PA38 Tomahawk

Pilot's Notes

Second Edition - August 2021

Derived from various material by

Waypoints Aviation Ltd

Waypoints AVIATION

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Run-up amended to 1,800 rpm

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Introduction

These Pilots Notes have been prepared for the Piper PA38-112 Tomahawk. Because of the number of Tomahawks being flown, the age and subsequent variation in equipment fit and the range of locations they are being flown from, these notes are fairly generic. I expect users of these notes will make appropriate variations as they wish, to suit their particular aircraft, their organisation and their circumstances/preferences.

These notes have been compiled to give pilots an operational knowledge of the Tomahawk, together with airframe and engine data and notes on the handling of the aircraft. They should be read in conjunction with the approved Aircraft Flight Manual (AFM) for each particular aircraft flown. Should the information given in these Pilots Notes conflict with that in the applicable AFM, the latter should be taken as the overriding authority.

Should you or anyone you know wish to offer constructive comment on the content of these notes they would be highly valued.

Please contact Mark Woodhouse at waypointsnz@gmail.com.

Should you or anyone you know wish to obtain an electronic copy of these notes, they are freely available at https://www.waypoints.nz/pages/free-stuff.

Disclaimer

This publication is intended to be a learning tool for pilots converting onto and operating the PA38 Tomahawk.

These notes were derived and compiled from a wide range of sources, and while the quality and accuracy of these sources appears to be reliable, there is every possibility that errors exist in this document.

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Chapter One

General

Introduction

The Piper PA38-112 Tomahawk is a two-seat, fixed tricycle undercarriage, general aviation aircraft, originally designed for flight training, touring and personal use. It has a single-engine, low-wing cantilever monoplane with a T-tail and an enclosed cabin. The Tomahawk is powered by a Lycoming O-235 four-cylinder piston engine with a twin-bladed tractor propeller. It has two front-hinged doors for access to the cabin.

The Tomahawk was Piper's attempt at creating an affordable two-place trainer. Before designing the aircraft, Piper widely surveyed flight instructors for their input into the design. Instructors requested a more spinnable aircraft for training purposes, since other two-place trainers such as the Cessna 152 were designed to spontaneously fly out of a spin. The Tomahawk's NASA GA(W)-1 Whitcomb aerofoil addresses this requirement by making specific pilot input necessary in recovering from spins, thus allowing pilots to develop proficiency in dealing with spin recovery.

Design and Development of Tomahawks

The Tomahawk was introduced in 1977 as a 1978 model and the aircraft was in continuous production until 1982 when production was completed, with 2,484 aircraft built.

The 1981 and 1982 models were designated as the **Tomahawk II**. They incorporated improved cabin heating and windshield defroster performance, an improved elevator trim system, improved engine thrust vector, 100% airframe zinc-chromate anti-corrosion treatment, better cockpit soundproofing, larger six-inch wheels and tires for greater propeller ground clearance and improved performance on grass and dirt runways, among other enhancements.

Safety Record of Tomahawks

According to the Aircraft Owners and Pilots Association Air Safety Foundation, which published a *Safety Highlight* report on the PA38, the Piper Tomahawk has a one-third lower accident rate per flying hour than the comparable Cessna 150/152 series of two-place benchmark trainers. However, the Tomahawk has a higher rate of fatal spin accidents per flying hour. The National Transportation Safety Board (NTSB) estimated that the Tomahawk's stall/spin accident rate was three to five times that of the Cessna 150/152.

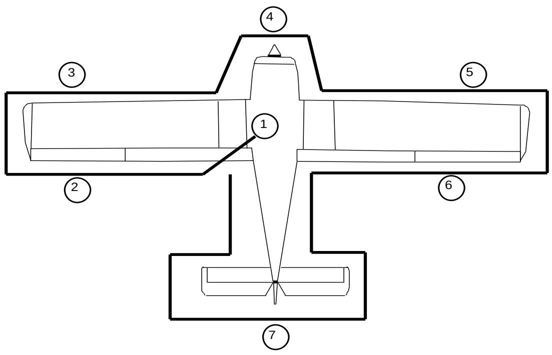
According to the NTSB, the Tomahawk's wing design was modified after FAA certification tests but was not retested. Changes included reducing the number of full wing ribs and cutting lightening holes in the main spar. The aircraft's engineers told the NTSB that the changes made to the design resulted in a wing that was soft and flexible, allowing its shape to become distorted and possibly causing unpredictable behaviour in stalls and spins. The design engineers said that the GAW-1 aerofoil required a rigid structure because it was especially sensitive to aerofoil shape, and that use of a flexible surface with that aerofoil would make the Tomahawk wing "a new and unknown commodity in stalls and spins".

FAA Airworthiness Directive 83-14-08, issued in September 1983, mandated an additional pair of stall strips to be added to the inboard leading edge of the PA-38 wing to "standardise and improve the stall characteristics".

Chapter Two

Preflight Inspection

PRE-FLIGHT INSPECTION
PIPER PA38 Tomahawk



Apart from the specific checks which must be accomplished below, the pilot must check that all flight controls are unobstructed, and all surfaces are clear of ice, snow and frost. Check doors and access panels (not in use) are properly secured, ports and vents unobstructed and aircraft free from damage and fluid leakage.

Visual inspection is defined as follows: check for defects, cracks, detachments, excessive play, unsafe or improper installation as well as for general condition. For control surfaces, visual inspection also involves additional check for freedom of movement and security.

1. Cabin

(a) Check the following:
Aircraft Flight Manual;
Pilots Operating Manual/Handbook;
Airworthiness Certificate;
Aircraft Technical Log;
First Aid Kit (if fitted);
Axe (if fitted);
Fire Extinguisher (if fitted); and,
Life Jackets (if required for flights over water).

(b) Check that the windscreen is clean.

(c) Remove control column lock.

(d) Ignition switch OFF.

(e) Throttle CLOSED.

(f) Mixture IDLE CUT OFF.

(g) Fully lower the flaps.

(h) Take the fuel dipstick and test cup.

2. Left Wing (Trailing edge)

(a) Check the flap hinge points and actuator arm.

(b) Check the aileron hinge points and actuator arm for freedom of movement and security.

CAUTION
In windy conditions avoid putting fingers between aileron and wing structure as serious injury could result.

3. Left Wing

(a) Inspect the wing tip (including navigation light) for condition.

(b) Check the upper and lower surfaces of the wing from the wing tip. Should pick up any wrinkles in the wing skin possibility indicating it's been stressed.

(c) Check the wing leading edge for condition.

(d) Check that the wing tiedown is disconnected.

(e) Check the pitot tube for condition and blockage.

(f) Check the stall warning vane for movement.

(g) Check the fuel tank vent for blockage.

(h) Check the main wheel strut and tyre for condition and correct inflation.

(i) Check the check the wheel and tyre for leaking/condition of brake caliper.

(j) Visually the check fuel quantity using the fuel dipstick.

(k) Check that the fuel filler cap is secure.

(l) Sample fuel from the fuel tank sump drain valve and check for:

Absence of water;

Correct fuel grade; and,

Absence of sediment.

(m) Positively ensure the drain is CLOSED.

4. Nose

> **WARNING**
> Never allow yourself or anyone else to stand or put any part of the body within the arc of the propeller, since a loose or broken wire, or a component malfunction, could cause the propeller to be live and to suddenly rotate.

(a) Check the general condition inside the left side of the engine bay, looking for oil leaks, bird's nests, foreign objects etc.

(a) Check the brake hydraulic fluid reservoir level.

(b) Sample fuel from the strainer drain. Using the sample cup, pull the knob for at least 4 seconds.

(c) Check the sample cup for:

Absence of water;

Correct fuel grade; and,

Absence of sediment.

(d) Positively ensure the drain is CLOSED.

(d) When closing the cowling ensure the catches are secure and hinges on the top secure.

(e) Check the spinner and propeller for nicks and security.

(a) Check the general condition inside the right side of the engine bay, looking for oil leaks, bird's nests, foreign objects etc.

(f) Check the engine cooling air intakes and ensure the oil cooler is clear of obstructions and check its condition.

(g) Check that the carburettor air filter is clear of obstructions and check its condition.

(h) Check the landing light for condition and cleanliness.

(i) Check the nose wheel strut and tire for condition and correct inflation and oleo for condition.

(j) Check the engine oil level. Do not over tighten the dipstick.

> **NOTE**
> Do not operate with level less than 4.5 litres. Fill to 5 litres for extended flight.

(d) When closing the cowling ensure the catches are secure and hinges on the top secure.

5. Right Wing

(a) Visually check the fuel quantity using the fuel dipstick.

(b) Check that the fuel filler cap is secure.

(c) Sample fuel from fuel tank sump drain valve and check for:

Absence of water;

Correct fuel grade; and,

Absence of sediment.

(d) Positively ensure the drain is CLOSED.

(e) Check the fuel tank vent for blockage.

(f) Check the main wheel strut and tyre for condition and correct inflation.

(g) Check the check the wheel and tyre for leaking/condition of brake caliper.

(h) Check that the wing tiedown is disconnected.

(i) Check the wing leading edge for condition.

(j) Check the upper and lower surfaces of the wing from the wing tip. Should pick up any wrinkles in the wing skin possibility indicating it's been stressed.

(k) Inspect the wing tip (including navigation light) for security and condition.

6. Right Wing (Trailing Edge)

(a) Check the aileron hinge points and actuator arm for freedom of movement and security.

(b) Check the flap hinge points and actuator arm.

CAUTION
In windy conditions avoid putting fingers between aileron and wing structure as serious injury could result.

7. Empennage

(a) Check the side of fuselage for dents, wrinkles or cracked paint around rivets which could indicate overstressing.

(b) Check that the tail tiedown is disconnected.

(c) Check control surfaces for:
Freedom of movement;
Security; and,
Integrity of hinges, fasteners and split pins.

(d) Check the lights for security and cleanliness.

(e) Check the antennae for integrity and security.


Hobbs
Tacho

PA38 TOMAHAWK NORMAL CHECKLISTS

BEFORE ENGINE START

Tech Log/Docs .... Check when maintenance due
Tacho.................................. Note the tacho reading before start up
Seats.................................. Adjusted; Locked; Belts On
Flaps.................................. Up
Park Brake .... On
Master Switch...................... On
Instruments.......................... Checked
Altimeter.............................. Set (aerodrome elevation/QNH)
Circuit Breakers .... Checked
Fuel Selector........................ On - lowest tank
Mixture................................ Rich
Throttle................................ Set ½ cm open
Carb Heat .... Off
Beacon .... On
Fuel Pump............................ On; Pressure checked
Primer.................................. As required; Locked

ENGINE START

Propeller Area...................... Clear
Ignition Switch..................... Start
Throttle................................ Set 1000 RPM
Alternator / Ammeter.......... Positive charge
Oil Pressure .... Checked
Ignition .... Checked (L – R – Off – Both)
Fuel Pump............................ Off
Throttle................................ Set 1200 RPM
Avionics .... Radios On; Frequencies set
Transponder .... Set SBY; Set 1200
R/T.. Advise taxiing
Brakes .... Release; Test

ENGINE RUN UP

Park ....45° to final approach (if possible)
Park Brake ....On
Throttle.................................1200 RPM
Area ....Checked
Temps and Pressures ....Checked
Fuel Selector ....Fullest tank
Throttle.................................1800 RPM
Carb Heat ....Checked
Ignition ....Checked (L – Both – R – Both)
Suction..................................Checked
Alternator / Ammeter...........Checked
Temps and Pressures ....Checked
Throttle.................................Check idle; Check the carb heat at idle
Reset 1200 RPM

PRE-TAKE OFF CHECKS (D.V.A.'s)

T - Trim ....Set for Take-off
T - Throttle Friction ....Set
M - Mixture ....Rich; Carb Heat Off
F - Fuel.............................Selector On - fullest tank;
Contents sufficient; Primer Locked;
Pump On; Pressure checked
F - Flaps...........................Set; Visually checked
I - Ignition........................On Both; Master On
I - Instruments ....Checked
H - Hatches; Harness .....Secure
C - Controls ....Full, free and correct movement

Radio Frequencies

Motueka/Tasman Traffic: 127.3
Nelson Tower: 127.4
Nelson ATIS: 129.1

LINE UP CHECKS

Landing Light .... On
Transponder .... On ALT
D.I. .... Aligned with the runway

AFTER TAKEOFF (CLIMB) CHECKS

Flaps .... Up
(min 65 kts and 200 feet AGL)
Temps and Pressures......... Checked
Fuel Pump .... On in the circuit / Off above 1000 ft agl

PRE-LANDING CHECKS

B - Brakes .... Checked; Park brake Off
U - Undercarriage .... Down
M - Mixture .... Rich
F - Fuel............................. Selector On; Contents sufficient;
Primer Locked;
Pump On; Pressure checked
H - Harness....................... Checked

FINALS CHECKS

Landing Area .... Clear
Carb Heat .... Off

AFTER LANDING CHECKS

Flaps .... Up
Landing Light .... Off
Transponder .... Off
Carb Heat .... Off
Fuel Pump .... Off

SHUTDOWN CHECKS

Park Brake ....On
Throttle.................................1000 RPM
Avionics ....121.5 checked; Off
Ignition ....Checked (L – R – Off – Both)
Mixture ....Idle Cut Off
Throttle.................................Closed (as the engine stops)
Beacon ....Off
Ignition ....Off (put the key on the console)
Master Switch.......................Off
Control Locks.......................Installed (if required)
Tacho ....Note the tacho reading at shutdown

HASELL CHECKS

H - Height...........................Sufficient for recovery at a safe height
A - Airframe.......................Flaps up
S - Security ....Harness tight;
No loose objects
E - Engine..........................Carb Heat as required;
Temps and pressures checked
L - Location.......................Not over built up areas
L - Lookout ....Around, above and below

SCADIE CHECKS

S - Suction.........................Checked
C - CO Monitor..................Checked
A - Amps............................Checked; Alternator charging
D - D.I. ....Checked with compass
I - Icing ....Check Carb Heat
E - Engine..........................Instruments and fuel checked

Chapter Four

Piper PA38 Tomahawk - Expanded Normal Checklists

The following is an expansion of the Normal Operations Checklists. These notes should help you to understand what to do and why you are doing it.

BEFORE ENGINE START

Ideally, for start and run-ups or any other time when the aircraft is stationary, the wind should be on the nose. In any case, to reduce high abnormal loads on the propeller shaft and the engine mounts, the crosswind component should be less than 10 knots.

The propeller area should be visually checked clear of personnel and obstructions and vehicles. The area ahead should be clear in case of brake failure. The intended taxi path should also be clear. The area behind the aircraft should be clear to avoid damage to equipment or other aircraft and inconvenience to other personnel.

Tech Log/Docs..Check when maintenance due

Before every flight you must ensure the aircraft is airworthy by checking the Tech Log, normally kept in the folder with the Aircraft Flight Manual, to ensure there is adequate flight time remaining for your flight, before maintenance action is due. At the Walsh you are assisted in this by an entry in the checklist folder. However, this does NOT absolve the pilot-in-command from the responsibility of ensuring the aircraft is airworthy.

Tacho ....Note the tacho reading before start up

Note the tacho reading before the engine is started. Use the space on the bottom of the ATIS pad, or use another suitable piece of paper. Keep this ATIS pad/piece of paper in a handy and secure place, so that you can use it again at the end of you flight.

Seats ....Adjusted; Locked; Belts On

The seats on most light aircraft can be adjusted fore and aft. Adjust the seat so that you can reach the rudder pedals with your knees still comfortably bent. This will ensure that you can exert full rudder pedal movement if required. Seatbelts or harness are fastened when seated. Normally, the cabin doors and windows are closed, but this can be checked again later on, prior to takeoff. This covers the situation when, on a hot day, the doors/windows are left open while taxiing.

Flaps...Up

Flaps should be up for taxiing, if they are down they may be damaged by stones or other objects which may be flicked up by the propeller or tyres.

Park Brake ....On

Use your feet to pressure the toe brakes sufficiently to feel the hydraulics resisting. There is no need to use all your strength. The same applies to the park brake. Now set the park brakes on.

Master Switch..On

The master switch controls most of the aircraft's electrical equipment, including the starter. Note that it does not control the engine ignition itself, which is supplied by the two independent magnetos.

Instruments...Checked

These should be checked to see that they appear serviceable prior to starting the engine. This is simply a visual scan from left to right of the instruments, checking for faults such as cracked glass and bent needles. Having completed the flight instruments continue the scan on to the engine instruments. Scan from left to right as for the flight instruments. If the aircraft has been run recently the fuel pressure may be high.

Altimeter...Set (aerodrome elevation/QNH)

If you have access to an aerodrome ATIS, set the **QNH**. QNH is the atmospheric pressure which, when set, will have the altimeter reading height above sea level.

Circuit Breakers ....Checked

Check visually for circuit breakers that have popped. If popped, see a Flying Instructor.

Fuel Selector...On – lowest tank

The PA38 Tomahawk, the selector has 3 positions; **Left**, **Right**, or **Off**. Select the tank with the lowest contents.

Mixture...Rich

Move the lever to the full rich position. Do not recycle the lever. For the duration of most of your initial flying training the mixture will be needed in the **Rich**, or fully forward position.

Throttle ....Set 1/2 cm open

Open the throttle only slightly. About 1/2 cm, measured at the **top** of the throttle lever, should be sufficient. This is the approximate position of the throttle which will give a good start and 1000 RPM after start. Most difficult starts are caused by the throttle being set too wide. Do **<u>not</u>** cycle the throttle. Although this can be used to prime the carburettor, it adds to the danger of an engine fire. The primer is provided for this purpose.

Carb Heat ....Off

Do not cycle the lever if it is in the **Off** position.

Beacon ....On

The 'beacon' is the red rotating anti-collision beacon on the tail fin which should be turned on prior to start so that personnel can become aware that the aircraft engine is about to start. You do not normally need the Nav Lights during the day. On some aircraft the wing tip strobes are on a combined switch with the beacon and consequently their use should be restricted at night as they may cause a distraction to other pilots and to ground personnel in the vicinity, in which case switch on the Nav Lights and cycle the Landing Lights On/Off/On to warn of a pending engine start.

Fuel Pump ....On; Pressure checked

Aircraft with low wings (PA38) require an electric fuel pump to supply fuel to the engine when the engine driven pump is not working (e.g. now, before start).

Primer...As required; Locked

If the engine is warm, no priming is normally required. If the engine fails to start, use one full stroke of the primer. On the first start of the day use two full strokes, or three if it is very cold. When using the primer, draw the pump out to its full extent, wait a few seconds for the fuel to be sucked into the pump and then push it back in fully. This process ensures that the pump works efficiently, it is sometimes possible to hear the fuel being sucked into the pump. Ensure that the primer is securely locked, otherwise serious inflight fuel problems may develop.

ENGINE START

Propeller Area ....Clear

After the Before Engine Start checks have been completed, a final look outside the aircraft should be made to ensure that it is all clear around the aircraft just prior to starting the engine. Even the area behind should be considered, because a person there may be walking towards the front of the aircraft to check something. The propeller is potentially very dangerous and we must ensure that an unaware or inattentive person is not injured by it. For night operations the landing light should be cycled on/off/on, for lookout and to warn of the intention to start the engine. Many pilots back up this visual check by calling "Clear the Prop" out the window.

Ignition Switch ....Start

One hand should be placed on the throttle, and the feet should be near the brakes. Parking brake systems are not infallible, and these should not be relied upon to stop the aircraft moving forward after the engine has started. When ready, engage the starter mechanism.

Starting is achieved by turning the ignition key to the start position. The throttle is not to be cycled/pumped during the start as this may induce a carburettor fire if the engine backfires.

The key should be released to **BOTH** as soon as the engine has started.

The engine is to be turned over for a maximum of four 10 second periods during a start attempt, following which a period of five minutes is to be allowed for the starter motor to cool. Following the second unsuccessful 10 second attempt, complete the Flooded Start procedure below.

Seek maintenance assistance following an unsuccessful set of four start attempts.

If away from your home base, attempt one more set of four 10 second attempts and if a start is not achieved seek maintenance assistance before subsequent start attempts.

Throttle...Set 1000 RPM

A low power setting of approximately 1000 RPM is best until the engine settles down, begins to warm and the oil pressure rises.

Hold the throttle gently in your fingers. There is no 'one best way' to hold the throttle, it varies from person to person, and your instructor will show you some alternatives.

However, whichever method you choose, it is important that it allows you to exercise precise throttle control and allows you to apply small, accurate adjustments when either increasing or reducing power.

Alternator / Ammeter ....Positive charge

The battery supplies electrical current to the electrical system when the engine is not operating (e.g. for starting). When the engine is operating, the alternator supplies electrical current to the electrical system and replenishes the battery. Remember, neither the battery nor the alternator supply the ignition system. That is the function of the magnetos.

The ammeter in most modern light aircraft indicates the charging rate applied to the battery by the alternator, i.e. it is a "centre-zero" ammeter. Immediately after engine start the charge rate will be reasonably high as the alternator replenishes the battery. There should be a high positive needle deflection, to the right of the scale.

A "zero-left" ammeter will show the alternator output, and after start it should be well off the left, to somewhere near the middle of the scale.

Oil Pressure ....Checked

As soon as the engine is running smoothly, the oil pressure should be checked; if it does not rise to the specified value in about 30 seconds the engine should be shut down to prevent damage. Without oil pressure the engine's moving parts will not be lubricated and the engine will seize up, very expensive!

CAUTION

Check the oil pressure immediately after starting the engine.

If no pressure rise is evident after 30 seconds, shut the engine down immediately and inform an instructor.

Next, a reading of the oil temperature should be noted. The oil temperature is often slow to rise in cold weather, but normally if a steady reading is observed after engine start it is acceptable.

Ignition ....Checked (L – R – Off – Both)

Check **LEFT; RIGHT; OFF; BOTH.**

This is a double check. We are completing a 'dead cut' check, i.e. checking to see if the ignition goes dead when it is selected to **LEFT** or **RIGHT**, and a 'live mag' check, i.e. checking to see if the mag is live when it is selected to **OFF**. Therefore the ignition is being checked for correct operation of the **LEFT/RIGHT** and **OFF** positions.

To check the ignition system select the **LEFT** magneto for about one second, repeat for the **RIGHT** magneto, then briefly select to the **OFF** position without allowing the engine to stop, then back to **BOTH**.

When you move the ignition switch from **BOTH** to **LEFT**, then **RIGHT**, the engine should continue running, at reduced RPM. This confirms that both magnetos are operating. Then move the switch **briefly** to **OFF**, then back to **BOTH**.

The engine should cut out while the switch is in the **OFF** position. This confirms that there is no short circuit and that the ignition wiring is correct. If the engine dies when the **LEFT** or **RIGHT** magneto is selected then that magneto (and the aircraft) is unserviceable. If the engine runs when the ignition is selected to **OFF**, then there is a fault in the ignition system and the aircraft is unserviceable.

CAUTION
If the engine cuts out when the switch is on LEFT or RIGHT, or continues to run when the switch is OFF, shut the engine down and inform your Flying Instructor.

Fuel Pump ....Off

Check the fuel pressure to ensure that it remains constant.

Throttle...Set 1200 RPM

By now the engine should have settled and warmed enough to allow you to set 1200 RPM. This slightly higher RPM will reduce the chance of plug fouling, which tends to occur if the engine is idled for prolonged periods at low power. In general avoid idling the engine on the ground at low power for any longer than you have to.

Avionics..Radios On; Frequencies set

Transponder..Set SBY; Set 1200

Set **Standby** and set the standard code for VFR aircraft, which is 1200.

The transponder is a radio device that sends a signal to ground based radar so that the area radar controller can identify the aircraft and its altitude on their screen. **Standby** allows the unit to warm up without sending a signal.

Normally light aircraft are not allocated a specific transponder code, however ATC subsequently instruct you to set a particular code.

For your information, unless otherwise directed by ATC, light aircraft flying under Visual Flight Rules normally set:

- 2200 in a controlled aerodrome circuit;
- 1400 in General Aviation Training Areas; and,
- 1200 on cross-country flights.

R/T ....Advise taxiing

See the Radio Procedures section in your Flight Training Record.

Brakes...Release; Test

Close the throttle, release the park brake, apply just sufficient power to start moving. When releasing the park brakes ensure that they are completely off, it is possible for them to appear to be off but to be partially on.

When in a clear area, apply the toe brakes sufficiently to feel their operation, then continue. The brake test should be done gently, with even pressure on both brakes. If one brake is not working the aircraft will swing in the direction of the good brake. Pass control to the left seat pilot/instructor if present, to allow them to check the brakes from their side.

> **NOTE**
> The brake test does not have to bring the aircraft to a complete stop.

FLOODED START PROCEDURE

Should the engine become flooded due to over priming follow this Flooded Start procedure.

Mixture..Idle Cut Off

Throttle..Full

The throttle should be fully open to allow the maximum amount of air to be pumped through the carburettor and engine to clear the excess fuel.

Fuel Pump..Off

Ignition ....Start

Keep one hand on the throttle and the other on the ignition while the engine is turning on the starter. Once the engine fires the left hand should move to the control column while you reduce the throttle with the right hand. If the engine is flooded it may initially cough a few times prior to running but once it starts it can pick up RPM very quickly, so be ready to reduce throttle rapidly.

Throttle..Retard

Mixture..Advance

Once the engine has started with the mixture lean it will run for some time before dying. So there is no need to rush to get the mixture rich. Make sure the engine is throttled back to a safe idle speed (about 1000 RPM) before enriching the mixture. Now go back to the Engine Start checks and continue from:

Throttle..Set 1000 RPM

Continue with the **ENGINE START** checklist.

ENGINE RUN - UP

Park .... 45º to final approach (if possible)

Park the aircraft at about 45º to the runway and facing toward the final approach, but within 30º of the wind if it is 15 knots or more. Parking this way will ensure that you keep your prop wash clear of following aircraft and it allows you to see aircraft behind you and on final approach. You must give due consideration to other aircraft that also need to use the run-up area. Try to park so that they can manoeuvre around behind you, so that they can utilise spare space further along. If the opportunity arises, you may be able to move further along yourself. Always exercise courtesy and patience, and never pass another aircraft on the runway side, always pass behind and then only if it is not at high run-up power.

Park Brake .... On

The brakes are normally parked for the run-up. However do not rely solely on the park brake, keep your feet on the toe brake as well during the high power run-up.

Throttle... 1200 RPM

Set 1200 RPM whenever you are stationary.

Area .... Checked

There should be no aircraft or personnel close behind, and the run-up should not be carried out in front of a tent or open hanger as the slipstream may cause damage and may blow grass and other small objects around.

Temps and Pressures .... Checked

These should be in the green range. Before increasing the RPM the oil temperature should be increasing and the oil pressure should be over 25 psi.

Fuel Selector .... Fullest tank

You started the engine and taxied to the run-up position on the tank with the least fuel, therefore it is reasonable to consider that there are no apparent problems with the fuel feed from that tank. Now you should change to the tank with the most fuel for the run-up. If there are no problems during the run-up it is reasonable to consider that there are no apparent problems with the fuel feed from that tank as well. You should leave it on this fullest tank for the takeoff.

If you forget to change tanks before the run-up, **DO NOT** change tanks after the run-up and before the takeoff. You have not verified that feed from both tanks is reliable, and shortly after takeoff is not the time to find out you have a problem. Takeoff on the tank you have been feeding from and make your change later in the flight – at a time when you feel you can handle a fuel problem if one develops after the tank change.

Throttle... 1800 RPM

Always use smooth throttle movements and avoid sudden and coarse movements which can put stresses on the internal parts of the engine, such as pistons and crankshaft. Select the RPM initially by ear, then check the tachometer (engine RPM gauge). Glance outside as you increase power to make sure the brakes are holding and the aircraft is not moving forward.

Carb Heat ....Checked

Move the carburettor heat control to **ON** for the absolute minimum time that it take to notice an RPM drop. A small drop of between 20 and 100 RPM is a normal indication. The readings should return to normal when the carb heat is selected off.

> **NOTE**
> If no RPM drop is noted when the carb heat is applied during run-up, the carb heat control may not be working. An excessive RPM drop (>200 RPM) may indicate an exhaust system fault. In either case, **do not takeoff.**
>
> Return to the club and inform your instructor.

> **CAUTION**
> Do not use carb heat excessively on the ground as this allows unfiltered air (i.e. air with dust, pieces of grass seed, etc) to pass into the engine.

Ignition ....Checked (L – Both – R – Both)

Check **LEFT; BOTH; RIGHT; BOTH.**

Move the ignition switch first to the **LEFT** magneto position and note the RPM drop (from 1800) Next move the switch back to **BOTH** to clear the other set of spark plugs. The RPM should go back up to 1800. Then move the switch to the **RIGHT** magneto, note the RPM drop and return to **BOTH**.

Read out a quick estimate of the values of the RPM drop on each magneto. E.g. "**LEFT** 130 drop; **BOTH** returns; **RIGHT** 100 drop; **BOTH**". Do not linger on only one magneto. The maximum drop is 175 RPM, with a maximum of 50 RPM difference between each magneto.

If there is doubt concerning operation of the ignition system, an RPM check at a higher engine speed, say 2000 RPM, will usually confirm whether a deficiency exists.

On occasions it is possible to experience rough running when magneto checks are carried out. This plug fouling may be due to accumulations of oil or lead on the plug electrodes. If this problem is encountered the following procedure should be applied:

- Check that the area behind and adjacent to the aircraft is clear and the brakes are firmly applied.
- Run the engine at 2000 RPM for up to 30 seconds then try a further magneto check.
- If rough running persists run the engine at **full power** for 5 to 10 seconds then throttle back to 2000 RPM and carry out a further magneto check.
- If the problem persists the aircraft is unserviceable and must be returned to engineering for rectification.
- Under no circumstances is the mixture to be leaned to clear the plugs.

If the selection of a single magneto, either **LEFT** or **RIGHT**, causes the engine to stop, or if any other malfunctions are noted, the engine should be shut down and the matter reported to an instructor.

CAUTION

If the engine dies when either of the magnetos is selected **DO NOT** reselect the ignition back to **BOTH** to try to keep the engine running, as this may lead to a serious backfire and engine damage.

Rather, leave the ignition in the position it is in when the engine died, close the throttle and allow the engine to stop rotating. When the engine has stopped completely, restart it and return to dispersal and report the problem to an instructor.

Suction..Checked

The suction reading in the green range is an indication that the vacuum pump, which is used to drive the gyros for the Attitude Indicator and the Direction Indicator, is operating.

Alternator / Ammeter...Checked

By the run-up stage, the charge rate should be very small or zero. A zero-left ammeter shows the alternator output, and should be just off the left of the scale. A centre-zero ammeter shows the flow of current into and out of the battery and should be very near the centre of the scale.

NOTE

If the ammeter shows a discharge during run-up, cycle the master switch once. This condition may have been caused by a sticking voltage regulator.

Never switch the landing lights on and off, to check the alternator/ammeter. This is very damaging to the landing light filament.

Temps and Pressures..Checked

Whilst at high power, the engine oil pressure and temperature gauges should be read again to ensure that both are giving steady indications within the green arcs. This is a more appropriate stage for this check as any malfunction of the oil system will be more likely to manifest itself after a period of engine operation at high power.

Throttle..Check idle; Check the carb heat at idle
Reset 1200 RPM

The throttle should be closed smoothly and completely to check that the engine still runs with the throttle in this position. Minimum idle, with the throttle completely closed, should be smooth and about 500-700 RPM. Apply carb heat briefly when the engine is at idle to ensure the engine runs at idle with the carb heat on.

If the engine idles between 700 and 800 RPM, note the figure and report it to a Flying Instructor on your return. If the engines idle at >800 RPM the flight should be terminated and maintenance assistance sought. The oil pressure MUST be above 15 psi.

NOTE
If during these power checks, the prescribed limits of RPM, pressure, temperature etc. are exceeded, the aircraft should not be flown.

In these circumstances return to the Club and report the problem to a Flying Instructor.

PRE-TAKE OFF CHECKS (D.V.A.'s)
(Drills of Vital Action)

A complete set of Pre-Takeoff Checks are to be carried out prior to the first takeoff of an air exercise and if After Landing Checks are begun or the aircraft systems are significantly reorganised. However, following a "Stop and Go" or "Stop and Backtrack" an abbreviated Pre-Takeoff Check of 'Trims; Flaps; and Engine Temps and Pressures' is all that needs to be carried out.

T - Trim ....Set for Take-off

Check the trims for free movement both sides of the neutral position, then set them for takeoff. There is no need to exercise them through their full range of movement.

T - Throttle Friction ....Set

The throttle friction nut gives us control over how easily the throttle can be moved. It should be firm, but not tight.

M - Mixture ....Rich; Carb Heat Off

F - Fuel...Selector On - fullest tank;
Contents sufficient; Primer Locked;
Pump On; Pressure Checked

The best way to remember these is **C**ock **C**ontents **P**rimer **P**ump and **P**ressure (2 C's then 3 P's)

The primer should be checked by gently pulling it with your hand to confirm that it is locked, as it cannot be checked visually.

F - Flaps...Set; Visually checked

Often takeoffs can safely be made with the flaps up, however if the runway surface is wet and/or long grass, or the runway length is short, takeoff distance is reduced by approximately 10% with the flaps set at the first notch. That said, climbing performance is reduced with flaps down; i.e., to climb above an obstacle the aircraft does better with flaps up. Flap settings greater than the first notch are not recommended for takeoff. At the Club, regardless of the fact that the runway is relatively long, to practise reconfiguring after takeoff, we usually use the first notch in the Tomahawk.

I - Ignition ....On Both; Master On

I - Instruments...Checked

A visual scan of the instruments left to right across the panel. Important items are:

- ASI zero;
- AI erect;
- Altimeters - QNH set. Airfield deviation ± 50 feet;
- Suction - Positive suction (Possibly lower than 5 inches due to low RPM);
- Turn coordinator - power warning flag away, wings level, ball in the centre;
- D.I. and compass aligned. BUG set to runway heading, or otherwise as required; and,
- VSI ± 200 feet; and,
- Engine Temps and Pressures in the Green Range.

H - Hatches; Harness..Secure

Confirm all latches on the aircraft's hatch/doors are secured both visually and by pushing on the hatches/doors. Check the passengers visually and aurally for harnesses secure. Close the storm window in the PA38. Confirm that there are no loose articles in the cockpit which may obstruct the controls on takeoff or inflight and remove all maps, documents and folders from your knees as these may restrict control column movement.

C - Controls...Full, free and correct movement

Do not slam the controls hard against the stops, or damage may result. Move them gently but firmly through their full range of movement. This may seem an easy check but is often skimped on. The correct technique is:

- FULL forward control column. If the elevator is visible in your aircraft, visually check that it is positioned up at its leading edge and down at the trailing edge.
- FULL left control column. Visually check that the left aileron is positioned up and that the right aileron is positioned down.
- Maintain the aileron position and move the control column FULL aft. If the elevator is visible in your aircraft, visually check that it is positioned down at its leading edge and up at the trailing edge.
- FULL right control column. Visually check that the right aileron is positioned up and that the left aileron is positioned down.
- Maintain the aileron and move the control column FULL forward.
- Centralise the ailerons then the elevator.

There should be no restrictions during this procedure. If any deviation or problem is observed or suspected the flight is to be terminated and maintenance assistance sought. There are many cases in the past of incorrectly rigged or jammed/restricted controls which have led to major problems on takeoff and in flight.

Full rudder deflection may not be able to be applied on some aircraft types, such as the PA38 Tomahawk, as the rudder pedals are also fixed to the nose wheel, which may resist rudder pedal movement when stationary on the ground. Forcing the rudder pedals may damage linkages and cables.

LINE UP CHECKS

These checks should be carried out as you line up on the runway or vector. Ensure the approach path is clear and while the aircraft is being taxied into position on the active runway complete the Line Up Checks.

Do not linger on an active runway. Once you have lined up for takeoff, the aircraft should normally be rolling within 15 seconds, at the most.

As you begin to taxi into position on the active runway give consideration to applying the Carb Heat for a few seconds. This will ensure the carburettor is completely clear of icing, especially on a maximum performance takeoff. The risk of carb icing must be balanced against the risk of ingesting grass seed into the carburettor from the unfiltered carb heat air. Carb icing is most likely on a moist morning, when the grass is probably wet from the dew. Grass seed is most likely on dry long grass, when the heads are present.

Landing Light ....On

Transponder ....On ALT

Set the transponder to **ALT** (altitude).

D.I. ....Aligned with the runway

Cross check the DI with the magnetic compass and confirm that they agree with the runway you are cleared to use e.g. 200° if using Runway 20. Do not attempt to read the magnetic compass while applying brakes or accelerating as this causes it to swing excessively if you are on East or West.

AFTER TAKEOFF (CLIMB) CHECKS

Flaps ....Up
(min 65 kts and 200 feet AGL)

Once at a safe airspeed, greater than 65kts IAS and clear of obstacles (200ft above obstacles), smoothly retract the flaps if they have been set for takeoff or if these checks are being carried out after a go-round. Raising the flaps at too low an airspeed or too early can lead to a loss of lift that could cause the aircraft to sink back towards the ground or obstacles.

Temps and Pressures...Checked

If climbing out to the training areas, or if sustaining the climb for any other reason, continually monitor the engine temperatures and pressures.

Fuel Pump ....On in the circuit / Off above 1000 ft agl

If you are remaining in the circuit, the electric fuel pump on the PA38 Tomahawk should normally be left on.

If you are departing the circuit, the electric fuel pump should be turned off passing 1,000ft agl in the climb. Pressure should checked to ensure that the engine driven pump is working correctly.

> **CAUTION**
> If fuel pressure drops suddenly when you turn the electric fuel pump OFF, or the engine runs rough or dies, immediately reselect the pump back ON, as the engine driven fuel pump may have failed.
>
> Maintain the climb if possible and recircuit to land as soon as possible.

PRE-LANDING CHECKS

The Pre-Landing Checks are normally carried out when on the downwind part of the circuit.

B - Brakes..Checked; Park brake Off

Pressure is applied to the brakes to ensure that there is sufficient pressure for them to operate. Press the toe brakes just sufficiently to determine that there is resistance. It is better to find out now that the brakes will not work, rather than after landing with the fence at the end of the runway looming up.

After the test, ensure the park brakes are off. It is possible for the park brake to appear to be off but in fact be partially on. Therefore physically ensure it is completely off.

U - Undercarriage...Down

Most of the aircraft you will fly in your early training have fixed undercarriage but this item is included to ensure it is not forgotten if you go on to more advanced aircraft later on.

M - Mixture...Rich

F - Fuel ....Selector On; Contents sufficient;
Primer Locked;
Pump On; Pressure checked

The cock should be selected to the fullest tank. Try to manage you fuel state to avoid changing tanks at this stage if possible, but do not hesitate to do so should the fuel state require it.

H - Harness ....Checked

Check that the harnesses are secure and ensure that any charts you have been using are safely stowed clear of the controls.

FINALS CHECKS

The Finals Checks are carried out when on final approach and a safe landing or touch and go is reasonably assured.

Landing Area ....Clear

Always check the landing area for yourself before completing the final approach and landing.

At a controlled aerodrome, you must receive a clearance from the tower before you can complete a landing or touch and go. Despite any clearance for the tower also check the landing area for yourself.

Carb Heat ....Off

In case a go-round becomes necessary, the carb heat should be returned to the **OFF (COLD)** position on final approach, when you are sure that you would be able to glide the aircraft to a safe landing area if the engine stopped. If it was still **ON (HOT)**, the engine would still develop adequate power for the go-round, but only about 90% of full power.

> **NOTE**
> Despite having completed the Finals Checks, you may still carry out a **'go-round'** if you are not happy that you can complete the landing safely.

AFTER LANDING CHECKS

Unless specifically authorised by your instructor, before commencing these checks, wait until you have cleared the runway, then either stop or leave the power at idle and taxi at low speed until you have safely completed these checks. At no time are the completion of any checks to distract you from the primary task of controlling the aircraft.

Flaps ....Up

Flaps should be up when taxiing, remember if they are down they may be damaged by stones or other objects which may be flicked up by the propeller or tyres.

Landing Light ....Off

At night the landing lights should remain on until the aircraft has come to a final stop. However, consideration must be shown to other users of the aerodrome to ensure they are not dazzled by your landing light.

Transponder ....Off

Carb Heat ....Off

Even though you should have selected the carb heat to Off (Cold) in the finals checks, this is another back-up check, as dust and grass seed can be ingested into the carburettor through the unfiltered carb heat air intake if it is On (Hot) on the ground.

Fuel Pump ....Off

SHUTDOWN CHECKS

Before you reach the aircraft parking area check the brakes and the wind direction, then decide on your route to park the aircraft into wind in the required position. Be wary of simply parking facing the same way as everybody else, as the wind may have shifted and/or the other student pilots may have made an error.

Park Brake...On

Throttle..1000 RPM

Radios..121.5 checked; Off

Listen on the emergency frequency (121.5) to ensure that your last landing(s) did not activate the emergency beacon.

Ignition...Checked (L – R – Off – Both)

This check is the same as after engine start. We check **LEFT; RIGHT; OFF; BOTH**. The engine should continue to run in the **LEFT** and **RIGHT** positions, and should cut out when it is in the **OFF** position, if it does not then the ignition has a serious fault and this should be reported immediately.

Mixture...Idle Cut Off

The engine is shut down by starving the engine of fuel with the mixture control, **not** by turning the ignition off.

Throttle..Closed (as the engine stops)

Leave the throttle at the 1000 RPM setting until the engine has stopped firing, then close it completely. This prevents the engine from running on.

Beacon..Off

Ignition...Off (put the key on the console)

Immediately remove the key from the ignition and put it on the console dashboard. The key is to be returned to Operations after the last flight of the day or at any time the aircraft is unserviceable.

Master Switch...Off

Control Locks...Installed (if required)

If the weather is good and the wind light, your instructor may not require the control lock to be installed. However, they must be installed for overnight parking, or when the wind is strong or gusty. In the PA38 Tomahawk, lock the controls by fastening the lap belt over the control column yoke. Do not fasten it over the side with the transmit switches on as they are easy to damage and are expensive.

Remember, the "three Ms' (Mixture, Mags and Master) and the last visual check as you walk away from the aircraft.

Tacho ....Note the tacho reading at shutdown

Note the tacho reading after the engine has been shutdown. Use the space on the bottom of the Waypoints ATIS pad, or use another suitable piece of paper.

HASELL CHECKS

These checks are completed prior to any manoeuvre which takes the aircraft close to its limits, for example stalling and spinning. You will be taught how to complete these checks in the Stalling Brief and your instructor will demonstrate them to you in the aircraft.

H - Height..Sufficient for recovery at a safe height

A - Airframe..Flaps up

S - Security..Harness tight;
No loose objects

E - Engine..Carb Heat as required;
Temps and pressures checked

L - Location...Not over built up areas

L - Lookout..Around, above and below

SCADIE CHECKS

These checks are completed at regular intervals, say every 10 or 15 minutes. Your instructor will teach you how to complete them and demonstrate them to you in the aircraft.

S - Suction...Checked

The suction reading should be in the green range. If it is too low the instruments may not function reliably, if it is too high the instruments may be damaged.

C - CO Monitor..Checked

Carbon Monoxide is colourless and odourless, so a regular visual check of the CO Monitor is very important, potentially critical.

A - Amps..Checked; Alternator charging

Check to ensure that the alternator is charging. Also compare the actual load shown with the load you are drawing. For example the normal load with avionics all on and strobes on is around 25 - 30 amps. If you have the lights on the load will be closer to 40 amps.

D - D.I...Checked with compass

Before checking the direction indicator (D.I.) against the magnetic compass ensure straight, level and unaccelerated steady flight.

I - Icing..Check Carb Heat

Cycle the Carb Heat to check for carb icing, leave it **On** for 10-15 seconds. If the engine runs a little roughly it is an indication of normal operation. If the engine initially runs roughly then runs smoothly at an increased RPM, it is an indication that you had carb icing. You should increase the frequency of Carb Heat checks or leave it on until you have left the area of carb icing.

E - Engine..Instruments and fuel checked

Check temperatures and pressures. As well as confirming normal engine operation. If the temperatures are high it may be good practice to ease the power back to enable the engine to cool slowly. Check the fuel contents and consumption rate. Change tanks if required.

Chapter Five

Aircraft Handling

General

This section provides procedures for the conduct of normal operations of the Piper PA38 Tomahawk aircraft when it is operated by the Motueka Aeroclub.

During your flying training, control of the aircraft will often be passed back and forth between you and your Flying Instructor, at all times it must be clear who, either you or your Flying Instructor, is actually flying the aircraft. To ensure that this is achieved a simple procedure is laid down. When your Flying Instructor wants you to take control they will say 'You have control', you should place your hands and feet on the controls and reply 'I have control', they will then take their hands and feet off the controls and the aircraft is then yours. When your Flying Instructor wants to take control back off you they will say 'I have control', and place their hands and feet on the controls, you should reply 'You have control', and then take your hands and feet off the controls, the aircraft is then theirs.

Airspeeds for Safe Operations (KIAS)

The following airspeeds are those which are significant to the operation of the aircraft. These figures are for aircraft flown up to maximum gross weight, under standard conditions at sea level.

Performance for a specific aircraft may vary from published figures depending upon the equipment installed, the condition of the engine, airframe and equipment, atmospheric conditions and piloting technique.

Unless otherwise specified, these data are valid for standard operations at maximum weight in normal conditions.

Piper PA38 Tomahawk:

Normal Takeoff.. 60 kts IAS

Normal Climb... 70 kts IAS

Maximum Angle of Climb .... 61 kts IAS

Maximum Rate of Climb.. 70 kts IAS

Manoeuvring Speed (Va) - at MAUW .... 103 kts IAS

Manoeuvring Speed (Va) - at 580kg... 90 kts IAS

Maximum Flap Extension Speed (Vfe)... 89 kts IAS

Maximum Structural Cruising Speed (Vno) .... 110 kts IAS

Never Exceed Speed (Vne) .... 138 kts IAS

Normal Base and initial Final Approach Speed............................. 70kts IAS

Final Approach Speed – full flaps extended.................................. 65 kts IAS

Maximum Demonstrated Crosswind Velocity................................ 15 kts

Taxiing

Before taxiing the aircraft, ascertain that the propeller back blast and taxi areas are clear. Close the throttle, release the park brake, apply just sufficient power to start moving. When releasing the park brakes ensure that they are completely off, it is possible for them to appear to be off but to be partially on.

When in a clear area, apply the toe brakes sufficiently to feel their operation, then continue. The brake test should be done gently, with even pressure on both brakes. If one brake is not working the aircraft will swing in the direction of the good brake. Pass control to the left seat pilot/instructor if present, to allow them to check the brakes from their side.

NOTE
The brake test does not have to bring the aircraft to a complete stop.

While taxiing, make slight turns to ascertain the effectiveness of the steering. While doing this, cross reference into the instruments to check appropriate response. In a turn to the left, the compass and DI should show a decrease in heading/direction, and the balance ball should move out to the right. In a turn to the right, the compass and DI should show an increase in heading/direction, and the balance ball should move out to the left.

Pay careful attention to wingtip clearance when taxiing near buildings or other stationary objects. If necessary, arrange for a suitably experienced and briefed observer to "wing walk" until the aircraft is well clear of such obstacles.

When taxiing over uneven ground, avoid holes and ruts. Do not operate the engine at high RPM when taxiing over ground containing loose stones, gravel, or any loose material that may cause damage to the propeller blades.

Normal Takeoff

Prior to takeoff, give consideration to applying the Carb Heat for up to 15 seconds. This will ensure the carburettor is completely clear of icing, especially on a maximum performance takeoff. The risk of carb icing must be balanced against the risk of ingesting grass seed into the carburettor from the unfiltered carb heat air. Carb icing is most likely on a moist morning, when the grass is probably wet from the dew. Grass seed is most likely on dry long grass, when the heads are present.

Takeoffs can be made with the flaps up. However, if the runway surface is wet and/or long grass, or the runway length is short, takeoff distance is reduced by approximately 10% with the flaps set at the first notch. Climb performance is reduced with flaps down; that is, to climb above an obstacle the aircraft does better with flaps up. Flap settings greater than the first notch are not recommended for takeoff. At most organisations, to practise reconfiguring after takeoff, takeoffs are normally made with one stage of flap selected, i.e. the first notch in the PA38 Tomahawk.

The normal takeoff technique is conventional. The elevator trim tab should be set for takeoff, either to the indicated position or to neutral. When cleared for takeoff, open the throttle smoothly and fully. Hold it open by pushing it forward with your thumb, as vibrations from the engine or the rough ground may cause it to partially reduce, just when we need full power. Keep straight by using your rudder pedals to track directly at a feature that you have identified in front of you in the distance. Allow the aircraft to accelerate and apply light back pressure on the elevator control.

It is important to check that the engine is developing full power early in the takeoff run by checking for a minimum of 2,200 RPM. Any sign of rough engine operation, bad engine vibration or insufficient power is good cause for aborting the takeoff.

Raise the nosewheel at the appropriate speed, between 50 and 55kts IAS in the PA38, by applying a little elevator back pressure. The aircraft will lift off at approximately 60kts IAS. Raising the nose too high will result in a delayed takeoff.

When safely airborne, keep the wings level (with aileron) and relax the elevator back pressure a little to set and maintain the climb-out attitude, so that the aircraft accelerates to the applicable climb speed (70 kts IAS). Do not lower the nose too much however, or the aircraft may sink back onto the ground. Trim out the control forces.

When at a safe height and speed retract the flaps. A safe height is 200 feet above the ground or obstacles, and a safe speed is 65kts IAS. Once this speed has been achieved retract the flaps, then climb away at the normal climb speed.

Climb

The normal climb at maximum all up weight (MAUW) is made at 70kts IAS. The best angle of climb at maximum all up weight (MAUW) will be obtained at 61kts IAS at sea level.

The best rate of climb at maximum all up weight (MAUW) will be obtained at approximately 70kts IAS at sea level. As the best rate of climb speed is a constant TAS, the IAS should be reduced with height to maintain this best rate of climb TAS. In the circuit this is not a significant consideration, but at altitude it is. Above 4,000ft AMSL the best rate of climb speed should be reduced to 65kts IAS, reducing a further 1kt per 1000ft of altitude.

In the PA38 maintain the mixture control in the Full Rich position for takeoff and climb (to moderate altitudes).

Cruise (Straight and Level)

The cruising efficiency and speed is determined by many factors, including power setting, altitude, temperature, loading and equipment installed in and on the aircraft. The power setting for the cruise, normally around 2,300 RPM in the PA38, is set after the aircraft has accelerated to its normal cruising speed.

If you are leaving the circuit and training area on a cross-country flight, the mixture in the PA38 should be leaned during sustained cruise operation above 3,000ft to compensate for the reduced amount of air going into the engine at those altitudes, and at the pilot's discretion at lower altitudes when 75% power or less is being used.

The procedure in the appropriate engine operating manual should be used, but this is generally approximated by gently reducing the mixture until the engine begins to run just a little roughly, and then increasing the mixture about 1cm.

During the early stages of flight training, we are not sustaining cruise conditions, so we leave the mixture rich.

> **CAUTION**
> Prolonged operation at power above 75% with a leaned mixture will result in engine damage.

Spinning

While the PA38 is certified for intentional spinning, due to the dramatic movement of the rear fuselage and tail empennage, many organisations choose not to intentionally spin the aircraft.

Intentional spins are permitted only with flaps fully retracted for Utility Category operation.

Prior to Deliberate Spinning

Carrying baggage during the spin is prohibited and the pilot should make sure that all loose items in the cockpit are removed or securely stowed including the second pilot's seat belts if the aircraft is flown solo. Seat belts and shoulder harnesses should be fastened securely, and the seat belts adjusted first to hold the occupants firmly into the seats before the shoulder harness is tightened. With the seat belts and shoulder harnesses tight, check that the position of the pilots' seats will allow full rudder travel to be obtained and both full back and full forward control wheel movement. Finally check that the seats are securely locked in position.

> **CAUTION**
> No baggage allowed for spinning.

Spins should only be started at altitudes high enough to recover fully by at least 4,000 feet AGL, so as to provide an adequate margin of safety. A one-turn spin, properly executed, will require 1,000 to 1,500 feet to complete and a six-turn spin will require 2,500 to 3,000 feet to complete.

Spin Entry

The aircraft should be trimmed in a power off glide at approximately 75 kts IAS before entering the stall prior to spinning. This trim airspeed assists in achieving a good balance between airspeed and "g" loads in the recovery dive.

From the power-off glide at 75 KIAS reduce the airspeed at about I kt/sec until the aircraft stalls. Apply full aft control wheel and full rudder in the desired spin direction.

This control configuration with the throttle closed should be held throughout the spin. The ailerons must remain neutral throughout the spin and recovery, since aileron application may alter the spin characteristics to the degree that the spin is broken prematurely or that recovery is delayed.

Application of full aft control wheel and full rudder before the aircraft stalls is not recommended, as it results in large changes in pitch attitude during entry and the first turn of the spin. Consequently, the initial 2-3 turns of the spin can be more oscillatory than when the spin is entered at the stall.

Spin Recovery

Regardless of whether a spin was entered deliberately or inadvertently, the following procedure should be taken to recover:

- Check the throttle is fully closed;
- Check the ailerons are neutral;
- Apply and maintain full rudder opposite the direction of rotation;
- As the rudder hits the stop, rapidly move the control wheel fully forward. As the stall is broken, relax forward pressure to prevent an excessive airspeed build up;
- As rotation stops, neutralize the rudder and ease back on the control wheel to recover smoothly from the dive; and,
- Retract the flaps if they have been extended.

A good mnemonic is **PARE**. Power (off); Ailerons (neutral); Rudder (full opposite); and Elevators (ease out of the dive).

Normal recoveries may take up to one and a half turns when proper technique is used. Improper technique can increase the turns to recover and the resulting altitude loss.

The recommended spin recovery procedure has been designed to minimise turns and height loss during recovery. If a modified recovery is employed i.e., a pause of about one second, equivalent to about one half turn of the spin, is introduced between the rudder reaching the stop and moving the control column forward, spin recovery will be achieved with equal certainty. However, the time taken for recovery will be delayed by the length of the pause, with corresponding increase in the height lost.

In all spin recoveries the control column should be moved forward briskly, continuing to the forward stop if necessary. This is vitally important because the steep spin attitude may inhibit pilots from moving the control column forward positively.

The immediate effect of applying normal recovery controls may be an appreciable steepening of the nose down attitude and an increase in rate of spin rotation. This characteristic indicates that the aircraft is recovering from the spin and it is essential to maintain full anti-spin rudder (opposite rudder) and to continue to move the control wheel forward and maintain it fully forward until the spin stops. The aircraft will recover from any point in a spin in not more than one and a half additional turns after normal application of anti-spin controls.

Mishandled Spin Recovery

The aircraft will recover from mishandled spin entries or recoveries provided the recommended spin recovery procedure is followed. Improper application of recovery controls can increase the number of turns to recover and the resulting altitude loss.

Delay of more than about one and a half turns before moving the control wheel forward may result in the aircraft suddenly entering a very fast, steep spin mode which could disorient a pilot. Recovery will be achieved by briskly moving the control wheel fully forward and holding it there while maintaining full recovery rudder.

If such a spin mode is encountered, the increased rate of rotation may result in the recovery taking more turns than usual after the control column has been moved fully forward.

In certain cases, the steep, fast spin mode can develop into a spiral dive in which the rapid rotation continues, but indicated airspeed increases slowly. It is important to recognise this condition. The aircraft is no longer auto-rotating in a spin (in a stalled state) and the pilot must be ready to centralise the rudder so as to ensure that airspeed does not exceed 103 kt (VA) with full rudder applied.

Dive Out

In most cases, spin recovery will occur before the control wheel reaches the fully forward position. The aircraft pitches nose down quickly when the elevator takes effect and, depending on the control column position, it may be necessary to move the column partially back almost immediately to avoid an unnecessarily steep nose down attitude, possible negative "g" forces and excessive loss of altitude.

Because the aircraft recovers from a spin in a very steep nose-down attitude, speed builds up quickly in the dive out. The rudder should be centralised as soon as the spin stops. Delay in centralising the rudder may result in yaw and "fish-tailing." If the rudder is not centralised it would be possible to exceed the maximum manoeuvre speed (VA) of 103 kt with the rudder fully deflected.

Engine

Normally the engine will continue to run during a spin, sometimes very slowly. If the engine stops, take normal spin recovery action, during which the propeller will probably windmill and restart the engine. If it does not, set up a glide at 75 kt IAS and restart the engine using the starter motor.

Descent

Descent can be either a power off glide (with the throttle closed), or a power assisted descent, e.g. at about 90-100kts, with 1500-2000 RPM set in the PA38.

The disadvantages of a gliding descent are that the descent angle is not variable with changes to the power setting and that the engine cools rapidly and this can crack the cylinder heads.

The PA38 can be glided satisfactorily at 70kts IAS with power off.

If a prolonged power off descent is to be made, apply full carburettor heat prior to power reduction and check power response approximately every 1,000ft of descent by smoothly applying power and then re-closing the throttle. At about 100 feet before your level off altitude select the carburettor heat OFF (unless carburettor icing conditions are suspected), then simultaneously set power and attitude as required and trim out the new control forces.

A power assisted descent profile is used in the circuit and on most cross-country descent situations and will minimise the effects of the temperature cycle. This will help to prolong the engine cylinder life.

In the circuit, on base, the throttle is initially set to 1,500 RPM in the PA38, then varied as required to control the descent angle.

On cross-countries or when returning from a training area, the throttle should be adjusted to give 500 fpm rate of descent, (mixture full rich) and maintain an attitude for an airspeed of 90-100kts IAS. Remember carburettor heat may be required.

> **NOTE**
> Always apply carburettor heat before starting a descent with low RPM set.

Circuits

The purpose of flying circuits is to practise most of the previously taught exercises, e.g. takeoffs, climbing, turning, straight and level and descending, and to learn and practise landings. You will spend a significant amount of your early flying training time in the circuit, and so do all of the other students. As a result, the circuit is often busy and a continuous lookout and listen-out is vital to ensure you remain safely separated from the other aircraft.

In normal circumstances aircraft must maintain their position in the circuit, i.e. don't cut off other aircraft. The only exceptions to this are when specifically instructed otherwise by Air Traffic Control (ATC), and when practising engine failures after takeoff (EFATO), in which case the aircraft practising the EFATO is deemed to have left the circuit and must carefully rejoin the circuit, giving way to other aircraft. This may well involve a change of aircraft sequence, where the following aircraft will overtake (by cutting inside) the aircraft carrying out the EFATO.

Base Turn Procedure

Mid to late downwind identify a feature on the ground over which you wish to have your aircraft established straight-in on final approach at 500 feet AGL. As you approach abeam this 'straight-in feature' initiate the following procedure:

- Carry out a thorough **lookout**;
- Select the Carb Heat ON;
- Reduce the throttle to an appropriate power setting for the type of approach you are intending to carry out;
- Immediately begin a medium level turn to track toward your straight-in feature;
- When the IAS is in the 'white arc' select the first stage of flap; and.
- Allow the aircraft to descend and trim for the desired airspeed.

Naturally this 'standard' base turn procedure should be varied to take into account operational considerations such as wind, other air traffic and/or terrain/obstacles on final approach. However, do not continue extending the downwind beyond your selected base turn point waiting for the aircraft to slow down before turning.

Normal Approach

Approaching the base turn point carry out a thorough **lookout**, then apply the carb heat and reduce the throttle to about 1,500 RPM in normal 10-15 knot wind conditions. Remember that one of the effects of power reduction is that the nose of the aircraft will drop below the normal straight and level attitude. Do not let this happen, but rather maintain the nose attitude with elevator as you enter the level base turn. The nose will also yaw with power reduction, so maintain balance with rudder.

As the speed reduces into the 'white arc' select the first stage of flap and apply some coarse elevator trim as the flaps are lowered and allow the aircraft to begin descending.

Now finely trim the aircraft for 70kts IAS, or it will be very difficult to hold the required airspeed on base and finals, and you will require large elevator control forces during the landing flare, and this would make the landing more difficult.

The purpose of the base leg is to fly the aircraft to a position over the 'straight-in feature' at 500 feet AGL, lined up towards the landing runway, at 70 kts IAS.

On base leg and final, the primary means of adjusting the descent path is by varying power (RPM) with the throttle, and the required airspeed is maintained by small adjustments to the nose attitude. If you are low, increase the power setting by an appropriate amount, e.g. 100-200 RPM for a small correction, or possibly 300-500 RPM if a large correction is required. Conversely, if you are high, decrease the power by a proportional amount. If you are fast, select a slightly higher nose attitude and conversely if you are slow, select a slightly lower nose attitude.

Also, you can use the flaps to adjust the approach path. Using more flap will steepen your descent path if you keep the airspeed constant, so if you are lower than you think you should be on the final approach angle, delay flap application. If you recognise that you are high, putting flap down earlier, or putting more flap down than usual, will help to rectify the approach path. **Remember though, that the approach path is adjusted primarily by means of varying the power.**

When on final, use power and attitude changes together as required to maintain a constant approach path angle and the desired airspeed.

Increase the flap to the nominated amount, normally full flap for a normal landing. In the PA38 Tomahawk, which only has two flap selections, the first stage of flap is usually taken at the beginning of the base leg, and the second (final/full) stage is taken at about 300 feet above the ground.

When landing flap is selected, allow the airspeed to reduce, due to the increased drag, to the appropriate final approach speed for the conditions and the aircraft type you are flying. In the PA38 Tomahawk the airspeed may be reduced to **not below 65kts IAS** beginning the landing flare.

In gusty crosswind conditions increase the nominated final approach speed by half the gust factor (normally at least 5kts). In significant conditions a prudent pilot would also consider a reduced flap setting, normally only one stage in the PA38. However, in the early stages of your training you are unlikely to be flying in conditions that would require you to approach with reduced flap.

Late on final approach, at around 150 feet above the ground, make a mental note of 'speed; slope; and configuration', and complete the Finals Checks. At this stage I also make a mental note to look to the far end to help judge the round out and landing. Trust me, it helps!

If you are not confident that you are ready to execute a safe landing, then **you must discontinue the approach**. This is sometimes referred to as doing a 'go-round', going 'missed approach', or doing a 'baulked landing'. See below for details.

Flapless Approach

If there is a problem with the flaps and you have to make a flapless approach and landing, there will be less drag, so at the base turn point reduce the power to somewhat less than for a normal approach, but maintain a slightly higher speed than you would with flap extended, because the stall speed is a little higher.

In the PA38 set about 1300-1400 RPM. Maintain 80kts IAS on base. After turning onto final progressively reduce the airspeed to a final approach speed of 75kts IAS.

Flap lowers the nose and consequently improves the forward vision, so if you are approaching flapless you will notice the nose is slightly higher and vision slightly less. Avoid the tendency to fly a shallow approach because the picture out the front window is different. Maintain an approach angle of at least 3°.

Make sure you keep a little power on as you enter the flare. If you end up with the throttle closed before you enter the flare, and hold off too long, there is a possibility of a tail strike, i.e. scraping the tail on the ground as you land. Since the nose is already higher than normal there is less flare required.

Glide Approach

At the base turn point (the exact position depends on the wind), select the carburettor heat ON and close the throttle smoothly and fully.

Maintain 75kts IAS round base and onto initial finals. Select flap as required to control glide range. Reduce the airspeed to a final approach speed of 70kts IAS, maintaining at least 65kts IAS into the round out.

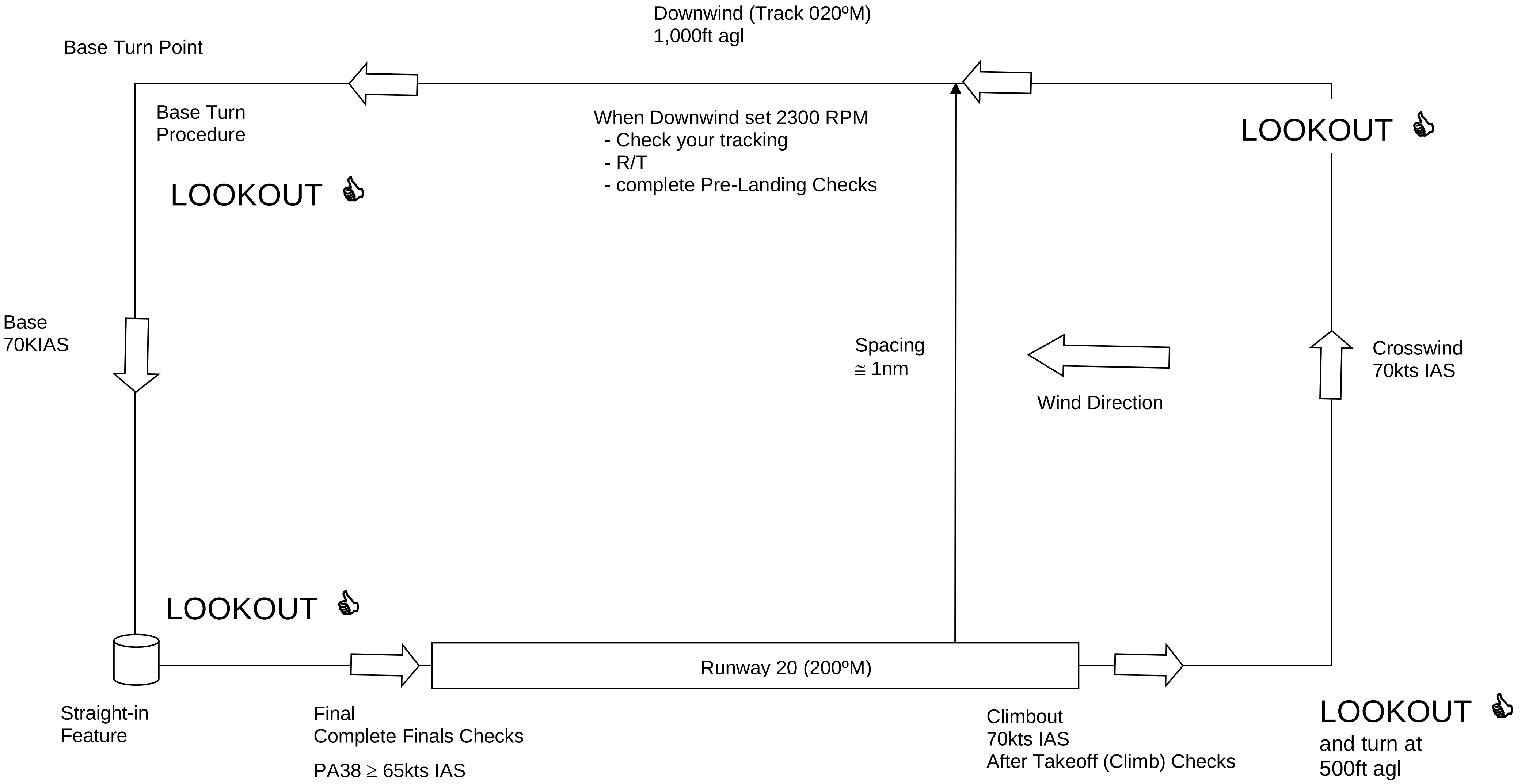
Never try to stretch the glide by raising the nose and reducing the airspeed.

Give a normal radio call in the downwind and consider advising other traffic that you are carrying out a glide approach by calling "Papa Alpha Foxtrot, downwind, touch and go, glide, number one". You MUST maintain your position in the circuit traffic, i.e. do not cut in front of other aircraft. To achieve this, consideration of the position of the other traffic and early planning is necessary.

Approaching to a Minimum Length Field

Configure the aircraft as per the normal approach however nominate a final approach speed of 1.3 V_{SO} for the actual weight, plus any gust factor. An early touchdown is desirable and appropriate braking should be applied in order to bring the aircraft to a prompt stop in the distance nominated.

Normal Circuit Diagram



The Landing

Maintain the descending attitude until at the round-out (flare) height. The height for this will be demonstrated by your Flying Instructor and is approximately 1-2 metres above the ground.

At that point, slowly begin to raise the nose to reduce the rate of descent, take all of the power off by smoothly closing the throttle, keep the wings level (with aileron) and fly parallel to and just above the ground (about ½ metre). As the aircraft decelerates you will need to slowly and continuously raise the nose to the landing attitude. Coincidentally, the landing attitude looks much the same as the takeoff attitude. This requires steadily more back pressure because the elevator is becoming less effective as the airspeed reduces, and because of the tendency of the nose to drop when power is reduced. If you apply the back pressure too quickly however, the wings will generate too much lift and the aircraft will balloon upwards. A slow application of back pressure is required, just sufficient to keep the aircraft flying parallel to and just above the ground. At the moment of touchdown, the nose attitude should be similar to the takeoff attitude.

Some students find it helpful to remember **"Level off; Power off; Hold off"**.

Touch down on the **main wheels** first. Gently lower the nose wheel to the ground and keep straight with rudder. Once the nosewheel is in steady contact with the ground, use brakes as required to bring the aircraft to a stop or slow taxi speed. When you are at a safe taxiing speed clear the runway. Then carry out the After Landing Checks.

If you are completing a 'touch and go landing', i.e. immediately taking off again, allow the aircraft to slow, as if you were completing a normal 'full stop landing', keeping straight with rudder, set the flap to one stage in the PA38 and smoothly reapply full power. Continue the takeoff and climb out as if you were flying a normal takeoff.

In the earlier stages of your training your Flying Instructor may select the flap for you, check the elevator trim and tell you when to smoothly reapply full power.

Go-Round

If a go-round is required from an approach or following some other exercise, with the aircraft in any given configuration, smoothly apply full power and establish a climb attitude, normally the maximum rate of climb attitude, **then** ensure that the carb heat is OFF.

Do not initiate a go-round by selecting the carb heat is OFF, if it is ON, so be it. Starting a go-round by selecting carb heat OFF will do nothing for the power output of the engine. However, smoothly applying full power with the carb heat ON will give you about 90% of the available power and do no damage to the engine. Then, when you have the manoeuvre completely under control, you can select the carb heat OFF to achieve 100% of the available power.

Wait for a positive rate of climb and reduce any flap to the setting normally used for takeoff. I.e. in the PA38 reduce to the first stage.

When at a safe speed and height, (65kts IAS in the PA38 and 200 ft agl), reduce any remaining flap to zero and then complete the After Takeoff (Climb) checks.

A good mnemonic for the go-round is: **"Power up; Nose up; Clean up"**.

Chapter Six

Limitations

General

The Piper PA38 Tomahawk is cleared for use as a training aircraft, subject to limitations given in the following paragraphs. These limitations must be observed at all times when operating these aircraft.

Airframe Limitations

Maximum Demonstrated Crosswind Velocity	15 kts IAS
Maximum Flap Extension Speed (Vfe)	89 kts IAS

The flap limiting speeds also apply to flight with the flaps lowered.

Manoeuvring Speed (Va) - at MAUW	103 kts

At aircraft weights less than the maximum AUW, the manoeuvring speed is reduced as the effects of aerodynamic forces become more pronounced. Linear interpolation may be used for intermediate gross weights. Manoeuvring speed should not be exceeded while operating in rough air.

Manoeuvring Speed (Va) - at 580kg	90 kts
Maximum Structural Cruising Speed (Vno)	110 kts
Velocity Never Exceed (Vne)	138 kts

Engine RPM Limitations

Maximum RPM	2600 RPM
Static RPM (at full throttle)	2200-2350 RPM

Engine Fuel System Limitations

Fuel Grade - Minimum	100/130
Total Fuel Capacity	32 US Gallons (121 litres)
Total unusable fuel	2 US Gallons (7.6 litres)
Fuel Consumption @ 75% Power	6.5 US Gallons (25.0 litres) per hour
Endurance @ 75% Power	4.1 hrs to 30-minute reserve
Minimum Fuel Pressure	0.5 psi
Maximum Fuel Pressure	8 psi
Normal Operating Range	0.5-8 psi

Engine Oil System Limitations

The oil capacity of the Lycoming O-235-L2C engine is 6 quarts, and the minimum safe quantity is 2 quarts.

Minimum Oil Pressure	15 psi
Maximum Oil Pressure	100 psi
Normal Operating Range	60-90 psi
Maximum Oil Temperature	118º C (245º F)
Normal Operating Range	23-118º C (75-245º F)

Maximum Operating Weights

Maximum AUW (Normal & Utility)	1,670 lb (757.5 kgs)
Maximum load in luggage locker (Station 105)	100 lb (45.3 kgs) Baggage loading should not exceed 25 lb 11.3 kgs) per square foot. No baggage allowed for spinning.

Centre of Gravity (CofG) Limitations

The CofG datum is 66.25 inches ahead of the wing leading edge.

The CofG limits (Normal & Utility) at 1,670 lb (757.5 kgs):

Forward CofG	73.5 in aft of datum
Aft CofG	78.5 in aft of datum

The CofG limits at 1,277 lb (579.2 kgs):

Forward CofG	72.4 in aft of datum
Aft CofG	78.5 in aft of datum

Manoeuvre Limits

Normal Category: No aerobatic manoeuvres, including spinning are permitted.

Utility Category: The following manoeuvres are approved in the Utility category only:

Manoeuvre	**Entry Speed**
Spins (Flaps Up)	Stall
Steep Turns	100 kts IAS
Lazy Eights	100 kts IAS
Chandelles	100 kts IAS

Flight Manoeuvre Load Factors

Maximum Positive Load Factor	Normal	Utility
- Flaps Up	3.8 G	4.4 G
- Flaps Down	2.0 G	2.0 G

Maximum Negative Load Factor — No inverted manoeuvres approved.

Miscellaneous Limitations

Flight in icing conditions is not permitted.

Smoking is not permitted in the aircraft at any time.

PA38 EMERGENCY CHECKLISTS

FIRE DURING START

Starter .... Keep winding

If the engine starts:

Throttle.................................. Set 1700 for two minutes
Engine.................................. Shutdown and seek engineering support

If the engine fails to start or the fire continues:

Throttle............................. Full Open
Mixture .... Idle cut off
Fuel Pump .... Off
Fuel Selector .... Off

If fire continues:

Master Switch .... Off
Ignition .... Off
Park Brake............................. Off

Abandon the Aircraft

Attempt to extinguish the fire if safely possible and seek engineering support.

ENGINE FIRE IN FLIGHT

Mixture .... Idle cut off
Throttle............................. Closed
Fuel Selector .... Off
Fuel Pump .... Off
Cabin Heat............................. Off
Cabin Vents .... Closed

Proceed with the forced landing.
If fire persists, make a high speed emergency descent.

ELECTRICAL FIRE IN FLIGHT

Master Switch................... Off
Cabin Vents .... Closed
Storm Window .... Open
Cabin Heat............................ Off

If smoke/fire continues:

Locate source and extinguish if possible.
If the smoke/fire continues carry out an emergency descent.
Land as soon as possible.

If smoke/fire stops:

All Electrics .... Off
Master Switch .... On

Essential electrics on, one at a time, to locate the source if possible.
If source identified, leave it off.

If unidentified smoke/fire reoccurs:

Master Switch................... Off

Continue NORDO, remaining VMC and clear of controlled airspace if possible.

LOW OIL PRESSURE

Pressure in Yellow arc

Oil Temperature..................... Monitor
Oil Pressure. .... Monitor
CHT...................................... Monitor

Set 1800 RPM, proceed to the nearest suitable airfield and land.
Maintain altitude and be prepared for complete power loss.

HIGH OIL TEMPERATURE

Oil Pressure........................... Monitor
CHT....................................... Monitor

If oil pressure is dropping and/or CHT is rising, set 1800 RPM, proceed to the nearest suitable airfield and land. Maintain altitude and be prepared for complete power loss.

If oil pressure and CHT are steady set 2000 RPM and continue to your destination. Check the oil level.

LOW FUEL PRESSURE

Fuel Pump .... On
Fuel Selector .... Change tanks

ENGINE ROUGH RUNNING

Carb Heat.......................... On

If rough running continues after 1 minute:

Carb Heat .... Off
Fuel Contents & Pressure ..... Check
Fuel Pump .... On
Fuel Selector .... On; change tanks
Fuel Primer .... In; locked
Mixture .... Adjust for max smoothness
Ignition................................. Try left, right, & both.

ENGINE FAILURE DURING TAKEOFF ROLL

Throttle .... Closed
Brakes................................ Full On

Advise ATC
Complete the **After Landing Checks**

If signs of fire or engine completely stopped:

Ignition .... Off
Master Switch .... Off

ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

Nose.................................. Lower
Airspeed .... 70 kts IAS
Throttle .... Closed

Select a landing field and plan your approach.

Mixture .... Idle cut off
Fuel Selector.......................... Off
Ignition .... Off
Flaps .... As required
Master Switch .... Off

ENGINE FAILURE IN FLIGHT (Restart procedure)

Airspeed .... 65kts IAS
Throttle .... Closed
Carb Heat .... On
Fuel Pump .... On
Fuel Selector.......................... On; Change tanks
Fuel Primer .... In; Locked
Mixture .... Rich
Ignition .... Try left, right, & both;
Start if the propeller has stopped
Throttle .... Open

If power cannot be restored carry out a forced landing.

Chapter Eight

Safety and Emergency Expanded Procedures

Introduction

This section provides the pilot with procedures that may assist him or her to cope with emergencies that may be encountered in operating a light aircraft.

Emergencies caused by aircraft or engine malfunction are extremely rare if proper maintenance procedures and operating procedures are followed and a thorough pre-flight inspection is completed prior to every flight.

Likewise, careful flight planning and good pilot judgement can minimise enroute weather emergencies. However, should any emergency develop, the Emergency Checklist items and the guidelines in this section should be considered and applied as necessary.

It is extremely important for you to remember that the most important priority in any normal, abnormal or emergency situation is to **fly the aircraft** safely and remain clear of cloud, obstacles and other aircraft. It is very easy to be distracted from this vital duty, but you must be vigilant to the possibility.

Procedures in the Emergency Checklists which are shown in **bold-faced type** are immediate actions which should be committed to memory.

The following paragraphs are presented to supply additional information for the purpose of providing the pilot with a more complete understanding of recommended courses of action and probable cause of an emergency situation. Whenever possible seek the assistance/advice of your Flying Instructor, Club base, ATC or other pilots as available.

Airspeeds For Safe Operations (KIAS)

Engine failure after take-off	70kts IAS
Manoeuvring speed	95kts IAS (At MAUW)
Maximum glide range speed	65kts IAS (At MAUW)
Precautionary landing with engine power	1.3 V_{SO} for the actual weight

Fire During Start

Engine fires during start are usually the result of over priming or pumping of the throttle combined with a backfire during the ignition phase. The first attempt to extinguish the fire is to try to start the engine and draw excess fuel back into the induction system.

If a fire is present before the engine has started, move the mixture control to idle cut-off, open the throttle and crank the engine. This is an attempt to draw the fire back into the engine and to use up excess fuel. If the engine has started, continue operating the starter for a few seconds to try to pull the fire into the engine. In either case, if the fire continues more than a few seconds, the aircraft must be shut down, then vacated immediately, and the fire should be extinguished by the best available means.

Never attempt a restart the engine until engineering support has been received.

Engine Fire in Flight

The presence of fire is noted through smoke, smell and/or heat in the cabin. It is essential that the source of the fire be promptly identified through instrument readings, characteristics of the smoke, or other indications, since the action to be taken differs somewhat in each case.

Check for the source of the fire first.

If an engine fire is present its source is more than likely the fuel, consequently the fuel should be 'starved' from the fire. Select the mixture to idle cut off, close the throttle, and switch the fuel selector to OFF if you can in your aircraft type. If there is an electric fuel pump fitted to your aircraft, it should be switched OFF. In all cases, the heater and defroster should be OFF, and the vents should be closed. Proceed with the power off forced landing procedure.

If an electrical fire is indicated (smoke in the cabin), the master switch should be turned OFF. The cabin vents and windows should be opened and the cabin heat turned OFF in an effort to clear the cabin of smoke. If you can identify the source of the fire/smoke and turn it off, then do so. Regardless, a landing should be made as soon as possible.

NOTE: The possibility of an engine fire in flight is extremely remote. The procedure given is general and pilot judgement should be the determining factor for action in such an emergency.

Electrical Faults

The loss or reduction of alternator output is indicated by a left deflection on the ***centre-zero*** ammeter. Before executing the following procedure, ensure that the reading is actually negative by actuating an additional electrically powered device, such as the pitot heat. If an increase in the left deflection of the ammeter is noted, alternator failure can be assumed.

The loss of alternator output is detected through zero reading on the ***left-zero*** ammeter and the illumination of the ALT light. Before executing the following procedure, ensure that the reading is zero and not merely low by actuating an additional electrically powered device, such as the pitot heat. If no increase in the ammeter reading is noted, alternator failure can be assumed.

The electrical load should be reduced as much as possible. Check the alternator circuit breakers for a popped breaker.

The next step is to attempt to reset the overvoltage relay. This is accomplished by moving the ALT switch to OFF for one second and then ON. If the trouble was caused by a momentary overvoltage condition (16.5 volts and over) this procedure should return the ammeter to a normal reading.

If the ammeter continues to indicate a failure, or if the alternator will not remain reset, turn off the ALT switch, maintain minimum electrical load and land as soon as practicable. All electrical load is being supplied by the battery. Take note of the remaining endurance and do **not** consider flight in IMC if you can possibly avoid it.

If you lose all electrical power, "total electrics failure", the aircraft will still fly perfectly well. However, your radios will not function, so avoid busy and controlled airspace if it is practical to do so, and land at a suitable aerodrome. If you think that it is best to return to land at a controlled aerodrome then carryout a standard overhead join so you can keep an extra good lookout for other aircraft. You should look for light signals from the tower, but land when you are sure that it is safe to do so, regardless of whether or not you see light signals.

If you are in the circuit, maintain your position (order) in the pattern of other aircraft and land off the next approach. If you are in a CTR, the control tower will pretty quickly work out that you have a problem because you are not responding to their radio calls. Again, you should look for light signals from the tower, but land if you are sure that it is safe to do so, regardless of whether or not you see light signals.

Electrical Overload (Alternator over 20 amps above known electrical load)

If abnormally high alternator output is observed (more than 20 amps above known electrical load for the operating conditions), it may be caused by a low battery, a battery fault or other abnormal electrical load. If the cause is a low battery, the indication should begin to decrease toward normal within 5 minutes. If the overload condition persists, attempt to reduce the load by turning off non-essential equipment.

Turn the BAT switch OFF and the ammeter should decrease. Turn the BAT switch ON and continue to monitor the ammeter. If the alternator output does not decrease within 5 minutes, turn the BAT switch OFF and land as soon as possible. All electrical loads are being supplied by the alternator.

NOTE: Due to higher voltage and radio frequency noise, operation with the ALT switch ON and the BAT switch OFF should be undertaken only when required by alternator failure.

Low Oil Pressure

Loss of oil pressure may be either partial or complete. A partial loss of oil pressure usually indicates a malfunction in the oil pressure regulating system, and a landing should be made as soon as possible to investigate the cause and prevent engine damage.

A complete loss of oil pressure indication may signify oil exhaustion or may be the result of a faulty gauge. In either case, proceed toward the nearest aerodrome preserving altitude where possible, and be prepared for a forced landing. If the problem is not a pressure gauge malfunction, the engine may stop suddenly. Maintain altitude until such time as an engine out landing can be accomplished if necessary. Don't change power settings unnecessarily, as this may hasten complete power loss.

Depending on the circumstances, it may be advisable to make an off aerodrome landing while power is still available, particularly if other indications of actual oil pressure loss, such as sudden increases in temperatures, or oil smoke, are apparent, and an aerodrome is not close.

If the engine does stop, proceed with a power off landing.

High Oil Temperature

An abnormally high oil temperature indication may be caused by a low oil level, an obstruction in the oil cooler, damaged or improper baffle seals, a defective gauge, or other causes. Land as soon as practicable at an appropriate aerodrome and have the cause investigated.

Loss Of Fuel Pressure

If loss of fuel pressure occurs, turn ON the electric fuel pump and check that the fuel selector is on the fullest tank.

If the problem is not an empty tank, land as soon as practicable and report the defect to either your Flying Instructor or to a more experienced Club pilot.

Carburettor Icing

Under certain moist atmospheric conditions at temperatures of -5°C to +20°C, it is possible for ice to form in the carburettor air induction system, even in summer weather. This is due to the high air velocity, with an associated pressure and temperature drop, through the carburettor venturi and absorption of heat from this air by vaporisation of the fuel.

To avoid this, carburettor air preheat (carb heat) is provided to replace the heat lost by the venturi effect and vaporisation. Carburettor heat should be used whenever the engine RPM is set to a low power setting, less than 2000 in the PA38. This will help to keep the carburettor air temperature out of the caution (yellow) range.

Waypoints AVIATION

Engine Rough Running

Engine rough running is often due to carburettor icing, which is indicated by a drop in engine RPM and may be accompanied by a slight loss of performance If too much ice is allowed to accumulate, restoration of full power may not be possible, therefore prompt action is required.

Turn the carburettor heat on (see the note below). The RPM will decrease slightly and roughness may increase. Wait for a decrease in engine roughness or an increase in RPM, indicating ice removal. If there is no change after approximately one minute, return the carb heat to OFF.

If the engine is still rough running, a check of the fuel contents and pressure should be made. The electric fuel pump should be switched to ON and the fuel selector should be changed to the other tank (providing there is adequate fuel in it) to see if fuel contamination is the problem. Check the engine gauges for abnormal readings. If any gauge readings are abnormal, proceed in accordance with the appropriate Emergency Checklist actions. In the PA38 the mixture should be adjusted for maximum smoothness. The engine will run rough if the mixture is too rich or too lean. Move the magneto switch to L then to R, then back to BOTH. If operation is satisfactory on either magneto, proceed on that magneto at reduced power, with mixture full RICH to a landing at the first available aerodrome.

If roughness persists, prepare for a precautionary landing at pilot's discretion.

NOTE: Partial carburettor heat may be worse than no heat at all, since it may melt part of the ice which will refreeze later in the intake system. Therefore, when using carburettor heat always use full heat and when ice is removed and the engine is running smoothly, return the control to the full cold position. In severe icing conditions carb heat should be left on and the mixture should be re-leaned accordingly.

Engine Failure

<u>During the Takeoff Roll:</u>

If the engine should run rough or fail during the takeoff roll, smoothly close the throttle and bring the aircraft to a complete stop as you would following a landing.

Advise other traffic (in a CTR advise ATC), as soon as possible, that you are stopping, i.e. **"Papa Alpha Foxtrot - STOPPING"**.

Look for signs of fire, and if you have any doubt, immediately shut the engine down, turn the fuel selector to OFF, turn the ignition and master switch to OFF and vacate the aircraft without delay. If you are comfortable there is no fire, complete the After Landing Checks.

If the engine has completely stopped inform the tower and secure the aircraft by completing the Shutdown Checks. Vacate the aircraft and wait for assistance in a safe place by the aircraft.

If the engine is still running, but you are not sure of its serviceability for further flight, either shut it down as above, or request a clearance to return to dispersal. Report the problem to your Flying Instructor.

Immediately After Takeoff:

If you have an engine problem immediately after takeoff the most important thing is to keep flying the aircraft.

If the engine stops completely you must lower the nose to maintain flying speed - at least 70kts IAS in the PA38, close the throttle and prepare to land in the most suitable place available.

Where you land will depend on your situation, however you should NOT expect to be able to turn back to the runway you took off from. It is better to pick a field pretty much in front of you. As your experience increases you should develop the ability to judge where the aircraft can reach, and a more 'imaginative' handling of the situation may be possible.

Your ability to complete any subsequent checks will depend on your situation and presence of mind. It is far better to control the aircraft to a safe landing, having done no other checks, than to complete all of the checks but to fail to fly the aircraft to the best landing site.

If the engine does not stop completely and partial power is available, you may be able to nurse the aircraft around the circuit, or to a position from which a glide approach to an alternate landing site is possible. Use any power that the engine is developing to manage your situation.

When you can, make a MAYDAY call.

In Flight:

If you have an engine problem at any time in flight, again the most important thing is to keep flying the aircraft.

Maintain flying speed and start to assess your situation. Have a good look around the instruments, listen to the engine, and look behind you for signs of fire. Consider anything that will help you establish what is wrong. Once you have an idea of the problem take whatever action you think is appropriate to preserve your life.

Complete whatever emergency checks you think are appropriate and when you can, make a MAYDAY call.

Again, it is far better to flying the aircraft to a safe landing having done no checks, than to meticulously complete the checks and lose control of the situation/aircraft.

Flap Failure

In aircraft with manually activated flap, such as the PA38, due to a jamming of the mechanism, and in aircraft with electrically operated flaps, the flap may fail due to an electric fault or failure. Neither of these events is likely, however they are possible.

If the flaps cannot be lowered, carry out a flapless landing and return to dispersal to report the problem to your Flying Instructor. Remember that without flap the aircraft's drag is slight less and the stall speed is slightly higher. Consequently, you will require slightly less power and you should maintain slightly higher speeds. Also, without flap the nose attitude will be slightly higher, so be careful not to over flare on landing. The landing attitude when flapless is much the same as for a normal landing.

If the flaps cannot be retracted after takeoff, maintain full power and climb at a safe flying speed to a safe height. In the PA38 use 70kts IAS. Even with full flap down at maximum weight the aircraft should still be able to climb adequately. When you have reached a safe height, allow the aircraft to accelerate to a little below the flap limiting speed and reduce the power to maintain that speed. Carry out an approach and normal landing at the nearest suitable aerodrome. Remember that because the flap may be extended on base and final earlier than normal, the required power may be higher.

Open Door

The cabin doors on most aircraft are double latched, so the chances of them springing open in flight are remote. However if you should forget or do not secure the door adequately the door may spring partially open. This will usually happen at takeoff or soon afterward. A partially open door on a PA38 will not affect normal flight characteristics, and a normal landing can be made with the door open.

Hinged doors will trail slightly open, and airspeed will be reduced slightly. Do not attempt to close the door until you are well clear of the ground, at least above 1,000 feet agl.

To close a hinged door in flight, slow the aircraft to 75 KIAS, close the cabin vents and open any windows. Then slam the door soundly. Remember to **FLY THE AIRCRAFT** at all times!

Insecure Seatbelt

Passengers seatbelts (or parts thereof) can sometimes be inadvertently shut in the door, leaving a loose section lying outside the fuselage.

If, when shortly after airborne, you hear a loud "banging" on the fuselage, continue to fly the aircraft and at a safe height (above 500 feet agl), check the right-hand passenger seatbelt. Should you confirm the above situation, return for a landing and correct the situation. It is usually not worth the risk to try to correct the situation in flight.

Remember, if it is a seatbelt causing the noise, little damage or danger will result.

Don't panic, flying the aircraft is your first priority!!

Brake Failure

Taxiing:

If the brakes should fail while taxiing, the decisions to be made by the pilot are dependent on the situation at the time, but with the objective of stopping the aircraft whilst avoiding contact with persons or property.

Steer the aircraft with the rudder pedals to avoid contact with obstructions. If the speed fails to decay at an acceptable rate, it is better to steer the aircraft between obstructions and allow the wings to absorb collision impact.

The quickest method of stopping the engine is to turn the ignition switches OFF. This will minimise any damage that may be caused by the rotating propeller.

Remember, grass surfaces will slow an aircraft at a greater rate than hard standing i.e. aprons, taxiways, etc.

Airborne:

Should brake failure be detected prior to landing, plan to carry out a minimum length field approach using the longest, preferably grass vector available. This will help improve deceleration. Remember, the landing roll with no brakes will be considerably longer than normally experienced when braking is available.

Circuit Breakers and Fuses

Circuit breakers and fuses are used to protect electrical components from an over-voltage or over-current condition, by automatically 'popping' (opening the circuit) and interrupting the current flow. They are designed to pop when specific conditions of time and current are reached. Those conditions generate heat and circuit breakers are designed to pop before this heat damages either the wiring or connectors.

Circuit breakers are thermal-mechanical in nature with bi-metallic elements, where one metal expands more under heating than the other, popping the breaker open. This also enables them to be reset, albeit only after they have cooled down. However, there are good reasons why it may not be advisable to do so and it is wise to think twice before resetting any circuit breaker in flight.

A popped circuit breaker or fuse is telling you that something is wrong - that there has been a serious electrical event. Extreme caution should be exercised. Resetting a circuit breaker that has tripped by an unknown cause should normally be a maintenance function on the ground. The old rule of thumb to automatically try one reset attempt is no longer considered prudent.

Often resetting a circuit breaker is met with no adverse results, however the opposite is sometimes true. Smoke, burning wires, electrical odours, arcing, and loss of related systems are possible outcomes. Once a fuse has 'popped' it cannot be reset and must be replaced.

Circuit breakers which have popped should not be reset in flight, and fuses which have burnt out should not be replaced in flight, unless the system which they are associated with is essential, and then do so only every do so once.

Wherever possible, this should only be done after consulting the relevant resources, e.g. the Aircraft Flight Manual, emergency checklists, and/or radioing for advice. In most cases it is advisable to delay the reset until the service is needed. For instance, there is no need to reset a landing gear circuit breaker that trips after takeoff until you are ready to land.

The electro-mechanical construction of a circuit breaker was not designed for use as a switch, and using it for this purpose causes premature wear and the risk of failure. If a circuit breaker fails it may pop when it shouldn't or remain set when it should have popped, neither option is desirable in flight.

Radio Failure

Modern aircraft radio equipment has a very good serviceability record. However, they do occasionally fail. Nevertheless, before declaring that a radio has failed, ensure that:

- The volume control ON/OFF switch has not been accidentally turned to OFF, or the volume turned to minimum;
- You check for noise output by selecting the squelch OFF;
- You check that the microphone selector is on the correct COM set, to ensure that lack of a reply is not due to your transmitting on the wrong COM radio;
- You check SPEAKER and/or PHONE buttons for correct positioning.
- Change headsets and/or plugs if possible; and,
- Use the hand-mike if one is available.

Remember, should both COMM sets be tuned to the same, or close to the same frequency and both SPEAKER and/or PHONE COMM buttons are engaged, when transmitting on one COMM set, it may interfere with the reception of the other, giving "feedback" through the audio system. This can give an erroneous indication of radio failure.

If you are sure that your radios will not function, set your transponder to 7600 and turn all of your external lights ON. Avoid busy and controlled airspace if it is practical to do so, and land at a suitable aerodrome. If you think that it is best to return to land at a controlled aerodrome then carryout a standard overhead join if you can keep an extra good lookout for other aircraft. You should look for light signals from the tower, but land when you are sure that it is safe to do so, regardless of whether or not you see light signals.

If you are in the circuit set your transponder to 7600, maintain your position (order) in the pattern of other aircraft and land off the next approach. The control tower will pretty quickly work out that you have a problem because you are not responding to their radio calls. Again, you should look for light signals from the tower, but land if you are sure that it is safe to do so, regardless of whether or not you see light signals.

Your transponder code 7600 will bring up an alarm in the area radar control centre if you are in radar coverage, and they will contact the nearest control tower to warn them of your communications failure.

Bird Strike

Bird strikes are quite possible near aerodromes nowadays. Should one occur during normal flight, damage to the aircraft will normally be minimal but will depend on the size of the bird and impact location on the airframe. However it is potentially more dangerous to attempt violent manoeuvres to avoid birds, especially close to the ground, than to maintain a fairly consistent flight path. Birds will usually avoid you, they are certainly better flyers, and they are much more manoeuvrable.

If you suspect you have had a bird strike proceed to a safe area and climb (if necessary) to a safe height. Then slow the aircraft to 65-70 KIAS and check by cautious "handling", that the aircraft will still fly satisfactorily at slow (landing) speed. If the slow speed handling check indicates some abnormal handling characteristics, maintain the airspeed at 10kts above the "problem" airspeed for the return to the airfield, approach and landing. Obviously select an airfield with a sufficiently long runway.

Proceed to the nearest suitable aerodrome at a slow, safe airspeed making a normal landing with a slightly higher threshold speed.

Chapter Nine

Systems Description

General Description

The Piper PA38-112 Tomahawk is designed as a basic training aircraft. It is a single-engined, fixed undercarriage, low wing monoplane of all metal construction. It has two-place seating with full dual controls, fully controllable nosewheel, toe brakes and a one-hundred-pound baggage capacity.

Piper PA38-112 Tomahawk specifications:

Engine:	Lycoming O-235-L2C air-cooled flat-four, 112 hp (84 kW)
Propeller:	2-bladed Sensenich metal fixed-pitch, 6 ft (1.83 m) diameter
Minimum crew:	One pilot
Capacity:	Two pilots or a pilot and a passenger
Length:	23 ft 1¼ in (7.042 m)
Height:	9 ft ¾ in (2.762 m)
Wingspan:	34ft (10.36 m)
Wing Area:	124.7 sq./ft (11.59 m^2)
Aspect Ratio	9.27:1
Aerofoil:	NASA GAW-1

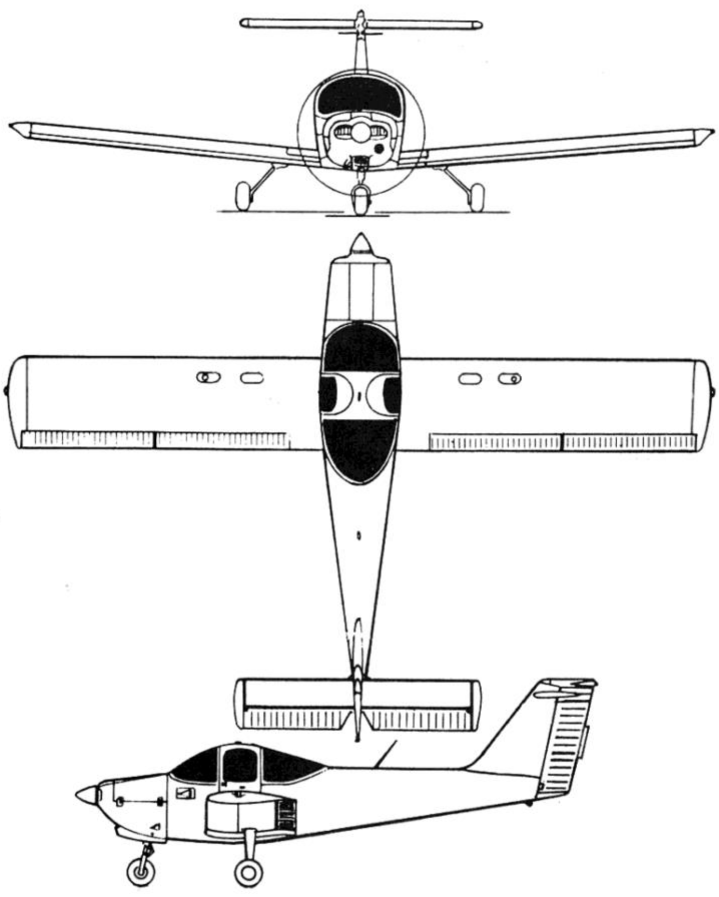


Fig. 9-1. Three-View Diagram.

Airframe

The primary structure, with the exception of the steel tube engine mount, steel landing gear components and isolated areas, is of an aluminium alloy construction. Fiberglass and thermoplastic are used in the engine cowling and in the extremities, i.e. the wing tips, fairings, etc., and in non-structural components throughout the aircraft.

The fuselage is a conventional, all-metal, semi-monocoque structure with riveted skin. The two cockpit doors, one on each side of the fuselage, are hinged forward, allowing entrance and exit across wing walks which extend to the trailing edge of each wing. Four large windows, including a windshield and a rear window, each of a one piece, wrap-around design, and two side windows, one in each door, provide an all-around view from the cockpit. Removable access panels on each side of the fuselage forward of the cockpit aid in inspection and maintenance of equipment aft of the firewall and forward of the instrument panel.

Each wing is a full cantilever construction incorporating a laminar flow NASA GA (W)-1 aerofoil section. The wings are all metal with the exception of the removable thermoplastic wing tips. An I-beam main spar extends through the length of each wing and into the centre of the fuselage where the spars are joined with high strength butt fittings, in effect making, one continuous main spar.

The main spar is attached to each side of the fuselage and to the centre fuselage tunnel. An aft spar in each wing extends from the wing tip to the wing root and is bolted to the side of the fuselage.

The empennage is a T-tail configuration with a fixed horizontal stabilizer mounted atop the vertical fin.

Flight Controls

Dual flight controls are standard equipment on the PA-38-112. The flight controls actuate the primary control surfaces through a cable system, and the controls are balanced for light operating forces.

The horizontal surface of the tail is a fixed stabilizer with a moveable elevator. An elevator trim control wheel, mounted between the two pilot's seats, operates the longitudinal trim function of the elevator (Figure 9-2). Rotation of the wheel forward gives nose down pitch trim and rotation aft gives nose up pitch trim. A trim position indicator is mounted adjacent to the trim control wheel.

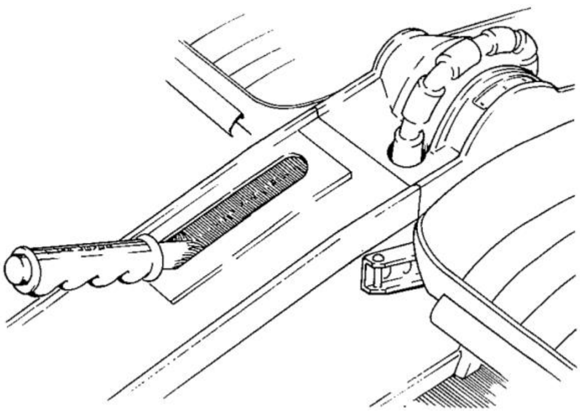


Fig. 9-2. Centre Console showing the Flap Lever and Elevator Trim Control.

The rudder is conventional in design and operation. A ground adjustable trim tab is attached to the trailing edge of the rudder.

The wing flaps are manually operated by the flap control level located between the two pilot's seats. The flap lever is connected to the flaps through a torque tube and push rods. The flaps can be set into three positions, being fully retracted (Up), half flap (21 degrees), and full flap (34 degrees).

To extend the flaps, press the button on the end of the flap handle to disengage the ratchet and pull the flap handle up and aft to the desired flap setting, hesitating momentarily as the ratchet locks into position. To retract the flaps, gently pull the flap handle up to reduce the load on the ratchet, then press the button on the end of the flap handle to disengage the ratchet and ease the flap handle down to the desired flap setting.

When the flap setting is changed, up or down, there is an associated pitch force change. The desired pitch attitude should be maintained through the elevator and the subsequent change in control force should be corrected by elevator trim.

Stall Warning

An approaching stall is indicated by an audible alarm located behind the instrument panel. The indicator activates at between five and ten knots above stall speed.

Engine and Propeller

The PA-38-112 is powered by a Lycoming O-235-L2C or O-235-L2A four-cylinder, direct drive, horizontally opposed engine rated at 112 horsepower at 2600 RPM. It is equipped with a starter, a 60-amp 14-volt alternator, a shielded ignition, two magnetos, vacuum pump drive, a fuel pump, and an induction air filter.

The engine cowlings are cantilever structures attached at the firewall and split horizontally. The metal upper cowling contains two top-hinged access panels, one on either side of the engine. The fiberglass lower cowling is a one-piece structure with integral air scoops. Both cowlings can be completely removed with the propeller in place.

The engine mount is constructed of tubular steel and is rigidly mounted to the firewall. The engine is attached with Dynafocal insulators to reduce vibration. The engine mount includes a provision for the attachment of the nose gear.

Cooling of the engine and accessories is by down draft air flow. Air enters through openings on each side of the propeller hub and is carried through a pressure baffle system around the engine and to a fixed exit in the lower cowling. Air for cockpit and carburettor heat also enters through the nose cowling to be ducted to the heater shroud on the muffler.

The oil capacity of the Lycoming O-235-L2C engine is 6 quarts, and the minimum safe quantity is 2 quarts. An oil cooler installation is available as optional equipment. The cooler is mounted to the left rear engine baffle and incorporates a low temperature bypass system. A winterisation plate may be provided to restrict air flow during winter operation.

Carburettor induction air enters a chin scoop intake in the lower cowling and flows directly through a filter and into the carburettor air box. The air box incorporates a positive shut-off carburettor heat intake so that when carburettor heat is selected. Induction air is drawn through a hose from the muffler shroud.

The stainless-steel exhaust system incorporates dual mufflers with heater shrouds to supply heated air for the cabin, the defroster system and the carburettor heat system. Exhaust gases are discharged through twin stacks protruding through the lower right of the bottom engine cowling.

A Sensenich 72CK-0-56 fixed pitch, two-bladed aluminium alloy propeller with a metal spinner is installed as standard equipment. The propeller has a 72-inch diameter with a 56-inch pitch, which is determined at 75% of the diameter.

Engine Controls

The engine controls consist of a throttle control and a mixture control lever located on the control quadrant on the lower center of the instrument panel (Figure 9-3), where they are accessible from both pilot's seats. The controls utilise Teflon-lined control cables to reduce friction and binding.

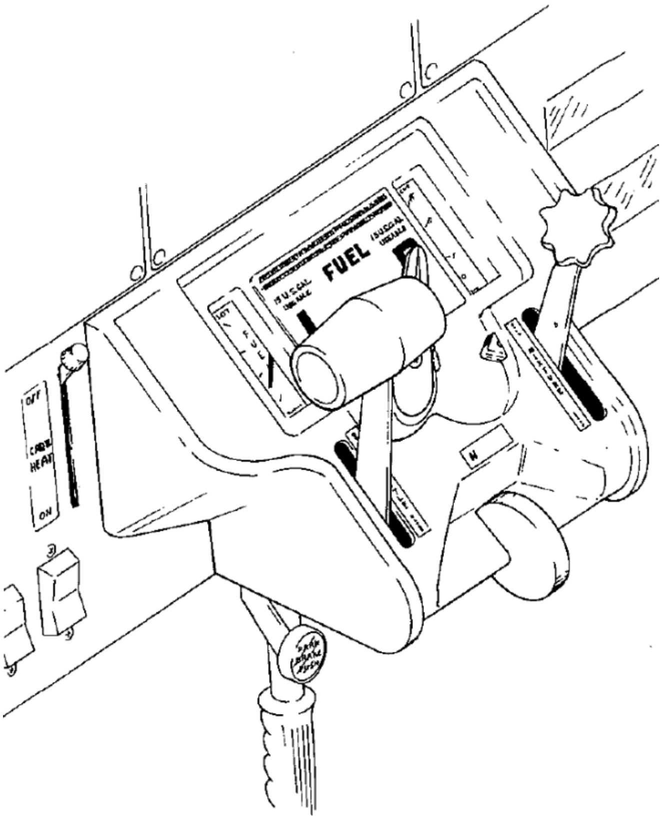


Fig. 9-3. Engine Control Quadrant.

The throttle lever is used to adjust engine RPM. The mixture control lever is used to adjust the air to fuel ratio. The engine is shut down by the placing of the mixture lever in the full lean position. For information on the leaning procedure, Chapter 5.

The friction adjustment wheel in the center of the control quadrant may be adjusted to increase or decrease the friction holding the throttle and mixture controls or to lock the controls in a selected position.

The carburetor heat control lever is located to the left of the control quadrant on the instrument panel. The control is placarded with two positions: "ON" (down), "OFF" (up).

Cabin Features

For comfort and visibility, the seats are adjustable forward and aft. The seat tracks are inclined and provide automatic vertical adjustment, the seat is raised in the forward position and lowered in the aft position. The seat adjustment levers are on the centres of the seat frames just below the forward edges of the cushions. Both seat backs tilt forward to allow access to the baggage compartment.

Lap and shoulder safety belts are fitted on both seats. Both lap and shoulder safety belts should be adjusted to a comfortably firm fit which allows adequate movement and the ability to reach all controls.

Some aircraft are fitted with inertia reel safety belts. Fin which case, for normal body movements, the inertia reel extends or retracts as required, but during sudden forward movement, the reel locks in place to prevent the strap from extending.

Standard interior equipment includes a pilot storm window, door pulls with integral armrests, a glare shield, an ash tray, and a carpeted floor. The microphone and earphone jacks can be located in various places, for example on the instrument console below the fresh air outlets or between the seats on the centre console. A tinted rear window is also standard equipment. Standard equipment on later model aircraft incorporates a glare shield with hand holds.

Each cabin door has an interior latch below the side window (Figure 9-4). The latch is engaged when the handle is in the down position. The overhead latch in the centre of the cockpit secures both doors (Figure 9-5) Before flight, the latches on both doors plus the overhead latch should be secured in the latched position. A key lock is installed on the exterior overhead latch.

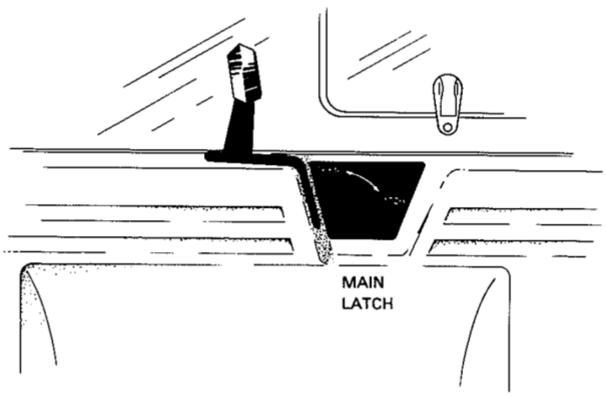


Fig. 9-4. Main Cabin Door Latch.

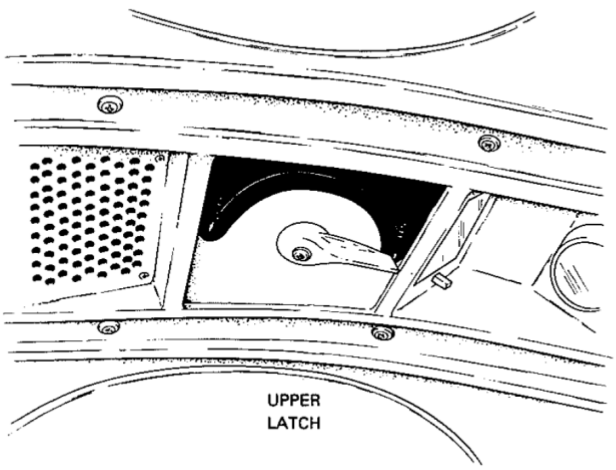


Fig. 9-5. Overhead Latch.

Optional equipment available for the cabin includes a tinted windshield and side windows, sun visors and entrance steps.

Heating and Ventilation System

Heat for the cabin interior and the defroster system (Figure 9-6) is provided by a shroud attached to the mufflers. Fumes in the cockpit could be an indication of an exhaust leak; therefore, if unusual odours are detected, the heater should be turned off, the fresh air intakes and side window opened (refer Chapter 8) and the system inspected before further operation. The amount of heat and the routing of airflow can be regulated with the controls located on the left instrument panel. Heater air may be directed to the outlets in the lower firewall below the instrument panel and the ducts mounted along the centre tunnel on the right and left cockpit floor or to defroster outlets at the base of the windshield.

Fresh air intakes are located on each side of the fuselage in the area aft of the engine cowling. Adjustable outlets on each lower corner of the instrument panel allow fresh air to be admitted and directed. An on-off lever is mounted below each fresh air outlet.

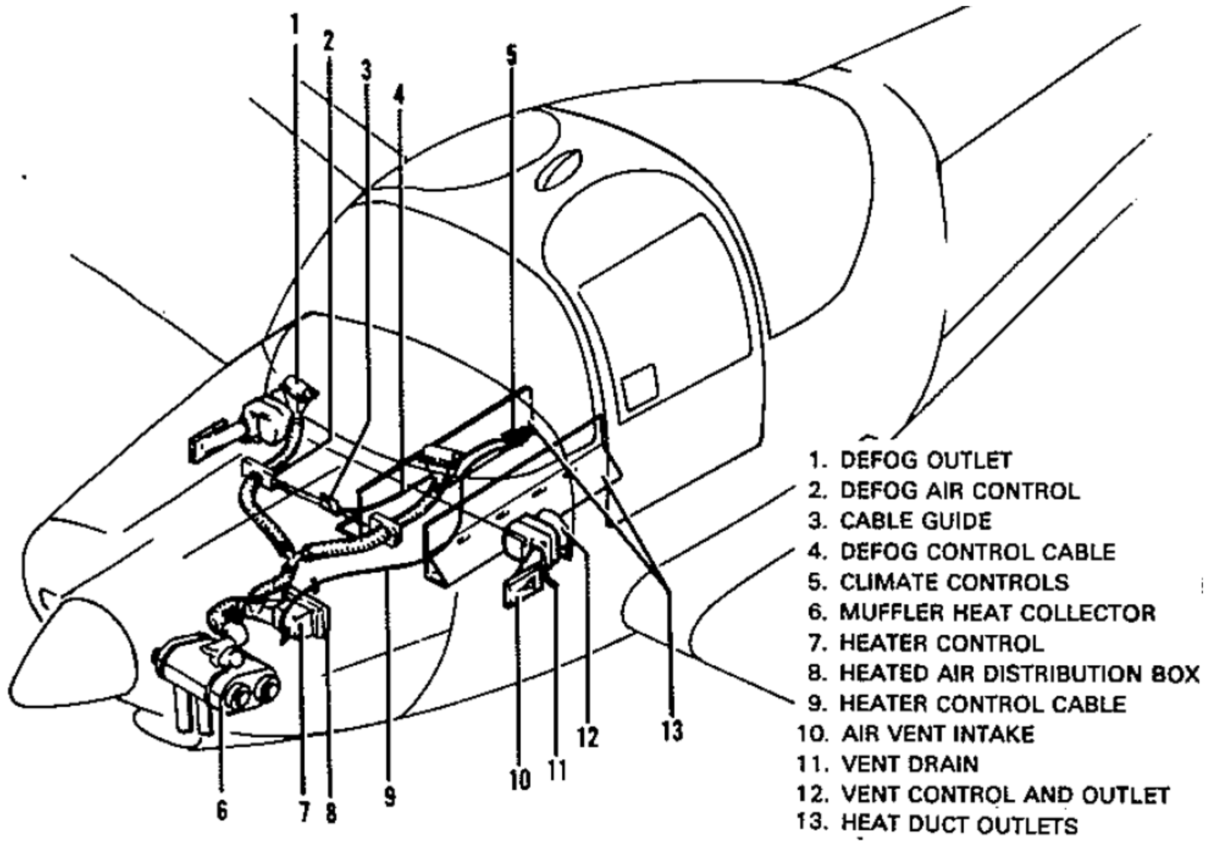


Fig. 9-6. Heating and Ventilation System.

Baggage Area

A 20 cubic foot baggage area, located behind the seats, is accessible from the cabin. Maximum capacity is 100 pounds. Tie-down straps are available, and they should be used whenever loads are carried.

NOTE
It is the pilot-in-command's responsibility to be sure that when baggage is loaded the aircraft CofG falls within the allowable CofG range. (See Chapter 11)

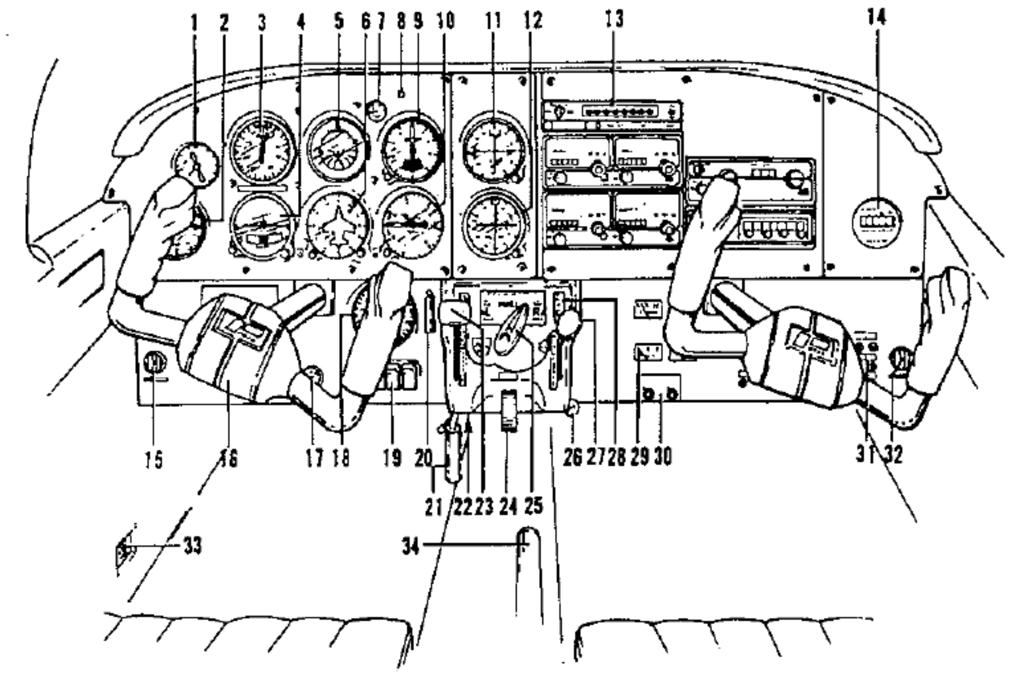
Instrument Panel

The instrument panel (Figure 9-7) is designed to accommodate instruments and avionics equipment for VFR and IFR flight. Radio equipment is mounted in the center and right instrument panel and flight instruments are mounted on the left. An engine instrument cluster in the lower instrument panel just right of the control quadrant includes a fuel pressure gauge, an ammeter, an oil temperature gauge and an oil pressure gauge. Fuel quantity indicators for each tank are mounted in the engine control quadrant on either side of the fuel selector. The tachometer is located to the left of the engine control quadrant. The alternator warning light is in the upper left instrument panel.

Circuit breakers are on the lower right of the instrument panel and electrical switches are just left of the engine control quadrant.

Heater controls are to the left of the pilot's control wheel. Fresh air vents are located to the extreme left and right lower corners of the instrument panel.

Standard instruments include a compass, an airspeed indicator, a recording tachometer, an altimeter, the engine instrument cluster, the fuel quantity gauges and the alternator warning light. The magnetic compass is mounted in the center of the cockpit at the top of the windshield.



1. CLOCK
2. ADF INDICATOR
3. AIRSPEED INDICATOR
4. TURN COORDINATOR
5. ARTIFICIAL HORIZON
6. DIRECTIONAL GYRO
7. VACUUM GAUGE
8. ALTERNATOR WARNING
9. ALTIMETER
10. RATE OF CLIMB INDICATOR
11. NAV 1 INDICATOR
12. NAV 2 INDICATOR
13. AVIONICS INSTALLATIONS
14. HOURMETER
15. CABIN VENT
16. CONTROL WHEEL
17. MAGNETO SWITCH
18. TACHOMETER
19. ELECTRICAL SWITCHES
20. CARBURETOR HEAT CONTROL
21. HAND BRAKE
22. ALTERNATE STATIC SOURCE (S/N 38-78A0001 THRU 38-81A0006)
23. THROTTLE
24. FRICTION CONTROL
25. FUEL SELECTOR
26. PRIMER
27. MIXTURE CONTROL
28. FUEL QUANITY GAUGES
29. ENGINE INSTRUMENTS
30. LIGHT DIMMER CONTROLS
31. CIRCUIT BREAKER PANEL
32. CABIN HEAT
33. STATIC DRAIN (S/N 38-78A0001 THRU 38-81A0006) ALTERNATE STATIC SOURCE AND DRAIN (S/N 38-81A0007 AND UP)
34. FLAP CONTROL LEVER

Fig. 9-7. Instrument Panel.

A variety of optional items are available for installation in the instrument panel. These options include a suction gauge on the upper left, an attitude gyro, a directional gyro, a true airspeed indicator, a vertical speed indicator and a turn coordinator in the flight instrument group, and an aircraft hour meter on the extreme right of the panel.

The gyros are vacuum operated through the optional vacuum system, and the turn coordinator is electric. A fuel primer system is operated by a primer pump to the lower right of the engine control quadrant. An electric clock is available for installation in the upper left corner of the panel. The optional outside air temperature gauge is located in the overhead cockpit area.

Intercom System

The intercom system provides for normal conversation between pilot and passenger. The system functions through all pilot headsets with a boom microphone. Volume and squelch controls are mounted on the instrument panel. The communication between the pilot and the passenger is voice activated when the system is turned on.

Radio communication between either pilot and a VHF radio facility is initiated through push-to-transmit switches mounted on the control wheels. Voice communication from a radio facility is audible through the headset.

Emergency Locator Transmitter (ELT)

The Emergency Locator Transmitter (ELT), sometimes referred to as an Aircraft Emergency Location System (AELS), are often enclosed under a hinged cover on the aft portion of the cockpit centre console or installed behind the baggage compartment frame. The ELT unit must meet the requirements of the New Zealand CAR Part 91.529.

The transmitter operates on a self-contained battery which has a battery replacement date marked on the transmitter label. To comply with CAA Rules, the battery must be replaced on or before this date. The battery must also be replaced if the transmitter has been used in an emergency situation or if the accumulated test time exceeds one hour, or if the unit has been inadvertently activated for an undetermined time period.

The CAA Rules also requires that the ELT must be tested and inspected within the preceding 12 months or 100 hours aircraft time.

When installed in the aircraft, the ELT transmits through the antenna mounted on the fuselage. The ETL main unit is also equipped with an integral portable antenna to allow the locator to be removed from the aircraft in an emergency and used as a portable signal transmitter, although leaving the aircraft is usually not recommended.

The ELT should be checked before and after flight, by tuning a radio receiver to 121.5 MHz, to make sure that it has not been accidentally activated, see below. If there is an oscillating sound, the ELT may have been activated and should be turned OFF immediately. Re-arm the unit and then recheck.

ARTEX ME406

The Artex ME 406 ELT is an automatically activated ELT. The system consists of an instrument panel mounted remote switch (Figure 9-8), the ELT main unit (Figure 9-9), a buzzer, installed next to the ELT unit and an antenna which is mounted on the fuselage.

When the ELT is switched on it broadcasts a standard swept tone on the international distress frequency of 121.5 MHz. Additionally, the 406 MHz transmitter turns on every 50 seconds for 520 milliseconds. During that time an encoded digital message is sent to any receiving satellite. The information contained in this digital message is:

- The serial number of the transmitter or Aircraft I.D.
- The country code; and,
- The ID Code.

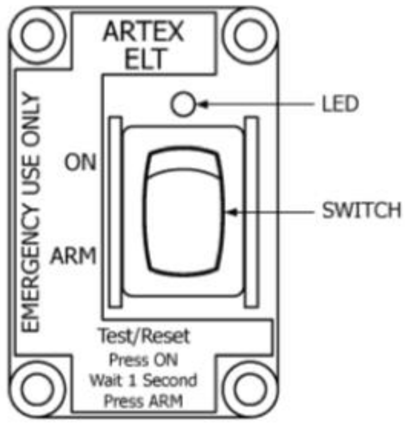


Fig. 9-8. ELT Remote Switch.

Once the ELT is activated and the 406 MHz signal is detected by a satellite and a position is subsequently calculated, the 121.5 MHz transmissions are used to home in on the site at which the ETL was activated.

One advantage of the 406 MHz transmitter is that it will produce a much more accurate position, typically 1 to 2 kilometres as compared to 15 to 20 kilometres for 121.5 MHz transmitters. The ELT also transmits a digital message which allows the Rescue Coordination Centre New Zealand (RCCNZ) to contact the owner/operator of the aircraft from information registered to a particular ELT in the RCC database. The information contained in this database, that may be useful in the event of a crash, is:

- The type of aircraft;
- The address of the registered owner;
- The telephone number of the registered owner;
- The aircraft registration; and,
- An alternate emergency contact.

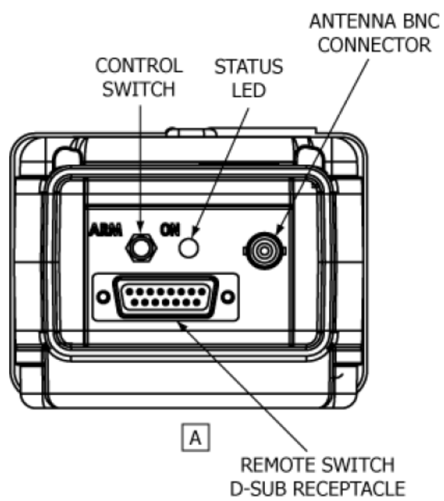


Fig. 9-9. Main ELT Unit.

Because aircraft VHF radios are not capable of receiving 406 MHz transmissions, the available methods of monitoring the ELT are the flashing light on the remote unit in the cockpit; the flashing light on the ELT main unit; the buzzer built into the main unit; or the 121.5 MHz transmissions which may be monitored on the aircraft's radio.

An acceleration indicator {g-switch) will activate the ELT upon sensing a sudden change of velocity along the aircraft's longitudinal axis. As long as the ELT is locked into its mounting tray, it will activate in the event of extreme deceleration. Neither the cockpit switch nor the ELT unit switch can be positioned to prevent automatic activation once the unit is mounted correctly.

The ELT can also be manually activated, for example after an emergency landing or for testing. It is manually activated either by positioning the instrument panel mounted remote switch to the "ON" position or by positioning the control switch on the main ELT unit to the "ON" position.

When the ELT is activated, the presence of the emergency swept lone and a flashing front panel LED light will immediately begin to continuously flash to indicate the normal functioning of the ELT.

In normal operations, the instrument panel mounted remote switch must be in the "ARM" position and the main switch of the ELT unit must be in the "ARM" position during flight. The ELT is then in standby-mode, which means the ELT can now be activated by the g-switch in the event of extreme deceleration.

Although not common, it is possible for the ELT to be activated by hard landings or in heavy turbulence. The ELT should then be reset by toggling the instrument panel mounted remote switch from the "ARM" position to the "ON" position and then back to the "ARM" position, or if the panel mounted remote switch is already in the "ON" position, it must be placed back into the "ARM" position. Then listen to 121.5 on the radios to check that the ELT is not transmitting. It should be remembered that the ELT cannot be reset if either the panel mounted remote switch or the main unit switch is in the "ON" position.

NOTE

In the event of an inadvertent activation of the ELT, the pilot-in-command must immediately report the activation to the nearest Air Traffic Service (ATS) unit in order that Rescue Coordination Centre (RCC) action, commenced as a result of the activation, will be terminated.

Testing an ELT

A function test of the ELT is required every 12 month's or 100 hours aircraft time. While this is a test that can be completed by pilots, most pilots do not normally meet the training and authorisation requirements to do so. Refer CAR Part 43.51(b) and Part 43 Appendix A.

To carry out "pilot maintenance" a person must hold a pilot licence with an appropriate aircraft type rating, provided the pilot is authorised by the aircraft operator to perform the specified maintenance tasks and the pilot is adequately trained by an appropriately trained, licenced and type-rated engineer. Consequently, most ELT function tests are carried out by maintenance engineers.

AIPNZ GEN 3.6 states that an ELT transmitter test is authorised **ONLY on 121.5 MHz** and you must adhere to the following procedure:

- Test the ELT in a shielded area under controlled conditions;
- Restrict testing to **no longer than three audio sweeps and NOT exceed 20 seconds**;
- Carry out testing only within the first five minutes after the hour, e.g. between 1500 and 1505 hrs. Emergency tests outside this time must be coordinated with both the nearest ATS unit and RCCNZ; and,
- **Do NOT test the ELT when airborne**.

NOTE
Live testing of 406 MHz is **NOT permitted** unless it is coordinated with the RCCNZ at least two working days prior to the test, and with notification of the ELT HexID/UiN, time and location of the test, and the person to contact during the test.

Fire Extinguisher

A portable fire extinguisher is often mounted to the floor of the baggage compartment directly behind the flight control console between the seats. The extinguisher should be of a suitable for use on liquid or electrical fires. They are usually operated by aiming the nozzle at the base of the fire and squeezing the trigger grip. Releasing the trigger automatically stops further discharge of the extinguishing agent. Read the instructions on the nameplate and become familiar with any unit fitted on the aircraft before an emergency situation. The dry powder type extinguisher is fully discharged in about 10 seconds, while the Halon 1211 type is discharged in 15 to 20 seconds.

WARNING
The concentrated agent of Halon 1211 or their by-products when applied to a fire are toxic when inhaled.

Ventilate the aircraft's cabin as soon as possible after fire is extinguished to remove smoke or fumes.

Fuel System

Fuel is stored in two sixteen US gallon fuel tanks (15 gallons usable), giving the aircraft a total capacity of thirty-two U.S. gallons (30 gallons usable). The tanks are secured to the leading edge of each wing with rivets. When installed, a filler neck indicator aids in determining fuel remaining when the tanks are not full.

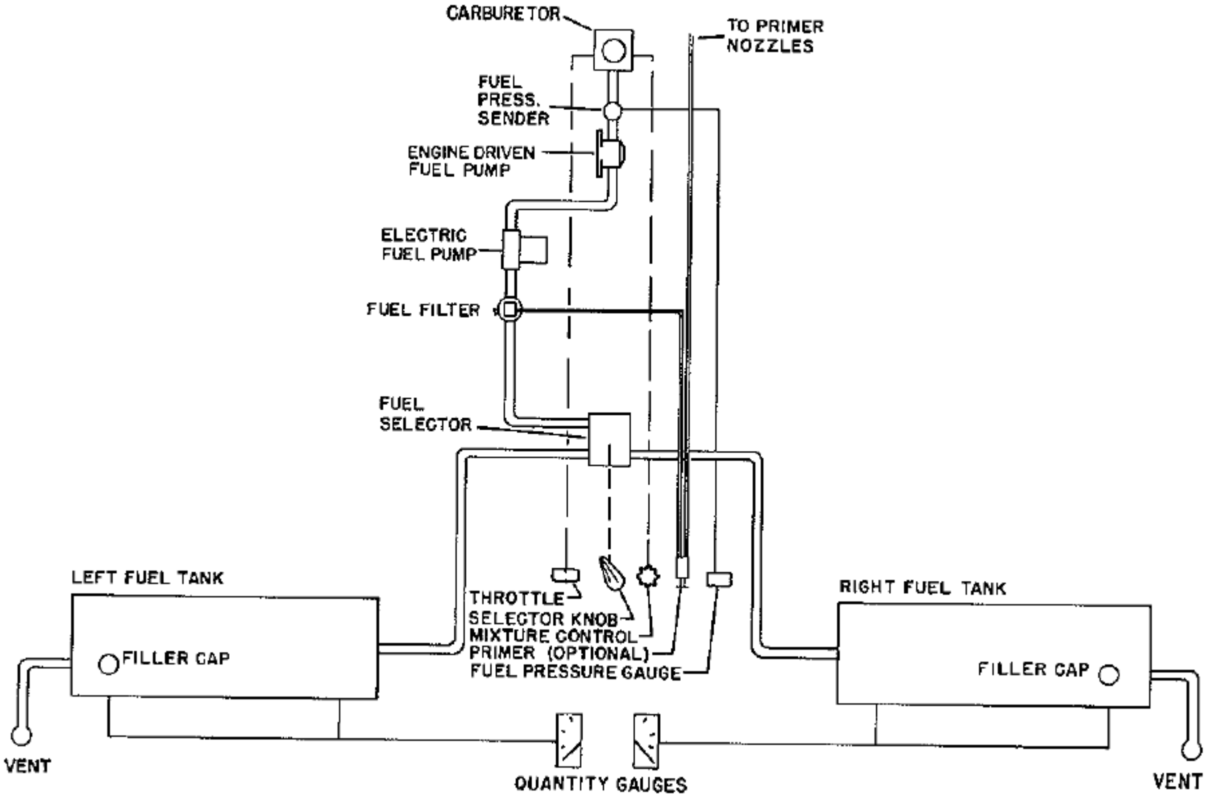


Fig. 9-10. Fuel system.

When filling the fuel tanks, observe all safety precautions required when handling gasoline. Fill the fuel tanks through the fillers located on the forward slope of the wings. When using less than the standard 32-gallon capacity, fuel should be distributed equally between each side. When the filler neck indicator is installed, there is approximately 10 gallons in the fuel tank when the fuel level is even with the bottom of the filler neck indicator.

Aviation fuel (AVGAS) of a minimum grade of 100/ 130 is specified for this aircraft. Since the use of lower grades can cause serious engine damage in a short period of time, the engine warranty is invalidated by the use of unapproved fuels.

Each tank has an individual sump drain in the bottom, inboard rear corner (Figure 9-11). These fuel sump drains should be opened during your pre-flight check and after refueling, to avoid the accumulation of contaminants such as water and/or sediment.

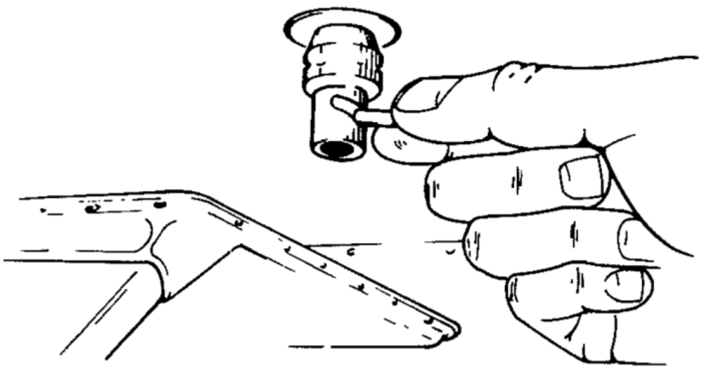


Fig. 9-11. Fuel sump drain.

A fuel strainer, located on the lower left front of the fire wall, has an external quick drain which is accessible from outside the left nose section. The strainer should also be drained during your pre-flight check. Each of the fuel tank sumps should be drained first. Then the fuel strainer should be drained twice, once with the fuel selector valve on each tank. Each time fuel is drained, sufficient fuel should be allowed to flow to ensure removal of contaminants. This fuel should be collected in a suitable container, examined for contaminants and colour, and then discarded.

CAUTION

When draining any amount of fuel, care should be taken to ensure that no fire hazard exists before starting the engine.

After draining, each quick drain should be checked to make sure it has closed completely and is not leaking.

The fuel tank selector control is located in the center of the engine control quadrant (see Figures 9-3, 9-7 and 9-8). The button on the selector cover must be depressed and held while the handle is moved to the OFF position. The button releases automatically when the handle is moved back to the ON position. A fuel quantity gauge for each fuel tank is located on either side of the fuel tank selector, each gauge showing the quantity on the same side as the corresponding fuel tank (refer to Figures 9-3 and 9-7).

An engine priming system is installed to facilitate starting. The primer pump is located to the lower right of the engine control quadrant (refer to Figure 9-7).

An auxiliary electric fuel pump is provided in case the engine-driven pump fails. The electric pump should be ON for all takeoffs and landings and when switching tanks. The fuel pump switch is located in the switch panel to the left of the throttle quadrant (refer to Figure 9-7).

The fuel pressure gauge is mounted in a gauge cluster located to the right of the engine control quadrant (refer to Figure 9-7).

Electrical System

The electrical system includes a 14-volt, 60-ampere alternator, a voltage regulator, an overvoltage relay, a battery contactor and a 12-volt, 25-ampere hour battery (Figure 9-12). The battery is entirely enclosed in a vented stainless-steel box mounted in the engine compartment on the upper right forward side of the firewall. The voltage regulator and overvoltage relay are located on the right aft side of the firewall behind the instrument panel.

The master switch and magneto switch are on the lower left instrument panel, below the left control wheel. The master switch is a split rocker switch. One side of the switch is for the battery ("BAT") and the other is for the alternator ("ALT"). The words "master switch" as used in these Pilot's Notes, and unless otherwise indicated, refer to both the "BAT" and "ALT" switches, and they are to be depressed simultaneously to ON or OFF as directed.

Other electrical switches are located on the lower part of the instrument panel just left of the engine control quadrant, and rheostat knobs which control the intensity of instrument and radio lights, are placed to the right of the engine control quadrant.

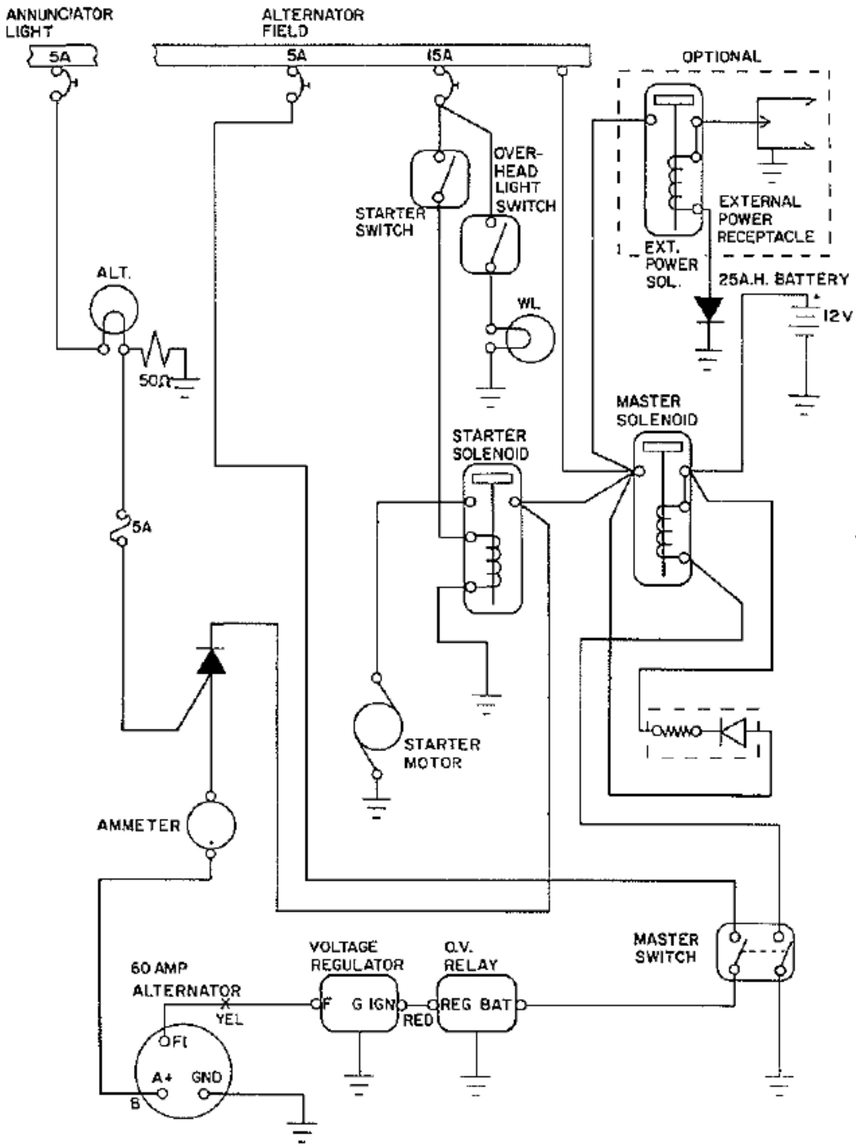


Fig. 9-12. Electrical System Schematic.

Standard electrical accessories include a starter, a key lock ignition, an electric fuel pump, an audible stall warning, fuel gauges, an ammeter, and an alternator warning light.

The electrical system provides for the addition of such optional accessories as interior and exterior lights, a heated pitot head, and communication and navigational equipment. The anti-collision beacon and landing lights are controlled by rocker switches on the switch panel.

An ammeter is mounted in the instrument cluster to the right of the engine control quadrant. The ammeter as installed indicates the electrical load on the alternator in amperes. With all the electrical equipment turned off and the master switch turned on, the ammeter will indicate the charging rate of the battery. As each electrical unit is switched on, the ammeter will indicate the total ampere draw of all the units including the battery. For example, the maximum continuous load for night flight with radios on is about 30 amperes. This 30-ampere value, plus about two amperes for a fully charged battery, will appear continuously under these flight conditions.

The amount of current shown on the ammeter will indicate if the alternator system is operating normally, as the amount of current shown should equal the total amperage drawn by the electrical equipment which is operating.

An overvoltage relay protects the electronics equipment from a momentary overvoltage condition (approximately 16.5 volts and up) or a catastrophic regulator failure.

If no output is indicated on the ammeter during flight, all unnecessary electrical equipment should be turned off to reduce the electrical load. The 5-ampere field circuit breaker should be checked and reset if open. If the breaker is not open, the "ALT" half of the master switch should be turned off for I second to reset the overvoltage relay. If the ammeter continues to indicate no output, electrical load should be maintained at the absolute minimum and the flight should be terminated as soon as practicable.

The circuit breakers are located on the lower right of the instrument panel. Each circuit breaker on the panel is of the push to reset type and is clearly marked as to its function and amperage.

Circuit provisions have been included to handle the addition of various items of optional equipment (Figure 9-13).

Circuit breakers are designed to "pop" in the event of excess current and/or over voltage, in order to protect the associated aircraft system and reduce the chance of overheating and potentially an electrical fire. Popped circuit breakers should only be reset if the pilot-in-command considers that the system is required for safe flight, and then only one attempt to reset should be made. A popped circuit breaker should be allowed to cool for at least two minutes before attempting a reset. If the circuit breaker subsequently pops again, it should be left popped.

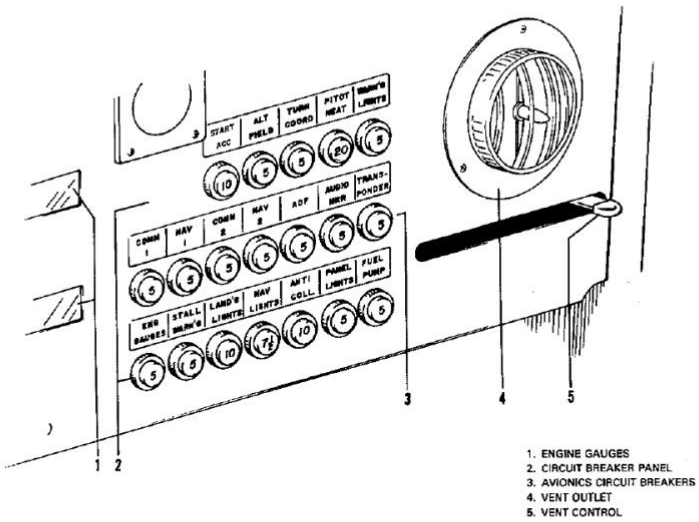


Fig. 9-13. Circuit Breaker

Pitot Static System

The pilot-static system supplies pressure to operate the airspeed indicator, the altimeter and the optional vertical speed indicator (Figure 9-14). Pilot pressure is picked up by a pilot head installed on the bottom of the left wing and static pressure is picked up by the pads on both sides of the aft fuselage.

A static valve located below the center instrument panel under the left side of the control quadrant provides an alternate static source for the system when opened. A static drain and static valve located on the lower left side panel provides an alternate static source for the system when opened. Static lines can be drained through a valve located inside an opening on the lower left side of the fuselage interior.

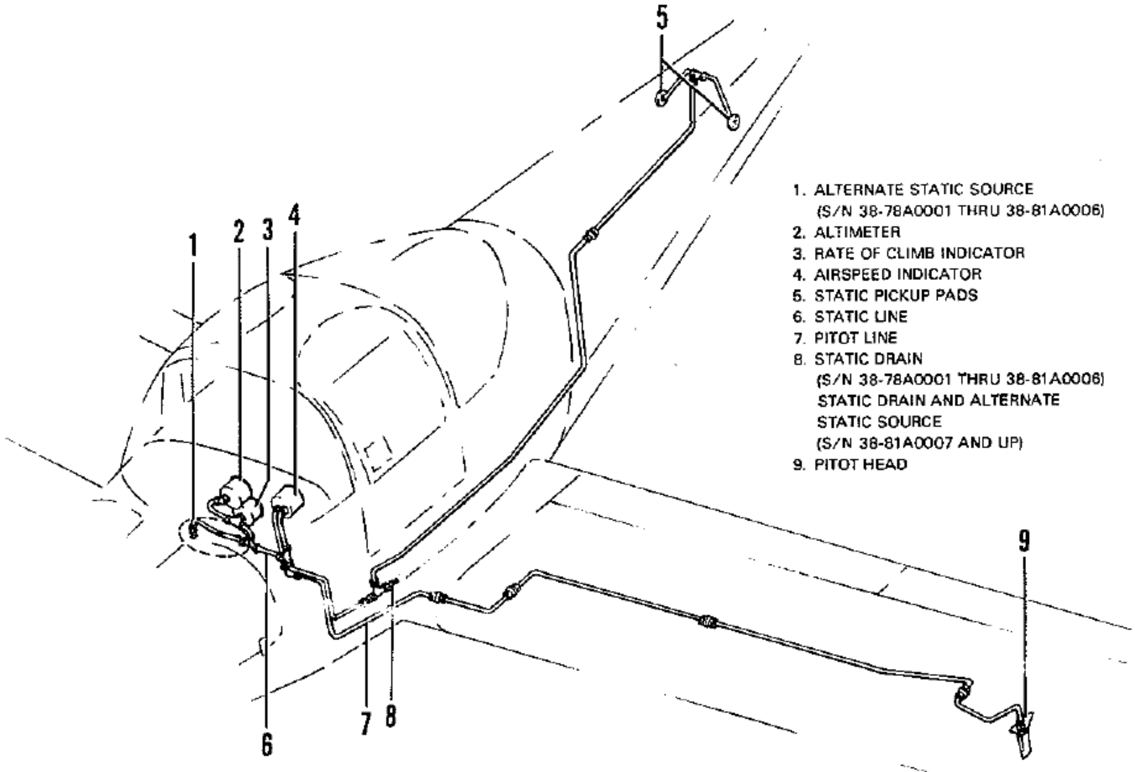


Fig. 9-14. Pitot Static System.

A heated pitot head which alleviates problems with icing and heavy rain is available as optional equipment. The switch for the heated pilot head is located on the electrical switch panel to the left of the control quadrant.

To prevent bugs and water entering the pilot hole, a cover should be placed over the pilot head while the aircraft is parked for an extended period. A partially or completely blocked pilot head will give erratic or zero readings on the instruments.

NOTE
During your preflight, check to make sure the pilot cover is removed.

Vacuum System

The vacuum system is designed to operate the air driven gyro instruments. This includes the directional and attitude gyros when installed. The system consists of an engine driven vacuum pump, a vacuum regulator, a filter and the necessary plumbing.

The vacuum pump is a dry type pump. A shear drive protects the engine from damage. If the drive shears, the gyros will become inoperative.

A vacuum (suction) gauge mounted on the upper left instrument panel provides a pilot check for the system during operation. A decrease in pressure in a system that remained constant over an extended period may indicate a dirty filter, dirty screens, possibly a sticky vacuum regulator or leak in the system. Zero pressure would indicate a sheared pump drive, defective pump, possibly a defective gauge or collapsed line. In the event of any gauge variation from the norm, the pilot should have a mechanic check the system to prevent possible damage to the system components or eventual failure of the system.

A vacuum regulator is provided in the system to protect the instrument gyros. The valve is set so the normal vacuum reads 5.0 ± 0.1 inches of mercury, a setting which provides sufficient vacuum to operate all the gyros at their rated RPM. Higher settings will damage the gyros and with a low setting the gyros will be unreliable. The regulator is located behind the instrument panel.

Vacuum pressure, even though set correctly, can read lower at very high altitude (above 12,000 ft), and at low engine RPM (usually on approach or during training manoeuvres. This is normal and should not be considered a malfunction.

Landing Gear and Brakes

The fixed gear on the Tomahawk is equipped with Cleveland 5.00 x 5 or Cleveland 6.00 x 6 wheels on the nose wheel (Figure 9-15) and two main landing gear (Figure 9-16). Cleveland single disc hydraulic brake assemblies are installed on the main landing gear. All three wheels carry 5.00 x 5 or 6.00 x 6 four ply tube type tires.

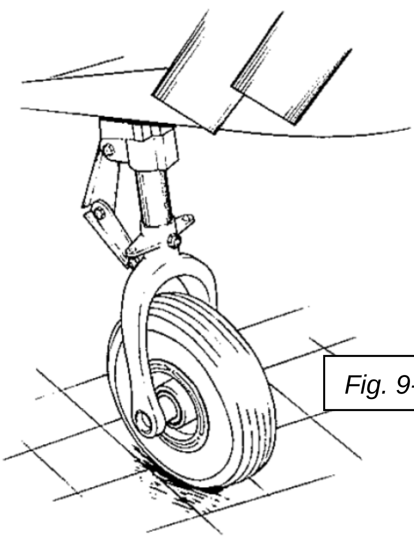


Fig. 9-15. Nose Wheel.

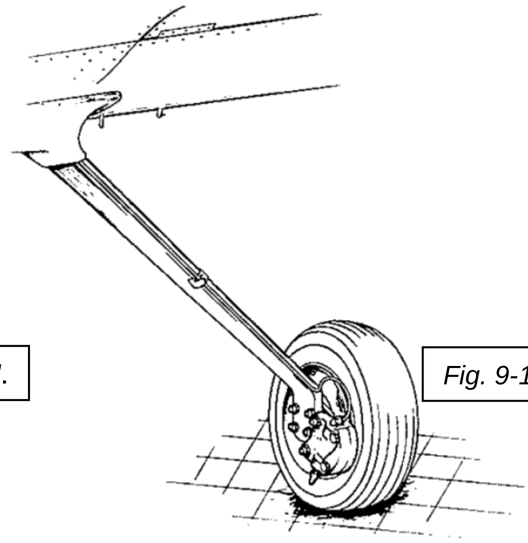


Fig. 9-16. Main Wheel.

The nose gear strut is of the air-oil type with a normal static load extension of 3 inches. A tow bar fitting is incorporated into the strut. The main gear struts are single-leaf steel springs. The springs, axles and fittings of the main gear are interchangeable.

The nose gear is steerable by use of the rudder pedals through a 60-degree arc, 30 degrees each side of centre. The toe brakes aid in the execution of tighter turns.

The standard brake system includes a master cylinder and brake fluid reservoir which is installed on the top left forward face of the firewall (Figure 9-17).

The parking (hand) brake handle/knob is mounted below and near the centre of the instrument panel (refer Figure 9-7). To set the parking brake, first depress and hold the toe brake pedals and then pull out on the parking brake handle/knob. To release the parking brake, first depress and hold the toe brake pedals and then push in on the parking brake handle/knob.

CAUTION
No park brake action will occur if handle/knob is pulled prior to toe brake application.

A toe brake pedal is included on each rudder pedal. Each toe brake includes a separate brake cylinder above the pedal. With this installation, the left or the right brake may be operated separately to aid in steering and turning.

CAUTION
Brakes should not be set when overheated or during extremely cold weather when accumulated moisture may freeze a brake.

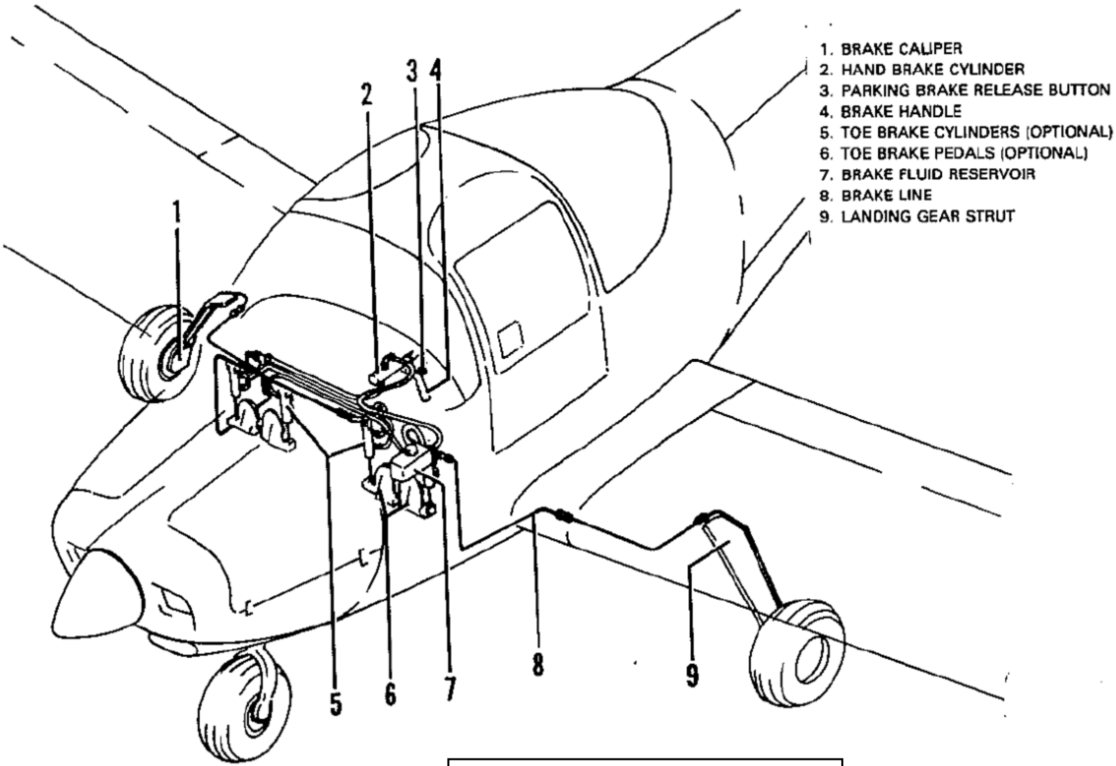


Fig. 9-17. Brake Systems.

Chapter Ten

Performance

Introduction

Aircraft performance requirements under New Zealand's CAR Part 91 are placed in rule 91.201(2) which reads:

> *Each pilot-in-command of an aircraft shall ensure the safe operation of the aircraft and the safety of the occupants during flight time.*

Performance management is one of many factors to be considered for compliance with this rule, but is a critical factor, particularly in relation to takeoff and landing. The takeoff and landing phases of flight are the most critical phase of flight and a significant number of accidents and incidents occur during these phases. A critical element for a safe takeoff or landing is that they can be conducted within the confines of the runway to be used.

CAA New Zealand Advisory Circular AC91-3 "Aeroplane Performance Under Part 91" provides methods acceptable to the CAA for showing compliance with 91.201(2). This material is intended for pilots-in-command of small single-engine aircraft being operated under CAR Part 91 on VFR operations.

The pilot-in-command may use any of the following three methods for calculating takeoff and landing performance:

- The Group Rating System;
- Civil Aviation Safety Order Nr 4 (CASO 4); and/or,
- Aircraft Flight Manual Data.

The Group Rating System

The performance group rating system can be used as a simple method for pilots-in-command of aircraft with a MCTOW of 2,270 kg or less to determine the adequacy of the runway length for takeoff and for landing in their particular aircraft type.

Under the Civil Aviation Regulations 1953, each aircraft type with a MCTOW of 2,270 kg or below was given a group rating number which is specified in the opening pages appended to the Aircraft Flight Manual (AFM). The number for a particular aircraft type is determined on the basis of its takeoff and landing performance. The group rating number for the PA38 Tomahawk is **6** at 757 kg (1,670 lb).

Each runway is given a group ('Gp') number between 1 and 8, and in practice a pilot may use, without further need to complete a performance calculation, any runway that has a group number equal to or greater than the aircraft's group rating number.

Therefore, the pilot-in-command of a PA38 Tomahawk up to 757 kg, may continue to use that group rating number (6) for compliance with the performance requirements at any runway with a group number of 6, 7 or 8.

Civil Aviation Safety Order Nr 4 (CASO 4)

Under the Civil Aviation Regulations 1953 aircraft performance requirements for many aircraft type was prescribed under Civil Aviation Safety Order No 4 (CASO 4). While the Civil Aviation Regulations 1953 and the associated Safety Orders have been superseded by Civil Aviation Rules (CARs), AC91-3 "Aeroplane Performance Under Part 91" gives authority for the continued use of these CASO 4 performance charts (P-charts).

According to AC91-3, if the aircraft has a P-chart in its Aircraft Flight Manual (AFM), the pilot-in-command may continue to use the P-charts to calculate takeoff and landing distances, using the day private operations data. The PA38 Tomahawk AFM has CASO 4 P-charts.

Based on the all up weight of the aircraft, the P-chart allows the pilot-in-command to determine the takeoff or landing distance required, taking into account:

- The density altitude of the aerodrome to be used;
- A correction for the runway surface, paved or grass;
- The operation type (private day operations);
- A correction for a uniform runway gradient (slope); and,
- A correction for the surface wind component (headwind or tailwind).

The performance information given in these graphs is derived from gross data, that is, it is the expected performance of an average PA38-112 Tomahawk aircraft and no margins for engine and/or airframe deterioration have been applied. The takeoff distance calculated for private operations represents the absolute minimum distance acceptable and pilots should carefully consider all factors before taking off at an airfield with only this distance available.

<u>Associated Conditions</u>

- Engine — Lycoming O-235-L2C at full throttle;
- Wing Flaps — Chart 1 - Zero Degrees;
- Chart 2 - Takeoff Position (One notch - 21º);
- Airspeed — 1.2 time the power off stalling speed, appropriate to the weight: and,
- Technique — The aircraft is held on the ground until the takeoff safety speed appropriate to the weight is reached and the initial climb is made at this speed.

Deviation from the above conditions will affect the resulting takeoff distance performance achieved.

The headwind correction grid on this graph is already factored, i.e. it is constructed on the basis that the effective headwind is 50% of the reported headwind component and the effective tailwind is 150% of the reported tailwind component. Consequently, to comply with NZ CARs, the reported wind component can be directly entered into the graph.

For the CASO 4 takeoff and landing P-charts for the PA38 Tomahawk, refer to Figures 10-1 to 10-3 on pages 10-3 to 10-5.

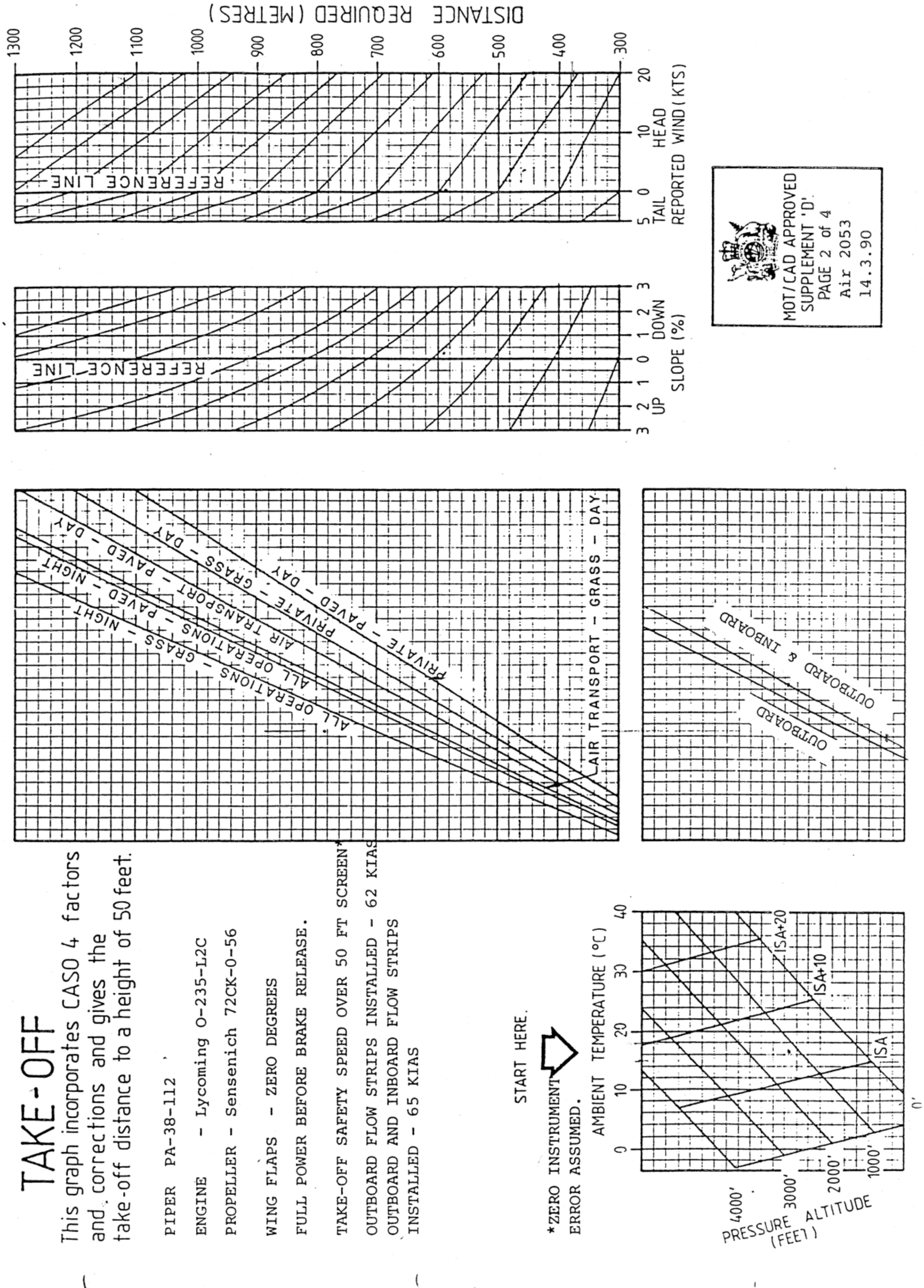


Fig. 10-1. CASO 4 Takeoff Chart 1 - Zero Degrees Flap.

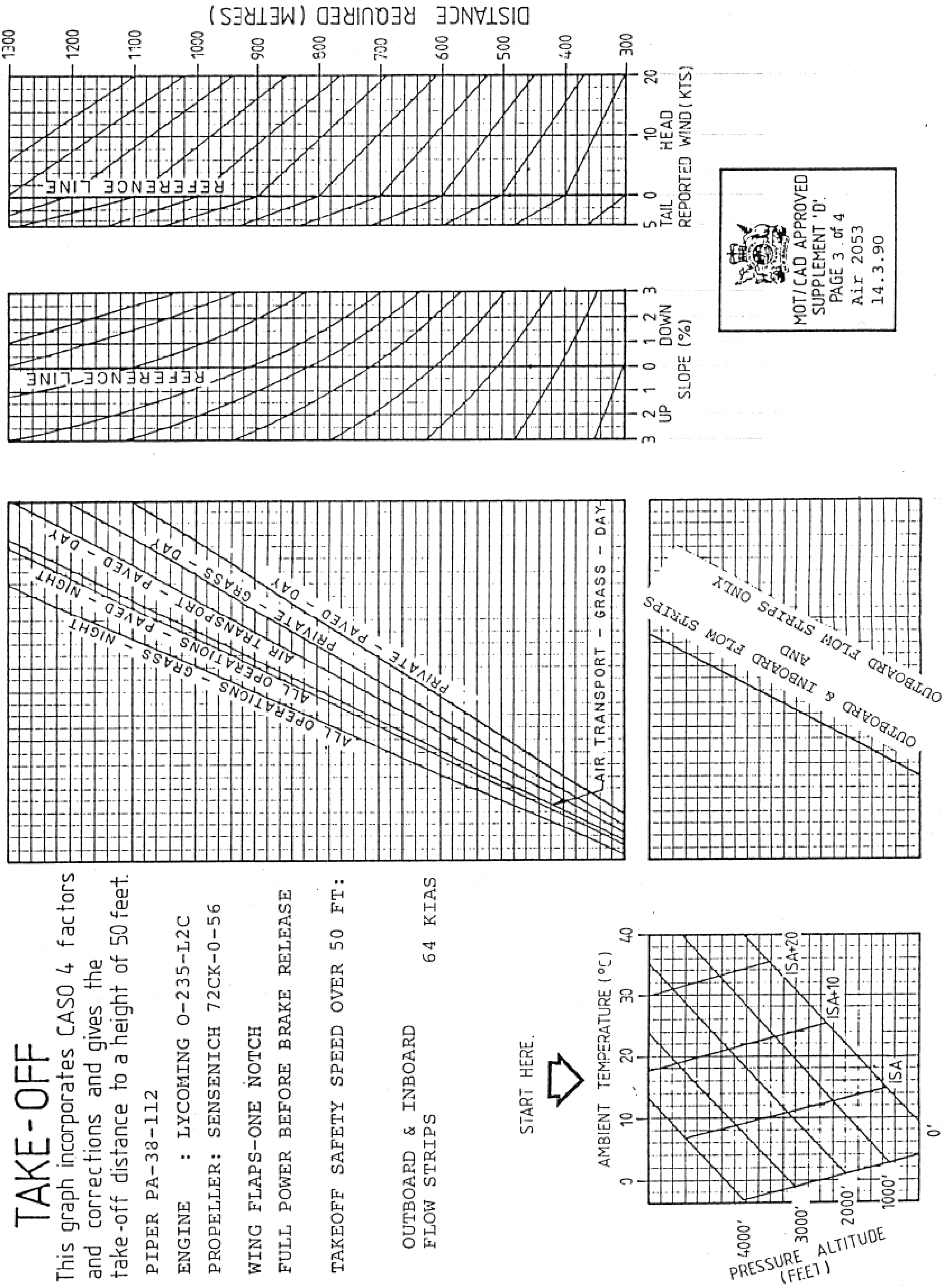


Fig. 10-2. CASO 4 Takeoff Chart 2 - Takeoff (Half) Flap 21 Degrees.

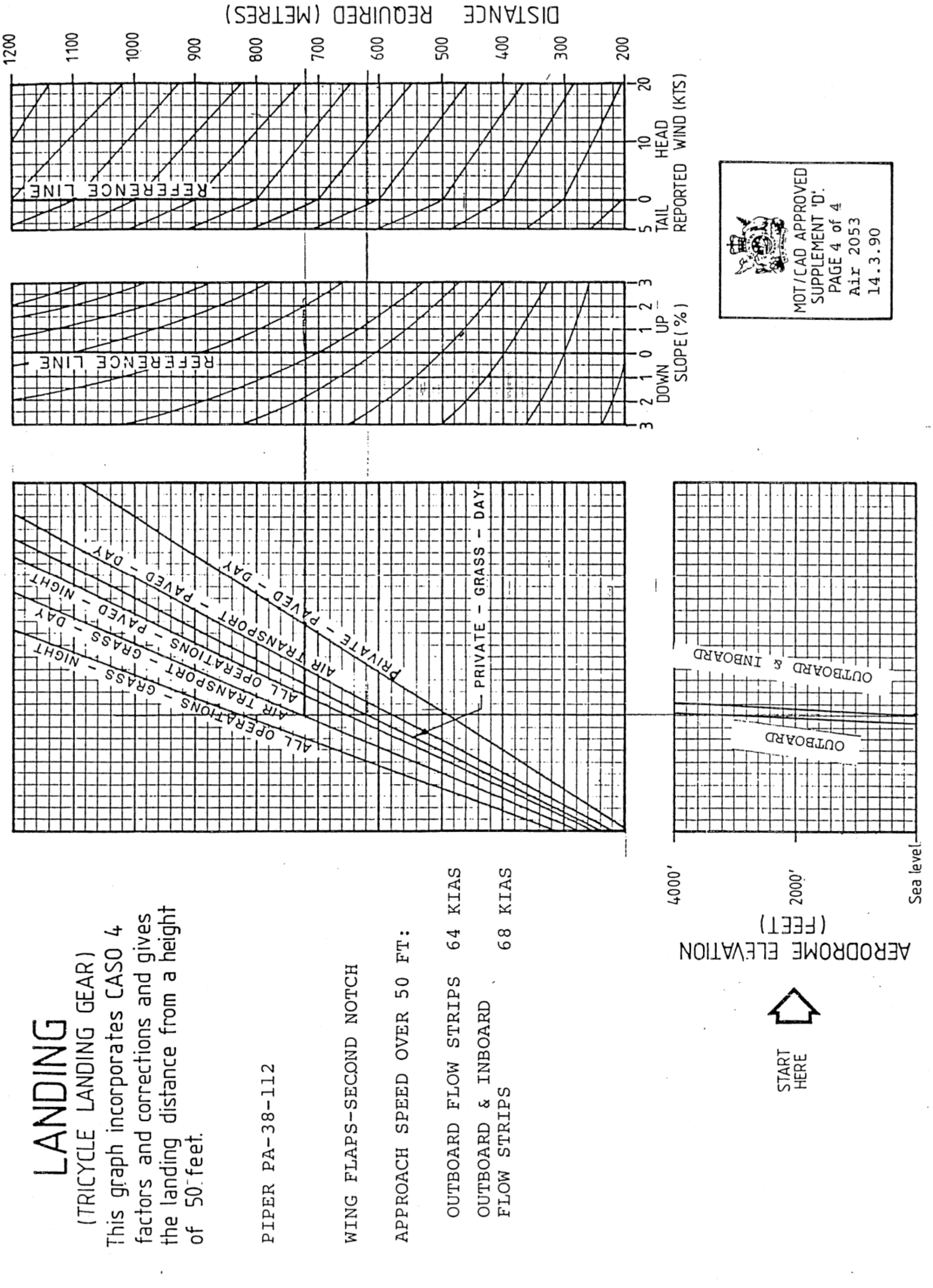


Fig. 10-3. Landing - Full Flap.

Aircraft Flight Manual Data

For calculating aircraft performance, the aircraft manufacturer has supplied performance data in the Aircraft Flight Manual (AFM). This data allows pilots-in-command to calculate, with some accuracy, the takeoff and landing distances, with a correction for density altitude, at various weights and for the surface wind. The manufacturer does not provide data to calculate the effect of runway slope or the different runway surface types. AC91-3 specifies data corrections for surface factors and slope. These are given on Tables 1 and 2 below.

For takeoff, pilots-in-command can use the AFM data to determine the distance to 50 feet, as this ensures the capability to clear obstacles close to the runway end (Figure 10-4). In addition, pilots should correct the takeoff distance to 50 feet derived from the AFM for:

- Other than a paved runway surface by applying the factors in Table 1 below; and,
- Runway slope by applying the factors in Table 2 up to a maximum of 3% slope.

For landing, pilots-in-command can use the AFM data to determine the distance from crossing the threshold at 50 feet, to come to a complete stop (Figure 10-11). In addition, pilots should correct the landing distance derived from the AFM for:

- Other than a paved runway surface by applying the factors in Table 1 below; and,
- Runway slope by applying the factors in Table 2 up to a maximum of 3% slope.

Table 1 Runway Surface Factors

SURFACE TYPE	TAKEOFF DISTANCE FACTOR	LANDING DISTANCE FACTOR
Paved	x 1.00	x 1.00
Coral	x 1.00	x 1.05
Metal	x 1.05	x 1.08
Rolled Earth	x 1.08	x 1.16
Grass	x 1.14	x 1.18

Table 2 Runway Slope Factors

DIRECTION OF SLOPE	% OF SLOPE	TAKEOFF DISTANCE CORRECTION	LANDING DISTANCE CORRECTION
Uphill	**1%**	+5%	-5%
	2%	+10%	-10%
	3%	+15%	-15%
Downhill	**1%**	-5%	+5%
	2%	-10%	+10%
	3%	-15%	+15%

For slopes expressed to a decimal point, e.g., 1.6%, the correction is 0.5% distance for each 0.1% slope.

In which case, for a runway slope of 1.6% the correction factor is 8% (5% + 3% (0.5 x 0.6)). Or for a runway slope of 2.2% the correction factor is 11% (10% + 1% (0.5 x 0.2)).

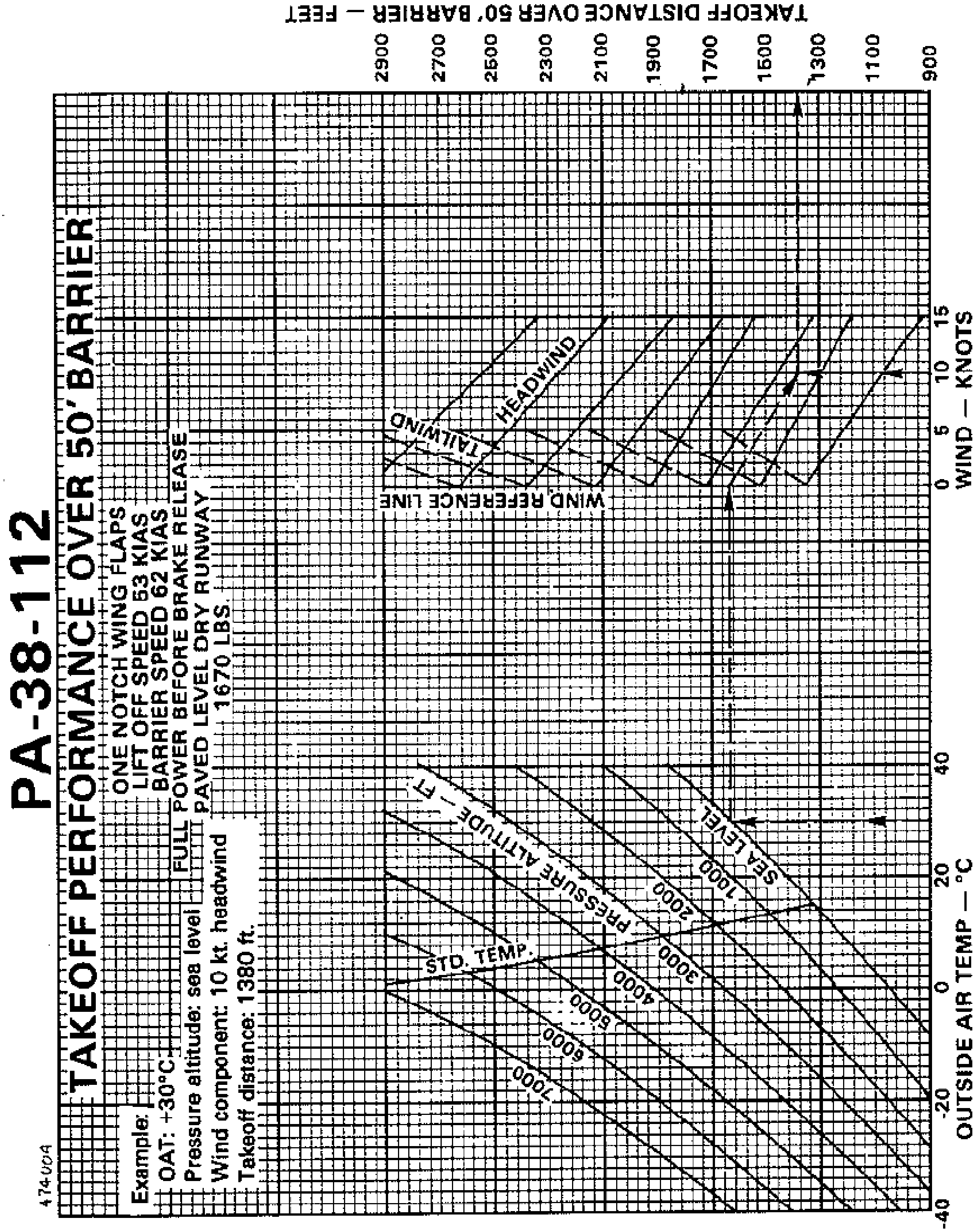


Fig. 10-4. AFM Takeoff Performance to 50 feet.

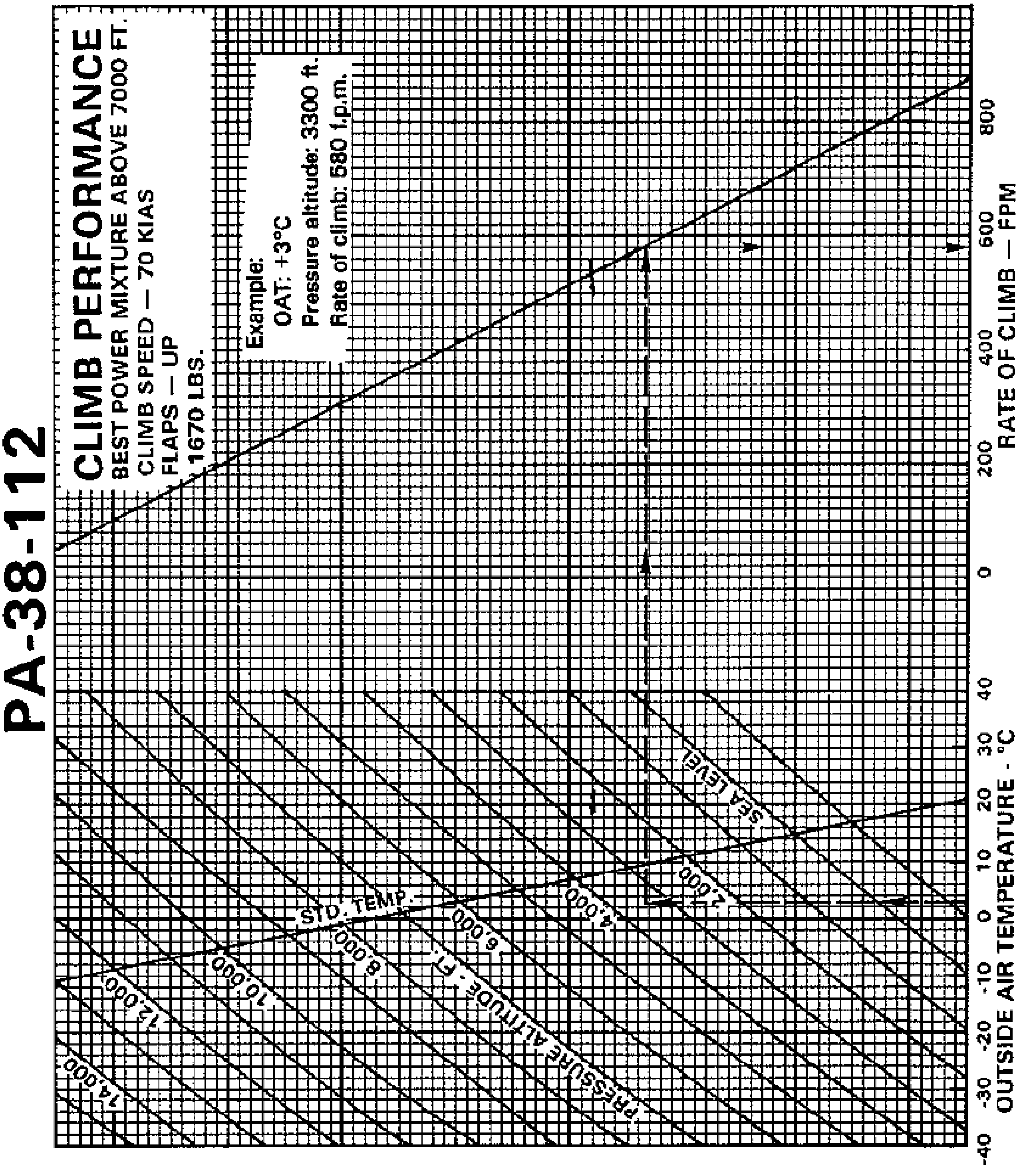


Fig. 10-5. AFM Climb Performance.

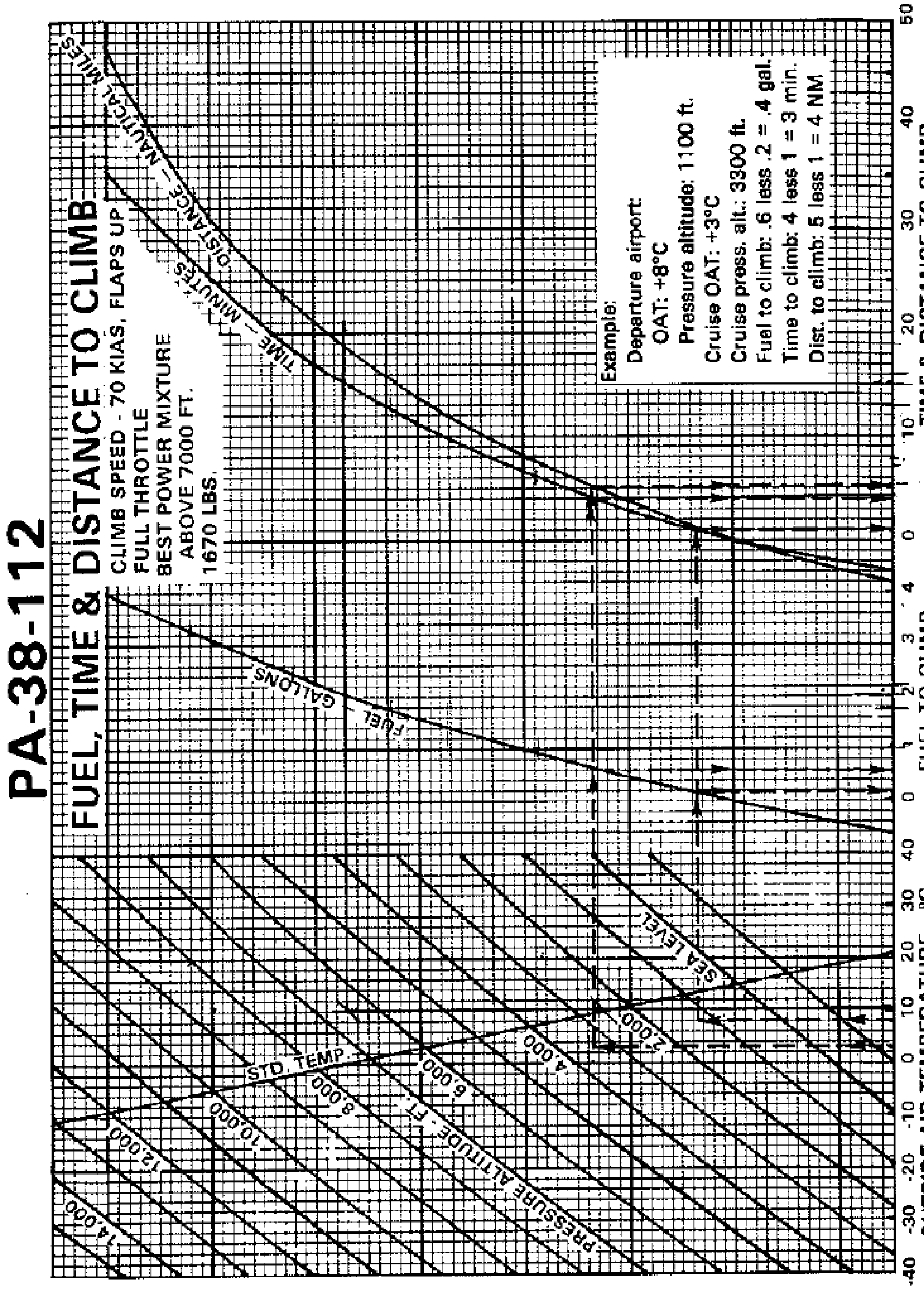


Fig. 10-6. *AFM Fuel, Time & Distance to Climb*.

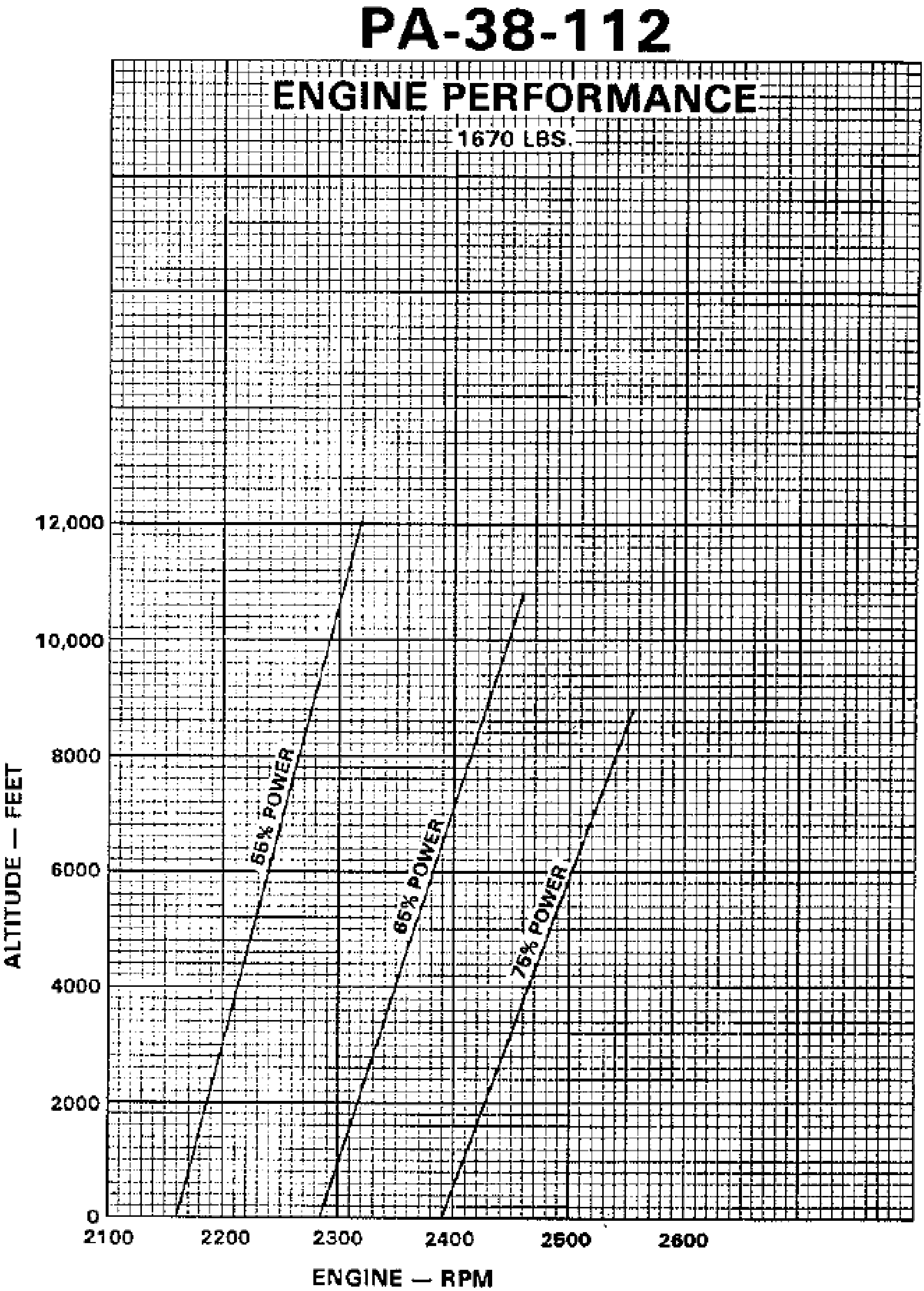


Fig. 10-7. AFM Engine Performance.

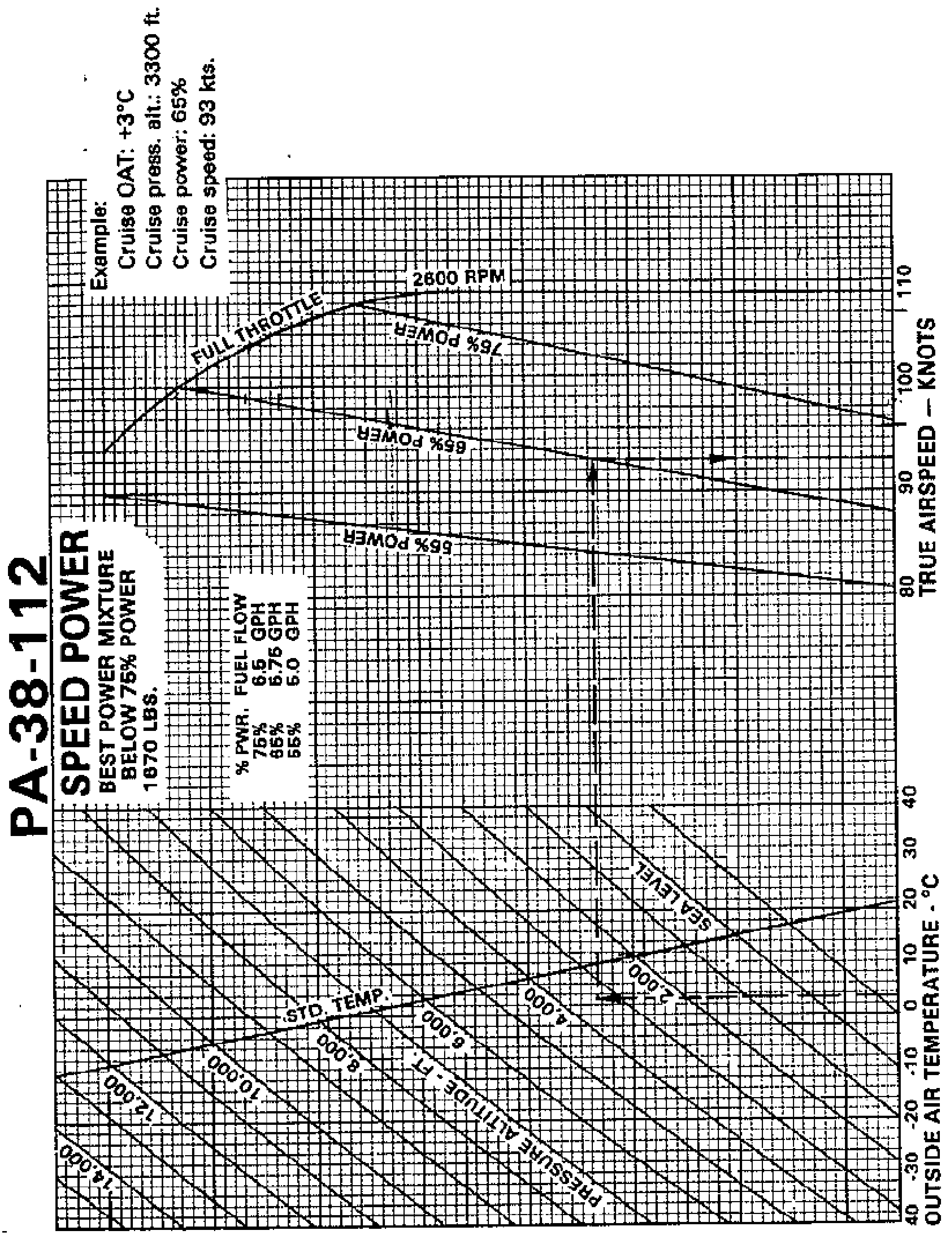


Fig. 10-8. AFM Speed Power.

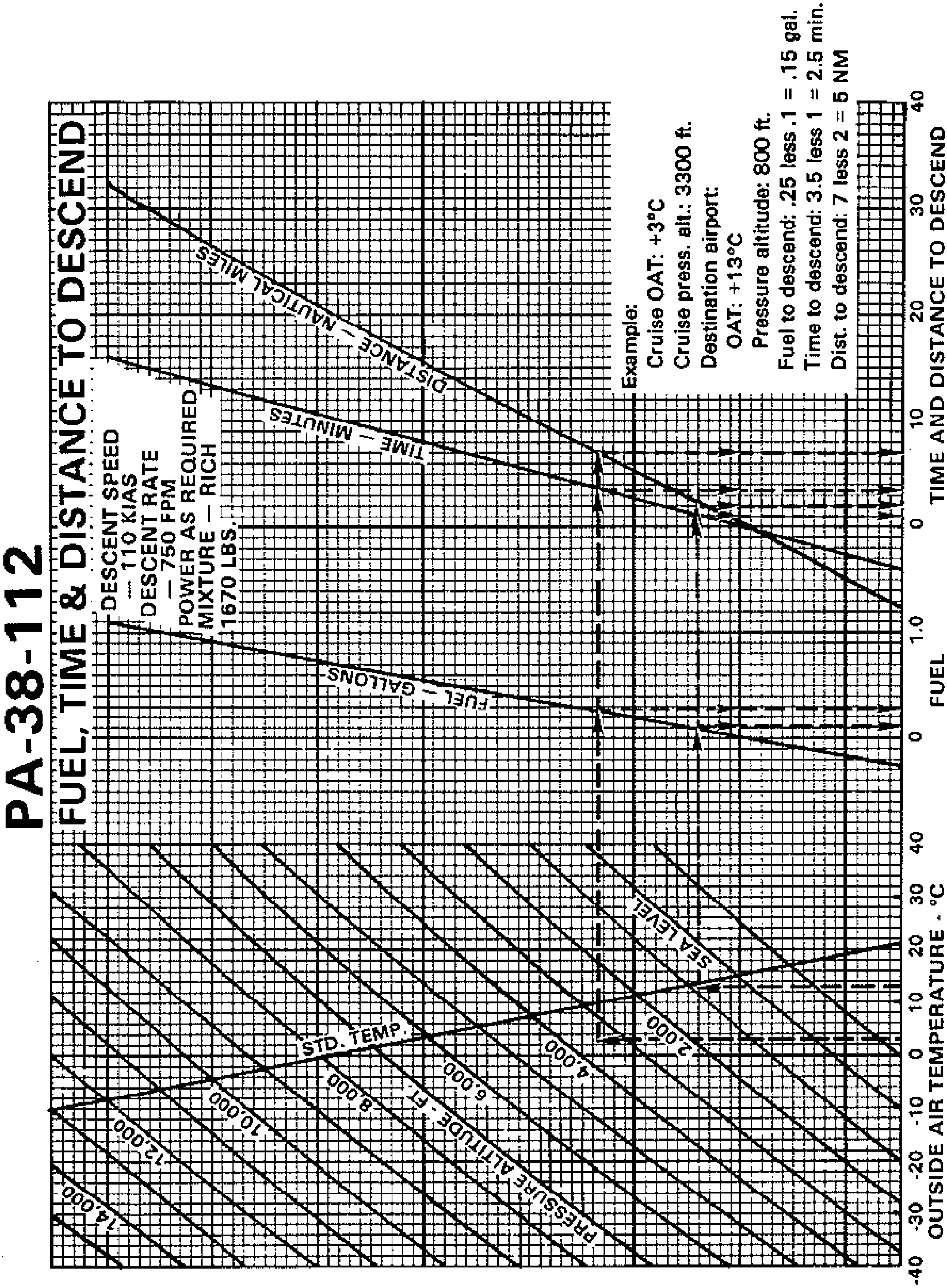


Fig. 10-9. *AFM Fuel, Time & Distance to Descend*.

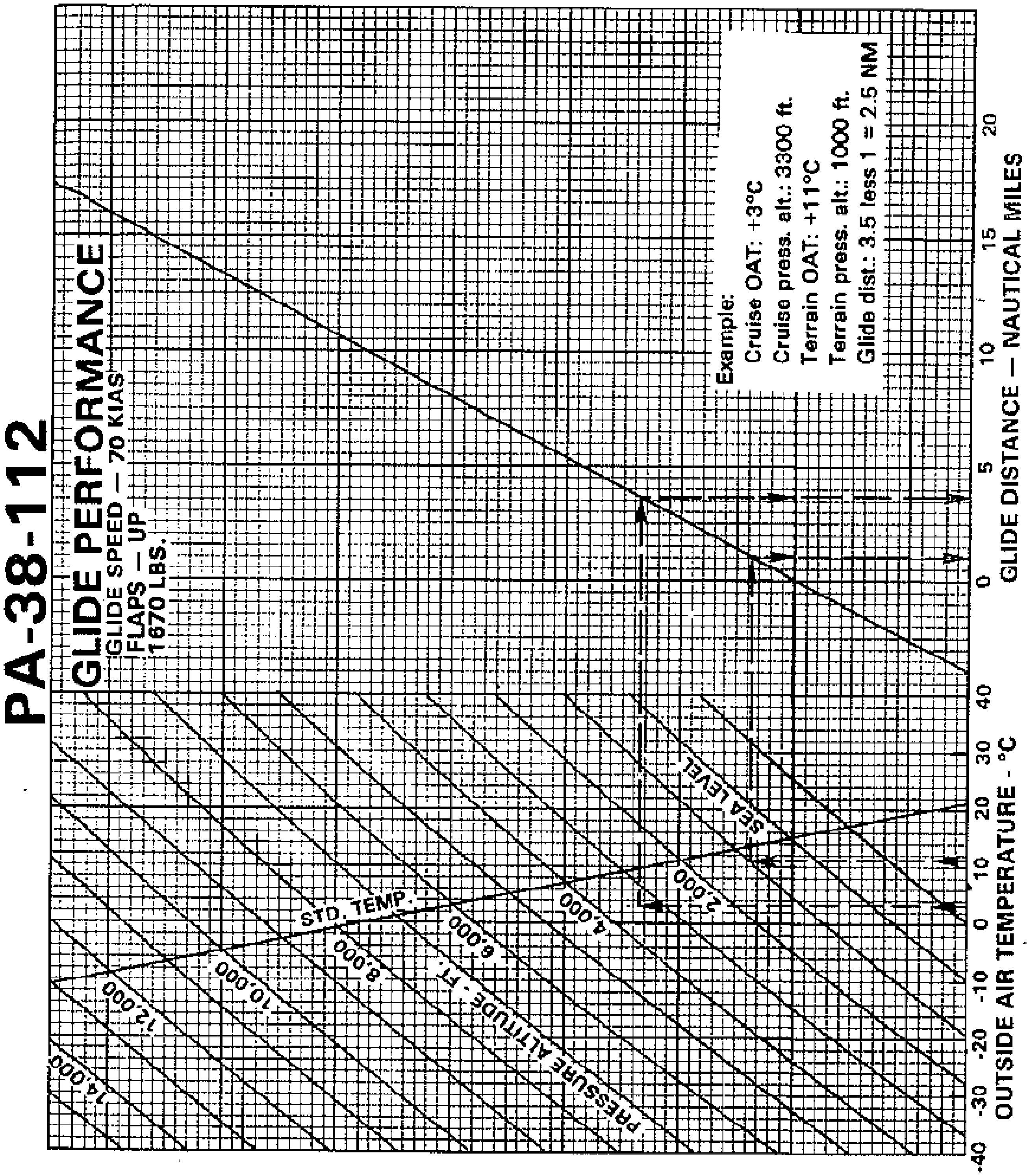


Fig. 10-10. AFM Glide Performance.

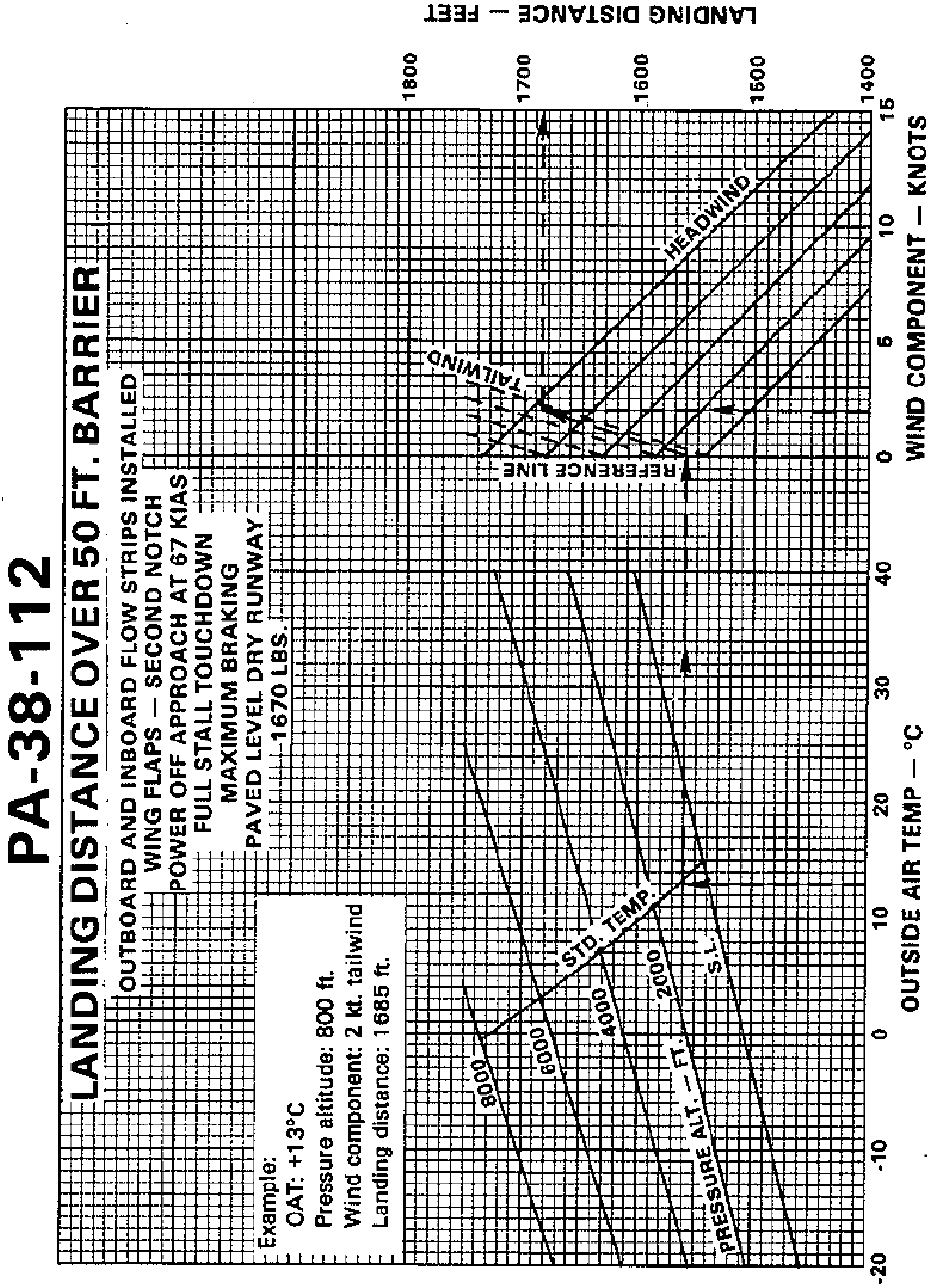


Fig. 10-11. *AFM Landing Distance from 50 feet*.

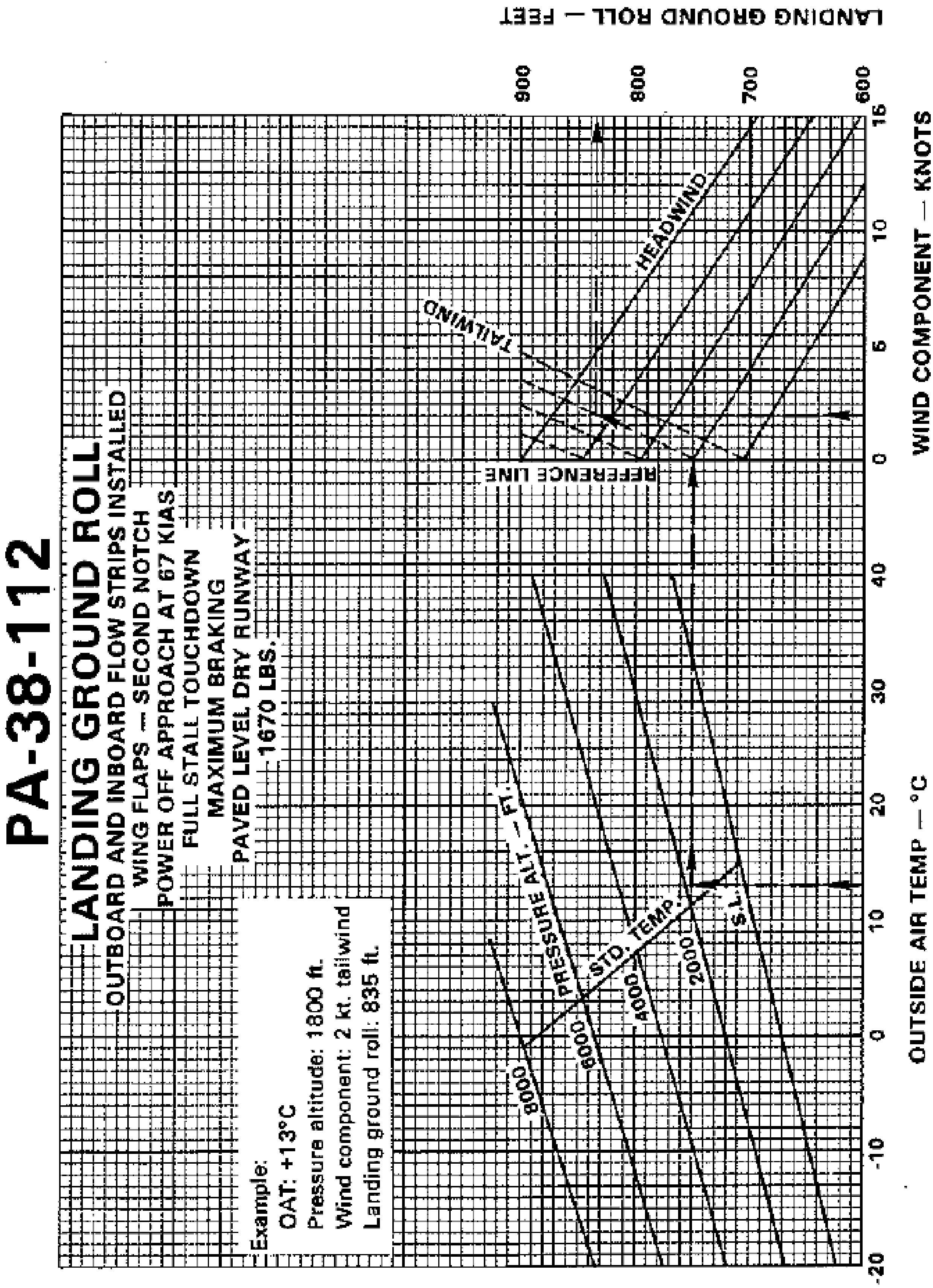


Fig. 10-12. AFM Landing Roll.

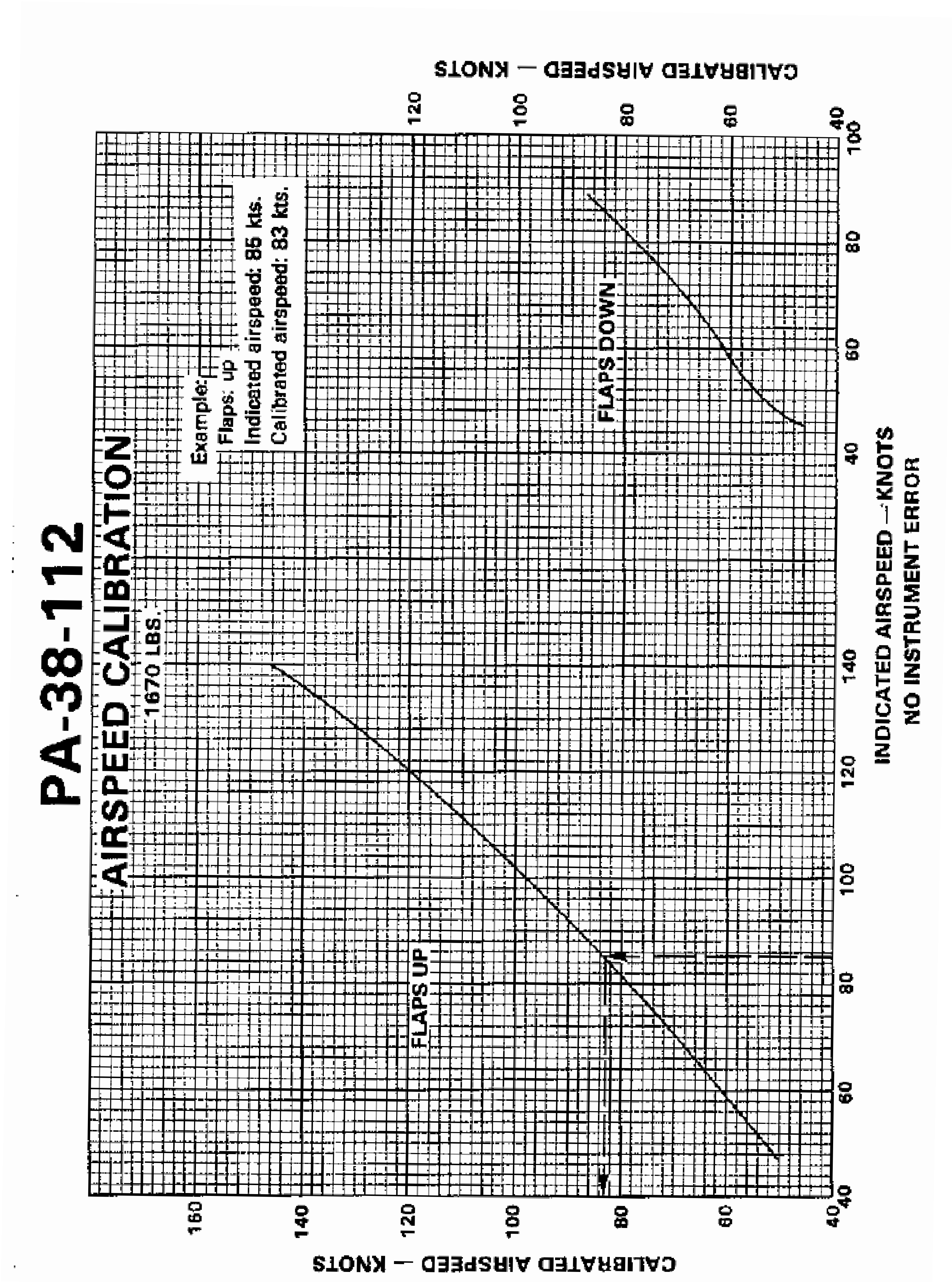


Fig. 10-13. AFM Airspeed Calibration.

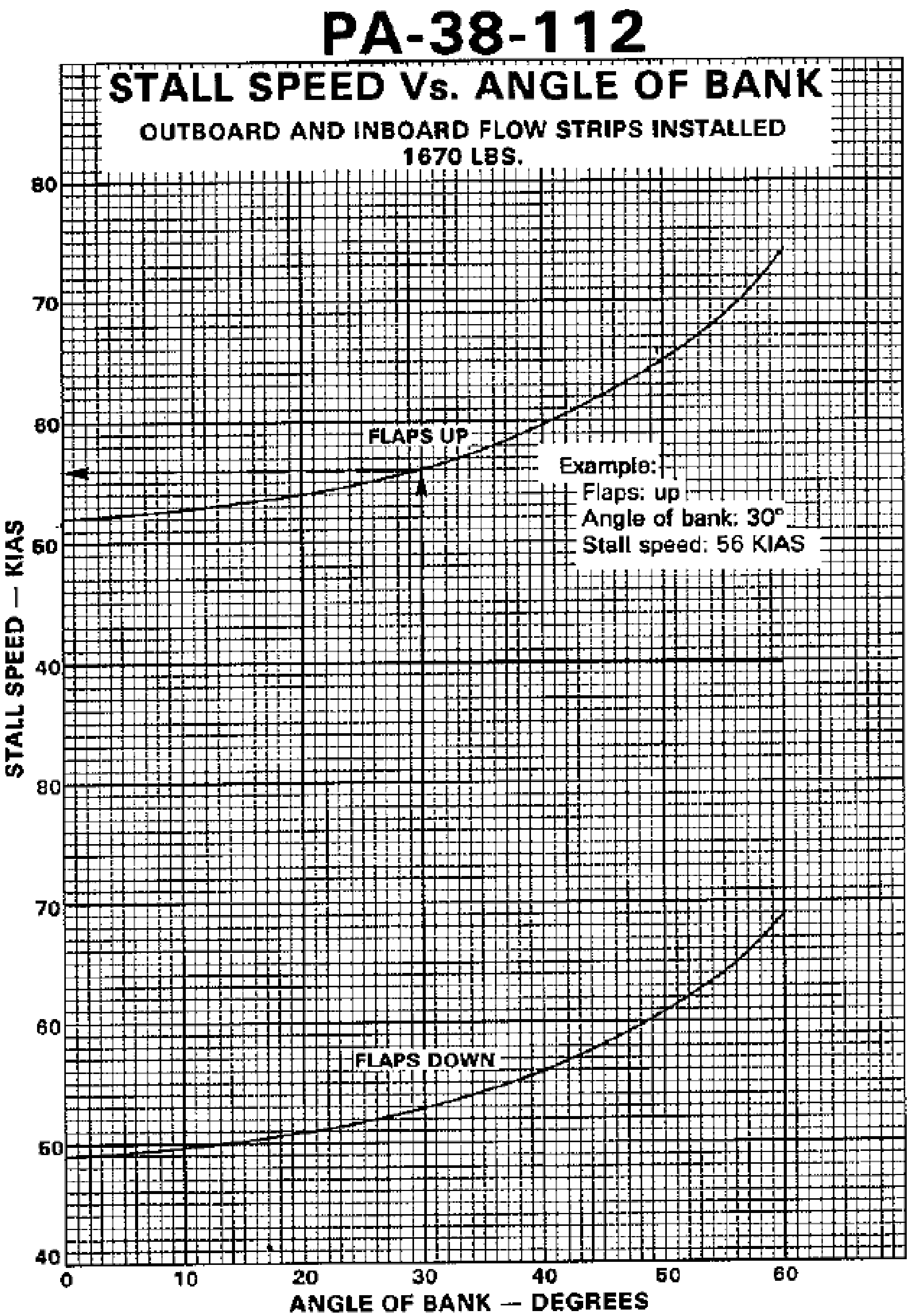


Fig. 10-14. AFM Stall Speed Vs Angle of Attack.

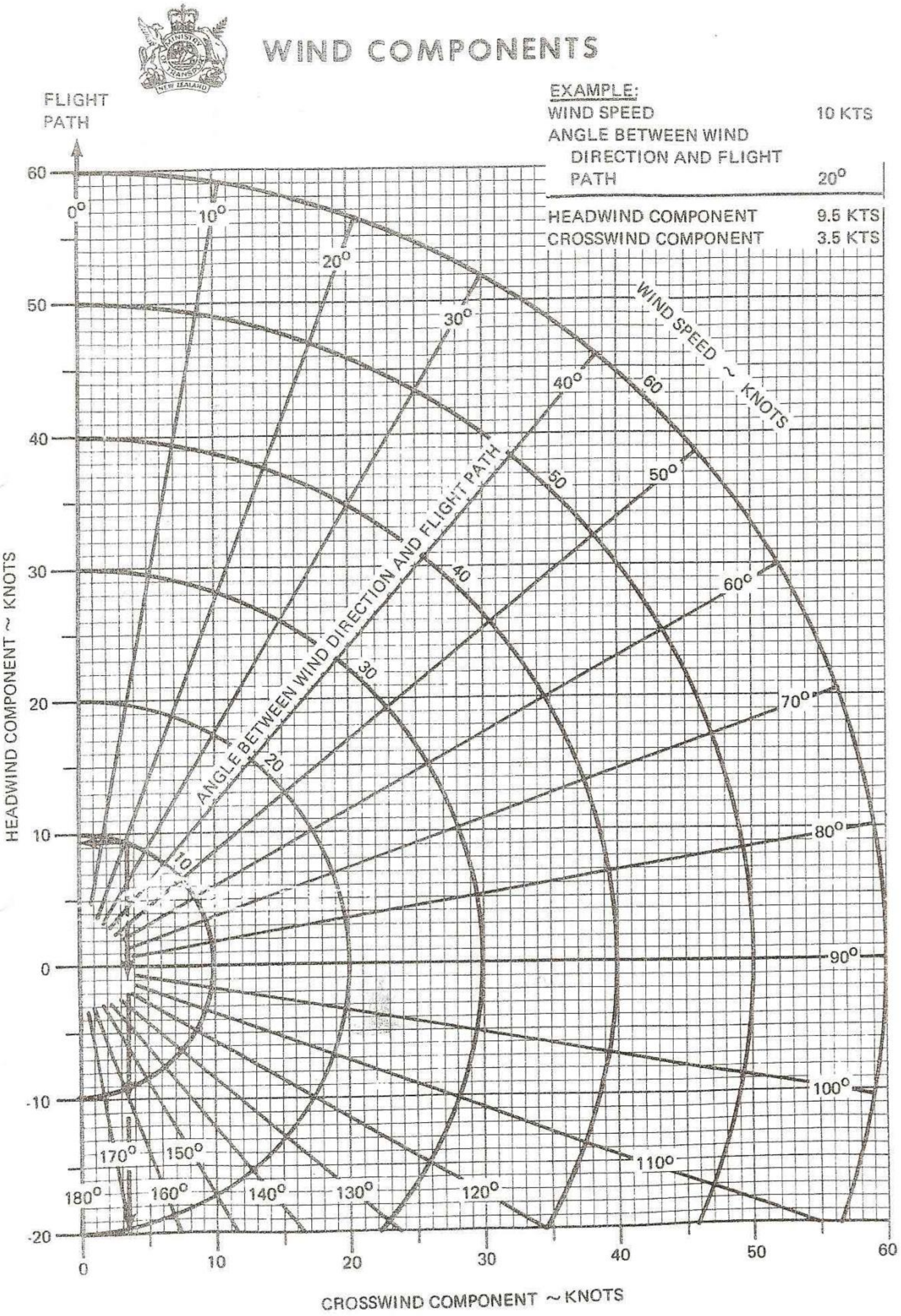


Fig. 10-15. Wind Components.

ISA CONVERSION

PRESSURE ALTITUDE VS OUTSIDE AIR TEMPERATURE

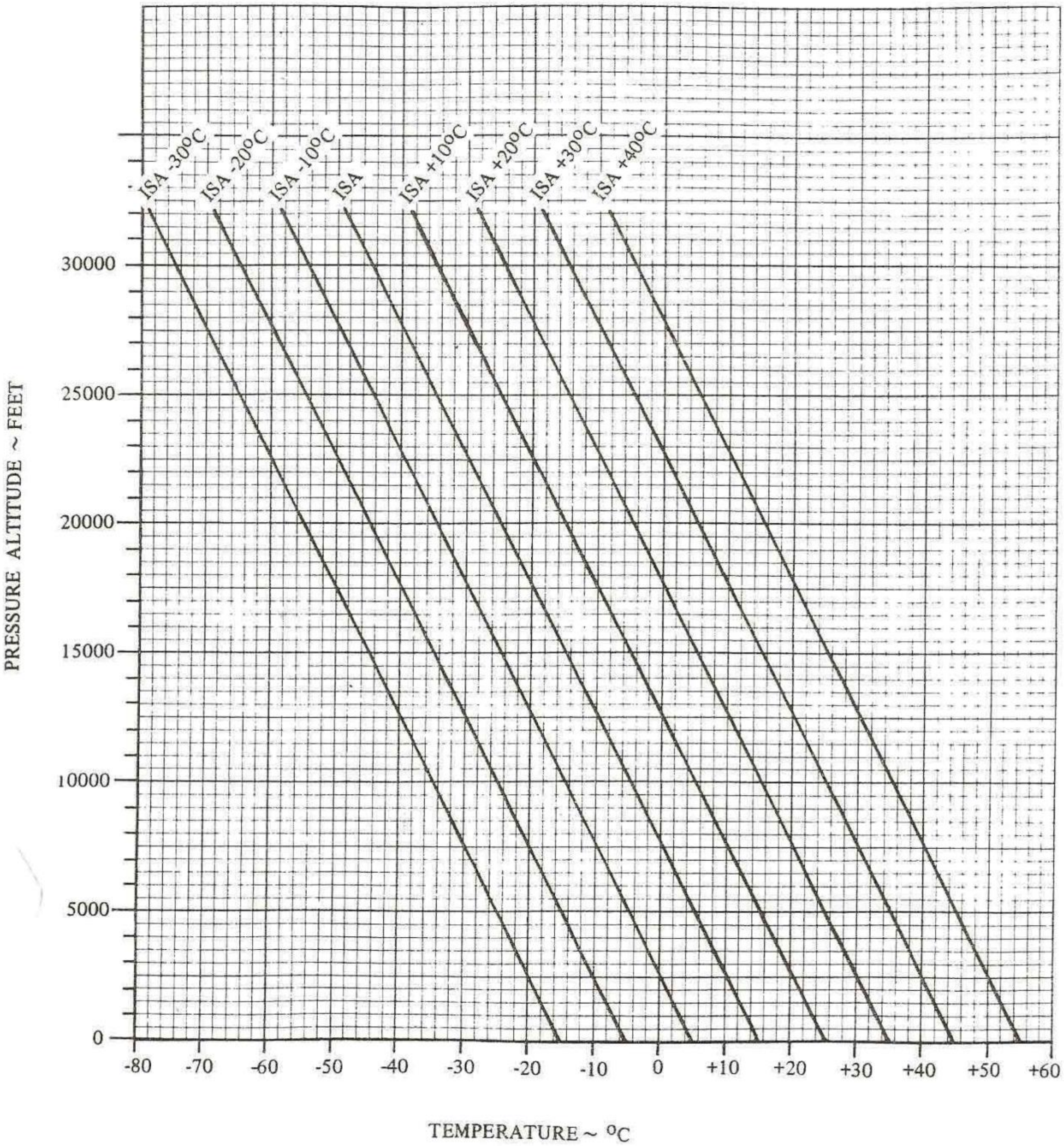


Fig. 10-16. ISA Conversion.

Wet and Contaminated Runways

These three methods for calculating aircraft performance assume that the runway surface used is not wet and is free of any contamination such as snow, ice or slush. In the case of a grass runway it is assumed that the grass is regularly mowed.

Wet, in relation to a runway, means a runway with sufficient moisture on its surface to cause it to appear reflective but without significant areas of standing water.

Contaminated, in relation to a runway, means more than 25% of the runway surface area within the required length and width is covered by surface water, slush, or loose snow more than 3 millimetres in depth, or ice on any part of the runway surface area.

If the runway surface conditions are wet or contaminated the pilot-in-command should assume that the calculated runway distance required will be understated.

Landing Distance

In the case of a wet or contaminated runway air transport operators are required have a landing distance available that is at least 115% of the landing distance calculated for a dry runway. It would be prudent for pilots of light aircraft on day private operations to do the same.

If you are using the group rating system, it would be prudent for pilots to ensure that the group rating of the runway to be used is at least one group rating greater than the one specified in the AFM. Alternatively, you can use the option of calculating the distance using a P-chart or the AFM data and apply a safety factor as in the preceding paragraphs above.

Takeoff Distance

Unlike the aircraft landing distance, the effect on the takeoff distance from a wet or contaminated runway has not been quantified at all. Pilots operating aircraft on air transport operations are not required to increase takeoff distances in such circumstances as the distance is already factored for the dry runway distance which in effect provides a reasonable buffer.

The three methods above for calculating performance presented in accordance with AC91-3 do not provide any margin for takeoff distance from a wet or contaminated surface. As these conditions will increase the takeoff distance required, it would be prudent for pilots to at least apply the same corrective factors as for the landing distance.

Long Grass

Since the type of grass, length of the grass, and the degree of wetness of any given grass runway will differ widely, it is not possible to calculate with any confidence the effect of long grass on takeoff or landing performance. However, it is certain that the longer and denser the grass the more effect it will have in retarding the aircraft's acceleration and thus increasing the takeoff distance required. The best advice is not to operate off a runway with long uncut grass.

AC91-3 "Aeroplane Performance Under Part 91" Summary

Whichever of the three methods chosen for performance planning and management, the most important aspect is that performance is thought about on **every** takeoff and landing. Believe me, it is not a pleasant realising late in the takeoff roll that you are running out of takeoff distance but that you are going too fast to stop in the distance remaining. All because no thought was given to runway distance available in the conditions. Seeing the end fence pass about a metre below the wheels is disconcerting, to say the least!

The other thought I would offer, is that if you are required to use a very sharp pencil to convince yourself that you have sufficient runway length, or to use the short takeoff technique of pushing the aircraft's tail back to the fence before beginning your takeoff roll - you should seriously reconsider whether you should even be attempting the takeoff. Have another coffee and talk to someone about it.

The same applies to landings, but to a much greater degree than for takeoff, pilot technique will determine runway distance required. If you are not confident that you have the aircraft completely set up to cross the beginning of the landing area (or at the committal point, if one is relevant to your approach) at the lowest safe energy state (height and speed), then you should **go around**. It may even be prudent to delay your approach until conditions improve, use a different runway or to divert to an alternative aerodrome.

Chapter Eleven

Weight and Balance

Introduction

This chapter deals with the Piper PA38 Tomahawk Basic Empty Weight (BEW) and maximum aircraft weights, and the effects of different weight loads on the fore and aft position of the centre of gravity (CofG).

In order to achieve the optimum performance and flying characteristics which are designed into the aircraft, it must be flown with the weight and centre of gravity (CofG) position within the approved operating range (CofG Range and Weight graph - Figure 11-5). Although the aircraft offers flexibility of loading, it cannot be flown with the maximum number of adult passengers, full fuel tanks and maximum baggage. With flexibility comes pilot responsibility. The pilot-in-command must ensure that the aircraft is loaded within the loading envelope before takeoff.

Misloading carries consequences for any aircraft, potentially lethal. An overloaded aircraft will not takeoff, climb or cruise as well as a properly loaded one. The heavier the aircraft is loaded, the less performance it will have.

Centre of gravity is a determining factor in flight characteristics. If the CofG is too far forward in any aircraft, it will be too stable in pitch and may be difficult to rotate for takeoff or landing. If the CofG is too far aft, the aircraft will be unstable in pitch and may rotate prematurely on takeoff or tend to pitch up during climb. Longitudinal stability will be reduced. This can lead to inadvertent stalls and even spins; and spin recovery becomes more difficult as the centre of gravity moves aft of the approved limit.

A properly loaded aircraft, however, will perform as intended. Before the aircraft is licensed, it is weighed, and a BEW and CofG location is computed. Using the BEW and CofG location, the pilot can easily determine the weight and CofG position for the loaded aircraft by computing the total weight and moment and then determining whether they are within the approved envelope.

The BEW and CofG location are recorded in the Aircraft Flight Manual (AFM) on the Weight and Balance Data Form (Figure 11-6). The current values should always be used. Whenever new equipment is added or any modification work is done, the aircraft engineer responsible for the work is required to compute a new BEW and CofG position and to write these in the AFM and Aircraft Log Book. The owner/operator should make sure that it is done.

A weight and balance calculation is necessary in determining how much fuel and/or baggage can be carried and the aircraft still remain within allowable limits. Check calculations prior to adding fuel to insure against improper loading.

The following pages show the method for computing takeoff weight and CofG.

PA 38 Tomahawk - Weight and Centre of Gravity (CofG) Limits

Maximum All Up Weight (MAUW)	757.5 kg (1,670 lb)
Forward Centre of Gravity Limit	184 cm up to 562.5 kg, reducing linearly to 186.7 cm at 757.5 kg, aft of the datum (72.4 ins up to 1,240 lb, reducing linearly to 73.5 ins at 1,670 lb, aft of the datum)
Aft Centre of Gravity Limit	199 cm aft of the datum (78.5 ins aft of the datum)
Basic Empty Weight (BEW)*	557.5 kg (1,229.1 lb)
BEW Moment Arm	189.89 cm aft of the datum (74.76 ins aft of the datum)
BEW Moment	105,863.90 kg/cm (91,888.46 lb/in)

***** The Basic Empty Weight (BEW) stated in the AFM includes all standard fixed parts plus full oil capacity and 2.0 gallons of unusable fuel, plus the optional equipment.

The datum is 168.275 cm (66.25 inches) forward of the wing leading edge.

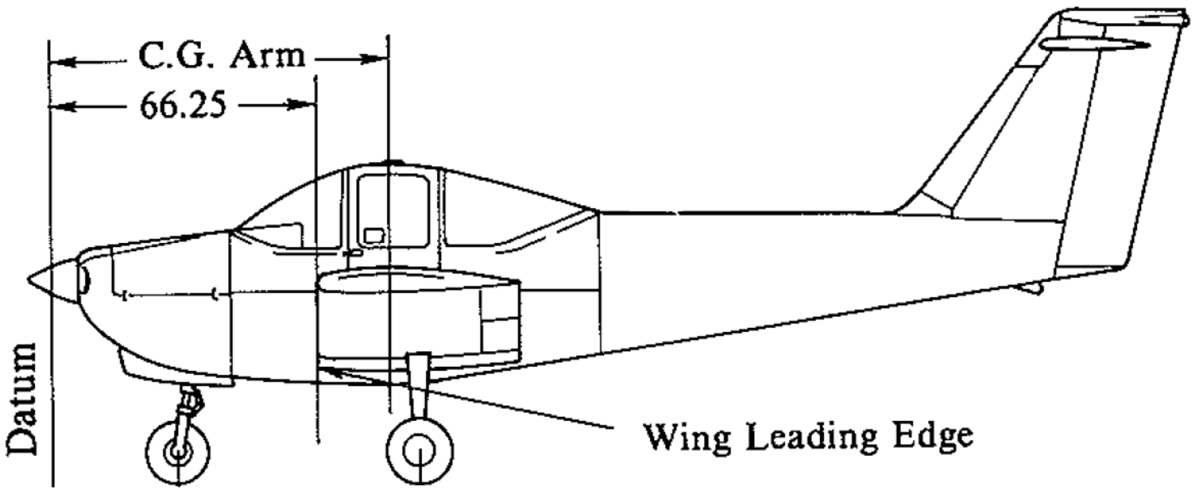


Fig. 11-1. Load Datum.

Weight and Balance Determination for a Given Flight

Enter the basic empty weight and add the weight of all items to be loaded:

- Use the Loading Graph (Figure 11-3) and Seat Position table (Figure 11-4) to determine the moment of all items to be carried in the aircraft;
- Enter the Basic Empty Weight moment and add the moment of all items to be loaded;
- Divide the total moment by the total weight to determine the CofG position; then,
- Use the total aircraft weight and the calculated CofG position on the CofG Range and Weight graph (Figure 11-5) to locate a point.

If this point falls within the CofG envelope, the loading meets the weight and balance requirements.

Example:

	Weight (Kgs)	Arm Aft of Datum (Centimetres)	Moment (Kg-cm)
Basic Empty Weight	557.5	189.89	105,863.68
Pilot and Passenger**	170 0	217.2	36,924.00
Fuel (30 US Gall Maximum)	28.0	191.5	5,362.00
Baggage (45.3 Kg maximum)*	2.0	292.1	582.20
Total Weight and CofG	**757.5**	**196.35**	148,731.68

Fig. 11-2. Loading Example.

*No baggage allowed for spins.

**Occupant CofG is shown with the seats in the fourth notch from the most forward position. See Figure 11-4 for the seat position and corresponding arm aft datum.

The CofG of this example loading problem is at 196.35 cm aft of the datum. Locate this point (196.35) on the CofG Range and Weight graph (Figure 11-5). Since this point falls within the CofG Range and Weight envelope, this loading example meets the weight and balance requirements.

NOTE
It is the responsibility of the pilot-in-command to ensure that the aircraft is loaded properly at all times.

Loading Graph

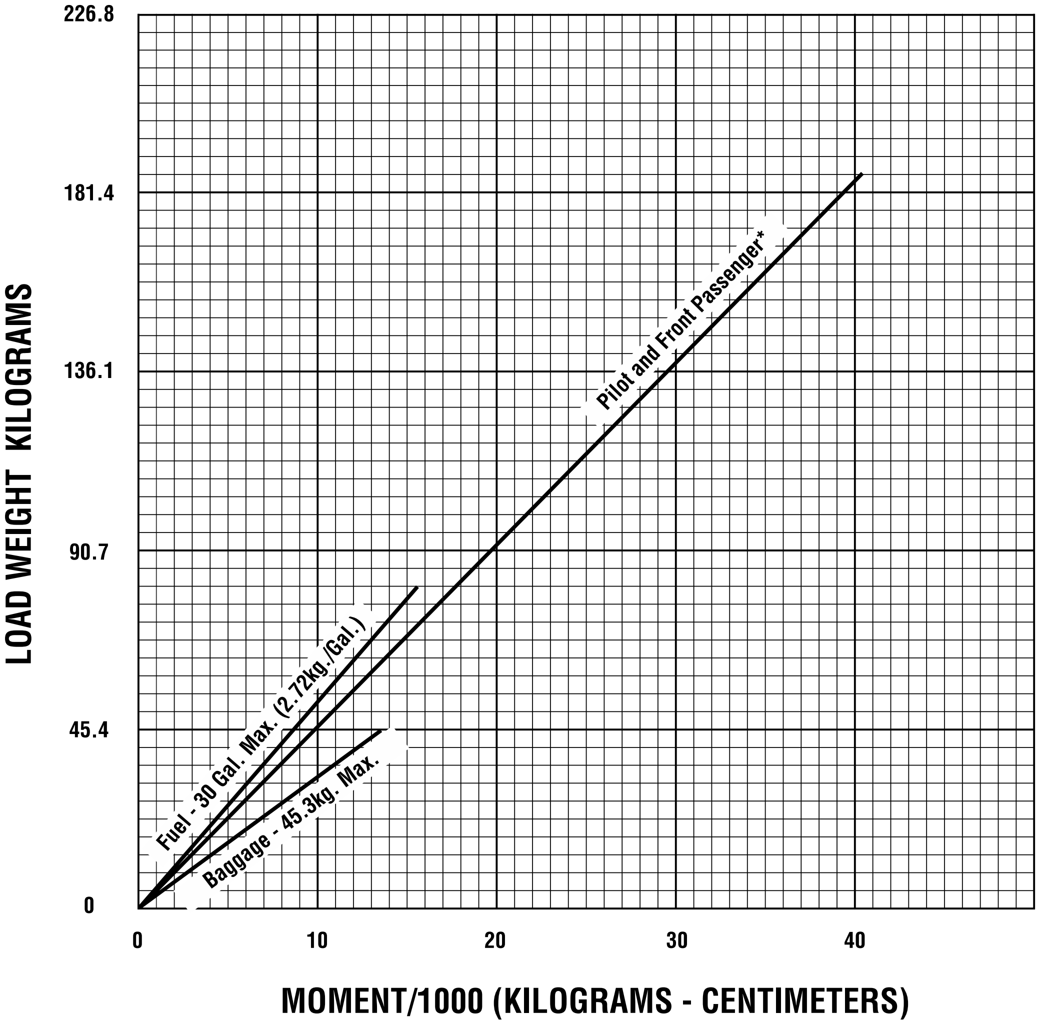


Fig. 11-3. Loading Graph.

*Loading graph is shown with the seats in the fourth notch from the most forward position.

If CofG falls near the forward or aft limits, occupant seat positions are important; and moments should be calculated by multiplying pilot and passenger weight by appropriate arm aft datum (see Figure 11-4), rather than determined by the loading graph.

Seat Position	Arm aft of Datum (cm)
FWD 1	205.2
2	209.0
3	213.1
4	217.2
5	222.3
AFT 6	227.3

Fig. 11-4. Seat Position and Corresponding Arm.

CofG Range and Weight Graph

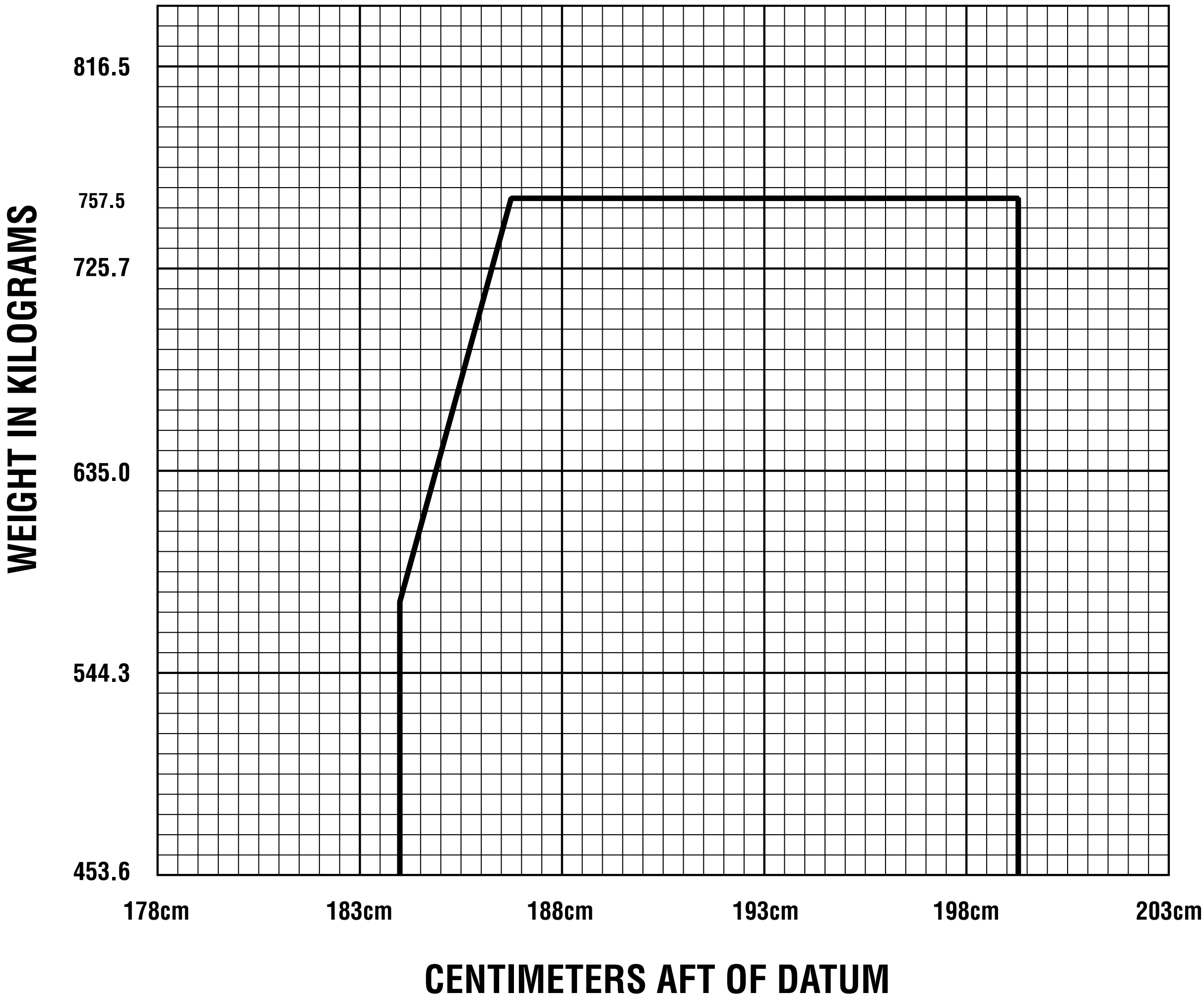


Fig. 11-5. CofG Range and Weight.

Weight and Balance Data Form (CAA 2173)

Weight and Balance Data

CAA
CIVIL AVIATION AUTHORITY OF NEW ZEALAND

ZK - PAF

Aircraft Make and Model	Piper PA38-112
EMPTY WEIGHT (see Notes)	1229.1 lbs
Datum Reference	Propeller
Longitudinal C of G (state Fwd or Aft of Datum)	74.76 ins aft
Lateral C of G (For Helicopters)	
MOMENT	91888.46

Unusable fuel quantity (included in empty weight)	
Refer to Flight Manual for further information	

Data established by Weighing or Calculation?	Calculation
Performed by - Name	G Ryan
Licence / Authorisation No.	10852
Date	22/07/2013
Reason	Installation of Wing Spar Kit #SA500
Report Ref / Job Number (if applicable)	
If established by calculation state when a/c weighed	16/08/1989
CAA 1464 AD Logbook Section 8 updated	Yes

Notes:

1. Empty weight includes: unusable fuel, fixed ballast, full operating fluids and items in the Equipment List over page.
2. Refer to Weight and Balance Section of Flight Manual for further information.
3. A new form is to be completed whenever revised weight and balance data is established either by weighing or calculation.

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Fig. 11-6. CAA Weight and Balance Data Form.

Weight and Balance Loading Forms

	Weight (Kgs)	Arm Aft of Datum (Centimetres)	Moment (Kg-cm)
Basic Empty Weight	557.5	189.89	105,863.68
Pilot and Passenger**		217.2	
Fuel (30 US Gall Maximum)		191.5	
Baggage (45.3 Kg maximum)*		292.1	
Total Weight and CofG			

	Weight (Kgs)	Arm Aft of Datum (Centimetres)	Moment (Kg-cm)
Basic Empty Weight	557.5	189.89	105,863.68
Pilot and Passenger**		217.2	
Fuel (30 US Gall Maximum)		191.5	
Baggage (45.3 Kg maximum)*		292.1	
Total Weight and CofG			

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	Weight (Kgs)	Arm Aft of Datum (Centimetres)	Moment (Kg-cm)
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Pilot and Passenger**		217.2	
Fuel (30 US Gall Maximum)		191.5	
Baggage (45.3 Kg maximum)*		292.1	
Total Weight and CofG			

	Weight (Kgs)	Arm Aft of Datum (Centimetres)	Moment (Kg-cm)
Basic Empty Weight	557.5	189.89	105,863.68
Pilot and Passenger**		217.2	
Fuel (30 US Gall Maximum)		191.5	
Baggage (45.3 Kg maximum)*		292.1	
Total Weight and CofG			

Fig. 11-7. Weight and Balance Loading Forms.

Chapter Twelve

Ground Handling

Towing and Pushing

The Tomahawk can be moved on the ground by the use of the nose wheel steering bar that is or by power equipment that will not damage or excessively strain the nose gear steering assembly. Towing lugs are incorporated as part of the nose gear fork.

The aircraft can also be pushed by hand. When pushing the aircraft rearwards by hand, push at the leading edges of the mainplane. When pushing the aircraft forwards by hand, push at the wing roots or trailing edge of the wing tips.

CAUTIONS

Do not tow the aircraft when the controls are secured.

When towing with the towbar or with power equipment, do not turn the nose gear beyond its steering radius in either direction, as this will result in damage to the nose gear and steering mechanism.

Do not push on the flaps, ailerons, elevators, rudder, or on the propeller blades under any circumstances.

Undue strain might be placed on them in such a manner as to weaken the structure.

Parking and Picketing

When parking the aircraft, be sure that it is sufficiently protected from adverse weather and that it presents no danger to other aircraft. Where practical, park the aircraft so that it faces into the prevailing or expected wind.

If the aircraft is to be parked outside, set the park brake on. If the aircraft is to be parked in the hangar and during refuelling, leave the brakes off. Fully close the cockpit doors.

CAUTION

Brakes should not be set when overheated or during extremely cold weather when accumulated moisture may freeze a brake.

Aileron and elevator controls should be secured with the front seat belt. If considered necessary, chocks may be used to properly block the wheels.

If the aircraft is to remain parked outdoors for a period of time, fit the pitot head cover, picket the aircraft securely, and if available, consider putting on the cockpit canopy cover.

To tie the aircraft down, pass a rope through the tie down holes on the lower side of each of the wings. Secure these ropes to the pickets or ground tie down points. Then place the control lock in position.

The park brake should not be left on after picketing, as the hydraulic brake system does not like being pressurised for long periods.

NOTE
Additional preparations for high winds include using tie-down ropes from the nose landing gear fork and the tail striker, and securing the rudder.

Inside back Cover

Waypoints AVIATION


Hobbs
Tacho
ZK-JRS
WASSI gratefully acknowledge
the estate of John Richards (JR).
Always a friend of The Walsh.
FUEL
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