



NATIONAL TECHNICAL UNIVERSITY OF ATHENS
SCHOOL OF MECHANICAL ENGINEERING
DEPARTMENT OF INDUSTRIAL MANAGEMENT AND OPERATIONAL
RESEARCH

Practice derived adaptations to formal procedures:
*The case of Mission Aviation Fellowship supplement for the Cessna C208
Pilot's Operating Handbook*

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ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ

ΣΧΟΛΗ ΜΗΧΑΝΟΛΟΓΩΝ ΜΗΧΑΝΙΚΩΝ

ΤΟΜΕΑΣ ΒΙΟΜΗΧΑΝΙΚΗΣ ΔΙΟΙΚΗΣΗΣ ΚΑΙ ΕΠΙΧΕΙΡΗΣΙΑΚΗΣ ΕΡΕΥΝΑΣ

Προσαρμογές επίσημων διαδικασιών που προκύπτουν από την πρακτική:

Η περίπτωση του τροποποιημένου εγχειρίδιου της Αδελφότητας
Αεροπορικών Αποστολών για το Cessna Caravan C208

ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

ΤΟΥ

ΓΙΑΝΝΑΚΟΠΟΥΛΟΥ ΚΩΝΣΤΑΝΤΙΝΟΥ

Επιβλέπων: Δημήτριος Ναθαναήλ
Λέκτορας Ε.Μ.Π.

Dedication and Acknowledgements

I would like to dedicate my dissertation to my mother Polyna, father Yiannis and my big African Family that supported me through out my years in the NTUA.

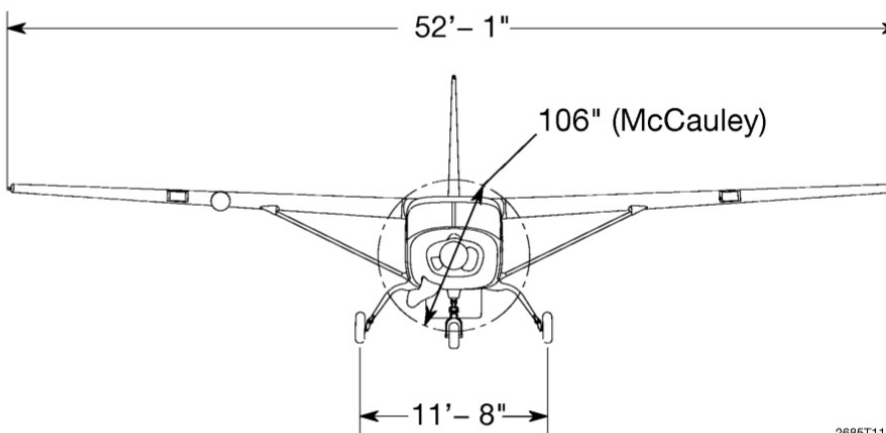
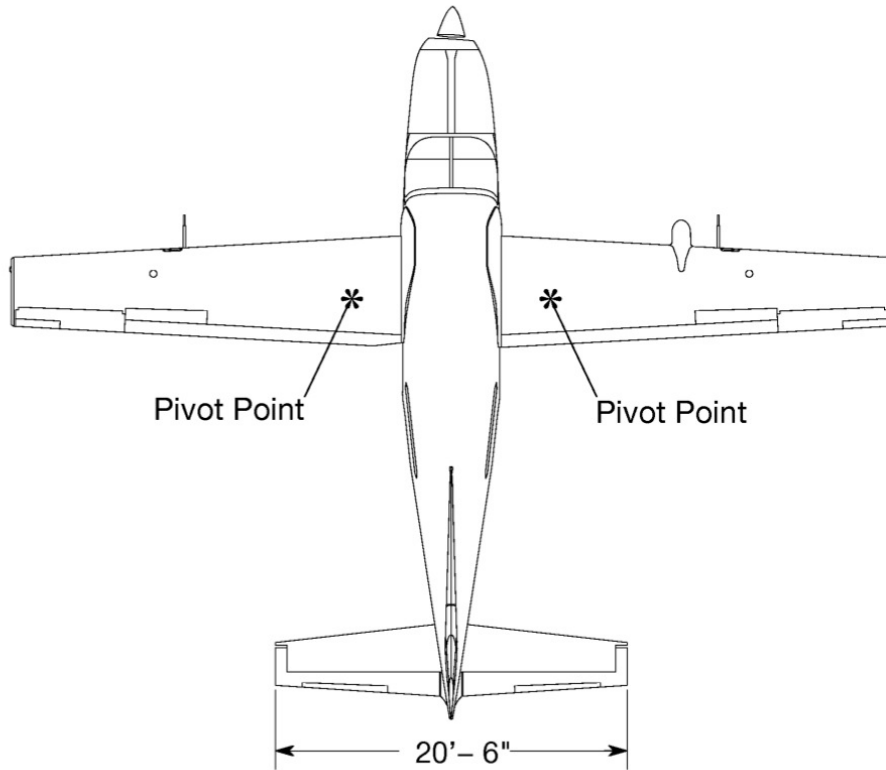
Many thanks to my supervisor lecturer Dimitrios Nathanail and the team in the Ergonomics unit.

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Purpose and Importance of the Research

The following dissertation is based on the analysis of different approaches and practices, applied on a Bush Aviation Operator's "Pilot's Operating Handbook and Safety Operation Procedures" (POH/SOP) derived from an aircraft manufacturer's identical documents.

Specifically, we will be comparing the Cessna's Caravan C208 POH and SOP with Mission Aviation Fellowship's (MAF) supplementary Handbook and Procedures for the referred aircraft that have been optimised over the years.

Understanding MAF's philosophy requires awareness of bush pilots and bush flying. Bush flying is the aviation practice of flying in remote and isolated areas where pilots face challenges that require a certain mentality and developed skills.

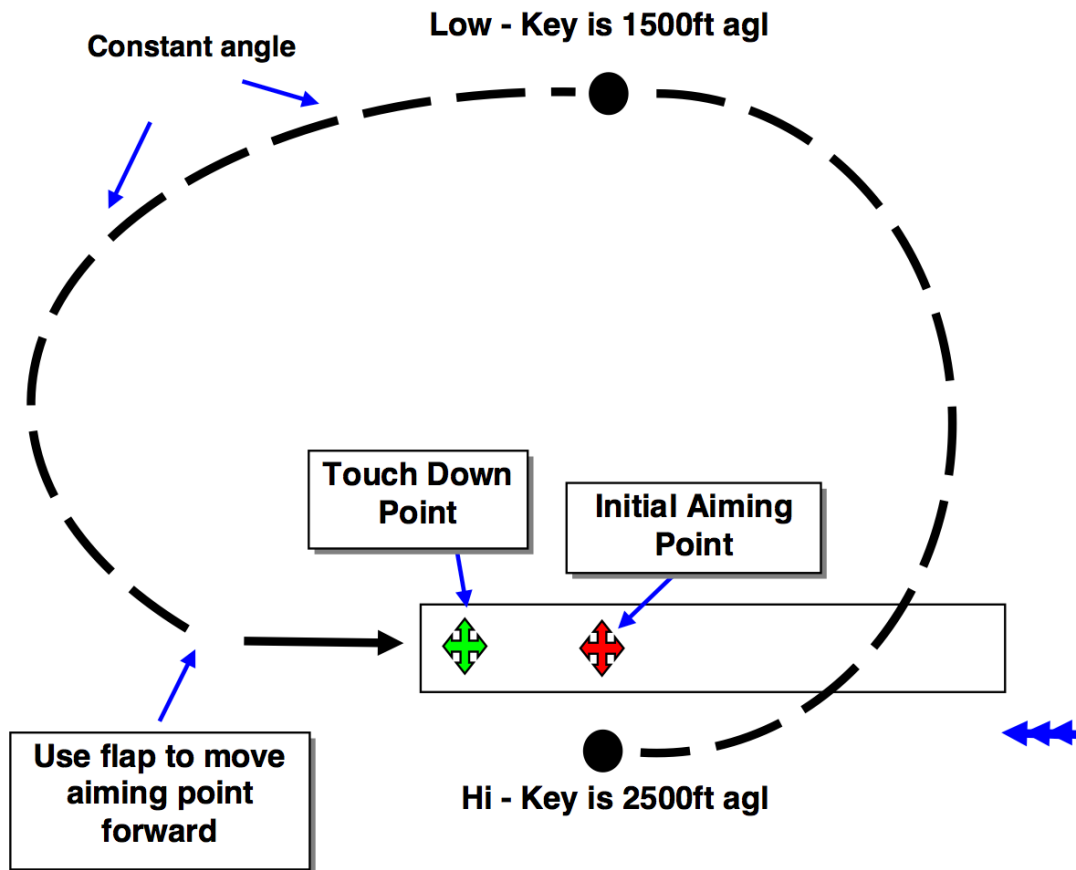
Most bush pilots in Africa fly general aviation (GA) aircraft transporting passengers, cargo and operate in the vast jungles, mountains and deserts where runways are short, composed of gravel, sand or mud and radio communications are limited. Furthermore, the lack of maintenance facilities and supplies as well as weather information, make every task more challenging. Hence, bush pilots are obligated to have technical knowledge and the ability to perform under pressure.

It's a common practice to meditate drills on emergency procedures while flying over isolated areas. In other words, "what if" scenarios. Illustrative, cruising over dense vegetation, create imaginary scenarios with random emergency procedures (i.e. fire, flameout, bird strike etc.). What are the first tasks that would need to be done? Scan the best area to land, LASSO¹? alternative options and so on.

In an emergency environment where a force landing is inevitable, it is essential that a pilot must give priority on finding an area to land safely and subsequently take actions recovering from the emergency. Noteworthy is MAF's fundamental procedure, fly the aircraft first and always. There aren't a few cases in which pilots were deeply engrossed trying to solve an emergency procedure puzzle and lose track of the aircraft's attitude ending in disaster. Pilots must always remember that the main goal in emergencies is to save lives. Although keeping the aircraft intact from damage should not concern a pilot, the less damage the aircraft sustains the greater are the survivability prospects of the passengers and crew.

The Constant Aspect Method (CAM) for forced landing without power comes very handy. The CAM is based on a High Key position of 2,500 ft above ground level (AGL), into wind, virtually above the initial aiming point. The initial aiming point is one third to a half of the way into the selected landing area. The Low Key position is 1,500 AGL, downwind, abeam the initial aiming point, approximately 1.5 nm out. From the Low Key position a constant angle is maintained with the initial aiming point. As the aeroplane descends, it needs to move closer, to keep the aspect (or angle) constant. If the aspect looks flat, the aeroplane is too far out, and the pilot needs to turn in. If the aspect looks too steep, the aeroplane is too close in, and the pilot needs to turn out. Once the pilot is sure he can make the initial aiming point, he should lower flap in order to bring the initial aiming point back to the beginning of the landing area.

¹ LASSO: Length, Altitude, Slope, Surface, Obstructions



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To the meaning comes MAF's pilot decision making in emergency situations were a pilot should refer to the 6Gs mnemonic which is now gradually replaced by the A-B-C-D-E-F-G mnemonic³. They both can be applied to every aircraft flying today and have already saved lives.

The 6Gs mnemonic stands for Glide-Grass-Gas-Gab-Guts-Get out!, where Glide obviously stands for gliding the plane with the correct speed/descent rate, Grass stands for finding the correct area to land the plane, Gas is to make sure that there is gas in the tanks and it's not what is causing the problem, Gabs means to declare an emergency through the radio's guard frequency of 121.5 MHz (IAD), Guts stands for fastening tight the seat belts and harnesses and finally Get out.

More or less the mnemonics are corresponding to each other, however the A-B-C-D-E-F-G is more common now days as aircrafts get more complex and at the same time carry more passengers. Each letter exemplifies the following:

² Hi and Low key points

- A for Airspeed, were a pilot should set the aircraft to a low powered best endurance airspeed.
- B for Best Field, taking in consideration that in any possible moment the situation can get worst finding promptly a safe area to land is of the essence. Hence, priority is always given on selecting the best field to land by using the high and low key points.
- C for Cause, as once decided and approaching the best field to land, attention can now be given to determine the cause.
- D for Distress as the pilots has to transmit his intentions on the IAD frequency of 121.5 MHz.
- E for Emergency Brief being that passengers will have been alerted by that time, they should be instructed to prepare for a possible forced landing. Noteworthy is the emergency briefing has to be carried out in a strong, calm and positive voice according to MAF.
- F for Flaps and Fuel. The flaps have to be set for landing and Fuel to Cut-off position incase of spark or fire.
- G as on the 6Gs mnemonic is for getting out of the aircraft.⁴

Most of MAF's mnemonics have been enhanced and applied on Cessna's aircrafts, as their history of working together goes way back. Most known in their fleet was the Cessna 206, also know as the back bone of the fellowship. Nimble aircraft that could take off and land from short, rugged airstrips, allowing MAF to support those that no one else could reach. Since the Cessna 206 had a piston engine and run on avgas, which is scarce in many parts of Africa, it was gradually replaced by the Cessna Caravan C208.

Method

The study began by examining thoroughly Cessna's POH/SOP⁵ for the Caravan C208 as well as MAF's Handbooks⁶. Upon gathering all the information needed we created a questionnaire with which we interviewed pilots and aviation maintenance technicians (AMTs) that worked or had witnessed the work of MAF.

The interviews approach was in a friendly environment, at the head offices of Zemen Flying Services, the Addis Ababa Bole International Airport (HAAB) GA Parking area as well as inflight. One final meeting also took place through web video call as the pilot's schedule was not feasible.

The interview with the AMTs was very enlightening as we came to the conclusion that most bush pilots are assisting with the aircraft's service and maintenance. This is a basic practice when flying in the bush was the common answer.

The conclusion of the research came from the interviews we had with the pilots, and apart from the valuable story telling and some encyclopaedic aviation facts the meaning came with the following questioning:

⁴ The A-B-C-D-E-F-G mnemonic is further analysed on the Handbook Emergency Procedures

⁵ Pilot's Operating Handbook and FAA Approved Airplane Flight Manuals at Revision 1, Dated 5 June 2008 (Part Number 208PHBUS-01)

⁶ Operations Manual Part B - C208 Standard Operating Procedures MEO.01 Revision 0, January 2005

- i) Why do you think that MAF got in the process of making such changes on the manufacturers POH/SOP
- ii) In which cases would you use the MAF POH/SOP and in which the manufacturers POH/SOP?
- iii) As an experienced bush pilots yourself, would you make any changes on the existing POH/SOP?
- iv) If any, personal experience(s) on emergencies that you have used any of the POHs
- v) Notes/Tips that you think are worth mentioning in my Dissertation

Although the interviews were mostly formal in the beginning, eventually a great deal of information was gathered. Most MAF pilots and technicians use their POH/SOP like a Bible as they say, but at the same time have their own ways of doing things, especially in routine circumstances. For instance, AMTs will not always use a torque wrench when changing tyres as counting bolt grooves is quicker and will have more or less the same result. Pilots do not always use their weight and balance charts as they know more or less what their weight would be in every leg of the flight. Ultimately, both pilots and AMTs are very serious when it comes down to safety and service.

Cessna

The Cessna Aircraft Company is a general aviation aircraft manufacturing corporation headquartered in Wichita, Kansas (U.S.A.).

Clyde Vernon Cessna designed the very first Cessna in 1911 a monoplane of spruce and linen. After his first successful flight, Clyde was nicknamed the “Bird-man of Enid”. Sixteen years later, Cessna Aircraft Corporation was born. The company’s first aircraft was an unconventional monoplane that featured a wing without braces or struts, a design that has been the industry standard ever since.



In Cessna’s first decade, the company earned a reputation for safety and performance that it still holds today. More than eight decades later, Clyde Cessna’s passion and vision are mirrored every day by the people who work for Cessna. Whether in an office or in the factory, every Cessna employee is driven by a spirit of innovation and passion for aviation.

Cessna Caravan C208

The Cessna C208 Caravan is a single engined turboprop, fixed tricycle landing gear, short haul regional airliner and utility aircraft. The airplane typically seats nine passengers with a single pilot. It is also used for cargo feeder liner operations. It is engineered for hard work, with matchless cargo hauling capacity and industry leading dispatch reliability.

The latest version, the Grand Caravan C208B, is even more imposing. It is 1.2 meters longer than the original Caravan and is the largest single-engine turboprop utility aircraft currently in production.

Cessna has produced four Caravan models, plus several variations: a special-missions version available with roll-up cargo door and pod for carrying eavesdropping electronics, a military cargo version, and a floatplane. The Caravan is available with either straight or amphibious floats. The Wipline floats are huge affairs on dry land, the top of the amphibious float is 1 meter high. Fifteen float-equipped short-body Caravans have been sold. (Floats are not available for the stretch Caravans.)

The prototype Caravan first flew in December 1982. It was intended as a replacement for Cessna 206s, 208s and other smaller, ageing utility aircraft doing hard labor in remote regions of Africa and other places where facilities can be crude and avgas scarce.

Even before it was certified in 1984, the Caravan found a big home in the U.S. Federal Express Corporation (FedEx) ordered a specially equipped, windowless version, the 208A Cargo to expand and extend its overnight small-package pickup and delivery service to medium and small communities. Since then, Cessna's Caravan business has been driven largely by Fedex's needs, and after putting its first batch of Caravans in service, Fedex discovered the airplane was limited by volume rather than weight. Cessna's solution was to add 50 cm to the Caravan's fuselage ahead of the wing and 50 cm behind the wing. The stretch added 34% more volume to the fuselage and resulted in the 208B Super Cargomaster.

The C208B will hold 10 m³ of cargo. Cessna also offers an optional 3.2 m³, 500 kg belly pod and rumour has it that animals and even people have been carried in Caravan pods in remote places of Africa. Cessna increased the 3630 kg (8000 lbs) maximum takeoff weight of the Cargomaster to 3970 kg (8,750 lbs) for the stretched Super Cargomaster but stuck with the same 600 shaft horsepower (SHP) Pratt & Whitney PT6A-114 turboprop engine. However, the Super Cargomaster was restricted to 3630 kg (8000 lbs) for flight in icing conditions because of reduced climb performance at the higher gross weight. Cessna corrected the problem by upgrading to a 675 shp PT6A-114A engine.

The Grand Caravan, fourth in the Caravan series, was introduced in October 1990. It incorporates all the best features of the other models, including the more powerful engine, longer fuselage, and cabin hardware that enables it to be quickly converted from a people hauler to a cargo truck or a combination of the two.

Because beauty wasn't even on the first page of Cessna's priority list for the Caravan, designers concentrated on features that help the airplane and pilot do their work better. Ease and cost of maintenance also were primary considerations, starting with the propeller, a fat, three blade McCauley which replaced the composite Hartzell. Taking into consideration that more than 50% of Caravans operate on gravel runways were FOD, loss of material, segregation and rutting of the propeller blades is a common problem, the switch was made to metal because it costs half as much to buy and repair, according to Cessna which owns McCauley.

The Grand Caravan has four doors. One for each crew member, a right side air stair door, and a yawning left side cargo door. The cabin has 14 seats. There is plenty of room for more, but few countries allow more than 14 people in a turbine airplane without imposing some extensive and expensive additional requirements, according to Cessna⁷. Firing up the Pratt & Whitney is a simple matter of toggling the battery, fuel boost, and start switches. As the gas generator (Ng) speed passes through 12 percent, the fuel condition lever is moved to Low Idle position. At 52 percent Ng, the starter switch goes to Off. Except for cockpit checks, that's it.

Occasional use of the Beta range to reverse propeller pitch keeps the taxi speed to a manageable clip and helps save the brakes, which are very effective. Mash either pedal, and the Grand Caravan will pivot on a main tire.

Cessna suggests two notches (20 degrees) of flaps for the takeoff roll. Even though with 680 kg (1500 lbs) under maximum takeoff weight, the initial acceleration is slow, but there isn't much runway spent before rotating at 65 kts (120 km/h). Ground roll for a maximum gross weight takeoff in sea level standard conditions (SSL) is 415 m (1365 ft), according to handbook figures.

Levelling with the horizon the airplane cruises and climbs at 110 kts (205 km/h) and between 900 and 1000 fpm (feet per minute)(270 and 305 m/min). In low altitude level cruise at 1900 rpm, the airspeed stays just below 175 kts V_{MO} (Maximum Operating Speed). The ideal setting though is a quieter, more comfortable 1750 rpm at 6000 ft. Those numbers represent a true airspeed of 180 kts on about 190 kg/h of fuel with 235 liters of fuel, according to the handbook. A cargo pod would reduce the cruise speed by about 9 kts.

With 1269 liters of usable fuel, the Grand Caravan will fly for 4.6 hours at maximum cruise power with a 45 min reserve, according to specifications. The most common version is loaded with most of the options on Cessna's list, including Bendix/King KFC 150 autopilot/flight director system and RDS 81 radar, yet it can still take on full fuel and 780 kg of payload. Reducing the fuel load to 50% and the power to best range cruise, the plane can carry 1270 kg of people/cargo and cruise for three hours at 147 KTAS (Knots True Airspeed) on 178 liters of fuel per hour.

About the control surfaces, long, single slotted flaps that incorporate leading edge vortex generators and trailing edge angles (to keep airflow attached and thus maintain the effectiveness of the flaps) enable the Grand Caravan to easily beat the 61 kts stall requirement for single engine aircraft. Long flaps mean short ailerons, so the Grand Caravan has spoilers to augment roll control. Roll forces are light considering the huge wing, and there is almost no adverse yaw.

⁷ The FAA permits a maximum of nine passengers and two crew

If there is no comparison in size between a Grand Caravan and a 182, there is in flying qualities. In fact, the flying characteristics are similar to a smaller Cessna with an advantage of a spacious cockpit. It's remarkable that the Grand Caravan can take on two tons of fuel and payload and still handle like a much smaller airplane.

The Grand Caravan is at home in any environment.

Worth analysing is also the Cessna Caravan's legendary PT6 engine. The Pratt & Whitney Canada Inc. PT6A-114A power plant is a free turbine engine. It utilises two independent turbines; one driving a compressor in the gas generator section, and the second driving a reduction gearing for the propeller.

Inlet air enters the engine through an annular plenum chamber formed by the compressor inlet case where it is directed to the compressor. The compressor consists of three axial stages combined with a single centrifugal stage, assembled as an integral unit.

A row of stator vanes located between each stage of compressor rotor blades diffuses the air, raises its static pressure and directs it to the next stage of compressor rotor blades. The compressed air passes through diffuser ducts which turn it 90° in direction. It is then routed through straightening vanes into the combustion chamber.

The combustion chamber liner located in the gas generator case consists of an annular reverse-flow weldment provided with varying sized perforations which allow entry of compressed air. The flow of air changes direction to enter the combustion chamber liner where it reverses direction and mixes with fuel. The location of the combustion chamber liner eliminates the need for a long shaft between the compressor and the compressor turbine, thus reducing the overall length and weight of the engine.

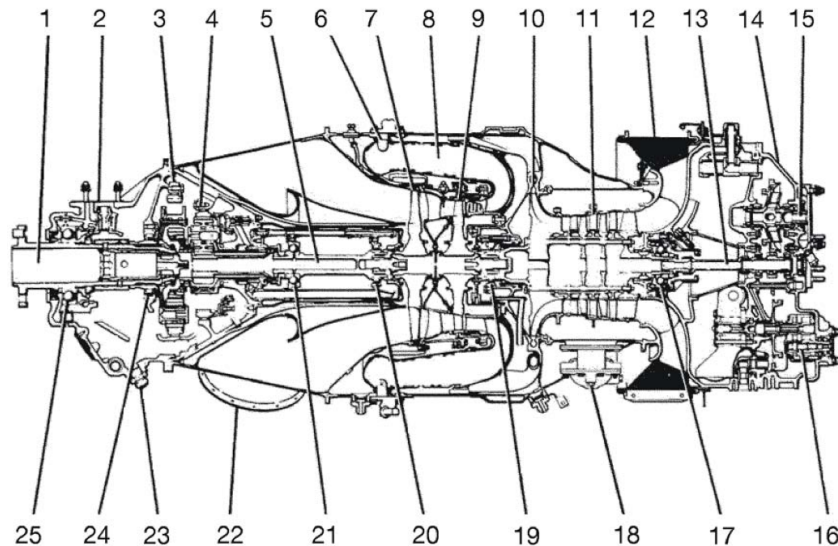
Fuel is injected into the combustion chamber liner by 14 simplex nozzles supplied by a dual manifold. The mixture is initially ignited by two spark igniters which protrude into the combustion chamber liner. The resultant gases expand from the combustion chamber liner, reverse direction and pass through the compressor turbine guide vane to the compressor turbine. The turbine guide vanes ensure that the expanding gases impinge on the turbine blades at the proper angle, with a minimum loss of energy. The still expanding gases pass forward through a second set of stationary guide vanes to drive the power turbine.

The compressor and power turbines are located in the approximate center of the engine with their shafts extending in opposite directions. The exhaust gas from the power turbine is directed through an exhaust plenum to the atmosphere via a single exhaust port on the right side of the engine.

The engine is flat rated at 675 shaft horsepower (1865 foot-pounds torque at 1900 RPM varying linearly to 1970 foot-pounds torque at 1800 RPM). The speed of the gas generator (compressor) turbine (N_g) is 37,500 RPM at 100% N_g . Maximum permissible speed of the gas generator is 38,100 RPM which equals 101.6% N_g . The power turbine speed is 33,000 RPM at a propeller shaft speed of 1900 RPM.

All engine-driven accessories, with the exception of the propeller tachometer-generator and the propeller governors, are mounted on the accessory gearbox located at the rear of the engine. These are driven by the compressor turbine with a coupling shaft which extends the drive through a conical tube in the oil tank centre section. The engine oil supply is contained in an integral tank which forms part of the compressor inlet case. The tank has a drain and fill capacity of 9.5 U.S. quarts and is provided with a dipstick and drain plug.

The power turbine drives the propeller through a two-stage planetary reduction gearbox located on the front of the engine. The gearbox embodies an integral torque-meter device which is instrumented to provide an accurate indication of the engine power output.



- | | |
|--|--|
| 1. Propeller Shaft | 13. Accessory Gearbox Drive Shaft |
| 2. Propeller Governor Drive Pad | 14. Accessory Gearbox Cover |
| 3. Second Stage Planetary Gear | 15. Starter-Generator Drive Shaft |
| 4. First Stage Planetary Gear | 16. Oil Scavenge Pump |
| 5. Power Turbine Shaft | 17. Number 1 Bearing |
| 6. Fuel Nozzle | 18. Compressor Bleed Valve |
| 7. Power Turbine | 19. Number 2 Bearing |
| 8. Combustion Chamber | 20. Number 3 Bearing |
| 9. Compressor Turbine | 21. Number 4 Bearing |
| 10. Centrifugal Compressor Impeller | 22. Exhaust Outlet |
| 11. Axial-Flow Compressor Impellers (3) | 23. Chip Detector |
| 12. Compressor Air Inlet | 24. Roller Bearing |
| | 25. Thrust Bearing |

8

Uncomplicated and enthralling is the way the inertial separator system in the engine functions. It is simple air inlet duct that prevents moisture particles and dust from entering the compressor air inlet plenum when in bypass mode. The inertial separator consists of two movable vanes and a fixed airfoil which, during normal operation, route the inlet air through a gentle turn into the compressor air inlet plenum. When separation of moisture particles is desired, the vanes are positioned so that the inlet air is forced to execute a sharp turn in order to enter the inlet plenum. This sharp turn causes any moisture particles to separate from the inlet air and discharge overboard through the inertial separator outlet in the left side of the cowling.

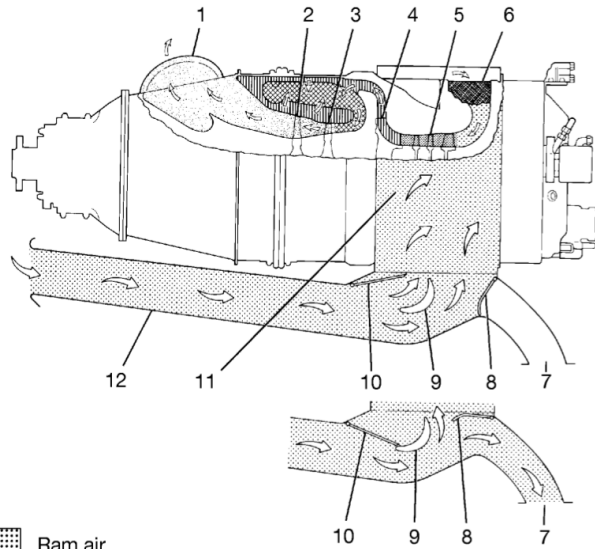
Inertial separator operation is controlled by a T-handle located on the lower instrument panel. The T-handle is labeled BYPASS-PULL, NORMAL-PUSH. The inertial separator control should be moved to the BYPASS position prior to running the engine during ground or flight operation in visible moisture (clouds, rain, snow, ice crystals) with an OAT of 5°C (41°F) or less. It may also be used for ground operations or takeoffs from dusty, sandy field conditions to minimise ingestion of foreign particles into the compressor. The NORMAL position is used for all other operations.






The T-handle locks in the NORMAL position by rotating the handle clockwise 1/4 turn to its vertical position. To unlock, push forward slightly and rotate the handle 90° counterclockwise. The handle can then be pulled into the BYPASS position. Once moved to the BYPASS position, air loads on the movable vanes hold them in this position.

⁸ PT6A-114A power-plant components

ENGINE AIR FLOW

139404



- | | | |
|---|--|-----------------------------------|
|  | Ram air | |
|  | Ram air compressed while flowing through three stages of axial-flow impellers | 1. Primary Exhaust Pipe |
|  | Ram air compressed while flowing through centrifugal impeller | 2. Power Turbine |
|  | Compressed air injected with fuel and ignited | 3. Compressor Turbine |
|  | Burned fuel-air mixture is expanded and drives compressor turbine and power turbine, and is then exhausted | 4. Centrifugal Impeller |
| | | 5. Axial-Flow Impellers (3) |
| | | 6. Engine Air Inlet |
| | | 7. Inertial Separator Outlet |
| | | 8. Inertial Separator Rear Vane |
| | | 9. Inertial Separator Airfoil |
| | | 10. Inertial Separator Front Vane |
| | | 11. Induction Air Inlet Plenum |
| | | 12. Induction Air Inlet Duct |

Mission Aviation Fellowship

Mission Aviation Fellowship (MAF) is a christian organisation that provides aviation, communications, and learning technology services to more than 1000 Christian and humanitarian agencies, as well as thousands of isolated missionaries and indigenous villagers in the world's most remote areas.

MAF serves people who deal with challenges due to isolation in regions such as Africa, Asia, Eurasia, and Latin America by providing: medical assistance, disaster response, community development, training, and evangelism support churches.

In 1943 three World War II pilots began meeting for prayer, Bible study and since airplanes could overcome geographical barriers they started discussion of missionary aviation. In 1946 the dream comes true, MAF is founded, purchases it's first aircraft (a red Waco biplane four-place cabin with a new 220-horsepower Continental engine) and flies the first mission in Mexico.

Although MAF's first flights from Sudan into Ethiopia were in the early 1950s, their service began there in 1981 to support the famine intervention efforts.

The team that helped the organisation get into the air included Jim Truxton, Betty Green, Grady Perret and Charlie Mellis.

Jim Truxton (MAF Service 1945 - 1985) a Navy pilot was a visionary who helped gather together the initial aviators who would then become the founding team. He served initially as president although all the decision making was made by consensus. Grady Perret (MAF Service 1945 - 1982) served as an advanced instructor for Royal Air force pilots during the war. Charlie Mellis (MAF Service 1946 - 1973) was an Air Force B-17 pilot known for his aviation organisation skills. Betty Green (MAF Service 1944 - 1982) was a women's Air Force Service pilot flying a variety of aircraft during the war.

Major role thought, played Hobe Lawrence (MAF Service 1948 - 1986) who had the most flight experience and utilised his background over the years in conducting country wide surveys, developing the flight orientation program for new pilots and supervising other technical efforts. Also, Elias "Hatch" Hatcher (MAF service 1948 - 1971) who was both a pilot and a licensed aviation mechanic created the first Standard Operation Manual to complement Hobe Lawrence's flight program for potential pilots.



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¹⁰ The Cessna Caravan 208 - Gibe dam airport, Ethiopia

Handbook Analysis

Each aircraft comes with documentation and a set of manuals with which a pilot must be familiar in order to fly that aircraft. This includes the airplane flight manuals (AFM), the pilot's operating handbook (POH), and aircraft documents pertaining to ownership, airworthiness, maintenance, and operations with inoperative equipment. Knowledge of these required documents and manuals is essential for a pilot to conduct a safe flight.

An AFM is a document developed by the manufacturer and approved by the FAA. This book contains the information and instructions required to operate an aircraft safely. A pilot must comply with this information which is specific to a particular make and model aircraft, usually by serial number. The Pilot's Operating Handbook as well as the Standard Operating Procedures (SOP) are part of the aircraft's flight manuals.



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¹¹ From left to right: Cessna's POH/SOP 2008 edition cover, POH/SOP 2012 edition cover

Cessna's Pilot's Operating Handbook contains the nine following sections:

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The GENERAL section provides the basic descriptive information on the airframe and power-plant. It also includes 2D drawings of the aircraft that provides dimensions of various components (wingspan, maximum height, overall length, wheelbase length, main landing gear track width, diameter of the rotor system, maximum propeller diameter, propeller ground clearance, minimum turning radius, and wing area). This section serves as a quick reference and helps a pilot become familiar with the aircraft. The last segment of the General section contains definitions, abbreviations, explanations of symbology, and some of the terminology used in the POH as well as metric and other conversion tables.

The LIMITATIONS section contains those limitations that are necessary for the safe operation of the aircraft, power-plant, systems, and equipment. It includes operating limitations, instrument markings, colour-coding, and basic placards. Some of the limitation areas are airspeed, power-plant, weight and loading distribution, flight. Placards that are located in conspicuous places, contain information having a direct bearing on the safe operation of the aircraft are also in display.

The EMERGENCY PROCEDURES section contains checklists that describe the recommended procedures and airspeeds for coping with various types of emergencies or critical situations. The most emphasised emergency procedures are engine failure, fire and system failure. Procedures for inflight engine restarting and ditching are also included. The manufacturer also includes an emergency checklist in an abbreviated form, with the order of items reflecting the sequence of action, followed by amplified checklists that provide additional information on the procedures. Finally, a subsection titled 'Abnormal Procedures' describes recommended procedures for handling malfunctions that are not considered emergencies.

The NORMAL PROCEDURES section begins with a list of the airspeeds for normal operations. The next area consists of several checklists that include preflight inspection, before starting procedures, starting engine, before taxiing, taxiing, before takeoff, climb, cruise, descent, before landing, balked landing, after landing, and post flight procedures. An Amplified Procedures area follows the checklists to provide more detailed information about the various previously mentioned procedures.

The PERFORMANCE section contains all the information required by the aircraft certification regulations and additional performance information important to pilot ability to safely operate the aircraft. Performance charts, tables, and graphs vary in style, but all contain the same basic information. Examples of the performance include a graph or table for converting calibrated airspeed to true airspeed, stall speeds in various configurations and data for determining takeoff and climb performance, cruise performance, and landing performance.

The WEIGHT AND BALANCE/EQUIPMENT LIST section contains all the information required by the FAA to calculate the weight and balance of an aircraft, including sample weight and balance problems.

The AIRPLANE AND SYSTEM DESCRIPTION section describes the aircraft systems in a manner appropriate to the pilot for operating the aircraft.

The HANDLING, SERVICE AND MAINTENANCE section describes the maintenance and inspections recommended by the regulations and manufacturer (airframe, engine, propeller, components etc.). This section also describes preventive maintenance that may be accomplished by certificated pilots, as well as recommended ground handling procedures. It includes considerations for hangaring, tie-down, and general storage procedures for the aircraft.

The SUPPLEMENTS section contains information necessary to safely and efficiently operate the aircraft when equipped with optional systems and equipment (not provided with the standard aircraft). Some of this information may be supplied by the aircraft manufacturer or by the manufacturer of the optional equipment¹². Autopilots, navigation systems, and air-conditioning systems are examples of equipment described in this section.

¹² The appropriate information is inserted into the flight manual at the time the equipment is installed. I.e. Garmin, Honeywell, Bendix Aviation, Aspen Avionics etc.

MAF's Pilot's Operating Handbook contains the fifteen following sections:

00.2 Table of Contents

Section - 00 Introduction.....	1
Section - 0 General Information, Units of Measurement.....	0-1
Section - 1 Limitations and Use of Checklists.....	1-1
Section - 2 Amplified Normal Procedures.....	2-1
Section - 3 Expanded Pre-Flight and Flight Checklist.....	3-1
Section - 4 Abnormal and Emergency Procedures.....	4-1
Section - 5 Expanded Emergency Checklist.....	5-1
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Section - 10 Configuration Deviation List.....	10-1
Section - 11 Minimum Equipment List MEL.....	11-1
Section - 12 Survival and Emergency Equipment.....	12-1
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As seen above, MAF's POH hierarchy is more or less based on Cessna's POH. The main difference is that the 'EMERGENCY PROCEDURES' are split into two more detailed sections, *Abnormal and Emergency Procedures* and *Expanded Emergency Checklist*.

To be more functional and 'easy to find', MAF has each section of the main Table of Contents further divided into subsections, paragraphs and subparagraphs. The abbreviations are listed alphabetically instead of by type, and the NOTES, CAUTION and WARNINGS have been replaced by Can, May, Shall and Must.

Besides the hierarchy most of the changes are done on checklists and procedures. Expanded Pre-Flight, Flight checklists, Emergency Procedure checklists and so on, have flow charts and mnemonics to make them more functional. MAF also has sub-sections through out the POH/SOP containing a review of information that enhances the safe operation of the aircraft. For example bush landing/TO tips, physiological factors, general/severe weather information, fuel conservation procedures, high altitude operations.

Subsequently analysing the differences from the contents of Amplified Normal Procedures/Expanded Pre-Flight and Flight Checklists (Normal Procedures), Abnormal and Emergency Procedures/Expanded Emergency Checklist (Emergency Procedures) and Weight and Balance, we created various tables with which we studied the logic behind MAF's derived adaptations.

Furthermore they were included as part of the interview we had with the pilots.

Taking each section separately, the considerable differences from the Amplified Normal Procedures/Expanded Pre-Flight and Flight Checklists (Normal Procedures) were:

- Cabin and Before Starting Engine
- Before Start (Before Starting Engine)
- Engine Start (Starting Engine)
- After Start and Before Takeoff
- Runway Items and Before Starting Engine
- Runway Items and Normal Takeoff
- After Take (Takeoff)
- Climb (En route Climb)
- Cruise
- Descent
- Pre-Landing (Before Landing)
- Finals (Landing)
- Emergency Descent (Rough, Smooth Air)

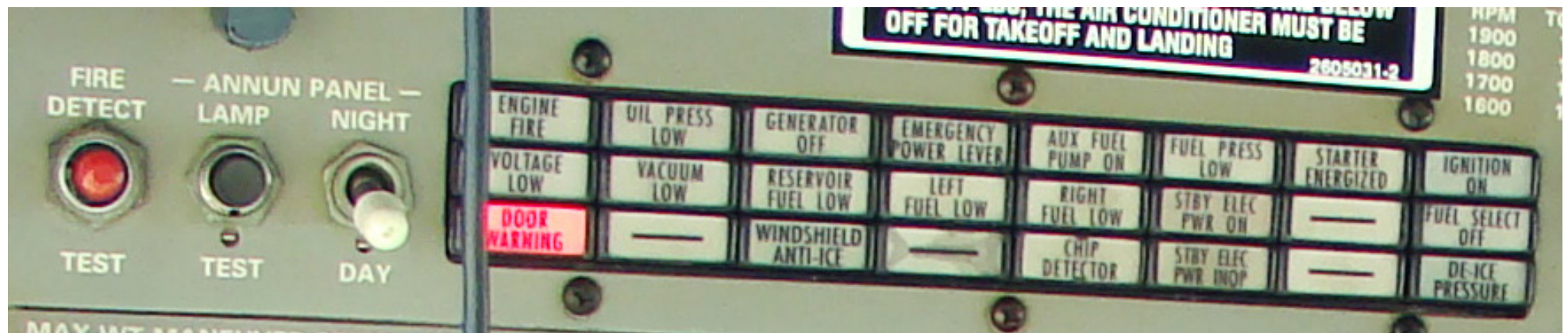
From the Emergency Procedures/Expanded Emergency Checklist (Emergency Procedures):

- Engine Failure After Takeoff below 300 ft (Engine Failure Immediately After Takeoff)
- Engine Fire Warning Light (Smoke and Fire In Flight - Red Engine Fire CAS message)
- Forced Landing Without Power (Emergency Landing without Engine Power)

And finally the Weight and Balance records followed by the interviews we had with the pilots.

Amplified Normal Procedures/Expanded Pre-Flight and Flight Checklists - Normal Procedures

§	MAF			§	Cessna		
3-2	3.1.2.	Cabin		4-18		BEFORE STARTING ENGINE	
	38.	Fire Detect System	Test		24.	TEST SWITCH	PUSH UP (for FIRE DETECT warning)
							PUSH DOWN (for FUEL SELECTOR warning)
<p>The test is performed by pushing a red button until an alarm sounds through the cockpit's sound system and a red light appear on the annunciator panel.</p> <p>According to Cessna the check is performed on the 'before starting engine' checklist as part of checks that need to be done before starting the engine. Adverse, MAF performs the check on the 'cabin' checklist as passengers have not yet boarded the plane during the check, being the alarm sound sometimes can cause distress to the passengers.</p>							



§	MAF			§	Cessna		
3-6	3.2.2.	Before Start		4-17		BEFORE STARTING ENGINE	
	1.	Pre-flight / Door Checklist	Complete		2.	All Key Locking Cabin Doors	UNLOCKED
	6.	Pilot Seat/Seat Belt	Pins checked, secure		22.	WING FLAPS HANDLE	UP
<p>The before starting engine checklist is performed inside the aircraft after all external checks have been completed. All key locking cabin doors can only be checked from the outside of the aircraft. Therefore MAF created a placard placed on the pilot's left hand door which contains all the external checks needed to be complete before entering the aircraft.</p> <p>Wing flaps handle up position is not mentioned on MAF's POH as there have been cases where pilots did not apply 20° of flaps during takeoff and were not able to rotate the aircraft. The flaps would sometimes be forgotten on the up position from Cessna's 'after landing' checklist.</p> <p>MAF also created pins that latch under both pilot's and copilot's seat and secure it from sliding aft and forth in case of improperly locking the seat's position. Cessna is using the following warning:</p> <p style="text-align: center;">WARNING</p> <p>Failure to correctly use seat belts and shoulder harnesses could result in serious or fatal injury in the event of an accident</p>							

Door Checklist

1st Flight	After Refuel	Each Flight	Last Flight
1 - 9.	3 - 9.	5 - 9.	
1.	Locks, Covers	Unlocked/Removed	Install
2.	Oil Filler Cap	Installed & secure	Check level
3.	Fuel Caps	Secure	Fuel Filter
4.	Fuel Drains	Checked	FCU Drain
5.	Control Locks	Removed	Install
6.	Propeller	Inspected	Tied
7.	Chocks	Removed	Install
8.	Doors & Pod Doors	Closed & Latched	Locked
9.	TAILSTAND	Stowed	Install

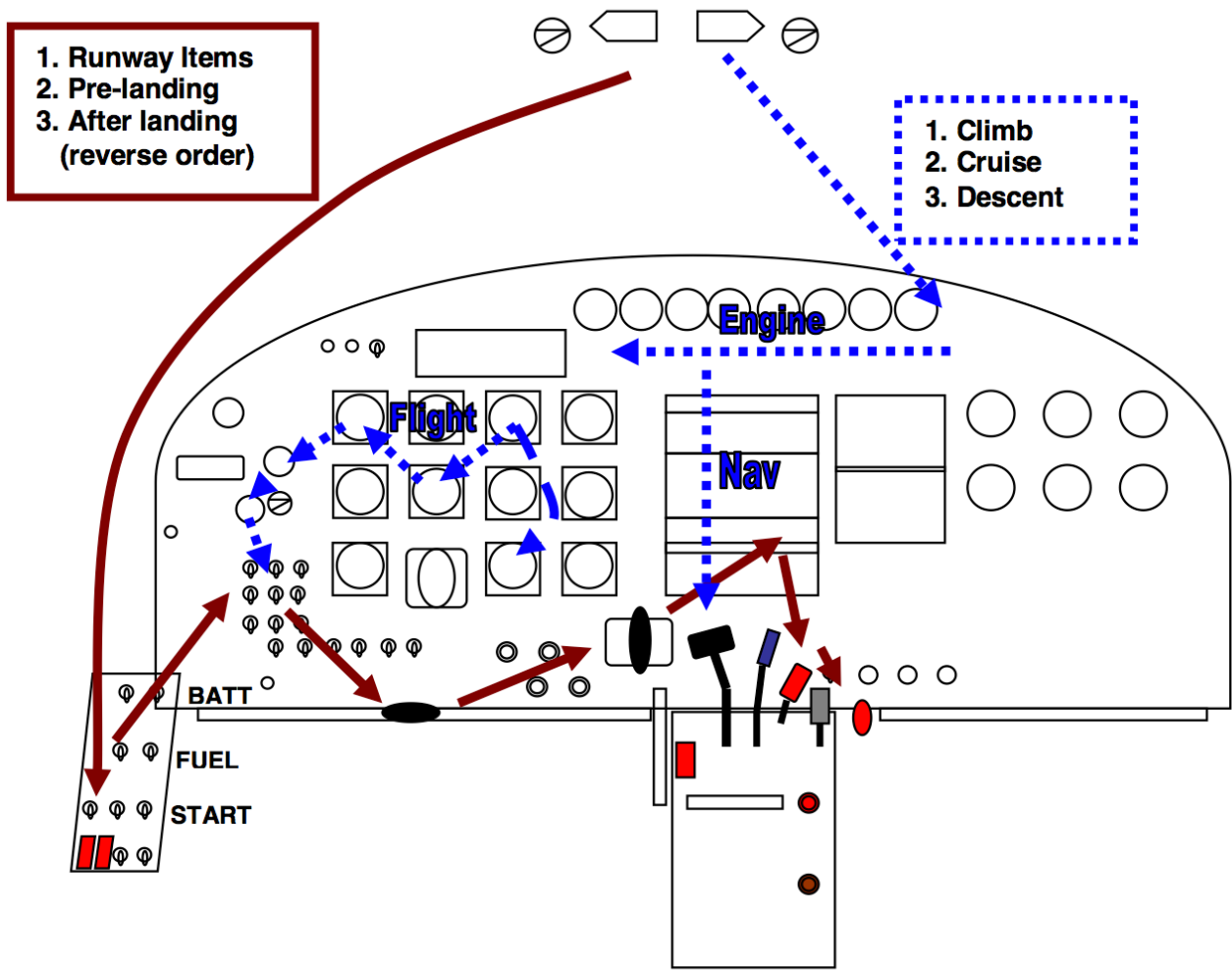
§	MAF		§	Cessna	
3-7	3.2.3	Engine Start (aircraft battery)	4-18	STARTING ENGINE (Battery Start)	
	1.	Fuel Selectors		1.	BATTERY Switch ON
	2.	Circuit Breakers		2.	BCN Switch ON
	3.	Ignition		3.	AVIONICS No. 1 Switch ON
	4.	Lights & Electrics		4.	EIS CHECK PARAMETERS (verify no red X's)
	5.	Battery Switch		5.	BUS VOLTS CHECK (24 volts minimum)
	6.	Volts		6.	EMERGENCY POWER Lever NORMAL (full aft position) (verify EMERG PWR LVR CAS MSG - OFF)
	7.	Beacon		7.	Propeller Area CLEAR
	8.	Parking Brake		8.	FUEL BOOST Switch ON a. FUEL BOOST ON CAS MSG ON b. FUEL PRESS LOW CAS MSG OFF c. FLOW PPH ZERO
	9.	Inertial Separator		9.	STARTER Switch ON a. IGNITION ON CAS MSG CHECK b. OIL PSI STABLE (12% minimum) c. Ng
	10.	Emergency Power Lever		10.	FUEL CONDITION Lever LOW IDLE a. FLOW PPH CHECK (for 90 to 140 pph) b. ITT MONITOR (1090°C maximum, limited to 2 sec) c. Ng 52% MINIMUM
	11.	Power Lever		11.	STARTER Switch OFF (verify STARTER ON CAS MSG OFF)
	12.	Prop Lever		12.	EIS CHECK NORMAL
	13.	Fuel Condition Lever		13.	GENERATOR CHECK LOAD (verify GENERATOR OFF CAS MSG OFF and BAT AMPS charging)
	14.	Bleed Air / Cabin Heat		14.	FUEL BOOST Switch NORM (verify FUEL BOOST ON CAS MSG - OFF)
	15.	Fuel Quantity		15.	AVIONICS No.2 Switch ON
	16.	Fuel Boost Switch		16.	NAV LIGHTS ON
	17.	Propeller Area/ Brakes		17.	Cabin Heating, Ventilating and Defrosting Controls AS DESIRED

One of the most effective practices MAF uses is the integrated checklist procedures into single crew operations is the cockpit flow pattern. Using this method, the required tasks are performed by the pilot following the flow pattern and then the expanded checklist is used to verify that all checks have been correctly completed. This checklist procedure shall be accomplished for every phase of flight.

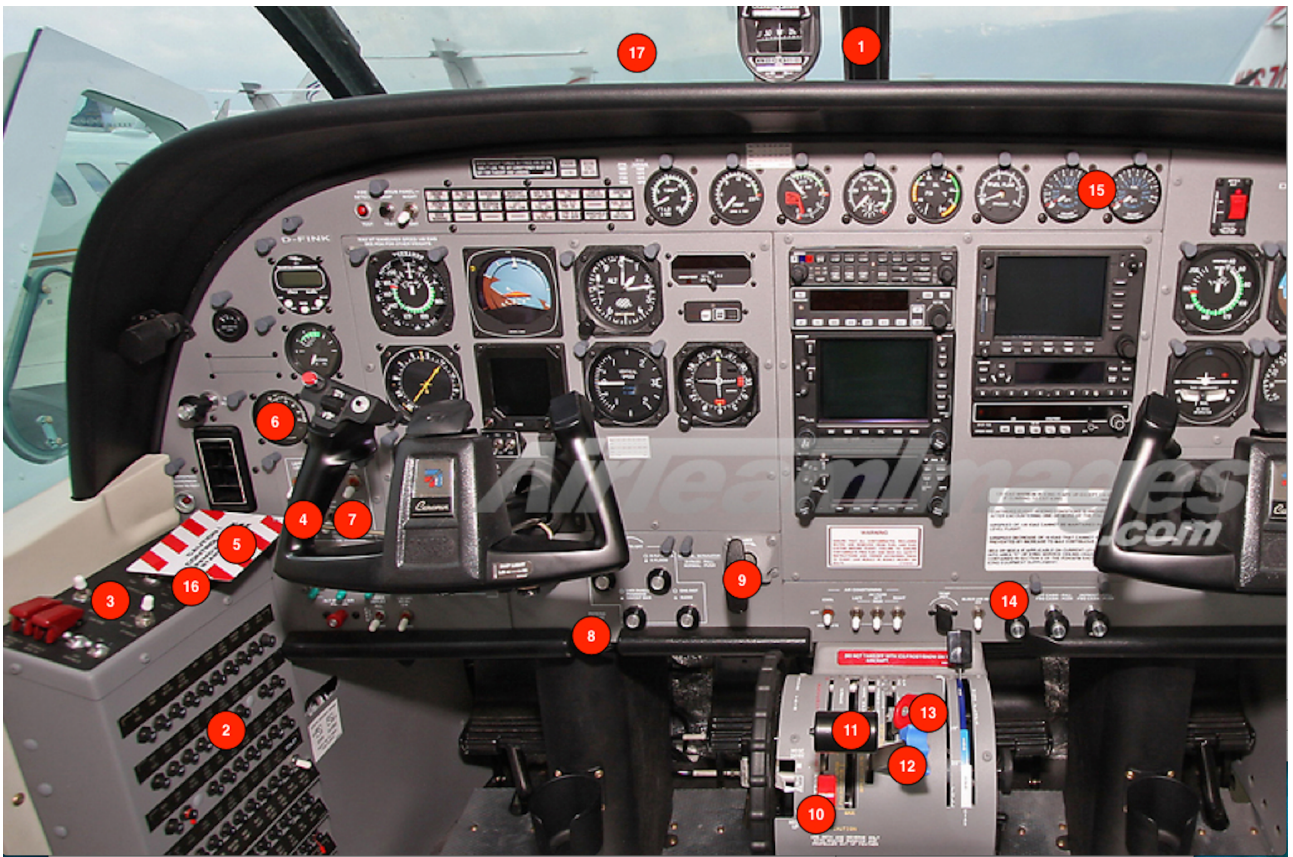
Once pilots become very familiar with this checklist procedure, the abbreviated checklist can then be utilised as a means of cross checking the cockpit flow pattern. Apart from the two general flows the Ceiling console (from back to front), Circuit breaker panel (bottom up), Electric side console (from back to front), Power Quadrant and Bleed Air Heat (left to right) are checked.

Consistent use of the flow patterns should ensure that all items are correctly actioned. Missed items should then be picked up by correct use of the expanded or abbreviated checklist.

The C208 In Flight Checklist is standardised into two general flow patterns as indicated below:



As an example we will be comparing the differences between MAF's and Cessna's engine start checklists from the table above. It does not take much to envision the functionality of the flow chart as on the task reproduction seen below:



§	MAF		§	Cessna
3-7	3.2.3.	<p align="center">Engine Start (aircraft battery)</p>	4-19	<p align="center">STARING ENGINE (Battery Start)</p>
	<p align="center">NOTE: Hand Position during engine start</p>	<p>a. Left Hand resting on the Switch Console, middle finger resting on the Fuel Boost Switch.</p> <p>b. Thumb and index finger pinching the Starter Switch. Malfunctions during the first stage of the engine start, the No Fuel stage, move Fuel Boost Switch and Starter Switch into OFF position at once.</p> <p>c. Right Hand resting on the Fuel Condition Lever</p> <p>d. Eyes should be directed toward the engine instruments, especially the ITT gauge, to monitor start progress.</p> <p>Abort the start during the second stage of the engine start, the Fuel On stage, by pulling both hands back, middle finger turns Fuel Boost Switch off, index finger and thumb move Starter Switch to off and then to motor right hand pulls Fuel Condition Lever to CUT-OFF</p>		<p align="center">CAUTION</p> <p>* if ITT climbs rapidly towards 1090°C, be prepared to return the FUEL CONDITION Lever to CUTOFF.</p> <p>*Under hot OAT and/or high ground elevation conditions, idle ITT can exceed maximum idle ITT limitation of 685°C. Increase Ng and/or reduce accessory load to maintain ITT within limits.</p>
<p>This mnemonic is made to avoid damaging the power plant. Aborting a startup by naturally turning the starter switch to motor, the igniters will shut off and outside air will enter the engine through the intake ducts and cool it down.</p> <p>MAF also mentions Warm Engine Start. If the engine is warm, the starter is engaged with fuel CUT-OFF (instead of low idle) and as the engine starts to spin the ITT drops below 150°C. As soon as it drops drops below the 150°C limit the Fuel Condition Lever is set to Low Idle and the rest flows as intended. In Cessna's POH other than the CAUTION message, warm engine start is not mentioned.</p> <p>The task reproduction is as seen on page 25.</p>				



§		MAF		§		Cessna	
3-8	3.2.4	After Start		4-22		BEFORE TAKEOFF	*Cessna's 'after start' checklist is integrated in the 'before takeoff' checklist
	1.	Inertial Separator	BYPASS		5.	Altimeters: a. PFD 1 and 2 BARO b. Standby Altimeter	SET SET
	9.	G - GPS	Select Route		6.	ALT SEL	SET
	10.	N - Nav aids	VOR/DME/ADF/Marker Beacon Select/Identify/Display available NAV Aids		20.	INERTIAL SEPERATOR	SET
	11.	R- Radars	Rad Alt - Test set 200ft/Transponder - Test Storm Scope/Weather Radar - Test		21.	Avionics and Radar	SET FOR DEPARTURE
	12.	G - Gyros	Erect/Aligned/Slaved		22.	Nav Source	SET FOR DEPARTURE
	13.	A - Autopilots	Autopilot Test Procedure		20.	INERTIAL SEPERATOR	SET
	14.	S - Set Up	Track/Altitudes/GPS - Nav Switch Radios/VHF/HF				
<p>Cessna's after start checklist is integrated in the before start checklist. MAF uses a separate after start checklist to minimise the workload during holding short off a runway. The GNARGAS mnemonic provides a flow of the procedures contrary to Cessna.</p>							

§	MAF			§	Cessna		
3-10	3.2.9	Runway Items		4-17		BEFORE STARTING ENGINE	
	3.	Ignition	ON, check annunciator		10.	IGNITION Switch	NORM
3-12	3.3.6	Pre-landing					
	3.	Ignition	ON, check annunciator				
<p>In the NORM (normal) position, igniters light only when the starter is engaged. To prevent the engine from shutting down in case of a flameout, MAF keeps the igniters ON during take off and landing. On the other hand Cessna suggests the NORM position through out the whole flight as igniters are expensive and wear extensively when in the ON position.</p>							

§	MAF			§	Cessna		
3-10	3.2.9	Runway Items		4-25		NORMAL TAKEOFF	
	10.	Flaps	Set for Take Off, Check indicator, and visually		1.	WING FLAPS Handle	20°
<p>Cessna does not approve flap settings greater than 20° for takeoff, as the drag increases severely. Although not recommended, MAF gives the option to pilots to fully retract the flaps during rotate in STOL circumstances.</p>							

§	MAF			§	Cessna		
3-10	3.3.1.	After take		4-25		TAKEOFF	
	4.	Power Lever	Set 1500ft.lbs until maximum ITT 720°		2.	POWER Lever	SET FOR TAKEOFF (observe Takeoff ITT and Ng limits)

§	MAF			§	Cessna		
3-11	3.3.2.	Climb		4-26		ENROUTE CLIMB	
	3.	Engine Instruments	Normal, within limits TQ set 1500ft.lbs until ITT 720°C		4.	PROP RPM Lever	1600-1900 RPM
	8.	Passengers	Monitor comfort		6.	POWER Lever	SET (observe Maximum Climb ITT and Ng limits)
							Refer to Maximum Engine Torque for Climb chart in Section 5. NOTE Engine operations which exceed 740°C ITT can reduce engine life. CAUTION For every 10° below -30°C ambient temperature, reduce maximum allowable Ng by 2.2%

§	MAF			§	Cessna		
3-11	3.3.2	Cruise		4-28		CRUISE	
	2.	Engine Instruments	Normal, within limits TQ 1200ft.lbs ITT 700°C max Consult POH for flights above FL125		3.	PROP RPM Lever	1600 to 1900 RPM
	7.	Passengers	Monitor comfort		4.	POWER Lever	SET (observe Maximum Climb ITT and Ng limits)

§	MAF			§	Cessna		
3-11	3.3.5.	Descent		4-29		DESCENT	
	3.	Engine Instruments	Normal, within limits TQ 1000ft.lbs ITT 700°C max		6.	POWER Lever	AS REQUIRED
	8.	Passengers / Cabin	Briefed / Secure				CAUTION Set PROP RPM Lever at 1900 RPM prior to beginning any instrument approach procedure

§	MAF			§	Cessna		
3-12	3.3.6.	Pre-landing		4-29		BEFORE LANDING	
	1.	Landing Briefing	Wind - LASSO		4.	PROP RPM Lever	MAX (full forward)
	3.	Ignition	ON, check annunciator on				
	7.	Abort Procedure	Select - Abort point				

§	MAF			§	Cessna		
3-12	3.3.7.	Finals		4-29		LANDING	
	1.	Propeller	MAX RPM		4.	POWER Lever	BETA RANGE AFTER TOUCHDOWN

Taking full advantage of an aircraft's capabilities is a general philosophy in the aviation industry. Working in harsh conditions though, reliability and durability play a major role. Keeping the above in mind and with a limited budget, MAF kept the low limits of the manufacture as their high limits¹³.

Illustrative during a climb, Cessna suggests pilots to observe their Internal Turbine Temperature (ITT) stay below 740°C and keep the RPM between 1600-1900. Although engine operations which exceed 740°C ITT can reduce engine life, the engine's high temperature limit is 800°C for a limited period of time.

Supplementary MAF supersedes Cessna's limits and advises pilots to keep a maximum of 720°C ITT and a torque of 1500 ft.lbs (Cessna's limit is 1865 ft.lbs). The RPM are not mentioned as they are proportional to torque and at the same time a more accurate reading for the engine's performance/life.

Worth noticing is MAF's landing briefing, Wind - LASSO (Length, Altitude, Slope, Surface, Obstructions). For every landing, a pilot needs to know the elements that comprise LASSO as well as wind speed and wind direction. For most of MAF's airstrips this information is available to pilots in the form of a flight chart, composed by other pilots who have landed there previously. However when approaching a new or unknown strip, the pilot must be able to gather this information to make a safe landing. This is typically done by a first relatively high altitude pass, followed by two more passes, each lower than the one before. Each pass gives the opportunity to pilots to determine the length of the landing strip, the altitude they would be approaching the strip, what is the surface composed of, if there is a slope, the wind direction by observing moving trees, grass, hovering birds, etc. and possible obstacles in the way (rocks, logs, animals, humans etc).



¹³ Note Cessna's Caution on descent for setting propeller RPM Lever at 1900 RPM prior to beginning any instrument approach procedure while MAF keeps the TQ at 1000 ft.lbs

Abnormal and Emergency Procedures/Expanded Emergency Checklist - Emergency Procedures

§	MAF		§	Cessna		
5-2	5.1.9	Engine Failure After Take-off (below 300 ft)	3-8		ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF	
	1.	Airspeed	85 knots	1.	Airspeed	85 KIAS
	2.	Power Lever	IDLE	2.	PROP RPM Lever	FEATHER
	3.	Flaps	As required	3.	WING FLAPS Handle	AS REQUIRED (20° recommended)
	4.	Prop Lever	As required	4.	FUEL CONDITION Lever	CUTOFF
	5.	Shutdown	Go to checklist 10	5.	FUEL SHUTOFF Knob	PULL OFF
	5.1.10	Shutdown		6.	FUEL TANK SELECTORS	OFF (warning horn will sound)
	1.	Fuel Condition	Lever CUT-OFF	7.	BATTERY Switch	OFF
	2.	Fuel Shutoff	Pull OFF			
	3.	Fuel Selectors	Both OFF			
	4.	Batter Switch	OFF			
<p>A takeoff is the most critical time to suffer an engine failure. The airplane is slow, close to the ground. Altitude and time will be minimal. Until feathered, the propeller of the failed engine will be windmilling, producing a drag and yawing tendency. Airplane climb performance is marginal or even non-existent, and obstructions may lie ahead.</p> <p>The engine failure after takeoff emergency procedures are almost identical. Noteworthy is that MAF does not require the propeller to be feathered at a height as low as 300 ft above ground level (AGL), in the sense that their isn't much gain of distance comparing to the time that might be spent feathering the propeller were another task could take its place.</p>						

§	MAF		§	Cessna	
5-8	5.1.18.	Engine Fire Warning Light	3-14		SMOKE AND FIRE ENGINE FIRE IN FLIGHT (Red ENGINE FIRE CAS MSG)
	1.	Cabin Heat Firewall Shutoff		1.	POWER Lever IDLE
	2.	Fire Detect CB		2.	PROP RPM Lever FEATHER
	3.	Verify Engine Fire in Flight		3.	FUEL CONDITION Lever CUTOFF
	4.	Power Lever		4.	FUEL SHUTOFF Knob PULL OFF
	5.	Prop Lever		5.	CABIN HEAT FIREWALL SHUTOFF CONTROL PULL OFF
	6.	Fuel Condition Lever		6.	Forward Side Vents CLOSE
	7.	Fuel Shutoff		7.	Overhead Vents OPEN
	8.	Forward side		8.	VENT AIR FANS ON
	9.	Vent Fans		9.	WING FLAPS Handle 20° - FULL
	10.	If fire out proceed with forced landing		10.	Airspeed 80 - 85 KIAS
	11.	If fire persists, emergency descent		11.	Forced Landing EXECUTE (as described in Emergency Landing Without Power)

1

1 mere reference: Checklist 5.1.21/22 on page 38 compared to Cessna's corresponding checklist

The engine fire warning procedure for some is consider the foundation of the making of MAF's supplement for the Cessna Caravan's POH/SOP. The lack of MAF's 3rd procedure in Cessna's checklist can be the cause of shutting down a perfectly working engine, ditching a plane and result in disaster. It all has to do with how the linear heat detection (LHD) system works.

The LHD is a line type form of fixed temperature heat detection that can detect fire or a heat condition anywhere along its entire length of cable. This proprietary cable has a range of temperature ratings in order to accommodate varying types of conditions or environments (intake, compressor, combustion chamber, turbine, exhaust, etc.)

The outer jacket of the cable is specifically chosen for the environment and conditions where it will be installed. The polymer or mylar sheathing breaks down or becomes soft at specific temperatures allowing the inner conductors to contact each other or short, which causes an alarm. In other words, flexible electric closed loops, which experience a resistance decrease as temperature increases until reaching threshold levels defined by the manufacturer. Lastly, the wire is typically comprised of a combination of metals (steel, copper, tin, etc.) which gives the wire extremely low resistance. Although the wire is twisted in order to give it strength and to provide shielding from electromagnetic and radio frequency interference, it does not make it vibration proof.

The number one cause of false engine fires on the C208 is due to vibrations created by the propeller, affect the LHD attached across the length of the engines housing, resulting to a false reading. Noteworthy also are MAF's head procedures. By shutting off the cabin heat firewall, any air or smoke (in case of real fire) coming from the engine is blocked and by pulling off the fire detection circuit breaker to stop the fire alarm, panic is decreased. The result, the following more critical tasks can be done in a calmer environment.



§	MAF			
5-5	5.1.14	Forced Landing without Power		
	A.	Airspeed	TRIM:	4112 kg 95 kts 3400 kg 87 kts 2835 kg 79 kts
	B.	Best Landing Site	Select best, Wind/LASSO Plan Descent, Hi / Low Key	
	C.	Cause	Air Start No Start Power Lever Prop Lever Fuel Condition Lever Fuel Shutoff Fuel Selectors Ignition Standby Elect' Power Fuel Boost	Go to checklist 5.1.11 Shut Down IDLE FEATHER CUT-OFF Pull OFF Both OFF NORMAL OFF OFF
	D.	Distress Call	Position (GPS), Heading / Altitude Problems, Intentions ELT ON / 7700	
	E.	Emergency Brief	Inside: Seat Belts, Exits & Survival kit. Secure heavy objects Outside: Landing area location	
	F.	Flaps	Crew Doors Flaps Battery	Latch open As required OFF after flaps
	G.	Get out	Evacuate with survival kit & fire extinguisher	

§	Cessna		
3-13	EMERGENCY LANDING WITHOUT ENGINE POWER		
	1.	Seats, Seat Belts, Shoulder Harnesses	SECURE
	2.	Airspeed	100 KIAS (flaps UP) 80 KIAS (flaps FULL)
	3.	POWER Lever	IDLE
	4.	PROP RPM Lever	FEATHER
	5.	FUEL CONDITION Lever	CUTOFF
	6.	FUEL BOOST Switch	OFF
	7.	IGNITION SWITCH	NORM
	8.	STBY ALT PWR Switch	OFF
	9.	Nonessentials Equipment	OFF
	10.	FUEL SHUTOFF Knob	PULL OFF
	11.	FUEL TANK SELECTORS	OFF
	12.	WING FLAPS Handle	AS REQUIRED (FULL recommended)
	13.	Crew Doors	UNLATCH PRIOR TO TOUCHDOWN
	14.	GENERATOR Switch	TRIP
	15.	BATTERY Switch	OFF
	16.	Touchdown	SLIGHTLY TAIL LOW
	17.	Brakes	APPLY HEAVILY

As mentioned before, according to MAF in the event of an urgent or emergency situation the pilot should refer to the A-B-C-D-E-F-G mnemonic. Cessna does not practice any mnemonics in the event of an emergency but only apply the checklist. In nearly all situations this mnemonic can assist the pilot in providing the framework for guiding the decision making process. In the case of most power plant annunciator panel indications e.g. fuel, oil pressure, chip detector etc the pilot should work through the mnemonic methodically as time permits. As an example the following scenario will highlight how the mnemonic should be used in a potential emergency of fuel low reservoir light ON:

A - Airspeed. In most cases the pilot should reduce power and thus fuel flow and trim the aircraft for a low powered best endurance airspeed of 90-100 kts / ~800ft.lb.

B – Best Field. Straight away the pilot should be considering that the engine could fail at any point and therefore priority should be given to selecting a best field and planning the descent to the High and Low key points and circling over the initial chosen landing area.

C – Cause. Once established overhead the selected landing area, attention can now be given to ascertaining the cause of the particular malfunction and monitoring the system for any further signs of serious deterioration. Compared to a piston engine, fewer options are available to the pilot to remedy the situation once the Fuel-ON; Boost-ON; Ignition-ON; (F-B-I) checks have been carried out.

D – Distress Call. The distress call should initially prompt the pilot to make contact with Flight Following or an appropriate ground station. The aircraft's position, nature of distress and the pilot's intentions should be transmitted. The pilot should call on his CRM skills and "ask" for assistance and shed some of the possible decision making load where applicable to maintenance or operations personnel.

E – Emergency Brief. The emergency brief should initially be used to inform the passengers of the situation and what may occur. They should be instructed to prepare for a possible forced landing and should be suitably kept up to date with proceedings as the situation develops or changes. If a forced landing eventuates the emergency briefing needs to be carried out in a strong, calm and positive fashion. To enhance passenger recollection, the pilot should repeat the emergency section of the initial pre-flight passenger briefing.

F – Flaps/Fuel. Flaps as required to make the landing area in the situation of a forced landing. Fuel Off (Engine Shutdown) if for some reason this has not been carried out already.

G – Get Out.

MAF recommends repeating the A-B-C-D-E-F-G mnemonic to see if any further updates should be made. Example, Better landing area available (B), any further trend in aircraft or engine performance (C), update aircraft position, any new information to pass on to Flight Following (D), update passengers of emergency planning or any developments (E). If after monitoring the aircraft it shows some stability with its performance, then the pilot could consider looking for a more suitable landing area, or even considering foot printing¹⁴ to a close by airstrip.

¹⁴ "Foot Printing" is the term used to describe a flight procedure where the pilot endeavours to fly to an airfield or suitable landing area by navigating in the best possible manner

Mere reference: Checklist 5.1.21/22 reported in page 34 compared to Cessna's corresponding checklist

§	MAF		
5-5	5.1.21	Emergency Descent (Rough Air)	
	1.	Seat Belts	Secure
	2.	Power Lever	IDLE
	3.	Prop Lever	MAX RPM
	4.	Flaps	UP
	5.	Airspeed	Not exceeding Va 4112kg 143 kts 3400 kg 137 kts 2835 kg 125 kts
	6.	Forced Landing	Go to checklist 5.1.14
5-5	5.1.22	Emergency Descent (Smooth Air)	
	1.	Seat Belts	Secure
	2.	Power Lever	IDLE
	3.	Prop Lever	MAX RPM
	4.	Flaps	10°
	5.	Airspeed	Max 175 kts
	6.	Forced Landing	Go to checklist 5.1.14

§	Cessna	
4-6		EMERGENCY LANDING WITHOUT ENGINE POWER
	1.	Seats, Seat Belts, Shoulder Harnesses
	2.	Airspeed
	3.	POWER Lever
	4.	PROP RPM Lever
	5.	FUEL CONDITION Lever
	6.	FUEL BOOST Switch
	7.	IGNITION SWITCH
	8.	STBY ALT PWR Switch

Weight and Balance

Weight and Balance is the procedure of achieving a weight and moment of the airplane within certain limits. Usually sample forms are provided for reference as well as procedures for calculating the weight and moment for various operations.

In order to achieve the performance and flight characteristics which are designed into the airplane, it must be flown within approved weight and centre of gravity limits. Although the airplane offers flexibility of loading, it cannot be flown with full fuel tanks and a full complement of passengers or a normal crew and both cabin and cargo pod loading zones filled to maximum capacity. The pilot must utilise the loading flexibility to ensure the airplane does not exceed its maximum weight limits and is loaded within the centre of gravity range before takeoff.

Weight is important because it is a basis for many flight and structural characteristics. As weight increases, takeoff speed must be greater since stall speeds are increased, the rate of acceleration decreases, and the required takeoff distance increases. Weight in excess of the maximum takeoff weight may be a contributing factor to an accident, especially when coupled with other factors such as temperature, field elevation, and runway conditions, all of which may adversely affect the airplane's performance. Climb, cruise, and landing performance will also be affected. Flights at excess weight are possible, and may be within the performance capability of the airplane, but loads for which the airplane was not designed may be imposed on the structure, especially during landing.

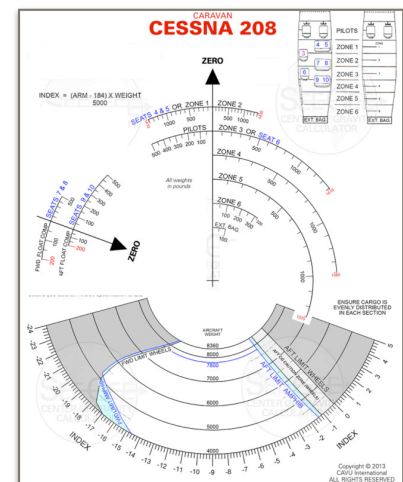
The pilot should routinely determine the balance of the airplane since it is possible to be within the maximum weight limit and still exceed the centre of gravity limits. An airplane loading which exceeds the forward centre of gravity limit may place heavy loads on the nose wheel, and the airplane will be slightly more difficult to rotate for takeoff or flare for landing. If the centre of gravity is too far aft, the airplane may rotate prematurely on takeoff, depending on trim settings.

A properly loaded airplane, however, will perform as intended. Before the airplane is licensed, a basic empty weight (BEW), centre of gravity (C.G.) and moment are computed. Specific information regarding the weight, arm, moment, and installed equipment for this airplane as delivered from the factory can be found in the plastic envelope in the back of this POH/AFM. Using the basic empty weight and moment, the pilot can determine the weight and moment for the loaded airplane by computing the total weight and moment and then determining whether they are within the approved Centre of Gravity Moment Envelope.

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Cessna's latest weight and balance record demands a military type load adjuster¹⁵. The load adjuster is a balance computer similar in form to the conventional circular slide rule. It consists of a base, a slide and a transparent, movable indicator. A load adjuster should only be used for the aircraft that has been intended to. Whenever the aircraft adds or removes equipment the load adjuster must be revised.

The process begins with the basic operating weight and index. The load adjuster is placed over the weight and balance chart with index always placed under the cursor or hairline. Then the cursor is moved either clock or counter clock wise to determine the weight and index units for each



¹⁵ Typical load adjuster

load item added to the basic operating weight. As each load item is considered, the cursor is moved until all items are loaded, including fuel. After the final movement of the cursor, the total weight index will appear under the cursor hairline.

The load adjuster also has a c.g. grid which permits quick conversion of the answer from total weight index to c.g. in % MAC. Inasmuch as the load adjuster is designed for one model airplane, the fore and aft limits are indicated on special scales. After determining total weight index, the location of the c.g. relative to its limits can easily be seen. A diagram of the aircraft's fuselage is normally included on the load adjuster. This diagram is used to help identify various compartment locations.

CESSNA 208B WEIGHT AND BALANCE RECORD				DEP. DATE 2		ORIGIN		AIRCRAFT NO.																						
				FLIGHT NO.		DESTINATION																								
ITEM		MAX. LOAD	ITEM WEIGHT	ITEM INDEX	WEIGHT INDICES																									
ZONE					25	50	75	100	150	200	250	300	350	400	500	600	700	800	900	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000
C A B I N C A R G O	1	1780																												
	2	3100																												
	3	1900																												
	4	1380																												
	5	1270																												
	6	320																												
TOTAL		3400																												
P O D	A	230																												
	B	310																												
	C	270																												
	D	280																												
PILOT & FLT KIT		+																												
OBSERVER		+																												
TKS FLUID		+																												
TOTAL PAYLOAD		-																												
A/C EMPTY WT.		+																												
ZERO FUEL WEIGHT		-																												
T.O. FUEL		+																												
T.O. WEIGHT		-																												
MAX ALLOWABLE T.O. WEIGHT		-																												
TAXI FUEL		-																												
RAMP WEIGHT		-																												

FUEL INDICES							
WT.	INDEX	WT.	INDEX	WT.	INDEX	WT.	INDEX
50	1	500	11	950	21	1400	32
100	2	550	12	1000	23	1450	33
150	3	600	13	1050	24	1500	34
200	4	650	14	1100	25	1550	35
250	5	700	16	1150	26	1600	36
300	7	750	17	1200	27	1650	37
350	8	800	18	1250	28	1700	38
400	9	850	19	1300	29	1750	39
450	10	900	20	1350	31	1800	40

NOTES:

ENTER ONLY LAST THREE DIGITS OF THE TOTAL IN ITEM INDEX COLUMNS

C.O.% MAC

C.O.% MAC

EMPLOYEE NO.

EE-61142

ALL FAA AND COMPANY LOADING LIMITATIONS AND WEIGHT AND BALANCE REQUIREMENTS SATISFIED IN ACCORDANCE WITH FAR 135.615C AND 135.615D.

Interviews

Subject A

A) Why do you think that MAF got in the process of making such changes on the manufacturers POH/SOP?

Changes were made to adhere the recommendations of the manufacturer and CAA, probably better than any other operator. It's specially made for bush pilots and bush flying operations.

B) In which cases would you use the MAF POH/SOP and in which the manufacturers POH/SOP?

I would use MAF's POH/SOP for ease of procedures/operations.

I would use Cessna's POH/SOP for liability issues. Nowadays it's very common to see operators trying to (copy MAF) adjust/modify the manufacturers POH/SOP to fit their needs. In most cases ending in disaster! This is why the CAA has been very strict and is forcing all operators to use only the manufacturers POH/SOP. E.x. if we had an accident we would not have a solid leg to stand on. MAF changed the cockpit check order to make them flow but rarely do we miss anything out.

After all the MAF POH/SOP was intended only for bush pilots and besides, Cessna has been learning!

(see Operations Manual Part B – C208 – KE – Amdt 4 – 19 December 2012)

C) As an experienced bush pilot yourself, would you make any changes on the existing POH/SOP?

Although putting 'IGNITION ON' for takeoff and landing might save your life on an unexpected engine flameout, if you ask me, it's a waste of igniters. Haven't heard of a workhorse experience that problem even in the worst possible flying conditions.

D) If any, personal experience(s) on emergencies that you have used any of the POHs

MAF used to be more divergent back in the day but still is regarded as a bush operator. I've used emergencies from the bush strip/field landing on the MAF's bush operating handbook.

E) Notes/Tips that you think are worth mentioning for my Dissertation

Subject B

A) Why do you think that MAF got in the process of making such changes on the manufacturers POH/SOP?

During my years of MAF 1993-2006 there was no replacement of the C208 POH, but a couple of documents were used to augment the information supplied in the POH, namely:

- 1) C208 SOP to address the company operating procedures and limitations in the bush flying environment
- 2) C208 Ground School Manual, to set the company training standards for C208 conversion
- 3) MAF Pilot Handbook, addressing the expected operating standards of MAF bush flying but not specifically on C208 operations

B) In which cases would you use the MAF POH/SOP and in which the manufacturers POH/SOP?

Aircraft has to be operated in accordance with the information provided by the manufacturer. The company information does not supersede the information supplied in the POH but covers the items not supplied by the POH because of the specifics in the operational environment. C208 SOP included abbreviated checklist for normal and abnormal/emergency operations. C208 SOP was also used in some occasions to set higher/tighter limits than those supplied by the manufacturer, such as higher amounts of reserve fuel. In some cases, the manufacturer does not give specific instructions, possibly because of liability. In those cases, the items should be augmented by the operator, for example when to use the inertial separator and when not.

C) As an experienced bush pilot yourself, would you make any changes on the existing POH/SOP?

I have not been with MAF for 8 years now and my knowledge of their present documentation may be out of date. We were instrumental in developing standards for MAF cold weather operations. Any new information that adds value in terms of flight safety, performance, economics, or efficiency, should be considered to support the documentation provided by the manufacturer.

D) If any, personal experience(s) on emergencies that you have used any of the POHs

We used to be trained on principle of 6 G's for emergencies: Glide-Grass-Gas-Gab-Guts-Get out. It works with any aircraft and has proved to be useful in preparing for in-flight emergencies.

E) Notes/Tips that you think are worth mentioning for my Dissertation

Wish you every success.

Subject C

A) Why do you think that MAF got in the process of making such changes on the manufacturers POH/SOP?

Since MAFs operations are mostly done in the bush and the aircraft as well as pilots are always flown at their limits they had to introduce methods and practices to increase safety, reduce workload and safely use the aircraft in the best possible way.

B) In which cases would you use the MAF POH/SOP and in which the manufacturers POH/SOP?

Since MAFs manuals are always based on the manufacturers recommendations and procedures and have only added increased safety standards and procedures I would always use MAF POH/SOP.

C) As an experienced bush pilot yourself, would you make any changes on the existing POH/SOP?

I have 8000 Hrs mostly flown in the bush of Africa and with the Cessna Caravan 208 aircraft. I have always used like a bible MAF's POH/SOP and I have never had any incident so I believe that the people which have elaborated them have done a grate job to keep us safe and alive. In short, NO CHANGES.

D) If any, personal experience(s) on emergencies that you have used any of the POHs

I once experienced an engine failure on a Cessna 206 and by following the engine failure procedures using the high and low key points as well as the 6 Gs method I performed an excellent off airport landing with no passenger injury and no damage to the aircraft. The POH/SOP of MAF have greatly contributed to this emergency.

E) Notes/Tips that you think are worth mentioning for my Dissertation

Please refer to the ENGINE FIRE EMERGENCY PROCEDURE OF MAF and see that the first action to take according to MAF is to verify the actual emergency in contrary to the manufacturers manual which states to shut down engine. A perfectly healthy engine was shut down in the past because of a faulty fire warning system.

Subject D

A) Why do you think that MAF got in the process of making such changes on the manufacturers POH/SOP?

The manufacturers POH is the legal document the operator must comply with. They are the ones who designed, tested and certified the aircraft. However the criteria they use for the performance charts are quite different than the actual circumstances MAF operates under overseas. Therefore MAF has developed their own Performance Charts (P-Charts) which are then approved by the relevant Civil Aviation Authority under which they are given an AOC - Aircraft Operating Certificate.

B) In which cases would you use the MAF POH/SOP and in which the manufacturers POH/SOP?

Apart from the Performance (P-Charts), I would use the manufacturers POH for all other operating procedures.

C) As an experienced bush pilot yourself, would you make any changes on the existing POH/SOP?

I have not operated a MAF aircraft for quite some time and I believe that their POH is periodically being assessed so it is hard for me to offer any changes of my own without knowing for sure what MAF has/hasn't done.

D) If any, personal experience(s) on emergencies that you have used any of the POHs

I have had an engine failure, and a few cockpit smoke related incidents none of which gave me time to actually use the POH checklist. The emergency procedures we initiate by memory as part of our training and periodic checks were implemented with a positive outcome in each case. I readily acknowledge that the outcomes could have been quite different and I only have God to thank for protecting me and my passengers.

E) Notes/Tips that you think are worth mentioning for my Dissertation

I am assuming that your dissertation is more comprehensive than POH and SOP issues. One subject that I have long since sensed the need to address is that of determining how many flight hours should be permitted. Each CAA has their limits on both, but there is no distinction as to what type of flying is being done.

For example - one pilot flies a well equipped IFR aircraft and does 4 hours with 2 landings at a well prepared airport. The second pilot flies 4 hours, often times in minimum VFR weather and averages 3 T/O and landings per hour at marginal airstrips. He also deals with many more passengers, cargo, tickets, manifests etc. at each stop. Both pilots have flown 4 hours but it is obvious which one will be the most fatigued, yet the maximum permitted flight hours per month is the same for each pilot.

Unfortunately I don't have an easy solution but perhaps part of the solution could include at least the amount of landings permitted.

If I may say what some may consider a wild statement, it is this. Since being in the aviation business now for approx. 44 years and particularly in the last 15 years or so, it has been my observation that the general consensus is that a manual must be written for every possible situation, the more manuals that are written the safer everyone will be. This is a generalisation, but in my humble opinion, manuals in themselves will never stop an accident or incident from happening. They must be followed for any hopefully positive outcome. Unfortunately it is impossible to know everything that is in every manual that is constantly being produced.

Why are the manuals that were produced a few year ago now not good enough, so that someone has to write another one? It seems to me that there will always be a manual that will be presented in which the pilot/crew can be seen to be at fault, in the case of an accident/incident.

Well, I have said enough for now.

Conclusion

Knowledge of an aircraft's POH/SOP help a pilot have ready access to pertinent information needed to safely fly a particular aircraft. By understanding the operations, limitations, and performance characteristics of an aircraft, a pilot can make good flight decisions. By learning what preventive maintenance is allowed on the aircraft, a pilot can maintain the aircraft in an airworthy condition. The goal of every pilot is a safe flight. Flight manuals and aircraft documentation are essential tools used to reach that goal.

From a manufacturer's perspective, a POH/SOP has to be general, structural and cover every aspect on legal based regulation. From a bush aviation operator's viewpoint though, a POH/SOP has to be especially designed for bush operations, be functional, cover every aspect on legal based regulation and at the same time be approved from both the CAA and the manufacturer itself.

To be more specific, Cessna as a manufacturer designs, creates and test flights an aircraft that has met the FAA's regulations and then, and only then gets into production. Based on the above, Cessna will then have to create the legal documentation and POH/SOP with which a pilot must be familiar in order to fly the aircraft. The POH/SOP has to provide information about the aircrafts limits, airworthiness, maintenance as well as operations with inoperative equipment.

The aftermath of the research was to identify and classify the differences on the POH/SOP of the two. As specified before the most important differences were on the Normal Procedures, Emergency Procedures and Weight and Balance.

In the normal procedures we identified 7 differences and classified them into 2 categories, of safety and practicality. Creating pins for the crew seats as well as having the ignition on during takeoff or landing are considered as safety practices. Although MAF is conservative and tries to minimise costs by saving on fuel and maintaining their aircrafts in top condition, wearing the costly igniters for some steps of the flight, is not considered an expense because safety is number one priority.

As for the door checklist, the G-N-A-R-G-A-S mnemonic and the flow charts for every procedure for before, in and after the flight, are functional practices with which MAF aids the pilots to successfully complete tasks.

In the event of an emergency a pilot's goal is to land the aircraft in safety and keep the passengers and himself as unharmed as possible. During an emergency though most pilots as most people do, are affected by the fight or flight response. The flight or fight is the natural response of the human's body activated alert system in stressful circumstances. Some of the symptoms are impaired thinking, confusion, blurred vision and cognitive problems.

By introducing the 6Gs mnemonic which now is gradually replaced by the A-B-C-D-E-F-G mnemonic, MAF is trying create adaptive procedures in order to be functional and save lives in those stressful circumstances. For example, in case of a forced landing it's much easier to act from memory (apply a mnemonic), rather than having to complete tasks by reading a checklist and at the same time fly the aircraft. Very crucial here are also the "what if" scenarios we referred as MAF's pilots common practices. Combined with some basic orientation skills and by being familiar with the surrounding terrain, can make a safe force landing definite.

In the next case study (most critical) though even the most skilled pilot can misinterpret a reading. Perceiving and identifying an engine fire in flight is not as simple as it seems. The LHD fire detection system we described before can be misleading. Although turbine engines are reliable, in case of power loss a successful restart is unlikely. Nonetheless a restart should be attempted, but emphasising the priority of flying the aircraft to a safe landing is most important.

In that manner, verifying the case of actual fire is critical for the next steps to be executed. If the fire alarm is activated due to a malfunctioning sensor, the only task to be completed is to pull out the corresponding circuit breaker. If there is an active fire though, MAF insists that the first task is not the rational shutting down of the engine but shutting off the cabin heat firewall. The reason is the aerotoxic syndrome which can cause symptoms of a mild headache to a severe seizure or even death. Any smoke entering the cabin from the engine will have to be blocked so the following more critical tasks can be done in a possible environment.

In terms of the above MAF pilots stick with their POH/SOP but always stay current with Cessna Handbooks for liability issues. Likewise Cessna has improved in many fields as competition has increased. As some bush pilots also say, Cessna has been learning.

Last but no least the Weight and Balance. Although the use of a load adjuster may be more accurate and structural, the indexgram system is practically accurate enough and easier to apply. The independence from a computer alone can minimise calculation errors as well as the time to complete the load sheet. MAF's load sheet also offers four filling sectors for multiple leg flights to avoid numerous sheets that may be unwittingly shuffled.

Looking back, numerous Caravan variations have been produced over the years such as the C208, the C208B Grand Caravan, the AC208 Military, the Amphibian etc. Cessna as every manufacturer make their Handbooks structural and complete, anticipated for the necessary knowledge that a pilot needs to be certified flying a certain type of aircraft. The documents are meant to stay current at all times, with most of the updates/changes being done unfortunately by trial and error.

Although testing an aircraft nowadays is burdensome and take lots of labor and simulation hours, the aircraft has to spend a great deal of time in the sky to display its weak point. Generally speaking, the harsher the conditions the greater the possibilities the flaw will present it self. MAF by nature is the ideal candidate for such circumstances.

Once a year, Cessna as MAF's major fleet manufacturer sends representatives to their hangars for improvement exchanging and updates on faults that may have appeared in service. Unfortunately that was never enough for MAF, with the outcome of designing a supplement of Cessna's handbooks and operating procedures. In some cases they even supersede the manufacturers limitations, procedures and performance information. All their POH/SOP descriptions are certified by every local civil aviation safety authority (CAA) they operate in as well as Cessna itself under the condition that the handbooks are practiced by the Mission Aviation Fellowship pilots only.

Besides, from the early years MAF conducted country wide surveys, developing a flight orientation program for pilots and technicians which was then complemented by the completion of their own operating handbooks. As from what time has shown, they are doing it right.

Resources

Tsagkas, Nathanael, Marmaras: Reliability Engineering System Safety - 2013

Δημήτριος Β. Ναθαναήλ: Προς μια φαινομενολογική προσέγγιση ανάλυσης γνωστικών συστημάτων: Συμβολή στο σχεδιασμό σύνθετων πληροφοριακών συστημάτων - 2004

Roy Rissanen: The secrets of successful bush flying - 2005

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