if modification is necessary to make the flight a possibility.

A flight consists of three phases of Pre-Flight Planning prior to the flight:

(a) With all the available information a decision is made as to the best route. The route is normally the shortest, but deviations from a straight track are easily justified.

(b) Using the information which permitted a route decision to be made plus knowledge of the aircraft's performance at different altitudes, a decision is made on the most favourable height. this decision could possibly result in the route having to be reconsidered.

(c) A final flight plan for the navigation of the aircraft is compiled.

During the actual flight, as a result of a variation from the expected, the flight plan is revised as required.

Reference: Hames C.S., 1965. The Commercial Pilot, Technical Extension Service, Perth, Western Australia.

3. NAVIGATION IN REMOTE AREAS

Sooner or later you will decide to make a journey into one of Australia's remote areas. The transition from cross-country flying in the more heavily populated areas of Australia to flying in the outback, however, should not be taken lightly.

Navigation in remote areas is not necessarily more difficult, but the lack of landmarks will require more disciplined flight planning and flying.

A number of accidents have occurred in the past when experienced pilots encountered navigational difficulties in remote parts of our huge and largely uninhabited country. a common theme has been :

* lack of experience; coupled with
* inadequate flight preparation; and
* poor in-flight navigational technique.

- Lack of Experience:

where does one again "experience"?

We are faced with "lack of experience" many times in our flying careers.

How do we gain experience, except by reading and studying and then finally "doing"? first solo, first cross-country flight as a single pilot-navigator - we are extending ourselves to new limits all the time, and in the process building up experience.

Often we learn some lessons that have been learned many times before by other pilots. Listen to them! But make your own operational judgements. "Biggles" stories might have something in them for you.

Read reports of trips where things did not go as planned (and learn from other pilot's experiences rather than your own) in magazines such as the Aviation Safety Digest.

The term "lack of experience" is used here in reference to navigational experience.

We assume that, as a responsible pilot, you would only venture forth into a remote area in an aeroplane in which you had recent flying experience and whose systems (fuel system, etc.) you were fully conversant with.

Reference: Thom. T., 1983. Private Pilot Navigation 2. Aviation Theory Centre, Williamstown, Victoria, 3106, Australia.

Inadequate Flight Preparation

There is no excuse for this, even for the most inexperienced pilot.

You must do your homework properly for a particular route, so that you can make reasonably correct in-flight decisions when the unexpected occurs. Of course, with proper preflight preparation, the "unexpected" seems to occur less often.

Poor In-flight Navigational Technique

Flying in remote and featureless areas of Australia requires some good DR flying.

Following dirt tracks that meander through the desert (and then peter out) is NOT a good navigational technique for the outback.

This is not to say that following the only railway line up to Alice Springs or the one-and-only sealed road across to Perth shouldn't be done - if this is an area for your own operational judgement - but we are referring here particularly to areas where such features are not available.

What can you, a pilot-in-command do to avoid the pitfalls that can occur in remote area flying?

4. FLIGHT PLAN CAREFULLY

The "DAY BEFORE" Type of Pre-Flight Planning

* Allow plenty of time to flight plan carefully without any pressure of time being placed upon you.

* Ensure that your charts are current and adequate for your intended route, plus or minus any reasonable planned or unplanned diversions.

* Examine your charts carefully for landmarks and distinguishing features along your proposed route, and to either side of track.

* Ensure that you are up to speed on your computer usage, especially in calculating HDGs, Ground Speeds and Times.

* Read and follow the advice contained in the Visual Flight Guide (VFG) - especially in the sections on safety - (VFG Section A, right at the beginning of the book, and VFG 46-3 to 7 on the Emergency Locator Beacon and Designated Remote Areas).

* Ensure that you carry the required radio and survival equipment and that it is in good condition. These requirements are specified in the Air Navigation Orders (ANOs) No. 20.8, 20.11 Appendix 3. If you have a High Frequency (HF) radio on board, ensure that you know how to operate it. HF radio is quite different to VHF radio in its operation. (Seek advice from your Flying Instructor and refer to our "Flight Radio Handbook").

* Make use of the local knowledge of other pilots and Briefing Officers who know the area you intend flying over. Determine suitable fix points and obtain as much information as possible on suitable landing areas along the route. Ensure that this information is reliable and up-to-date, because it is not unknown for non-licensed landing grounds on station properties to be abandoned because of flooding or in favour of a new more suitable site.

* If practicable, plan your route over these suitable landing areas.

Obtain A Thorough Met Briefing

* Ensure that you are briefed thoroughly on the route and for your destination and alternate aerodromes.

* Do not be embarrassed if you do not understand all aspects of the ARFOR or TAFs, or some of the abbreviations. Ask for clarification!

* Be wary of areas where visibility may be reduced in dust or haze.

* Do not plan on flying above a low layer of cloud for long periods where your visual navigation could be impeded.

* Try and determine an approximate altitude above which you will be out of the convective turbulence layer and its associated "bumpy ride" for the time at which your flight will occur.

Obtain a thorough Operational Briefing

* Flight service and Air Traffic Control personnel are aviation professionals. They are trained to a very high standard and it is their

job (and usually their pleasure) to assist you in any way possible. it is up to you as a pilot to REQUEST their assistance.

* Pay particular attention to landing area and aerodrome serviceability along your proposed route, especially following rain.

* Determine availability of the correct fuel at appropriate landing points.

* Determine if any military activity is planned in the area. Military jet low level navigation exercises do occur at high speed in remote areas - some of these aircraft are camouflaged fighters which are hard to see, and some of them large bombers, It is nice to know if they are around.

* Verify the time of Last Light for your destination.

Prepare a thorough and carefully-checked Flight Plan

* Check tracks and distances mentally following your computer calculations to ensure there are no gross errors, eg. tracks wrong by 90 or 180 degrees. Apply Magnetic Variation correctly (Variation East - Magnetic Least....)

* Check that drift has been allowed for in the correct direction and that ETIs are approximately correct.

* Plan on flying as high as is practicable:

  - a better picture of the country can be obtained;
  - on hot days, the flight should be smoother;
  - VHF radio coverage is better.

* Allow adequate FUEL, plus reserves - not only for the planned flight, but for any possible alternative action, including what procedures you will follow in case selected fix-points are not located as expected.

* Allow sufficient TIME for the planned flight plus any possible alternative action, especially if flying in the latter part of the day when Last Light is a very real consideration. It is only an extremely (over- ?) confident VFR pilot that would allow the bare legal minimum of 10 minutes prior to Last Light for arrival over the destination.

* Early departure times in the outback generally produce better flights. Cooler air gives better take-off performance and a smoother ride. Visibility may be better and the pressure of impending Last Light removed. the benefit of the early start can be lost if you dawdle along, though wasting time with inefficient flight planning, refuelling, etc.

* Allow for proper food and rest at appropriate intervals. It is not only the aeroplane that needs fuel.

5. IN-FLIGHT NAVIGATIONAL TECHNIQUE

* Fly estimated HDGs accurately. Do not allow the aircraft to wander off-track through inattention. Have in your mind an awareness of

approximate direction - and check that drift is applied in the correct direction for your desired track and the wind experienced. Check for drift soon after departure and adjust HDG as necessary.

* Map read carefully as the flight progresses. Even if you cannot pinpoint yourself visually at all times due to the lack of landmarks, at least know your dead reckoning (DR) position at all times based on estimated TR and GS since your last fix.

* Maintain an in-flight log, recording all HDGs flown and the TIME of any significant changes. It takes a few seconds to do any may prove invaluable.

* Maintain a general sense of direction and ensure that the Directional Indicator is re-aligned with the magnetic compass at regular intervals (every 10 or 15 minutes).

* Do not deviate from your flight plan without any real justification. A flight plan should be adhered to unless a positive fix indicates that you are off-track, or unless you change your intentions in-flight and prepare a new flight plan. With a positive fix, you have data that enables you to make a reasoned correction to your HDG flown.

* Anticipate your fix points some minutes ahead of your estimate for them and commence a good lookout, not just ahead but also to each side of track. Do not just wait for planned fix points to show up - anticipate them. Continually study the surrounding countryside, but not to the extent that it disturbs your accurate heading keeping.

* Positively establish your position in relation to a selected fix point before continuing on the next fix point.

* If you are unable to locate your selected fix point and you are uncertain of your position, commence your planned alternative action being aware of FUEL and TIME in particular. This alternative action could be to return to the last positive fix or to divert to some prominent landmark even if some distance away. In these circumstances you may have to abandon your original plan for proceeding to your original destination, in favour of a destination that is easier to locate and which is in a more accessible area. Maintain an accurate log in this procedure.

* If you depart from your original flight plan, notify your new intentions to the appropriate Flight Service or ATC unit, but do this after you have planned on your new course of action and flying the aeroplane is well in hand.

WHAT TO DO IF THINGS DO NOT WORK OUT AS PLANNED

* Do not become flustered. With reasonable planning, you should have allowed fuel and time to sort out this sort of problem. establish the fuel state and time remaining to Last Light.

* Do not assume that you are in a particular place because that is where you want to be. Keep an open mind and study the surrounding countryside carefully. Log all significant changes of HDG, the times they are made.

* Follow the procedures suggested on what to do if you are uncertain of your precise position or if you become lost.

* Advise Flight Service or Air Traffic Control of the situation. from the HDGs and times flown since your last positive fix, the SAR (Search And Rescue) organisation can plot your flight using the latest wind data and assist in establishing your position.

* If, despite your precautions, things go unexpectedly wrong and you are caught with insufficient fuel or daylight to reach your destination or a suitable alternate, be intelligent in the use of your resources.

Carry out a precautionary search and landing whilst you still have adequate fuel and daylight available. VFG Section A offers guidance on what to do if you are forced down, eg. staying with the aircraft and activating your ELB.

6. LOG KEEPING

The purpose of keeping a flight log is to record sufficient data:

* to enable you to determine your position at any time by DR;

* to have readily at hand the information required for radio position reporting.

Logged date is invaluable if you feel uncertain of your position at any time.

Keeping an in-flight log, however simple, helps in the methodical sequence of navigational activity of:

* calculation of HDG to achieve a desired TR;

* calculation of GS and ETI to determine ETA at the next check point;

* anticipation and recognition of check points;

* recalculation of HDG, GS and ETIs if necessary (and the cycle repeats).

An in-flight log need only be very basic. On a normal cross-country flight you should log:

* Actual Time of Departure (ATD) on the flight plan form;

* fixes (position and time) on the map;

* Track Made Good (TMG) on the map;
* changes of HDG (and airspeed) and time of making them;
* calculated GS;
* ETAs and revised ETAs at check points;
* altitudes.

7. VISIBILITY

GOOD VISIBILITY:

Cross-country flights by Visual Flight Rules (VFR) qualified pilots should only be carried out in good weather conditions which permit continual observations of the ground.

This means that you should generally be able to spot each check feature at an appropriate time prior to actually reaching or passing abeam it.

Good visibility decreases the workload on the pilot-navigator.

POOR VISIBILITY:

Reduced visibility brings additional problems to the pilot-navigator.

As well as making the actual handling of the airplane more difficult, say due to the lack of a natural horizon, it also means that check points may not come into view until you are almost upon them, and if the check points are some distance off-track you may not even see them.

Poor visibility may be due to smoke, haze, mist, rain, smog etc., and sooner or later you will be faced with the problems that reduced visibility brings.

Consideration should be given to turning back or to diverting if you feel that Visual Meteorological Conditions (VMC) cannot be maintained or if the visibility (even if in excess of VMC requirements) is still not adequate for your particular flight and your particular experience.

If you are expecting poor visibility en route it is advisable to select more en route check points that are closer to your desired track. this reduces the time between fixes and reduces the anxiety if you do not spot one of the check features, but the next one comes up on time shortly thereafter.

If several check points fail to appear, you could have reason to feel "uncertain of position".

8. POSITION UNCERTAINTY

UNCERTAIN OF POSITION

If you have flown for some time without obtaining a fix (say 20 or 30 minutes), you may feel a little uncertain of your precise position.

You will be able to calculate a DR position (using expected TR and GS), but you may feel a little anxious that you cannot back this up with a positive fix over or abeam some ground feature.

This situation is a normal one and is no reason for immediate anxiety. it is far from being "lost".

It is impossible to give a set of rules that covers all possible situations, but the following are general rules that may assist you.

What to do if a Check Point does not come into view at the Expected Time.

1. Log HDG (compass and DI) and TIME.

2. If DI is incorrectly set, then you have the information needed to estimate your actual position within reason, then to reset the DI and calculate a HDG and ETI to regain the desired track.

3. If DI is aligned correctly with the compass, then the non-appearance of a landmark, whilst it will perhaps cause you some concern, need not indicate that you are grossly off-track. You may not have seen the landmark for some perfectly legitimate reason - bright sunlight obscuring your vision, poor visibility, a change in the ground features not reflected in the chart (eg. removal of a TV mast, the emptying of a reservoir, etc.), or if you are navigating above even a small amount of cloud, the inconvenient positioning of some of this cloud may obscure your check feature.

4. If the next check point comes up on time or if you obtain a fix, the flight will continue on and the normal en-route navigation procedures will continue to apply.

9. PROCEDURE WHEN LOST

Becoming lost is usually the result of some human error.

Being lost is totally different to being temporarily uncertain of your position, where you can determine a reasonably accurate Dr position.

It is impossible to lay down a set of hard and fast rules on what to do if you are totally lost, except to give you the advice that careful pre-flight planning an in-flight attention to the normal simple en-route navigational tasks will ensure that the situation of being lost will never arise.

There is one thing that is certain if you over become lost. You must formulate a plan of action.

It is futile to fly around aimlessly in the hope of finding a pin-point

If you change your thinking from one of being "uncertain of position" to one of being "lost", then:

1. It is important to initially maintain HDG (if terrain, visibility and what you know of the proximity of controlled airspace permit) and carry out a SEQUENCE OF POSITIVE ACTIONS, and

2. If a vital check point is not in view at ETA, then continue to fly for 10% of the time since your last positive fix, and

3. Deciding what your last positive fix was, CHECK THE HEADINGS FLOWN SINCE THAT LAST FIX, ensuring that :

* the magnetic compass is not being affected by outside influences such as a camera, portable radio, or other magnetic material placed near it;

* the gyroscopic Directional Indicator (DI) is aligned with the magnetic compass correctly;

* magnetic variation and drift have been correctly applied to obtain your HDGs flown;

* an estimation of track direction on the chart against that shown on the flight plan is correct;

Then :

4. Establish a "MOST PROBABLE AREA" in which you think you are.

Two Suggested Methods;

Method 1: Estimate the distance flown since the last fix and apply this distance, plus or minus 10% to an arc 30 degrees either side of what you estimate the probable Track Made Good (probable TMG) to be.

FIGURE 1: ESTIMATING THE MOST PROBABLE AREA THAT YOU ARE FLYING IN

Method 2: Estimate your "most probable position" and draw a circle around it of radius equal to 10% the distance flown since the last fix.

* Establish a safety altitude to fly at to ensure adequate clearance of all obstacles in what you consider the general area to be. Be especially careful in conditions of poor visibility or low cloud.

* check large features within this area of the map with what can be seen on the ground. Try and relate features seen on the ground with those shown on the chart, ie: READ FROM GROUND TO MAP. Confirm the identification of any feature by closely observing secondary details around the feature, eg: a small irregular lake is confirmed by the position of a small town on a bend in the railway line as it turns from west to south. Double check any fix.

FIGURE 2: DOUBLE CHECK FIXES WHEN "LOST"

When you do positively establish a fix, re-check your Directional Gyroscope (DG or DI) and recommence normal navigational activity. Calculate the HDG, GS and ETI for the next check feature and set course for it.

5. When Lost, read from Ground to Map, ie: look for significant Ground features or combinations of features and try to determine their position on the map.

At all times continue to fly the aircraft safely. Maintain an AWARENESS OF TIME, especially with respect to LAST LIGHT and FUEL STATE.

If you are STILL UNABLE TO FIX YOUR POSITION, then you should consider taking one of the following actions:

1. Increase the "most probable area" by 10% to 15 or even 20% of the distance flown from the last fix.

2. Climb to a higher altitude to increase your range of vision.

3. Turn towards a known prominent line feature such as a coastline, large river, railway line or road, and then follow along it to the next town where you should be able to obtain a fix. (Don't forget that it may also lead you into a control zone around certain towns like Alice Springs).

4. Steer a reciprocal heading and attempt to return to your last fix.

5. Seek navigational assistance from the Flight Service (FS) unit or Air Traffic Control (ATC) unit that you are in radio contact with. It is wise to take this step prior to reaching "desperation stage". Information that may be asked for in helping to establish your position is time and position of your last fix, with headings and times flown since then.

Note the following important points:

* If you want to cover as much ground as possible with the fuel available, you should fly the aeroplane for best RANGE.

* Keep a Navigation Log going.

* Remain positively AWARE OF TIME. Keep your eye on the fuel and on the time remaining until Last Light. If Last Light is approaching remember that it will be darker at ground level than at altitude and that it becomes dark very quickly in the tropics.

* If you decide to carry out a precautionary search and landing, allow sufficient time and fuel to do this on the assumption that two or three inspections might have to be made before finding a suitable landing area. The Visual Flight Guide gives advice on what to do after such a landing (VFG Section 1).

WHY DID YOU BECOME LOST?

If at any stage you become lost, you should systematically try to determine the reason (either in-flight or post-flight) so that you can learn from the experience.

Common reasons for becoming lost include:

* incorrectly calculated HDGs, GSs, and ETIs (hence the need for you always to make mental estimates of approximate answers to these items);

* incorrectly synchronised Directional Indicator (DI or DG), ie. gyroscopic DI not aligned correctly with the magnetic compass. The DI should be checked every 10 or 15 minutes against the compass;

* a faulty compass reading (due to transistor radios, cameras and other magnetic objects placed near the compass);

* incorrectly applied Variation (Var East, Magnetic Least, etc);

* incorrectly applied drift (compared to TR, the HDG should be pointing into wind, ie. flying north with a westerly wind blowing would mean that the HDG should be to the left of track and into wind);

* a wind velocity significantly different to that forecast, and not allowed for in-flight by the pilot;

* a deterioration in weather, reduced visibility, increased cockpit workload;

* an incorrect fix, ie. mis-identification of a check feature;

* a poorly planned diversion from the original desired track;

* not paying attention to carrying out normal navigational tasks throughout the flight.

NOTE:
With regular checks of DI alignment with compass, reasonably accurate flying of HDG, and with position fixes every 10 or 15 minutes, none of these errors should put you far off-track.

It is only when you are slack and let things go a bit too far that you become lost.

10. PRECAUTIONARY SEARCH AND LANDING

If ever you find yourself in any of the following situations:

* running short of fuel
* unable to reach destination before darkness
* caught in bad weather
* suffering partial aircraft unserviceability
* pilot incapactitation etc.

it may be necessary to land as a precaution against having an accident.

In most cases only poor planning, poor airmanship and poor decision-making will allow such a situation to arise. However, a combination of adverse circumstances may leave you in the unhappy situation of being forced to land on an unprepared area, ie. "off-airport".

The aim of this exercise, then, is to teach you how to search for, locate and safely land on an un prepared site.

The technique is also most applicable to landing at unfamiliar private landing areas (ALAs). Many light aircraft accidents occur at ALAs when "aerodrome-trained" pilots attempt landings without adequate inspection of the landing area.

OPTIONS:

If things are going wrong consider your options. the following options apply to all of the above circumstances but are particularly applicable to bad weather. In order, they are :

Continue: This may not be the best option but it will be the most tempting. If you decide to continue do so cautiously. Leave a back door open so that you can retreat. Decide in advance how far you will go before you review this decision.

Hold: In some circumstances it may be possible to hold until conditions improve. This will depend on the type of weather, and fuel and daylight remaining.

Detour: It may be possible to detour around bad weather and still get to your destination.

Return to your departure aerodrome

Divert to another aerodrome of landing area.

Land off-airport: The least tempting but sometimes the best option.

Procedure

The procedure to be adopted will vary with the circumstances. For training purposes we will assume the worst combination of circumstances in which you find that you are:

* lost
* short of fuel and/or daylight; and
* in bad weather with low cloud and reduced visibility.

1. Slow down. Fly at the slowest safe airspeed. (See pilots notes for speed and flap setting). this gives you more time to think and to look.
   Keep well below the cloud base

2. Look for a suitable landing area. Consider size, shape, slope surface and surroundings. Carry out a methodical search. For preference follow a line feature. Alternatively, fly an expanding square or circle or creeping line ahead pattern.

Flying down wind will let you cover more territory but your ground speed will be higher (See 1 above). Transmit intentions on appropriate frequency.

3. Circle any promising landing area at cruising height to get a general picture of the area and to look for obstructions, particularly wires. Check adjacent areas for poles which may indicate the presence of wires.

4. Determine the wind velocity. (Smoke, drift, wind shadow or wind lanes on water). Choose a definite touch down point and landing path.

5. Inspect the landing area. Make an inspection run at approximately 200 ft above ground level (well above all possible obstructions) into wind and slightly to the right of the intended landing path, maintaining slow but safe airspeed (do not under any circumstances, get too close to the stall speed). Inspect the approach area, the surface and the climb out area.

6. Carry out a bad weather circuit. Perform pre-landing checks and emergency land briefing.

7. Carry out a practice short field landing approach. Do not come below the tree canopy height and look out for wires. Overshoot at approximately 50 ft AGL and carry out a further inspection of the landing area.

8. Land if satisfied. If you are now satisfied that a landing is feasible carry out another bad weather circuit and make a shortfield/roughfield landing. If you are in doubt carry out further practice approaches and inspections until you are happy or else go and look for another landing area.

After landing. Survival after landing will depend on circumstances. Before each flight you should consider whether you are properly equipped mentally, physically and materially to survive after a forced landing in your intended area of operations.

General. It's not where you land it's how you land that's important. A good landing in a bad area is survival. A stall/spin or graveyard spiral may not be survival even if you land on the biggest of airports. This procedure could take up to 20 minutes to perform, so don't leave it until the last minute to decide to land. If you do happen to land an aircraft off-airport a careful assessment of the conditions is essential before any attempt is made to fly it out. Specialist advice may well be necessary.

Reference: Aviation Safety Digest - VFR issue P16-17.

11. NAVIGATION: KEY TO SAFETY IN REMOTE AREAS

A review of accidents and incidents related to navigational difficulties in remote areas of Australia reveals a common theme - lack of experience coupled with inadequate flight preparation.

Note 1 Flight through corridors shall be made within sight of the highway concerned but in no case more than five miles therefrom.

Note 2 Australian administered islands adjacent to the Remote Area between Talgarno and Cairns are part of the Designated Remote Area

Note 3 Mainland within 50 nm of Darwin excluded from Designated Remote Area.

Reference: Aviation Safety Digest VFR issue P11-13.

Cross-country navigation in a light aircraft today is a very different matter from what it was three decades ago when the Digest first began publication. In that era of fabric-covered tail skid and tail wheel aeroplanes, which cruised at 80 knots and had an endurance of only about two and a half hours, a pilot's problems were mostly manipulative ones. If he could master these properly, the performance limitations of his aircraft made it unlikely that he would get into a great deal of trouble on a cross-country flight.

Today, the exact reverse is true. From a manipulative point of view, the most single-engine light aeroplanes, even high performance ones, are much easier to fly than their predecessors. But their speed and range is often such that quite minor navigational errors can easily become compounded into major ones if the pilot is not 'on top' of what he is doing.

In years gone by, apart from aircraft operated by aerial medical services, developmental air services, mining groups and aerial survey organisations, very little general aviation was done in the distant, sparsely settled areas of Australia. those that were operating, were in the main, flown by highly experienced 'bush' pilots who know their particular area intimately and whose names became household words in the regions they served. Today, however, the expansion that has taken place in the general aviation industry, and in private flying in particular, has changed this picture completely.

The fact that light aircraft are easier to fly and have an extensive range, naturally and quite properly encourages their use for long cross-country trips and 'tours'. and the increasing use of light aircraft for business as well as for pleasure, has inevitably led to a great deal more flying being done in the very areas where the light aeroplane is by far the most practical means of transport. This in turn has meant that many pilots, whose flying training and practice had previously been confined to operations in the more popular regions of the continent, have suddenly found themselves having to cope with the far different problem of navigating accurately in areas where hundred of miles separate the sort of landmarks and check points they have previously been accustomed to - highways, towns, railways, and so on.

The transition to this type of navigation is not one to be taken lightly, as many less wary pilots have already found to their cost. Pilots who have little or no experience in flying in remote areas may not appreciate that the Australian outback is a big country and, though light aircraft navigation in remote parts of the continent is not necessarily more difficult than in our closer settled areas, it is a task abounding in pitfalls for the unwary and the ill-prepared, and by its very nature is far less forgiving.

There are two particular factors which have undoubtedly contributed to navigation problems encountered by inexperienced pilots in recent years.

Both relate to pilot attitudes.

Over the past few years, the promotional advertising for some types of light aircraft has fostered the notion that the skills and judgements necessary to fly an aeroplane are little removed from those required for driving a motor car. Unfortunately, amongst some would-be aviators, this seems to have stimulated an 'aerial driver' outlook rather than a proper 'pilot-in-command' philosophy and has done nothing to encourage amateur pilots to aim at professional standards in all aspects of their flying.

The same sales promotional campaigns, in conjunction with undoubted virtues of the aircraft themselves, also seem to have introduced to the ranks of aircraft owners and pilots, persons who have learnt to fly because it provides them with an efficient means of transport in country or outback areas, but who have no real interest in flying other than this.

Attitudes of this sort are in marked contract to the emphasis on leadership and enthusiasm, pride in skill and airmanship, and esprit de corps which so characterised the aero club and flying school movement three decades or so ago, when private ownership of aircraft was the privilege of the very few. As a result, light aircraft flying today is much less subject to imposed discipline and far more individualistic in character. It is all the more necessary therefore that individual pilots take care to cultivate in themselves the right attitudes and self-disciplines so necessary for conducting their flying in a sound and safe manner.

The following comments, taken at random from BASI's investigation files, give some idea of the problems that are being encountered in remote area flying.

* "The pilot did not positively establish his position in relation to a selected fix point before continuing on to the next fix point".

* "The pilot became lost in a remote area because he did not make adequate preparation before departure, to ensure the safe navigation of the flight".

* "The pilot's navigational competence is obviously suspect, as shown by his failure to use his computer to calculate heading, ground speeds and times, and by his general lack of directional sense. If a forced landing had become necessary, the task of search probability area would have been made much more difficult because of the poor flight plan lodged by the pilot".

* "The situation in which the pilot found himself is typical of what results from sloppy flight planning and inattention to map reading by an inexperience pilot operating in a remote area. It could be said that this pilot was a SAR phase going somewhere to happen".

* The pilot was inexperienced both in flying generally and with the remote area in which he was operating. His aircraft carried no survival equipment, water, matches or survival beacon, and he had set out on the flight without ensuring that his HF radio equipment was serviceable. His flight planning was meagre in the extreme, and made no allowance for wind or for checking the progress of the flight in relation to recognisable landmarks".

* "The procedure adopted by the pilot in following unsealed roads involved substantial deviations from the flight planned track. As this was his first flight to the Northern Territory however, prudence might have dictated following the well-defined Barkly Highway to Tennant Creek, thence the Stuart Highway to Daly Water".

* "The tendency to deviate from the flight plan with no real justification, instead of stick to the plan, is something like people lost in a forest going round in circles. Obviously a plan is a plan and it should be adhered to unless a positive fix indicates the aircraft is off track".

* "If ever there was a case to demonstrate that accidents don't "just happen" but are the culmination of a chain of unfavourable events and circumstances this one does. In this case, the chain was formed by a series of factors which, for the most part, could be listed under the general headings of inadequate flight preparation and lack of planning".

These case histories, together with other accident and incident report data in the same category, show that there are several common factors contributing to the high incidence of navigation difficulties in the outback. For nearly always when navigational problems develop, the pilot is lacking in overall experience, recent experience or perhaps both. It must of course be accepted that inexperience in either of these areas will inevitably result in some mistakes. After all, this is no more than the price of real experience. But proper flight preparation and a sense of one's own limitations should ensure that such mistakes do not develop into navigational disasters. Clearly, one of the chief weaknesses is lack of real flight preparation - not just simply filling in a flight plan form, but as Air Navigation Regulation 231 on flight planning puts it, "... studying all available information appropriate to the intended operation....". This of course includes obtaining adequate information on weather conditions, both en route and at the destination, as well as the provision of an "emergency plan" that will enable the aircraft to safely reach an "alternate" if things go unexpectedly wrong. Also, if the flight is to be through one of the designated remote areas, it includes making provision for the special requirements concerning the carriage and use of HF radio and survival beacons.

An not only must one's technical competence and knowledge for the task be carefully considered. The flight time limitations laid down in Air Navigation Orders have been devised because experience shows them to be an essential component of safe aircraft operations. There are very sound reasons for them and pilots must remember that, just as a machine cannot function properly if it is not adequately fuelled and maintained, so the human body cannot function efficiently without proper food and rest at the right intervals.

Once in the air, other weaknesses in navigational technique take their toll. Principal among these seem to be inability to map read accurately and failure to appreciate the need to keep a detailed inflight log. Frequently too, the effect of these inadequacies is worsened by pilots becoming convinced, without any real evidence, that they are in a particular position, and by their becoming flustered, which leads them to make rash, ill-considered decisions.

There is evidence too, that some pilots, when venturing into unfamiliar territory, are reluctant to seek out and to clarify, from Briefing Officers, the very information that might save them from difficulty. This is probably born of a reluctance to admit their lack of knowledge of the area or their unfamiliarity with particular aspects of flight planning, but pilots who feel this way should remember that pride is a quality best forgotten when undertaking flights in the remote areas of Australia.

It has been pointed out many times that the development of an accident is nearly always an evolutionary process. In other words, an accident does not "just happen", but is usually the culmination of an insidious chain of events or incidents. Nowhere is this more true than with accidents resulting from navigational errors, where the event itself usually develops from seemingly insignificant omissions, errors and misjudgements, which, to the pilot concerned, seemed quite unimportant at the time. Yet with hindsight, it is frequently possible to see that if the formation of that chain could have been interrupted, the accident itself would have been averted.

One almost certain way of interrupting such a chain of events, provided that it is done in time to alter the course of the accident evolutionary process, and which is by far the most effective answer to a pilot's navigational problems when the situation seems to be getting out of hand, is to call for assistance. Over the years, incident records have revealed instances of pilots having been reluctant to call Air Traffic Control or flight Service Units when confronted with navigational difficulties. No doubt, the number of such cases is much greater than is revealed.

It is clear from the facts surrounding the known cases that the specialist officer on the ground could have provided valuable assistance had they been appropriately alerted. It is equally clear that failure to alert the ground organisation in such circumstances may expose perfectly innocent people to grave danger.

A point to be remembered is that the Department has a policy of granting immunity from disciplinary action to those pilots who, because of navigational or other difficulties, have a need to request assistance from the ground organisation. Certainly, such occurrences will be investigated. But this is done so that the circumstances which lead to the occurrence will be properly understood to the ultimate advantage and safety of users of our airspace.

What then can pilots, who are inexperienced in remote area navigation, do to avoid its many pitfalls? As already indicated, the answer lies in adequate flight preparation and in sound inflight judgement based on that preparation. Obviously pilots who have not done their homework properly for a particular route cannot expect to make the right inflight decisions when the unexpected occurs.

The advice summarised in this article may seem common sense and obvious to most. So it is - but it is also so basically vital to safe cross country navigation that it cannot be repeated too often.

Pilots who follow these rules will greatly improve their chances of completing their flight successfully and uneventfully. If however, despite all precautions, a pilot does require assistance he will have ensured that the SAR organisation is well informed about his intentions and is thereby able to provide whatever assistance is necessary. One the other hand, if a pilot has been aimlessly following odd roads or tracks without keeping any navigational log, the SAR organisation's task is immeasurably more difficult.

And don't think that because you have made one or two trips in remote areas you will be immune from trouble - it takes a lot of experience spread over different seasons and conditions (summer, winter, drought, particularly favourable seasons for growth and so on, all of which can change the appearance of the country radically) to become an accomplished remote area navigator. BASI's records show that the more experience a pilot has, the more he follows these golden rules.

To disregard any of these factors in the planning and subsequent conduct of a flight, can, as has been proved so many times before, lead to results that are not only tragic, but in all probability permanent. As a qualified pilot, you have the complete trust of your non-pilot passengers and their lives are in your hands. It is a heavy responsibility - see that you are worthy of it.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
WESTERN AUSTRALIA

OPERATIONS AND REPAIR AND MAINTENANCE MANUAL
WA HELITORCH

TABLE OF CONTENTS

1.0 HELICOPTER SAFETY (GENERAL):

1.1 Helipad Area Requirements:

A. Fire control operations necessitate construction of helipads in forested terrain. These diagrams provide guidelines for construction of helipads for the operation of all helicopters available to the Department.

The Final Approach and Take Off Area should be at least 25 metres in diameter, on a slope less than 7 degrees and free from hazards to at least stump height.

The Ground Effect Area should be at least 15 metres in diameter, and cleared of stumps to ground level. The stumps should also be marked with fluorescent paint if possible.

The Land and Lift Off Area should be clear of all obstructions and debris and be at least 5 metres square.

The ideal situation is a landing strip or cross roads that can be blocked.

Approach and departure paths should be placed roughly opposite, aligned with the prevailing wind. Trees should be removed to provide an obstacle free gradient of no more than 40 degrees.

Helipads built on the side of hills should concentrate clearing on the contour and downhill sides. (Figure 1) Appendix 4.

B. The Helipad Marshall or Officer-in-Charge is responsible for ensuring the area is clear of personnel and equipment during lands and take-offs.

C. The Helipad Marshall or Officer-in-Charge is to use correct marshalling signals as published in this manual.

D. When marshalling, stand with back to wind with both arms outstretched to indicate land area. Indicate wind direction with a flag or other visual indicator.

1.2 Approaching and Leaving:

A. Stay in Pilot's field of vision at all times.

B. Stay away from spinning main and tail rotor blades. They are not readily visible.

C. Stand outside the main rotor disc and enter in a crouch only when the Pilot or Flightcrew signals, i.e. gives the thumbs up sign.

D. Don't approach the helicopter until the rotors have completely stopped or started. A slowing main rotor tilts downwards, especially in windy weather.

E. Be aware of ground irregularities on uneven, sloping terrain, approach and leave on the lowest, downslope side to give yourself maximum clearance.

F. Carefully and gently close and latch doors. They are easily damaged.

G. Don't rush, take time to think and observe. Remember, a helicopter can move in all directions.

H. Look after your own gear and be ready to board when directed to do so.

1.3 Safety on the Ground:

A. Carry stretchers, tools and other objects horizontally firmly held below the waist. Never carry equipment upright or over the shoulder.

Carry long objects between two people.

B. Carry all hats, including hardhats, unless chin straps are secured.

C. Don't leave loose objects near helicopter or landing area where they may be blown about.

D. Remain well clear of landing or taking off areas when helicopters are operating.

Remain behind cover, well clear of the manoeuvring area to prevent injury by swirling dust in the rotor down wash.

E. If working near or on helipads always wear goggles and earmuffs.
If blinded by dust, cover eyes and crouch down with your back to the helicopter.

F. Don't smoke within 20m of a helicopter, fuel dump or refuelling equipment.

G. Ensure that camp fires are at least 100m away from helipads.

H. Stay away from any moving parts (tail rotor, linkages etc).

I. Always follow the directions given by the Pilot, Flightcrew or Helipad Marshall.

1.4 Safety in the Air:

A. Sit where instructed by the Pilot or Flightcrew.

B. Fasten seatbelts and keep them fastened at all times unless the Pilot directs otherwise.

C. Don't distract the pilot, especially during take-off and landing. Signal an intention to speak, and wait for response. Inform the pilot of any possible hazards he may not be aware of.

D. Don't smoke unless the pilot indicates it is safe.

E. Don't place loose objects indiscriminately in the cabin, they may move about and affect controls.

F. Don't throw objects from helicopter.

G. Don't open doors in flight unless instructed to by the Pilot or Flightcrew.

IF IN DOUBT - ASK THE PILOT

1.5 Baggage and Cargo:

A. Equipment is to be loaded only under the supervision of and direction from the Pilot or Flightcrew who are responsible for keeping the helicopter within its weight and balance limits.

B. Equipment and cargo must be unloaded under the supervision of the Pilot or Flightcrew with the same care as it was loaded. It should be handed out and carried below the waist away from the helicopter.

C. Know the approximate weight of your baggage.

D. External loads must be well secured with rope-ends kept short to avoid tangling.

E. In all loading, internal and external, unloading and refuelling follow the directions of the Pilot or Flightcrew.

2.0 IGNITION EQUIPMENT:

2.1 Helitorch:

A. The WA Dragon Helitorch is a device designed to dispense ignited gelled petroleum in large droplet form for lighting fires for a variety of forest and land management objectives.

The Helitorch is a 200 litre aluminium container that holds 130 litres of gelled petrol in the fuel storage area, a delivery pump system, fuel ignition system fire extinguisher system and power and control system. This particular helitorch design originated in New Zealand and has been modified to meet Australian Safety Standards. The following is a description of components of WA Red Dragon helitorch.

B. The fuel storage and delivery system, comprise a container pressurised by inert gas from which the fuel is drawn by a positive displacement pump. This offers a range of eight electrically and mechanically controllable dispensing rates.

C. The fuel ignition system comprises a propane torch in which flame is initiated by an automobile ignition system.

D. The fire extinguisher system operates around the fuel delivery and fuel ignition systems and is controlled by the helitorch operator.

E. The control system is mounted in a hand held box and operated from within the aircraft and comprises switches to activate propane flow, fuel flow and rate of flow and fire extinguisher functions. The former two functions are over-ridden by a master switch operating on the "Dead Man's Handle" principle. Power to operate the machine and the control system is provided by the aircraft auxiliary power supply or a 24v battery pack carried in the aircraft.

2.2 Incendiary Injection Machine:

This ignition system consists of a chemical ignition device, the priming and dispensing mechanism, the Incendiary Machine operator, the pilot and aircraft. Development has been oriented toward improving the automatic handling characteristics of the ignition device and to improve the safety, speed and reliability of the priming an dispensing equipment.

3.0 PERSONNEL:

The success of aerial ignition techniques depends largely on the individuals involved, their level of training and planning and management. The burn crew compliment consists of:-

3.1 Operations Officer (Burn Boss):

During the operation, the operations officer is responsible for the entire scene. His area of control includes all phases of the burning operation plus the helicopter pilot, Heliport Marshall/Loadmaster, helitorch incendiary machine operator, navigator and ground mixing crew.

The operations officer must be completely familiar with safe handling of flammable liquids and aerial ignition prescribed burning.

The main responsibilities of the operations officer on the helitorch operation are to:

1. Preplan

2. Ensure there is a job safety review just prior to burning, which covers:-

    * mixing of Surefire (Helitorch only)
    * working around helicopters
    * escape routes
    * treatment of accidents

3. Ensure all necessary equipment is available and on site.

4. Develop the plan for the heliport and mixing-site operation.

5. Conduct briefings and provide technical advice and information to personnel and other interested parties; provide photos and area maps during pre-burn briefings.

6. Develop communication plans to include direct ground to air communications between the ground crew and air crew.

7. Supervise the overall aerial ignition operation.

8. Gain approval to commence lighting from the Controller.

3.2 Pilot:

The pilot must be qualified in aerial ignition burning and have a certificate of competency in sling load operations for endorsement on a his helicopter pilot licence (helitorch and monsoon bucket only). Be familiar with procedures for handling flammable liquids. He must follow prescribed safety procedures. It is also the pilot's responsibility to ensure that the ignition machine is operational and that the required helicopter fuel is available on site.

3.3 Aircrew:

3.3a Helitorch Operator/Navigator (Helitorch Operations):

The Helitorch operator must be qualified in helitorch burning operations, and have accreditation for competency in Helitorch operations for endorsement on an aircrew Incendiary Machine Operator Certificate. The Helitorch operator performs the following duties:-

1. Reports to the fire boss

2. Maintains communications with the fire boss.

3. Requests mixing requirements of the Heliport Marshall/Load Master.

4. Directs pilot during ignition phase.

3.3b Incendiary Machine Operator and Navigator (Incendiary Machine Operations):

A navigator and incendiary machine operator accompany the pilot in the helicopter. The navigator must be familiar:

* with the block burning plan,
* with the ignition and spacing techniques, and
* must discuss these with the pilot before take off.

During the operation, the navigator operates the incendiary machine using the hand held control. This allows him control of the lighting pattern during turns outside the block and when avoiding swamps. The navigator regularly checks the spacing between runs and helps the pilot maintain the required spacing. The IMO must be fully familiar with the operation and maintenance of the incendiary machine. His role is to ensure its smooth operation during the flight.

3.4 Heliport Marshall/Load Master:

The Heliport Marshall/Load Master is responsible to the Operations Officer. This position is the most important since the mechanics of the mixing site and heliport operation revolve around it. This position will be filled by Qualified Personnel supplied by the Air Charter Company. Duties and responsibilities include:-

1. Be familiar with safety regulations and procedures during the handling of flammable liquids and helicopters,

2. Conduct emergency drill before the operation to ensure all personnel are familiar with escape routes, fire fighting and first-aid procedures.

3. Establish procedure for handling all movement of the helicopter in the fuel mixing area and on the heliport; this is done in conjunction with the pilot and ground crew.

4. Use standard hand signals to direct helicopter.

5. Prevent snagged lines while helicopter is hovering.

6. Keep unauthorised people at a safe distance from the helicopter.

7. Carry out refuelling of the Helicopter as required.

8. Plan and supervise all loading and unloading of the Helicopter.

3.5 Ground Crew (Helitorch Operations):

Usually three ground crew persons are necessary, gel Mixer, Fuel Pump Operator and Fire Extinguisher Standby Operator. These persons must be familiar with the safety, handling of flammable liquids, and movement around helicopters.

3.6 Burn Boss Assistant (Winter Burns Perth District):

Generally only one, but where multiple burns are programmed can be more.

Responsible to the Burn Boss, tasks include:-

1. Ensuring next burn is free of stock and persons and is available to burn.

2. Conduct weather readings on-site - including temperature, wind speed and direction, SMC humidity readings, cloud cover, (see sample sheet - appendix) and test fire behaviour.

3. Assists the burn boss with general duties as required - see burn boss above.

3.7 Ground Vehicles:

Vehicles required for each burn include a 4WD for the burn boss; a vehicle for the burn boss assistant; a helicopter tender vehicle carrying fuel for both the mixing gel for the helicopter or Incendiary Machine equipment/capsules plus helicopter fuel; and a heavy duty with foam attachments to be stationed at the helipad.

If the following situations occur, additional vehicles may be required:

* A high hazard area adjacent to the block to be burnt may require a water unit for surveillance;

* or where a number of burns are programmed in one day - a patrol function may be required to ensure each compartment burns out completely and safely.

4.0 PRE BURN OPERATIONS:

4.1 Administration Requirements:

1 Month Plus Prior to Burn

1. Maps of all available base helipads with associated two wheel drive vehicle access are compiled and sent to helicopter contractor, fire protection branch via Region.

2. Approximately a month prior to burning a pine burning prescription must be completed in conjunction with the pre-burn check list - CLM 32. The completed forms must be approved with the prescription by the regional protection officer.

No Rotary wing aircraft will overfly private property or built-up areas with the sling load attached.

When the Incendiary machine is being used the flight path will avoid private property/built-up ares.

1 Day Prior to Burn

The fire protection branch is contacted via Regions no later than 1530 hours the day before the burn. This allows time for them to place the helicopter contractor on standby, who in turn notifies Pearce Air Base of the probable requirements to fly in restricted airspace (Perth District only).

Day of Burn

1. On the morning of the burn the area is field checked and a test fire initiated. The results from the field trip together with an appropriate forecast is used to make the final decision. A positive or negative confirmation is generally made by 0900. From here the region is again notified who in turn contact the helicopter contractor.

2. If the burn is to go ahead a plan of the area including the helipad and its road access; names of all involved and start times, is left with the office receptionist. This information is to be used during SAR operations and any emergency situations that may arise.

4.2 Field Operations:

Six Weeks to One Day Prior to the Burn

1. Firebreak preparation is undertaken once identified during the prescription stage. Blocks to be burnt are isolated from non burn areas and large pine compartments may be broken up for ease of control.

2. To be completed prior to the burn is any 'edging' required. Because of 'edge effects' it may be necessary in both pine and hardwood operations to burn some 20 to 50 m in from the burn perimeter.

On the Day of the Burn

1. During the ignition stages navigational aids may be required. These are generally the lighting of the burn corners just prior to the first ignition run.

2. A safety measure also undertaken just prior to the burn are the closure of roads/tracks in the area. These include both those around the target area and the helipad.

6.0 AERIAL IGNITION - BURN TYPES AND AIMS:

6.1 Pine:

Perth District has conducted a series of aerial ignition pine experimental and operational burns since 1984 using helicopters. The latest in the winter 1992 were over needlebed and red tops. From these burns the following procedures and aims can be determined.

6.1.1 Aerated Fuels:

(i) RED TOPS (Compressed tops or windows as left by mechanical harvesting)

A. AIM - to effect graduated fuel reduction with minimum fire damage.

In heavy fuel concentrations two of more burns are required. The initial burn should be aimed at patch or hole burning of the tops, so that the succeeding burns in warmer conditions will not develop fire fronts. (A J ASHCROFT) NB: During aerial ignition the follow-up burning may be done by hand.

B. OBJECTIVE - to produce a fuel bed (disregarding limbs) of less than six tonnes per hectare.

C. CONDITIONS REQUIRED:

WIND - velocity should be steady generally exceeding 10 km/hr, but less than 40 km/hr.

SMC - original lighting between 20% and 24% with 15% or greater for follow-up to ignition.

AIR TEMPERATURE - should remain between 17oC and 22oC.

PROFILE MOISTURE - no burning should be undertaken unless the profile has been completely saturated and is drying from the top.

D. IGNITION TECHNIQUE

With the above conditions and the return of the compressed tops the best method of ignition was using the helitorch, flying along the rows.

During the cooler parts of the day or when the fuels were damper or more compact the ignition run was made in the needlebed adjacent and up wind of the logging debris. This would allow the fire 'build up' before blowing into the windows.

As the day warmed and the fuels dried or where they were less compact, the ignition run was made on top of the heaps.

(ii) GREEN TOPS

A. AIM - to reduce fuels in recently logged plantation areas with minimum fore damage to standing trees.

The dense green tops with high moisture content should be used as a 'blanket' to control the density of the fire.

The consuming rate of the fuel and hence its rate of spread. (A J ASHCROFT).

B. OBJECTIVE - to burn the green tops over winter to reduce potential fire hazard.

C. CONDITIONS REQUIRED:

WIND - open wind velocity less that 40 km/hr.

SMC - not to be less than 18% with the RH above 40%.

AIR TEMPERATURE - Between 18oC and 22oC.

PROFILE MOISTURE- to be saturated and drying from the top.

D. IGNITION TECHNIQUES - although a greentop burn has not been ignited using the helicopter I believe it would be possible using the helitorch.

ignition run would be in the needlebed between the debris rows with spacing depending on fire behaviour.

6.1.2 Needlebed:

A. AIM - as with all pine burning the aim of needlebed burning is to reduce the amount of fuel/hazard in the plantation for the following summer.

B. OBJECTIVE - to produce a fuel bed of less than 6 tonnes per hectare.

C. CONDITIONS REQUIRED:

WIND - steady at approximately 8 to 15 km/hr.

SMC - 20% to 25%.

AIR TEMPERATURE - we found with needlebed the air temperature range could be greater with minimum approximately 16oC to a maximum of around 23oC.

PROFILE MOISTURE - as with all pine burning operations the profile should be saturated and drying from the top.

D. IGNITION TECHNIQUES

Both AIIM and helitorch operations can be used for this type of burning. High levels of ignition as required for tops burning is not vital for needlebed burning, hence the capsules and wider spacing is adequate.

Flight lines should be across the wind and spacing determined by the fast fire behaviour.

6.1.3 Test Fire:

It must be noted that prior to any aerial ignition operation in a plantation a series of hand lit test fires are required. These should be in place before the final confirmation of the helicopter takes place, and in fact should be used to help make that decision.

6.1.4 Prescriptions:

Burn prescriptions should be completed and signed by the Regional Manager Protection for all aircraft pine burning operations.

Included should be an adequate plan for use by the fire boss and navigator which should show burn boundary, fuel ages for burn and adjacent area, buildings, powerlines and other structures, logging operations, private property, boundary problems , water points and helipad sites with their associated access.

6.2 Native Forest:

6.2.1 Banksia:

6.2.2 Coastal Heath:

(NB: This section has not been included in the manual at this stage as burning of these fuel types is yet to be undertaken).

7.0 POST BURN PROCEDURES:

7.1 Assessment:

Assessment following the burn can take place as soon as the running fire is out. There is no applicable form to be completed and I don't believe any is necessary. If the burn has achieved the objectives as per the prescription, no further action is required; if the burn is not completed then a modified prescription should be written and re-ignition planned.

If there is damage to crop trees or some problem areas exist within the burn, these should be also recorded during the post-burn assessment.

7.2 Fuel Availability:

7.2.1 Helicopters:

Type	Fuel	Available From	Approx Cost
Squirrel	Jet A-1	Shell Nth Fremantle	*$200/200l drum
Bell 206 Jet Ranger	Jet A-1	Shell Nth Fremantle	*$200/200l drum

* Drums not returnable - price included in total.

8. SAFETY CONSIDERATIONS GENERAL

8.0 Safety

The aerial Helitorch uses a high energy low flashpoint fuel of high volatility. The potential for an accidental fire or explosion as a result of careless or improper practice in handling such fuel is always present. A totally uncompromising approach to safe working methods and adherence to established rules is required at all times.

8.1 Safety at the Mixing Site

The detailed instructions relating to safety at the mixing site described in Section 4.2 shall be rigidly followed and adhered to. District staff are to be familiarised with the rules and the senior district person present shall ensure the compliance with these requirements by his staff.

8.2 Air Safety

The pilot in command is responsible for all matters relating to the safety of the aircraft, its passengers and its external load. It has been determined that flight parameters of a minimum air speed of 40 knots and height above aerial obstructions of 200 feet shall be maintained as far as possible to enable a controlled landing to be made in the event of an engine failure.

On no account will the air or ground crew despatch, use, or continue to use, the Helitorch should any of the following potentially unsafe conditions exist prior to or occur during flight.

1. Fuel leaks;

2. fire extinguisher exhausted or manual over-ride system disarmed or discharged;

3. carbon dioxide pressurising cylinder below permitted level;

4. propane gas leaks;

5. instability in pressurising system or indicator gauges for whatever reason;

6. faults in safety relief valve or low pressure sensor valve;

7. electrical faults;

8. loss or air / ground communications.

8.2 Air Safety (continued)

Aircrew shall be restricted to pilot and Helitorch operator at all times including ferrying to the target area when the Helitorch is attached. If additional passengers are to be carried for reconnaisance or planning of the lighting strategy the helitorch must be removed and unhooked from the helicopter.

8.3 Ground Crew at Target Area

For the duration of the lighting operation, ground crews at the target area must keep a minimum distance of 100m from the coupe boundary if located in a position where the aircraft passes them in a straight flight line, or 200m if located at an aircraft turn point. At the completion of the aerial lighting operation the aircrew shall advise by radio that the aerial lighting is completed and it is safe for ground parties to re-approach the target area.

8.4 Third Party Persons and Property

A representative of the District must be present on every target area before lighting commences, to confirm by radio to the aircrew that the area is clear of persons and property and that lighting may commence. Where it is necessary to close roads the District representative shall make the appropriate arrangements for the duration of the lighting operation.

9. DESCRIPTION OF SITE AND EQUIPMENT

9.1 Heliport

1. The heliport is the helicopter's staging area, it lands and refuels there. Equipment and helicopter fuel are stored at the heliport.

2. The heliport is usually at least 300 feet uphill or upwind of the helitorch fuel mixing site (CAA regulations prevent helicopters from landing within 300 feet of the fuel mixing site).

3. The heliport is usually chosen by the pilot. it should be easily accessible to the fire boss.

9.2 Helitorch Mixing Site

1. Safety equipment, mixing drums, fuel and chemicals are stored on this site.

2. The site is at least 100 x 100 feet with a clear approach and exit path for the helicopter.

3. It must be on flat or raised ground and not in a hollow where petrol fumes will accumulate.

4. Spilled fuel must be cleaned up and disposed of promptly.

5. If spilled fuel cannot be cleaned up, the mixing operation must be moved elsewhere.

6. The Heliport Marshall and ground crew person must always be present when operations are under way.

7. Unauthorised personnel and vehicles must be kept out of this area.

9.3 Helitorch

1. The W A Dragon Helitorch is a device designed to dispense ignited gelled petroleum in large droplet form for lighting fires for a variety of forest and land management objectives. (Refer to Section 2.1 page 4 for details)

9.4 Helitorch connection to Helicopter

1. For safety the helitorch is suspended under the helicopter on cables. Electric power to run the pump motor and igniter is supplied by the helicopter through an electrical connector.

2. To assist the pilot with the pick-up and set-down of the helitorch an external mirror is fixed to the helicopter to keep the unit in sight.

3. It is the responsibility of the pilot to test the hook releases, and electronics before the operation commences. This is done in a location other than the mixing area.

10. DESCRIPTION OF MIXING OPERATIONS

10.1 Safety Considerations

Due to the high volatility and low flashpoint of petrol, adherence to the following safety procedures and the need to exercise caution cannot be over- tressed.

Dangers to look out for include:

* Naked flames, smoking etc. within 30m of the mixing site;

* movement of vehicles within 30m of mixing site;

* unauthorised people not essential to the operation within 30m of mixing site;

* static electric discharge, from travelling in vehicles, pumping petrol;

* spark generating footwear, eg. spiked or nailed boots;

* inhalation of petrol fumes during mixing.

The mixing operation is the most important part of a helitorch operation. Contaminated gelling agents and petrol can have a drastic effect on the quality of gelled fuel and consequently the burning operation.

Procedures for mixing and gelling times will vary due to temperature of the petrol and the type of gelling agent used. The colder the petrol, the longer the gelling time. Alumagel gels slowly while Surefire gels quickly. Less than half as much Surefire is needed as Alumagel. Only Surefire is used in this State.

The length of time between mixing and using is also very important. Mixing should be done just prior to use rather than premixing large quantities; however, enough lead time is required to prevent delays in burning operations. It is generally acceptable to premix loads 20 to 30 minutes prior to use to ensure proper gelling.

Each operation will require some experimentation in the amount of gelling agent required per drum of petrol to obtain the proper mixture.

"Alumagel" and "Surefire" are non-hazardous gelling agents and may be shipped and stored with minimal precautions. Gelling agents should not be transported with helicopter fueling equipment. They must also be stored in a dry place and sealed in plastic bags to protect against moisture.

10.2 Support Equipment Required
(see checklist Appendixÿii)

Equipment considered desirable for an efficient, effective and safe helitorch operation includes :

1. Helitorch

2. 200 litre fibreglass lined mixing drum with 50mm outlet pipe and stop valve.

3. Non-sparking mixing paddles (aluminium or wood).

4. Flour sifter

5. Buckets, Plastic and funnel plastic.

6. Petrol Pump

7. Portable radios for communications with helicopter and ground crew.

8. Fire resistant overalls; nomex, PFZ wool or Proban treated cotton coveralls or cotton pants with long-sleeved shirts; NB: synthetic fabrics and short-sleeved shirts or short pants are not permitted; high visibility colours are preferred.

9. Rubber gloves for mixing crews (use optional)

10. Dust masks for mixing crew (use optional).

11. Hearing protection for mixing crew (use optional).

12. Hard hats, if worn, to be fitted with and secured by, a chin strap.

13. No caulk boots or hobb-nailed shoes.

14. Rags as needed for helitorch cleanup and long-handled washing brush.

15. "No smoking" signs posted in prominent places around the mixing site.

16. Direction signs posted to limit access and define areas.

17. Specified location for securing discarded or soaked rags, used chemical bags and trash.

18. Approved wet-type burn cloth, blankets.

19. Water for first aid purposes.

20. Water pump / truck to pre-soak heliport for dust control (optional).

21. Grounding rods.

22. Grounding cables.

23. The fuel mixing drum to be equipped with a small area cleared to base metal to receive magnet used to discharge static electricity.

24. Necessary tools for emergency maintenance of helitorch.

10.3 Material Required

1. Fuel supply; super petrol at ambient temperature (130 litres per full helitorch load). For small operations consider 200 litre drums. However, where operations are large an independant fuel supply truck is preferred; there must be no fuel leaks; tank must have shut-down valve at hose connections.

2. Gelling agent; as required - in pre-weighed packages of 350gms per drum to allow for gelling half loads without guesswork; for a full mix use two bags.

3. Solvent; as required for cleaning and helitorch maintenance; do not use petrol for washing and cleaning.

4. Liquid petroleum gas; (LPG).

5. Carbon Dioxide; CO_2.

10.4 Personnel and Safety Equipment

Two operators are required as follows:

(i) Gel mixer;

(ii) fuel pump operator;

In addition to the mandatory safety equipment of safety boots and helmets the operators shall wear fire resistant overalls of nomex, PFZ wool, or proban. Metallic mesh visors shall be fitted and worn on all helmets. The gel mixer should wear in addition rubber gloves and a suitable vapour mask or respirator (organic vapour). Dermex 5A barrier cream should be used as needed.

10.5 Bonding and Grounding Procedures

10.5.1 Equipment for Bonding and Grounding

An adequate number of suitable grounding cables and rods should be provided at the fueling site where fuel servicing operations are being conducted.

1. Bonding cables must be flexible and durable material. Plastic covered metal clothesline with heavy duty alligator clips / magnets work well.

2. Cables and grounding rods with as low an electrical resistance as possible should be used. All connections must be tight.

3. All bonding and grounding connections must be firm and unpainted.

10.5.2 Fueling from a Vehicle

1. Connect a grounding cable from the vehicle to the grounding rod. Ensure rod is in the ground and the cable connections are secure.

2. At the fuel nozzle and the fuel mixing drum site (50 to 75 feet away from the fuel supply) drive a grounding rod into the ground. Connect a grounding cable from the grounding rod to a convenient, unpainted metal point on the fuel mixing drum.

3. Bond the fuel nozzle to the drum before pumping fuel. The bond between the nozzle and the drum is essential and must be maintained throughout the fueling operation. Remove the bond only after fueling is completed.

4. Disconnection of bonding and grounding cables is in reverse order.

CAUTION: Conductive-type fuel hoses will not provide a satisfactory method of bonding. NEVER USE a plastic container for fueling which cannot be properly grounded and bonded.

5. Grounding a hovering helicopter is advisable. Use the fuel mixing drum grounding cable, to touch the hovering helitorch before handling. Electrical discharge from helicopters may be aggravated by wet ground.

10.6 Mixing Procedures:

Secure site; place warning signs at approaches to mixing site, clear 30m area around mixing site of unnecessary vehicles and people. Don safety clothing, check mixing drums and equipment are dry and clean. Fit outlet pipe to mixing drum and place on edge of tray top along with drum of super petrol. Fit petrol pump to petrol drum.

It is suggested that the following procedures be followed to bleed off the original static charge as well as any static generated during fueling operations.

Connect antistatic grounding leads between lug on mixing drum to top of petrol drum, the nozzle of the petrol pump and the lug on the mixing drum and drive grounding stake into the ground and connect to the vehicle.

Place mixing paddle in drum and have opened packets of Surefire or Alumagel and sifter handy.

When the level of petrol is a few centimetres deep fill the sifter with Surefire or Alumagel powder and gently shake into the petrol holding low in the drum to stop loss of powder to the breeze. Add slowly to ensure a smooth consistency. While adding the powder continue to pump the petrol and stir the powder in with the paddle. Reject any material which will not pass through the sifter.

CAUTION: Petrol often contains a poisonous lead compound; therefore personnel should keep their hands out of petrol or fuel mixtures containing petrol. The consistency of fuel can be tested with a wooden mixing paddle, not with the hands. Special care should be taken to keep petrol fuel mixtures away from the mouth and eyes, open cuts and abrasions.

Petrol fumes are injurious as well as flammable. Avoid inhaling fumes as much as possible. Never mix flame fuels inside a building or tent.

When the required load is reached (130 litres for a full load is indicated by the 2/3 full ring around the drum) remove the pump and leave the antistatic leads connected. Continue gently stirring the petrol, ensuring it is being mixed throughout. As the mixing continues the consistency of the petrol will gradually change.

It will take on a smooth glassy appearance and foaming and splashing will stop. Some 5 to 10 minutes after beginning, the gel will start to thicken up rapidly becoming noticeably heavier to stir. The surface consistency to watch for is a rough uneven surface due to lots of small gelling centres giving the appearance that it's boiling. If the paddle is scraped just free of the gel up the side of the drum, gelled petrol will remain on the paddle. At this stage stop the stirring as any further agitation will cause shear in the gel preventing further thickening. The longer the gel is left that day the better the consistency will become. Within about 15 minutes of commencing mixing, if using Surefire, the gel should be like a smooth heavy resin and quite elastic if scooped up the side of the drum. It is ready for use at this stage.

Gelling agents added after the mixture begins to gel will lump and most often not dissolve.

CAUTION: Do not use gel that is too thin because it will flame up on the end of the torch, break into smalled droplets and have a shorter burning time.

Mixing must be done with an aluminium or wooden paddle to avoid sparks. Be careful that the mixing paddle is not placed where it will pick up rocks or other debris which may damage the pump.

Use the wool / woven trash bag to cover the mixing drum whenever the helicopter is active to prevent contamination.

10.7 General Tips with Gel

Existing gels and new gels can be easily and successfully combined.

Once the gelling action has commenced more powder cannot be successfully added to the brew.

Presence of water or zinc will make gelling difficult/ impossible.

Very thorough mixing of the brew until gelled appears to get best results.

An existing gel cannot be successfully thinned, thickened or added to by the use of more petrol or gelling agent.

If a problem with the gel arises toss it out, clean equipment and start again.

Do not try to sieve a lumpy gel. It cannot be done successfully and will probably ruin the sieve.

10.8 Cleaning and Disposal of Waste

Cleaning is best done immediately with petrol. Rinse out mixing drum and outlet pipe into buckets. Clean out the buckets and dispose of petrol and gel waste by burning if safe to do so or by burying.

10.9 Excess Gel

This may be kept overnight for further operations by transferring into the 60 litre drums. Experience to date indicates that the gel may require to be remixed the following day to regain the desired consistency throughout. If no further burning operations are planned for the following day all excess gel should be disposed of.

11. OPERATING INSTRUCTIONS AND LIFT-OFF PROCEDURE

11.0 Operating Instructions

Before the commencement of each operating day a charged fire extinguisher, CO2 pressurising cylinder, and propane gas cylinder shall be fitted. If the device is being powered from its own battery pack then this should be charged overnight after each day's operation.

11.1 Test Procedure

1. Connect power and control line to unit (7 pin plug will only fit one way). Check control box for ignition to "OFF" fuel flow to "OFF" (Central) position and master switch (Dead Man's Handle) to "OFF" position. Connect power supply battery to control box lead.

2. Turn on fire extinguisher at cylinder valve check pressure at 700 kpa. Regulate if necessary at regulator valve.

3. Close tank lid and purge valve.

4. Turn on tank pressurisation cylinder slowly at cylinder valve. Check pressure at primary regulator at 200 kpa and 15 kpa at secondary regulator. Regulate if necessary at regulator valves.

5. Turn propane on at cylinder valve. (Pressure and flow pre-set).

6. Test fire extinguisher operation (red button).

7. Disconnect motor from pump connecting rod and lock in park position.

8. Test motor for operation in fast and slow modes (flow to "FAST" or "SLOW" and depress Dead Man's Handle).

9. Test for propane ignition (ignition switch to "ON", flow switch to "FAST" or "SLOW", Dead Man's Handle depressed). Extinguish with 2 second burst from extinguisher. A portable fire extinguisher must be present during this test.

10. Examine tank and all plumbing for signs of gelled fuel, CO2 or propane leaks.

11. Examine all strops and connectors for wear and security, strops correctly set up in relation to each other and long axis of lifting hook aligned to long axis of tank.

11.2 Preparation for Flight

1. Turn off tank pressurising cylinder and depressurise tank via purge valve, open lid.

2. Fill tank (max. load 130 litres : 2/3 of 200 1 drum).

3. Close and lock lid. Turn on CO2 pressurising cylinder with purge valve open for one minute, close purge valve.

4. Clean any gel spills from tank.

5. Check :

   * Fire extinguisher on;
   * propane on;
   * power and control lead connected;
   * auxiliary power lead in aircraft;
   * control box in aircraft;
   * tool box and spare fire extinguisher cylinder and goggles in aircraft;
   * over-ride fire extinguisher strop in aircraft and connected to an anchor point, despatcher's harness in aircraft and connected to an anchor point, operator has electrical tape in pocket.

11.3 Hooking Up and Ferrying to Target

Different pilots prefer differing hooking up and guidance methods. The pilot in command will brief and/or train the Load Master. The following procedure has proven most effective.

1. Pilot to direct ground crew in take-off direction : ground grew align helitorch accordingly.

2. Loadmaster stands clear of torch (must wear goggles, gauze screen mask, hard hat and earmuff set).

3. Helicopter assumes hover mode over torch; pilot signals to hook up.

4. Loadmaster attaches lifting strop eye and / or additional shackle depending on helicopter hook type and hands power and control cable and fire extinguisher cable to helitorch operator in rear seat (door open or removed depending on helicopter type). Helitorch operator holds cable and talks the pilot up, maintaining vertical position above torch. Vigilance is required to ensure no snagging of strops or cables on torch. Loadmaster retreats to position forward of aircraft in sight of pilot. Helitorch operator advises pilot all well for departure.

5. CAUTION: DO NOT CONNECT POWER AND CONTROL CABLE TO CONTROL BOX OR AIRCRAFT POWER OR BATTERY POWER UNTIL OVER TARGET.

11.4 In Flight Operation

11.4.1 To Operate

1. Connect control box to power and control cable and to aircraft or battery power supply.

2. Select fuel flow rate "FAST" or "SLOW".

3. Turn ignition to "ON".

4. Depress master switch (Dead Man's Handle) and hold down.

11.4.2 To Extinguish

1. Release master switch.

2. Allow 5 second delay.

3. Depress fire extinguisher button for three seconds.

4. Turn off fuel flow and ignition switches.

5. Disconnect from power supply if ferrying outside target area.

11.5 Ferrying From Target Area and Unhooking

11.6 Closing Down Procedures

To close Down (Overnight only)

1. Turn off: Fire Extinguisher} at
   CO_2 pressure cylinder } cylinders
   propane supply }

2. Disconnect power leads.

11.7 To Close Down (Several Days)

For a close down of longer than overnight it is necessary to remove the gel from both the storage tank and the helitorch plumbing system.

This is done as follows :

1. Remove gel from tank and filter as described in 7.3 and 7.4

2. Pressurise the tank as for flight.

3. Disconnect the lead from the coil to the spark plug at coil end.

4. Turn off propane supply at cylinder valve.

5. Run the gel pump until gel flow stops (catch gel in suitable container).

6. Add 5 to 10 litres engine oil to tank, run gel pump again until clear oil only flows.

To remove engine oil prior to next operation repeat steps 2 to 5.

11.8 To Close Down (Winter Storage)

Prior to winter storage it is essential that all gel residues are removed from the tank and plumbing system. To achieve this the following procedure is applied.

1. As for steps 1 to 6 in 6.7 above.

2. Remove gel filter screen and cover.

3. Drain surplus engine oil.

4. Thoroughly wash inside of tank with high pressure hot detergent washer until all gel residue gone then rinse with high pressure hot water until all detergent residue gone.

5. Refit gel filter screen and cover add 20 litres engine oil.

6. Run oil through gel pump until it emerges clean.

7. Tilt drum to coat all internal surfaces with oil.

8. Ready for storage until winter overhaul.

12. FIELD OPERATIONAL SERVICING

Field servicing comprises changing cylinders, removing left over gel and cleaning gel filter and may be performed by persons judged by the nominated officer as competent and trained to do so.

12.1 Changing CO2 Cylinders and Fire Extinguisher

It is important that the procedure given is followed in given order to avoid stressing gas tight joints and gas lines.

1. To Remove the Cylinder

Ensure cylinder valve is shut;

Loosen connecting nut and screw;

Undo cylinder clamp and remove cylinder;

2. To Replace Cylinder

Install fresh cylinder and do up connecting nut finger tight;

Fit cylinder clamp and tighten;

Tighten cylinder connecting nut and check for gas tight joint.

NOTE: Both the CO2 pressurising cylinder and the ire extinguisher have fibre washers between the connecting seat and the sealing nut. At every cylinder change check the washer is present and in good codndition and the seat free of contamination.

12.2 Changine Propane Cylinders

To Remove Cylinder

(i) Ensure valve is closed;

(ii) Undo outlet pipe from cylinder elbow and valve unit. It has a LHT thread;

(iii) Undo cylinder clamp and remove cylinder;

(iv) Undo elbow and valve unit from cylinder (finger tight only) check "O" ring for presence and condition and fit to fresh cylinder.

To Remove Cylinder

(v) Reverse above steps (i) to (iii).

IT IS RECOMMENDED THAT ALL PARTIALLY USED CYLINDERS BE VENTED TO ATMOSPHERE AS SOON AS REMOVED TO AVOID CONFUSION WITH FULL CYLINDERS

12.3 Removing Left Over Gel

1. Place driptorch on trailer ramp supported in horizontal position.

2. Close tank pressurisation cylinder valve and vent tank.

3. Remove filter cover and filter screen and replace with drain adaptor and hose (hose end in storage drum).

4. Pressurise tank as in 11.2 3.

5. When gel flow stops (CO2 flow into drum will be audible) close CO2 pressurising cylinder valve and vent tank.

6. Remove drain adaptor pipe and replace filter screen and cover.

12.4 Cleaning Gel Filter

The need to clean the gel filter varies inversely with the quality of the gel brewed and the clean- liness of the fuel and all containers used in the mixing process. At least daily and more often if the gel is suspect. The filter cover and screen should be removed and thoroughly cleaned with petrol and a soft brush if necessary. The filter cover threads and cover seat must be scrupulously clean and the fibre washer in good condition on the seat before refitting the screen and filter cover.

12.5 Field Repairs

Limited field repairs as detailed below may be carried out by appropriately qualified trades-persons and others suitably trained and qualified as determined by the nominated officer. (See Appendix 5, 6.2). Such authority shall be given in writing by the nominated officer naming the authorised person if not an appropriately qualified trades-person.

Such field repairs shall be limited to the following:

(a) Ignition circuit: Clean or replace spark plug, replace ignition coil, replace condenser, clean interruptor contact breaker points, fit exchange interrupter unit, replace voltage reducer.

(b) Propane circuit: Fit exchange control valve, fit exchange regulator unit.

(c) Fire extinguisher unit: Fit exchange control valve, fit exchange regulator unit.

(d) Gel pump motor: Fit exchange drive motor, replace circuit fuses, adjust pis

(e) Gel pump unit: Fit exchange unit.

(f) Alumagel circuit: Clean fuel filter.

(g) Tank Presssure system: Fit exchange regulating valves, replace pressure switch.

All replacement components must be procured from bonded store and unserviceable components returned to quarantine for repair/adjustment or disposal.

13. ANNUAL INSPECTION AND MAINTENANCE

During the winter months an annual inspection and maintenance schedule on helitorches shall be carried out under the direction of the nominated officer as follows.

13.1 Annual Maintenance Schedule SERVICE

1. Tank Unit Inspect tank for corrosion ________
Internal and external ________
Examine all welds and seams ________
Check frame for damage ________

2. Tank Lid Check screw threads for wear ________
Check seal ________
Check locating lugs for wear ________
Check locating bracket for distortions ________

3. Fuel Line Check fuel line for damage ________

4. Fuel Filter Remove filter and clean ________
Examine filter screen condition ________

5. Fuel non-return Valve Remove, dismantle and check all components ________
Examine valve and valve seat for wear ________
Replace valve seat O ring ________

6. Fuel check valve and Flame Stop Remove, dismantle and check all components ________
Examine valve seat for wear. ________
Test check valve lift pressure ________

7. Gel pump assembly Remove, dismantle and check all components ________
Replace spool rings ________
Replace spool O ring ________
Check spool and cylinder for wear ________
Check valve and valve seat for wear ________
Replace valve O ring ________
Check spool gudgeon bushes for wear ________
Test check valve lift pressure ________

8. Fire extinguisher Lines Check all piping for damage ________
Check pipe joins ________

9. Fire extinguisher Control Valve Remove, dismantle, check spool valve for wear ________
Replace all seals ________
Check solenoid current draw ________

10. Fire Extinguisher mechanical control Check condition of mechanical linkage ________
Lubricate, check condition of cable ________
Check breakaway linkage ________
Replace weak link wire ________

13.1 Annual Maintenance Schedule (continued) SERVICE

11. Fire extinguisher Fit serviced unit________
Regulator & gauge

12. Propane lines Check all piping for damage ________
Check pipe joints________
Carry out leak test ________

13. Propane control Fit serviced unit________
Valve
(Check with local gas dist./service)

14. Propane regulator Fit serviced unit________

15. Propane flashback Test valve ________
Check Valve Replace as required ________

16. Propane burner Examine, replace as required ________
Nozzle

17. Propane draft Check condition of screw ________
Shield Clean or replace as required ________

18. Tank CO2 pressure Fit serviced unit
regulator Service annually ________

19. Tank CO2 secondary
pressure regulator Fit serviced unit
and gauge Service annually ________

20. Tank safety valve Remove, dismantle, check condition
and operation ________
Replace worn parts as required
(must be resealed by DLI before ________
next use).

21. Tank purge valve Examine, test for leakage ________

22. Tank pressure lines Examine for damage ________
Test all points for leakage ________

23. Tank pressure Test operating pressures ________
Switch (low pressure) Service annually

24. Electrical wiring Examine condition of all wiring ________
Check all terminals ________
Check resistance of all switches
and wiring ________

25. Ignition coil Remove, test ________

26. Ignition Spark plug Replace ________

27. Ignition Examine condition of contact
Interrupter Unit breaker points ________
Clean or replace as necessary ________
Test ________

13.1 Annual Maintenance Schedule SERVICE

28. Voltage reducer Rest for correct voltage drop ________

29. Ignition condenser Test capacity ________
Replace as required ________

30. Fuel pump drive Remove, dismantle________
Motor Check condition, overhaul as
required ________

31. Drive motor fuses Replace ________

32. Flame shield Examine for damage ________
Replace as required ________

33. Fire extinguisher Subject to the required regular
cylinder, CO2 tests and inspections ________
pressure cylinder (Done as routine by filling agents)
propane bottle

34. Lifting, eye strops Examine condition, replace as
shackles and required ________
attachments

35. Control panel Check condition and resistance
of all switches ________
Examine wiring and terminals ________

36. Control panel Examine for damage ________
wiring loom Replace as required ________

37. Control panel loom Examine condition and for correct
breakaway operation ________
connections Replace as required ________

38. Lifting handles Examine condition________
and cap locating Replace as required ________
clips

39. Pressure relief Clean and service pressure relief
valve valve ________
Have recertified by Department of
Occupational Safety Health and
Welfare (DOSWA) Pressure Inspector________
and resealed

40. Finish and Signs Repaint unit as required and renew
signs and lettering as required ________

13.2 Maintenance and Repair Responsibilities

The Department shall nominate an officer as responsible for the proper and competent maintenance and repair of the helitorches. The nominated officer may acquire the services of appropriate trades-persons within and without the Department as required to discharge this function. No repair or maintenance work other than that specified in Section 12.5 field servicing may be carried out by any person without the authority of the monimated officer or his deputy and such authority shall be notified in writing.

Where it is necessary to remove a seal installed by an inspector of DOSHWA to effect an adjustment or repair the nominated officer or his deputy shall so arrange and shall take such steps as are necessary to ensure that the machine is not operated until resealed by an inspector of the DOSHWA.

The nominated officer or his deputy shall cause a log book to be kept with the machine in which the date and exact nature of any repair and the person performing it shall be recorded. A arecord of parts repaired or replaced contingent on such repairs shall be noted in the log. All repairs other than those refered to in Section 12.5 field servicing must be recorded.

13.3 Storage of Components

The nominated officer shall be responsible for the acquisition, checking for compliance of trueness to specification or approval of substitutes, storage, issue and disposal of all helitorch components. The nominated officer shall maintain a constantly updated inventory list of all components and their supply source used in the helitorch.

Secure storage of components shall be organised as follows:

(1) Bonded Storage: New components which have been checked by the nominated officer for trueness to specification and used components which have been repaired, serviced or otherwise brought back to serviceable condition shall be held in bonded storage and clearly marked "Serviceable component helitorch" by a label attached to each component.

(2) Quarantine Storage: Unserviceable components which are repairable shall be clearly labelled "Unserviceable component helitorch" and held in quarantine storage. New components awaiting checking for trueness to specification shall be stored in same storage prior to upgrading to bonded storage.

(3) Disposal: Unserviceable components which cannot be repaired or made serviceable shall not be returned to storage and shall be disposed of in the normal manner.

APPENDIX 1

SUPPORT EQUIPMENT CHECKLIST

Item No	Item	Quantity	Items Required on Site	Items on Site
1	Helitorch	1	_____	_____
2	Mixing Drums	2	_____	_____
3	Wool Bale (to cover drums or lids)	2	_____	_____
4	50 mm outlet pipe and valve	1	_____	_____
5	Mixing Paddle - non sparking	1	_____	_____
6	Storage Drum GO L2		_____	_____
7	Grounding Cable, antistatic lead	3	_____	_____
8	Grounding rod,	2	_____	_____
9	Small sledge hammer	1	_____	_____
10	Flour sifter	1	_____	_____
11	Plastic Buckets	4	_____	_____
12	Plastic funnels 250 mm	2	_____	_____
13	Petrol pump rotary	1	_____	_____
14	Fuel supply 200 litre drums	as needed	_____	_____
15	Fire Extinguisher dry powder 9 kg	2	_____	_____
16	Shovel Round mouth, short handle	1	_____	_____
17	Warning Signs	2	_____	_____
18	Clean rags	bagful	_____	_____
19	Solvent 20 litre drums	as needed	_____	_____
20	Plastic garbage bags	packet	_____	_____
21	Fire resistant overalls Proban 2 x M size, 2 x OS size	4	_____	_____

APPENDIX 1 (Continued)

SUPPORT EQUIPMENT CHECKLIST

Item No	Item	Quantity	Items Required on Site	Items on Site
22	Fire resistant overalls PFZ wool 2 x M size, 2 x OS size	4	_____	_____
23	Helmets with mesh visor, chin strap and earmuffs	4	_____	_____
24	Goggles	4	_____	_____
25	Rubber gloves	2 pair	_____	_____
26	Organic vapour masks	box	_____	_____
27	Fire Blanket	2	_____	_____
28	Extra CO2 cylinder pressure D size	2	_____	_____
29	Extra CO2 cylinder fire extinguisher	3	_____	_____
30	Extra propane LPG gas cylinder	3	_____	_____
31	Adequate Surefire	Plenty	_____	_____
32	Strops and lifting eye	1 unit	_____	_____

APPENDIX 2

TOOL BOX CHECKLIST

ITEM	TOOL BOX 1 - ELECTRICAL	QTY	
1	Control box	1	________
2	Control box power lead to aircraft supply	1	________
3	Control box power and control lead to dirptorch	2	________
4	7 Pin power and control lead fitting	1 pr	________
5	Adaptor lead control box to battery pack	1	________
6	24V Battery pack	1	________
7	Battery charger	1	________
8	Circuit Tester	1	________
9	Insulating tape rolls	3	________
10	Short leads and crocodile clips for battery charging	2	________

	TOOL BOX 2 - MECHANICAL		
1	Spanners adjustable 10"	2	________
2	Spanners adjustable 6"	2	________
3	Screwdrivers flat head medium	1	________
4	Screwdrivers flat head small	1	________
5	Screwdrivers phillips medium	1	________
6	Screwdrivers electrical small (terminal)	1	________
7	Pliers large combination	1	________
8	Side cutters	1	________
9	Scales to 20kg x 1/10kg	1	________
10	Plumbers tape rolls	2	________
11	Thread tape	2	________
12	Gel strainer hose convertor kit and hose	1	________
13	Pin punch 4mm	2	________
14	Sockets 15mm and 21mm	1 ea	________
15	1/2 drive ratchet handle	1	________
16	125mm extension	1	________
17	Soft scrubbing brush	1	________
18	Spanners ring gel filter cover 9/16 x 1/2AF	1	________
19	Pump con rod 10 x 11mm	1	________
20	Spanners box spark plug 5/8 x 11/16 SAE	1	________
21	Spanners OE 28 x 30mm	1	________
22	Log book	1	________

APPENDIX 3

SPARES AND ACCESSORIES

ITEM	QTY	
1	Static line for fire extinguisher lower section	________
2	Static line stop for fire extinguisher	________
3	Despatchers harness (aircraft operator to provide	________
4	Large shackle for bell 206	________
5	Breakaway joint copper wire	________
6	Spare pins for tank lid lock	________
7	Spare pins for ramp securing system	________
8	Fibre washers for cylind outlets (CO2)	________
9	'O' rings for cylinder outlets (propane)	________
10	Goggles	________
11	Spare shackles for strops	________

OTHER

1	Flight helmets and intercom leads		2	________
2	C/W bags	regular	1	________
		large	1	________

APPENDIX 4

NOTIFICATION OF NOMINATED OFFICERS BY THE
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
AS DETAILED IN SECTION 6.2

The following officers are nominated as being responsible for the proper and competent repair and maintenance of aerial driptorches as set out in this manual and detailed in Section 4.6 and Sections 6.2 and 6.3 until further notice.

Gerard Willem van Didden Aircraft Operations Officer

Garry James Kravainis Equipment Development Officer

Syd Shea
EXECUTIVE DIRECTOR

OPERATIONS MANUAL
SECTION 8-8
SUPPLEMENT - HELICOPTER OPERATIONS
WESTERN AUSTRALIA

8.8 WA DRAGON HELITORCH FIRELIGHTER SYSTEM

1. Introduction

The WA Dragon Helitorch is a device designed to dispense ignited gelled petroleum in large droplet form for lighting fires for a variety of forest and land management objectives. It is designed to be carried and operated as a helicopter sling load.

In essence, the device is made up of four systems viz : The fuel Storage and Delivery system, The Fuel Ignition System, The Fire Extinguisher system and The Power and Control System.

The Fuel Storage and Delivery System comprises a container pressurised by an inert gas from which the fuel is drawn by a positive desplacement pump which offers an electrically and mechanically controllable range of fuel flow rates.

The Fuel Ignition System comprises a propane torch in which flame is initiated by an automobile type ignition system.

The Fire Extinguisher System operates around the fuel delivery and fuel ignition systems and is controlled by the Helitorch operator or by a mechanical over-ride device in the event that the whole Helitorch has to be jettisoned.

The Control System which is mounted in a hand held box and operated from within the aircraft, comprises switches to operate gas ignition, fuel flow and rate of flow, and fire extinguisher functions. The former two functions are over-ridden by a master switch operating on the "Dead Man's Handle" principle. Operating and control power is provided by a self-contained battery system carried in the aircraft except for the previously referred mechanically controlled fire extinguisher.

2. Definitions

Burn Boss - means the person in charge of the burning operation in the target area.

Target area - The area within which it is planned to conduct and hold the lighting operation and resultant fire.

Helitorch Operator - The person responsible for the operation and permitted field maintenance of the Helitorch.

3. Responsibilities

3.1 The Operator

The operator of any helicopter shall not permit it to be used for the purpose of operating underslung burning equipment unless and until the following conditions have been complied with :-

3.1.1 The burning equipment is owned, maintained and operated directly by the Department of Conservation and Land Management, Western Australia.

3.1.2 The pilot in command of the helicopter has had prior experience of similar low level operations and has been briefed in the principles of fire behaviour and the use of the equipment.

3.1.3 An external mounted mirror is available to the pilot to facilitate burner pickup and setdown.

3.2 The Burn Boss Shall ensure that :-

3.2.1 The area to be burned is clearly defined and that the pilot in command is fully briefed on the boundaries and the burning plan.

3.2.2 The area to be burned is clear of stock, persons and third party property and remains so for the duration of the lighting operation.

3.2.3 Drums used for the transport, storage and mixing of burner fuel are clearly marked as such to prevent the possibility of contamination of aircraft fuel or refuelling equipment.

3.2.4 A shovel is to be available to bury spilt fuel or mixture.

3.2.5 A suitably sized fire extinguisher with an operator on standby shall be available during fuelling and refuelling operations.

3.2.6 Only persons essential to the conduct of the operation shall be within 50m of the operating base and refuelling site.

3.2.7 No smoking within 50m of the operating base or refuelling site.

3.3 The Pilot in Command

3.3.1 Shall satisfy himself that the burn boss has complied with items 3.2.1 to 3.2.7 above.

3.3.2 Shall ensure that the helicopter is operated at all times in accordance with the requirements specified in the Operations Manual for the use of the underslung burner.

3.3.3 Shall make the following Pre-flight checks :

3.3.3.1 all clevis and cable clamps and 'D' shackles checked for security.

3.3.3.2 The ignition function for the burner is checked with the connecting rod to the fuel pump disconnected, and placed in the locked position. A portable fire extinguisher is to be on hand during this test.

3.3.3.3 The fire extinguisher system is functional and the bottle is charged.

3.3.3.4 The proper functioning of the cargo hook release is checked in both manual and electrical modes.

3.3.4 Shall ensure that radio telephone communications is established between the helicopter and the burn boss before commencing the operation and that the operation is terminated if communications are lost.

3.3.5 Shall make an adequate aerial reconnaissance of the area to be burnt to locate hazards and establish the flight pattern to be used. Confirmation must come from the burn boss that he is operating over the correct area.

3.3.6 Shall ensure that not more than two passengers, being the helitorch operator and a navigator if reequired, are to be carried during burning operations.

3.3.7 Shall ensure that all persons on board wear the following protective clothing :

(i) Full length fire resistant overalls,
(ii) Boots (leather)
(iii) Gloves,
(iv) Helmets.

3.3 The Pilot in Command (continued)

3.3.8 Shall ensure that the underslung burner is not ignited except when under test or flying over the target area and whilst otherwise being transported by air, the following shall be done:-

(i) Fuel pump connecting rod disconnected and placed in the lock position,
(ii) Manual tap on propane gas bottle to be turned to off position,
(iii) Electrical control and power leads to be disconnected.

3.3.9 Shall ensure that the lighting operation is conducted in such a way that smoke does not obscure the area remaining to be lit.

3.3.10 Shall ensure that the lighting operation is conducted in such a way that in the event of a forced landing, a walk-away fire-free escape route exists at all times.

3.3.11 Shall ensure that the helicopter is disconnected from the burner and landed not less than two rotors' lengths away before refuelling either Burner or Aircraft.

3.3.12 Shall ensure that at least one member of the ground crew is adequately trained and briefed in the procedures of hooking up and disconnecting the helitorch from the aircraft in the hover mode.

4. Helicopter Types

Aerospatiale Lama, Squirrel, Hughes 500, Bell 206.

5. Techniques

Refer Section 7-17 of this Manual headed AERIAL IGNITION, para. 4, sub-paras (a), (b), (c) and (d) all apply.

6 Low Flying

Refer Section 7-17 of this Manual headed LOW FLYING, para 6.

7. UNANTICIPATED RIGHT YAW AT LOW AIRSPEEDS

Company pilots are to read Section 6, Appendix 4a on this subject, together with the relevant Section of the Bell 206 series Flight Manual.

APPRENDIX 2

WA HELITORCH

Operations, Maintenance and Repair Manual

Dept Conservation and Land Management
September 1994

APPENDIX 3

HELICOPTER LANDING SITE SPECIFICATIONS

The following helicopter landing site specifications are taken from the Aeronautical Information Publication (AIP) AGA 7.1-7.5, Authorised Helicopter Landing Sites.

With new regulations introduced recently by CAA, there are now two standard of helipads that are applicable for Departmental operations.

Basic Helicopter Landing Site (HLS):

The Basic HLS may be used only by day and must be large enough to accomodate the helicopter safely and has a surface capable of withstanding the loads involved (both static and dynamic) in its use by the helicopter.

Standard Helicopter Landing Site (HLS):

Physical Specifications:

Final Approach and Takeoff Area:

The minimum size of the approach and takeoff areas shall be a circle with a diameter twice the overall length of the helicopter using the area (17.7m in the case of the Bell 205, 212 and 412 helicopters).

This area must be free of all obstructions that could interfere with the manoeuvring of the helicopter. Trees should be removed to stump height.

Ground Effect Area:

The ground effect area, if required, shall be entirely located within the final approach and takeoff area, and shall be a circle with a diameter equal to the main rotor diameter of the helicopter (14.7m in the case of Bell 205, 212 and 412 helicopters). The lateral or longitudinal overall slope is not to exceed 1.8 or 7.5o.

This area must be clear of all obstructions to ground level.

Landing and Lift Off Area:

This area must be clear of any obstructions likely to interfere with the landing and takeoff. Its size shall be equal in size to the undercarriage ground contact points plus 1m on all sides (3.3 x 3.9m in the case of the Bell 205, 212 and 412 helicopters).

Approach and Departure Paths:

Approach and departure paths shall provide obstacle free gradients which conform to the performance of the particular aircraft. They will vary a good deal because of the many different locations for helipads. Ridgeline pads will require less clearing than a pad located at the bottom of a valley. Pilots will indicate if further clearing is necessary.

General:

- Locate helicopter landing areas so that takeoffs and landings are made into prevailing winds.

- Utilise ridgetops as much as possible.

- Always establish a wind indicator.

- Warn incoming Pilots if pads are thought to be excessively dusty.

- Mark all stump tops or large rocks close to the landing and lift off area with dazzle paint.