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Test Plan for N52BL

KR-2 Serial #7156

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Revision A.01

November 24, 2001

This is an incomplete draft of my test plan and is offered as a reference for those entering or already involved in their test programs. The plan is annotated where further information is to be added. The final draft of the plan will not be complete until just prior to certification. Your comments and suggestions for improvements are welcomed. I make periodic updates to this plan and post them on my web page at <http://flyboybob.com>, along with other items of interest to KR enthusiasts. You may also contact me through e-mail at
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This document has been developed from the initial work of Rick Junkin with the authors permission. It is based on revision 8 of the “Test Plan for N415RJ Junkin KR-2S Serial #491”, Copyright © 1997, 1998 Revision 8, 1/11/98

References

AC 90-89A, Amateur-Built Aircraft and Ultralight Flight Testing Handbook, 5/24/95
Flight Testing Homebuilt Aircraft by Vaughan Askue

DRAFT

DRAFT

Table of Contents

<i>Test Plan for N415RJN52BL</i>	<i>1</i>
<i>Table of Contents</i>	<i>2</i>
<i>Introduction</i>	<i>3</i>
Forward and Acknowledgements	3
Objective of Test Plan	4
Test Plan Format	5
General Test Documentation Methods	5
Instrumentation - See Appendix XXX	6
Aircraft Configuration	6
<i>Preparation</i>	<i>6</i>
Airport selection	6
Emergency Plans and Equipment	9
Test Pilot Qualification Criteria	12
Transporting The Aircraft To The Airport	13
Assembly and Airworthiness Inspection	14
Weight and Balance	15
Paperwork Required	15
Electromagnetic Interference (EMI) Testing	17
Power Plant Tests	18
Propeller Inspection	23
<i>Taxi Tests</i>	<i>24</i>
Objectives	24
Data to be Collected	24
Test Procedure	25
<i>Flight Tests</i>	<i>28</i>
Chase Plane Procedures	28
Emergency Procedures	29
Flight Procedures	30
<i>Data Analysis (to be expanded on)</i>	<i>47</i>
<i>Appendix 1. Aircraft Condition Inspection Checklist (Airworthiness Inspection) (to be expanded on)</i>	<i>48</i>
<i>Appendix 2. Aircraft Normal Procedures Checklist (to be expanded on)</i>	<i>52</i>

DRAFT

<i>Appendix 3. Aircraft Emergency Procedures Checklist (to be expanded on)</i>	57
<i>Appendix 4. Test Cards (one for each planned test/flight to include engine run in and taxi testing) (to be expanded on)</i>	59
<i>Appendix 5. Aircraft Squawk Record (suggested format) (to be expanded on)</i>	60
<i>Appendix 6. Glossary</i>	62
<i>Appendix XXX. Instrumentation Drawings and Schematics</i>	63
<i>Appendix YYY. Weather minimums</i>	64
<i>Appendix XYZ. Root Cause Analysis Methods</i>	65
<i>Appendix ZZZ. Flight Manual Preparation and Publication (to be expanded on)</i>	66

Introduction

Forward and Acknowledgements

Flight testing is a serious business. Aviation is very unforgiving of mistakes, and in the flight test arena the mistakes you have to deal with may have been made well before the airplane was ready to fly, back when it was still a pile of sticks in your garage or basement (or living room?). The only safety net you have available to you in this type of arena is a well thought out, disciplined test plan that you use as your guide for exactly how you will operate during the test period. To safely conduct the test program you must adequately prepare both the airplane and YOURSELF. This document created to accomplish that goal. It's not perfect, and at this point by no means complete, but perhaps some of the information in it will help you to think through your personal requirements for performing the test program required for your airplane.

I am developing this plan for the express purpose of testing N52BL, my KR2, and it is provided for home builders to use as a guide to performing a safe and thorough test program. The plan is loosely based on AC 90-89A, Amateur-Built Aircraft and Ultralight Flight Testing Handbook, dated 5/25/95, and includes suggestions and contributions from members of the KRNet. KRNet is a free Internet mailing list devoted to the open exchange of information pertinent to building and flying KR aircraft. You can subscribe to the KRNet mailing list by sending an email message addressed to majordomo@teleport.com, with "subscribe krnet-I [your email address]" in the body text.

DRAFT

This plan is a guide for the execution of my KR2 test program, and as such is not a “stand-alone” document. It does not contain guidance for trouble shooting or correcting deficiencies found during testing. I recommend “Flight Testing Homebuilt Aircraft” by Vaughan Askue, ISBN 0-8138-1308-5, as a basic starting point for determining how to address deficiencies. This book also explains in some detail many of the principals and procedures I have included in my test plan, and it contains references for more ideas on testing and corrective action.

Special thanks to Rick Junkin for his work in putting the framework of this plan together.

WARNING: The contents of this test plan are offered as a guide for individuals to reference while testing their experimental aircraft. It is the responsibility of the builder, test pilot and his support team to determine the safety and applicability of the information contained in this plan. Under no circumstances should the test program extend beyond the capabilities of the test pilot or the aircraft being tested. These capabilities must be assessed by a qualified and disinterested third party. **ALL ELEMENTS OF THIS PLAN ARE TO BE EXECUTED AT THE SOLE RISK OF THE TEST PILOT AND THE AIRCRAFT BUILDER.**

Objective of Test Plan

The objective of this test plan is to prepare N52BL for safe operation and determine the aircraft’s controllability and performance throughout the flight envelope for which it was designed and constructed. Data will be collected and recorded for all phases of the test program, particularly on any hazardous operating characteristics or design features. This data will be used to develop a comprehensive Flight Manual that specifies the aircraft’s performance parameters and defines its operating envelope.

Test Plan Format

DRAFT

The plan for each phase of ground and flight test will consist of the following elements: Title (Description), Objective, Data Points to be Collected, Test Procedure, and Risk Analysis. Test cards, provided in Appendix 4, contain the test procedures in checklist format to be used by the test pilot and support team in conducting the tests and recording data. I have developed test cards sized to fit a knee board. One thing missing from these cards is the operating limitations for each test, as I plan to post a separate card on my instrument panel with this information for each test. This information is critical to the safe operation of the aircraft, so post it where it can be referenced immediately and effortlessly. An ideal place to post this information is beside the airspeed indicator or in an open space on the panel that is within your cross check.

General Test Documentation Methods

All tests in this plan will be documented with video tape from a video camera secured to the center of the baggage shelf and aimed forward (see Appendix XXX for details). The camera field of view will be adjusted to include the cockpit instruments and as much of the “out the window” view over the nose of the aircraft as possible. The camera will be positioned as high as practical to maintain the horizon in the field of view. Audio will be input to the video camera directly from the aircraft intercom to allow the test pilot to provide additional verbal descriptive data regarding flight parameters and aircraft handling characteristics.

Flight parameter and engine performance data will also be collected via serial output from the RMI uEncoder and uMonitor. Output from these instruments will be collected on a laptop computer and time stamped for later review with the video tape. This data will be the primary source for performance information in the Flight Manual. Reference Section XXX of the Flight Manual for instrumentation details. Specific data points during each test will be recorded manually to augment/back up the automated data collection methods. A data card which describes the required starting/entry parameters for the test and the specific data points to be recorded manually will be developed for each test to be performed. The test pilot will speak data points into the intercom for recording on the video tape.

DRAFT

Aircraft Configuration

N52BL is a KR2 design conventional gear aircraft with a 98 horsepower turbo-charged GPASC 2600 Type IV VW engine. It was built using the Rand Robinson premold top deck and Diehl wing skins and stock retractable landing gear. The aircraft is built to plans, and has a center stick in the two place cockpit. The throttle and mixture control quadrant is located on the left side of the fuselage. The instrument panel is configured for day or night IFR flight, and uses digital avionics and instruments. All primary flight controls are actuated by cables. The elevator cables are connected from a bellcrank on the aft spar to the control stick with a push rod to eliminate elevator cable slack with aileron control input. Flaps are actuated by push rods from the flap torque tube. An electric trim system is used for all three axis.

Preparation

Airport selection

Objective

To select a suitable airport at which to conduct the taxi and flight test program.

Data to be collected: For each airport considered, collect the following information. Consider that taxi tests and flight tests may be conducted at different airports if necessary.

Runway headings

Multiple runways and taxiways oriented in the direction of local prevailing winds will help assure the ability to conduct test operations in changing weather conditions. The best conditions for taxi and flight testing are little or no wind and clear VMC (visual meteorological conditions).

Obstructions

Airports surrounded by buildings, power/telephone lines, trees, or other obstructions should be avoided. If obstructions are present, careful planning will be required to determine the safest departure route from the airport that affords the test pilot with the most options in the event of engine failure or other catastrophic failure on takeoff and climb out. Likewise, the approach to landing must be planned so as to determine the approach path that affords the most options in the event of emergencies during approach to landing.

Runway condition

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Runways and taxiways should be in sound condition (no major cracks or holes) and free of loose gravel, sand, or other debris. Grass or dirt runways must be thoroughly inspected for holes, ruts, or other irregularities that could cause problems. Runway access should be controlled by the airport authority or a member of the support team, and limited to only aircraft and emergency vehicles. Coordinate with the FBO, airport manager, or other controlling agency to establish access procedures.

Airport facilities

Minimum airport facilities should include a protected storage area for the aircraft, a fuel source, and access to a telephone (a cellular phone with extra batteries will suffice – check cellular network coverage). Larger airports tend to have better facilities, but traffic volume often makes them impractical for flight testing.

Airport traffic volume

High volume airports should be avoided. If you must use a high volume airport, talk to the FBO or control tower to determine when the traffic volume is typically the lowest, and plan your test activities for these periods.

Fire fighting equipment

Fire fighting equipment on the field is a definite plus, but not necessarily a requirement. The availability of this equipment will determine any additional equipment the ground crew must have at hand in the event of a fire. Hand held extinguishers will work, but an industrial grade fire bottle hitched to the back of the ground crew's 4 wheel drive vehicle could prove to be a life saver. Check with the FBO to see if they have this equipment available.

Emergency response team availability

In most cases the ground crew will have to serve as the emergency response team. Again, check with the FBO or tower for any established emergency response personnel or procedures, and determine what coordination is required to get the ground crew and vehicle access to the active runway.

Emergency landing fields

Survey the area surrounding the airport for emergency landing fields. Be realistic in your assessment, and approach this survey from the standpoint that you WILL have to land the airplane immediately after takeoff. The ideal airport will have a rural road with no telephone or power lines, running within 30 degrees of the departure end of the runway. Beware of farm fields, and be sure to take a walk through any fields you are considering using as emergency landing areas. Take a look at these fields again within one week of each flight to reconfirm that they haven't been plowed, planted, or otherwise made unsuitable for use as an emergency landing strip. The objective is not necessarily to land the airplane without damage (although that would be IDEAL!), but to be able to put the airplane on the ground in such a manner that you will be able to walk away from it. If no emergency fields are available, or you don't feel confident in your

DRAFT

ability to land the aircraft in the areas available, pick another airport. Remember, you WILL have to land your airplane immediately after takeoff.

The following parameters were extracted from AC 90-89A, Amateur-Built Aircraft and Ultralight Flight Testing Handbook dated 5/24/95, page 3. The aircraft wing loading assumed for the flight test phase is 12.5 pounds per square foot, and yields the following required take-off distances. These distances are for reference when choosing an appropriate site for both taxi and flight testing. Actual distances peculiar to N415RJ will be determined during testing.

Distance to take off at minimum smooth lift off speed, fly for 5 seconds without climbing, land and stop straight ahead	2,800 feet.
Distance to reach smooth lift off speed	700 feet
Distance covered in 5 seconds of flight at minimum lift off speed	550 feet
Distance to stop from minimum smooth lift off speed (including air and ground distance)	1600 feet
Distance to take off at slow approach speed and climb at 1 foot vertical per 20 feet lateral to an altitude of 50 feet	1900 feet

The ideal runway at sea level is at least 4,000 feet long and 100 feet wide. Add 500 feet for each 1,000 feet increase in elevation.

Emergency Plans and Equipment

(This section will be used to develop the Emergency Procedures Section of the Flight Manual)

Ground Crew.

The ground crew should consist of a minimum of 2 experienced individuals with the following responsibilities:

Assist the test pilot in ensuring that the aircraft is in airworthy condition for safe operation

Provide assistance to the test pilot in an emergency or any other situation in which assistance is required.

The ground crew should have a 4-wheel drive vehicle equipped with a VHF radio, cellular telephone, hand held GPS, sectional chart and road map, fire extinguisher(s), cutting equipment, and a first aid kit. All members of the ground crew must be capable and qualified to operate the emergency equipment.

DRAFT

Ground emergency Plan

Provide a copy of this plan to the ground support crew, the FBO/tower, and emergency response team at the field. The ground emergency procedures should be tailored to the specific operation of N52BL and its aircraft systems.

Canopy latching/removal (to be expanded on)

Safety harness release procedures (to be expanded on)

Location and operation of the fuel shut off valve(s) (to be expanded on)

Master switch location/OFF position (to be expanded on)

Cowling removal procedures (to be expanded on)

Battery location/access/disconnect procedures (to be expanded on)

Fire extinguisher location and use (to be expanded on)

Engine Failure (to be expanded on)

Runaway Throttle (to be expanded on)

Fire (to be expanded on)

Smoke in the Cockpit (to be expanded on)

Brake Failure/Stuck Brake (to be expanded on)

Wheel/Tire Failure (to be expanded on)

In-Flight Emergency Plan

DRAFT

N52BL will assume the lead of the formation in all flights involving a chase aircraft unless the lead is passed to the chase aircraft. Situations that would make this necessary are any emergencies that obscure forward vision (oil on the canopy, smoke in the cockpit, canopy bird strike, etc.) The first action of any airborne emergency will be to turn directly to the closest airfield or emergency landing field. Emergency procedures will be executed by the test pilot, and the chase or ground crew will back up and confirm his actions. The test pilot will be the final authority for all decisions, but all members of the support and chase team are encouraged to offer their assessment of the situation and recommended action.

Engine failure on take off (to be expanded on)

Engine failure in flight (to be expanded on)

Flight control malfunction/out of rig (to be expanded on)

Engine/cockpit fire (to be expanded on)

Engine Overheat (to be expanded on)

Structural Failure (to be expanded on)

Excessive Engine/Prop Vibration (to be expanded on)

Airport.

Brief Emergency Response Team on the above procedures. Advise the tower/FBO personnel that an experimental aircraft test is being conducted. These briefings should be conducted the day prior to the test flight so that all questions can be answered and additional resources, if required, can be obtained.

Hospital Locations/Phone Numbers

Investigate hospitals near the airport and in the designated flight test area and make a list of emergency phone numbers. The test pilot should have any medical allergies or conditions made known to health providers. Wear a medic alert bracelet or other identification prominently. The support team will have a copy of the pilot's medical history to pass to health providers, if necessary.

Cockpit Fire Extinguisher

DRAFT

A halon fire extinguisher will be secured to the front of the main spar under the pilot's legs with a quick-release that will allow one-handed access and operation.

Canopy Breaker Tool

The test pilot must have the ability to break through the canopy if necessary. A standard military survival-type knife will serve well for this purpose. The test pilot must be aware of the proper use of a knife to break through the canopy. The knife should be held in one hand, blade up with the sharp edge TOWARD the pilot, and the other hand positioned below the knife to direct the striking motion. The edge of the blade must be toward the pilot to assure that a glancing blow against the canopy will push the knife away from the pilots head -- trust me, it's how we were trained to do it in the F-4. Several blows may be required to create a hole large enough for egress from the cockpit. Secure the knife in its sheath above the fire extinguisher.

Fire/Pilot Protection

The test pilot will wear a nomex flight suit and gloves, high leather flight boots, and a helmet with a visor. The helmet will have a chin strap that can be securely fastened. The four point lap belt/shoulder harness will also be securely fastened.

Parachute/Ballistic Recovery System

The canopy will be rigged with removable safety pins to allow the pilot to jettison the canopy in an emergency bailout situation. A high-speed rated parachute will be worn by the pilot. This is to permit a high-speed bailout at lower altitudes in the event of structural failure. A ballistic recovery system may be installed in lieu of a personal parachute.

Test Pilot Qualification Criteria

Objective

To establish the minimum qualification and proficiency requirements for the test pilot.

Test Pilot requirements

Physically fit

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No alcohol or drugs (prescription or non-prescription) within the 24 hours prior to the test

Rated, current, and competent as assessed by a flight advisor and instructor.

Current medical and biennial flight review

Flight time requirements

At least 100 hours solo time

At least 50 hours and 50 take-offs and landings in a conventional gear airplane, 10 in the last 30 days

Familiar with airport and emergency fields

Has flown in similar/same type

Has had recent instruction or experience in same/ like-type

Has conducted practice flight test profile in same/ like-type

Has studied and practiced all in-flight and ground emergencies with ground crew, and has spent a minimum of 2 hours “chair flying” emergency procedures.

Has logged one hour of unusual attitude recoveries with an instructor within 45 days of flight

Has reviewed expected performance characteristics and studied all available material on the aircraft

Has reviewed NTSB reports on past accidents in same type aircraft

Has become completely familiar with the cockpit and can locate all cockpit switches while blindfolded.

Transporting The Aircraft To The Airport

Objective

Manage the risk associated with transporting the aircraft to the airport in order to avoid damage or incident.

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Data to be considered

Weather

Traffic flow/volume

Route

Conveyances available

Moving crew/volunteers

Methods of securing aircraft

Procedure

Confirm weather forecast acceptability

Verify hangar/storage space available

Contact crew

Get trailer/truck

Secure aircraft to trailer/truck

Secure wings to trailer/truck

Brief route/convoy procedures

Move to airport

Brief unload procedures

Unload aircraft and wings

Secure aircraft in storage area

Assembly and Airworthiness Inspection

Objective

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Provide for reassembly of the aircraft to minimize risk of damage or improper assembly. Further assure aircraft is in a condition to pass the FAA airworthiness inspection

Data to be considered

Assembly Planning

Assembly Sequence

Assembly Procedures

Aircraft Fitness Inspection Checklists

Procedure:

Assembly Checklist (to be expanded on)

Fitness Inspection Checklist (to be expanded on)

Field Check List (to be expanded on)

Weight and Balance

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WEIGHT AND BALANCE DATASHEET FOR KR-2S SERIAL #491				N415RJ
Owner / Builder	Richard M. Junkin			
<i>DATUM REFERENCE POINT IS FRONT BOTTOM OF FIREWALL</i>				
Weight at	WEIGHT (lb)	MOMENT ARM (in)	MOMENT WT. (in*lb)	
LEFT WHEEL	343.5	16.25	5581.88	
RIGHT WHEEL	340.5	16.25	5533.13	
TAIL WHEEL	4.5	153.25	689.63	
EMPTY WEIGHT	688.5		11804.63	
		17.15	CG (inches aft of datum)	
AIRCRAFT LOADING				
Fuel=6#/gal Oil=1.875#/qt				
	WEIGHT (lb)	VOLUMES	MOMENT ARM (in)	LOAD MOMENT. (in*lb)
LEFT WING LEADING EDGE	0		12.44	0.00
MAIN SPAR (front for ref)	0		23.25	0.00
MAIN GEAR Empty(@axles)	684.00		16.25	11115.00
OIL (4.5qt@1.875#)	8.44	4.5	-12.44	-104.94
FUEL (header 9.25 gal)	55.50	9.25	8	444.00
RIGHT FUEL (6.75gal)	0.00	0	30	0.00
LEFT FUEL (7.1gal)	0.00	0	30	0.00
PILOT	0		42	0.00
PASSENGER	0		42	0.00
LUGGAGE	0		55	0.00
TAILWHEEL (Empty@axle)	4.50		153.25	689.63
GROSS WEIGHT	752.44			12143.68
C. G. Inches from DATUM	16.14			
C. G. Range	13.44 - 28.44			

Paperwork Required

Objective

Ensure all paperwork is completed for FAA approval for flight testing.

Required Documents

Registration

Weight & Balance

Airworthiness Application

Airman Rating Application for Mechanic's Certificate (will probably be mailed to the FAA separately)

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Signed notarized affidavit stating that the aircraft was homebuilt from parts. This must be on file with the FAA before they can process the Mechanic's Certificate

Cutaway drawing and/or pictures of the aircraft to go to the FAA

Placards

Operating Limits (projected) marked on instruments

"EXPERIMENTAL"

Passenger Advisory

Aircraft ID Plate

Checklists

Detailed checklists are a must for the first few flights, regardless of how simple the aircraft is. There are many distractions on these flights, including your own excitement and the small crowd that may gather to witness your first flight. Detailed checklists will force you to develop the good habit patterns that will keep you safely flying your aircraft for as long as you own it. Here is a list of checklists you should prepare:

Preflight Inspection

Before Engine Start

Engine Start

15 Minute Checklist (for testing purposes)

Before Taxi

Taxi

Before Take Off

Take Off/Climb/Cruise

Descent/Before Landing

After Landing

Before Engine Shut Down

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Engine Shut Down

Securing Aircraft

Emergency Procedures

Flight Manual

Builder's Log (include pictures and tech counselor inspection forms)

Aircraft Log (This is the only required log for the airplane; engine, avionics, and prop logs are optional)

Engine Log

Prop Log

Avionics Log

Electromagnetic Interference (EMI) Testing

Objective

Ensure that all aircraft systems will operate normally with any combination of on board electrical equipment operating.

Data Points to be Collected

See table in procedures and on test card.

Procedure

All electronic systems on board must be operable in combination with any and all other systems on board the aircraft. These tests must be conducted with the engine running, and can be conducted in conjunction with the engine run-in tests. Use the following matrix to test systems operation. The matrix is filled from left to right, top to bottom, turning all systems off each time the right side of the matrix is reached. Monitor all systems for normal operation, and note any discrepancies by position on the matrix with a description of the abnormally operating system/systems malfunction.

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EMI Test Matrix	Engine	Trim	Comm Transmit	Transponder	Strobes	Nav Lights	Landing Light	Autopilot	Stereo	Engine Monitor	Micro Encoder	Fuel Pumps				
Engine																
Trim																
Comm Transmit																
Transponder																
Strobes																
Nav Lights																
Landing Light																
Autopilot																
Stereo																
Engine Monitor																
Micro Encoder																
Fuel Pumps																

Power Plant Tests

Objective

Ensure engine has been properly run-in in accordance with Revmaster’s recommendations and is safe to operate in all RPM ranges. Ensure an adequate fuel supply and flow rate at all angles of attack.

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Data Points to be Collected (need to state expected/limit parameters, and address instrumentation)

Usable fuel quantity

Fuel flow rate

Engine compression baseline

Ignition system performance

EGT/CHT parameters

Carburetor heat parameters

Mixture control

Idle speed

Evidence of leaks

Test Procedures

Pre-oil and cold compression test

Tools Required

Remove the rocker-box covers and one spark plug from each cylinder.

Using an external oil pump, or by rotating the propeller in the direction of rotation, pump a substantial amount of oil up from the sump into the rocker arms.

When the engine is pre-oiled, run a compression test of each cylinder. The results of these compression tests will serve as bench marks for subsequent compression checks.

Run-in procedures

Tools Required

Pre-run-in checks

Confirm all fuel and oil connections are tight.

Confirm adequate torque on engine mount bolts. Reference Revmaster manual for torque values.

DRAFT

Confirm all tools, rags, hardware, or other foreign objects have been removed from the engine and engine compartment.

Confirm 3.5 quarts of oil are in the engine.

Test and support equipment

Inventory a “pack-up” kit prior to beginning testing. The kit will include the following:

Operating CHT gauge to confirm proper flow of cooling air.

If only one CHT thermocouple, attach it to the rearmost cylinder on the right side (as viewed from the cockpit) of the engine.

Calibrated external oil pressure and temperature gauges

Use to test the accuracy of the installed gauges.

At least 50 feet of tiedown rope

Tiedown stakes

Two chocks for each wheel

Fire extinguisher

Assorted hand tools

Safety wire

Cotter pins

Ear and eye protection

Grease pencils

Logbooks

Clip board

Pen and paper

Watch to time tests

Rags

Engine manufacturer's instructions

DRAFT

Test Plan and Test Cards

Safety Precautions

Ensure aircraft is tied down, brakes on, and wheels chocked

All test personnel must wear eye and ear protection

All personnel must be checked out on the operation of the fire extinguisher(s)

Establish a "Hazard Zone" beside the engine, in line with and near the prop, and do not allow anyone in this zone while the engine is running. Paint the outline of this zone on the hangar floor or taxiway.

The first engine run (**use Revmaster's recommendations**)

Engine cool down (**use Revmaster's recommendations**)

After shut down (**use Revmaster's recommendations**)

Record engine run data (**to be expanded on**)

Mixture & Idle speed check

After completing the initial run-in tests, determine if the mixture and idle settings are correct by performing the following procedures

Warm up the engine until all readings are normal IAW Revmaster's specifications

Oil pressure
Oil temp
CHT
EGT

Adjust the engine to the recommended idle RPM

Slowly pull the mixture control back to idle cut-off

Measure and record the change in RPM just before the engine quits. Adjust the mixture setting to achieve a 50 RPM rise at shut down. If it does not rise at all, the mixture is too lean. If it rises more than 50 RPM, the mixture is set too rich.

Set the idle RPM about 100 RPM higher than the manufacturer's recommended idle RPM during the first 10 hours of the flight testing phase to ensure the engine will not quit when the throttle is retarded too rapidly, especially during approach to landing.

Ignition check

DRAFT

When a magneto check is performed, the engine should continue running smoothly with a slight RPM drop when running on one magneto. The average drop should be about 50 RPM.

A “hot magneto” check should also be performed to confirm proper grounding of the magnetos. If the engine does not quit when the magnetos are turned off, one or both of the magnetos are not grounded, and **THIS MUST BE CORRECTED IMMEDIATELY!** The most likely causes of a hot magneto are a broken “P” lead or a bad magneto switch. **INVESTIGATE FULLY AND DO NOT PROCEED FURTHER UNTIL THIS DISCREPANCY IS FIXED.**

Cold cylinder check

If the engine is running rough and ignition is believed to be the problem, perform a cold cylinder check.

Run the engine on the suspect magneto for about 30 seconds at 1200 RPM. Leave the magneto switch on this magneto and shut the engine down with the mixture control. Have a member or members of your test crew immediately make marks with grease pencils about one inch from the cylinder heads on the exhaust stacks. The marks should turn gray-white in color. If the marks don't burn on one or more cylinders, these cylinders are cold. This can be caused by bad spark plugs, bad ignition wires, or a cracked distributor in the magneto. To determine if the spark plugs are the problem:

Trade the spark plugs from a known cold cylinder with a known good cylinder. Run the test again, and if the previously good cylinder is now cold, and the other cylinder is good, the spark plugs are the problem.

Carburetor heat check

The carburetor heat on a normally aspirated engine should raise the venturi temperature by 90F degrees, and on a turbocharged engine by 120F degrees at 75% power. It is important to get these temperatures right, as not enough heat will not melt/prevent ice, and too much will cause the engine to lose power or shut down due to too rich a mixture. The temperature rise should be accompanied by a decrease in engine RPM.

Fuel flow and usable fuel check

Perform this check to make sure the aircraft will receive an adequate fuel supply at extreme angles of attack.

Raise the aircraft's nose to an angle 5 degrees higher than the highest anticipated climb angle. For an aircraft with conventional gear, dig a hole to put the tail in rather than put the mains on blocks to achieve this. For a tri-gear aircraft, make a ramp for the nose gear. Ensure the aircraft is securely chocked and tied down.

With a minimum known quantity of fuel in the aircraft, disconnect the fuel line from the carburetor, start a stop watch, and allow the fuel to drain into a container. For a gravity feed system, the flow rate should be 150% of that required by the engine at full throttle.

DRAFT

For a pressurized system, it should be at least 125%. When the fuel stops flowing, stop the watch and determine how much fuel drained out and how much fuel is left in the airplane (the “unusable fuel”). Calculate the fuel flow rate.

The formula for estimating the required fuel flow rate (pounds per hour) is $.55 \times \text{engine horsepower} \times 1.50$. Divide this by 60 to get pounds per minute, then divide this by 6 to get gallons per minute. For a pressurized system use 1.25 instead of 1.50 in the equation.

Ensure the contaminated fuel is disposed of properly.

Post run-in compression check

Perform a differential compression check on all cylinders after the run-in is completed. Any cylinder yielding less than 60/80 when hot needs to be investigated further. Have an assistant hold the propeller at top dead center for the suspect cylinder, apply compressed air to the cylinder, and listen for escaping air. If air escapes through the exhaust system, the exhaust valve seat is bad. If air escapes through the air cleaner or carburetor heat box, the intake valve seat is bad. If air escapes through the oil dip stick tube, the piston rings are bad.

Last check (before taxi tests)

After all the run-in checks and post-run-in checks are completed, change the oil and oil filter again. Check the old oil and filter for signs of metal, visually inspect the engine and perform a run-up check, then inspect for leaks. **THERE ARE NO SUCH THINGS AS MINOR PROBLEMS AT THIS POINT. DO NOT CONTINUE WITH TAXI TESTING UNTIL ALL ENGINE DISCREPANCIES ARE FIXED.**

Propeller Inspection

Objective

Develop and implement an ongoing inspection and maintenance process for the propeller.

Procedure

Inspect propeller for nicks and scratches. Blend/profile leading edge nicks to relieve stress concentrations, and refinish prop as necessary.

Inspect the prop hub bolts for security. Ensure that the nuts have not backed off by examining the paint marks on the nut side. Ensure any loosened nuts are re-torqued and remarked.

Enter any maintenance actions into the propeller log book.

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Taxi Tests

Objectives

Confirm that the pilot has access to and can operate all cockpit equipment with seat belt and shoulder harness properly fitted.

Ensure the aircraft tracks straight and there is adequate directional control at 80% of the anticipated take off speed.

Determine that the aircraft's engine cooling and brake systems are adequate for extended ground operation.

Predict the flight trim of the aircraft and its handling characteristics during take off and landing.

Determine the aircraft's high speed handling and braking parameters

Allow the pilot to become proficient with the ground handling and braking characteristics of the aircraft.

Data to be Collected

Tail lift speed (estimated at 80% of expected stall speed)

Take off speed

Engine performance/temps

Required control inputs (control stick movement as a percent of total range)

Proper instrument function

Braking performance

Ground handling characteristics

Evidence of leaks

Test Procedure

Preparation

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For a conventional gear aircraft, support the tail of the aircraft to the approximate take off attitude and allow the test pilot about an hour to familiarize himself with the change in the deck angle from the taxi to take off attitude. This preparation will help reduce the risk of the test pilot overreacting to an unexpected deck angle on the first flight.

Review the brake manufacturer's recommendations on conditioning the brake linings prior to commencing the taxi tests. Be sure to follow these recommendations so as not to degrade the high speed braking performance you will depend on during later testing and operation.

Review brake failure emergency procedures.

Low Speed Taxi Tests

Execute Preflight, Before Engine start, Engine Start, and Before Taxi checklists

Begin taxi testing in an open area away from hangars and obstructions. The initial taxi tests should be done at a speed no faster than a man can walk. Taxi straight ahead and assess brake effectiveness, landing gear alignment, drift, and ground handling qualities.

Execute 90, 180, and 360 degree turns, with and without brakes, to establish the turn radius capabilities. Continue these exercises until the aircraft can be competently controlled.

Closely monitor engine instruments to maintain all operating parameters within limits.

Ground crew will monitor the aircraft for signs of smoke, fire, fluid leaks, or other anomalies. Use prebriefed signals to indicate problems.

Confirm proper operation of flight instruments and avionics during taxi (compass, turn coordinator, VVI, radios).

Execute Before Engine Shut Down and Engine Shut Down checklists.

Carefully inspect the aircraft for oil and brake fluid leaks. ALL LEAKS ARE TO BE CONSIDERED MAJOR PROBLEMS AND THE TEST PROGRAM DISCONTINUED UNTIL THEY ARE FIXED!

High Speed Taxi Tests

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Ensure the test pilot and the test aircraft are prepared to become airborne during high speed taxi testing. It has happened before, and with a little preparation an accidental excursion into the surlies can be handled as a non-event. Thoroughly review the test plan for the first flight before beginning the high speed taxi tests, and ensure the aircraft is in a flyable configuration. Be sure to conduct the taxi tests with the appropriate amount of fuel (the same amount you will use for your first flight), and confirm that the CG is accurately calculated and falls within the design limits. Approach this phase of testing as if you were going to fly the airplane, and accomplish all the applicable preflight inspections and planning.

Determine direction of rotation of propeller - clockwise rotation (as viewed from the cockpit) will require right rudder at high power, counterclockwise rotation will require left rudder.

Increase taxi speed by no more than 5 knots/mph on each run. Do not increase the speed until everyone on the test team is satisfied with the aircraft and test pilot performance at the speed of the previous run.

At 80% of the predicted stall speed, the test pilot should be able to raise the tail (or nose on a nose-dragger). If unable, research the CG and landing gear location, there is a problem. With the tail raised, adjust the stab trim to zero stick pitch forces. This will be the initial "Take Off Trim" position. Mark the trim position indicator as appropriate. Do not move the trim position so that rigging adjustments can be made as necessary. Note the stick forces required to raise the tail. The stick travel required to raise the tail should not exceed 25% of the longitudinal range of travel. If it does, consider CG or gear placement problems.

As 80% of the stall speed is approached, the test pilot will test the effectiveness of the ailerons by attempting to rock the wings SLIGHTLY! Be aware that a misrigged aileron could cause the test pilot to drag a wing with a relatively small control input.

Duplicate taxi tests with the flaps/speed brake extended to determine any pitch authority changes or instability induced by these devices. Record this information and incorporate it in the Aircraft Flight Manual as a note, caution, or warning.

Determine the approximate point on the runway where lift off will occur and mark it with a green flag at the edge of the runway. Coordinate the use of runway markers with the FBO/airport authority.

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Determine how much runway will be required to stop in the event of a high speed abort. This distance is determined by accelerating to 80% of stall speed, then at a preplanned execution point at least 1600 feet from the end of the runway, pulling the throttle to idle and applying maximum braking to bring the aircraft to a complete stop. (The 1600 foot minimum is the estimated stopping distance required from smooth lift-off speed as extracted from AC 90-89A) Use caution not to tip the aircraft on it's nose. Measure the distance from the preplanned execution point to the point where the aircraft came to a complete stop. Once this distance is determined (after multiple test runs), add 30% and measure this distance back from the *departure* end of the runway. (Just so there is no confusion, the departure end is the end you will be stopping at or flying over, NOT the end you begin the take-off roll from.) Mark it with a red flag -- this is your "go - no go" decision point for the flight tests.

Performs "skips" or "land-backs" to explore the ground effect handling characteristics. The purpose of this procedure is to familiarize the test pilot with the landing characteristics of the aircraft (ground effect handling, float, effects of power modulation, etc.) Extreme caution must be exercised to apply only the amount of power required to lift the plane off in ground effect and then land again before the "go - no go" point on the runway is reached. Applying and maintaining full power till lift off will cause you to make an unintentional first flight. Retard the throttle to maintain no more than 5 knots above the anticipated stall speed of the aircraft during the skips. This phase of testing must be approached with a great deal of discipline as the temptation to perform a premature first flight will be high. This is your opportunity to learn how to land the airplane without having to worry about getting it slowed down to landing speeds.

Measure the stick travel required to get the airplane airborne. Again, stick travel should not exceed 25% of the total range of travel from center.

Taxi testing is complete when everyone on the test team is satisfied with the performance of the aircraft and the test pilot.

Inspect the aircraft thoroughly with special attention to the landing gear, brake system, engine and propeller. **ALL DISCREPANCIES MUST BE FIXED BEFORE MOVING TO THE FLIGHT PHASE OF TESTING.** Examine all fuel system filters and screens for metal, and change the oil and oil filter, again inspecting for metal. After this procedure is complete, perform a leak check on the engine and fuel system by performing a run-up check and then inspecting the engine for leaks.

Flight Tests

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Chase Plane Procedures

If you can't find anyone with formation flying or chase experience, **DO NOT USE A CHASE PLANE.** The increased risk is not worth the benefit the chase plane provides. A chase plane will be used for the first flight and any following flights at the discretion of the test pilot. The chase plane will serve the following functions:

Observe the aircraft for indications of problems not visible to the test pilot

Clear for other traffic in the test area

Assist in an emergency situation

Maintain situational awareness on the closest emergency landing field at all times and be ready to direct the test pilot to this field.

The chase position will be 100 to 200 feet at either the 4 o'clock or 8 o'clock position and slightly below the test aircraft. This position affords the chase aircraft the best vantage point for observing the test aircraft and clearing ahead for traffic while maintaining a position so as not to distract the test pilot. The low 6 o'clock position should be avoided as anything falling or breaking off the test aircraft is likely to hit an aircraft in this position.

The chase aircraft will have a minimum crew of two. The primary pilot will be responsible for flying the aircraft and maintaining a safe distance from the test aircraft, and the second pilot will be responsible for all other duties listed above. The chase plane crew will be thoroughly briefed on the test profile to be flown and will fully understand their responsibilities and expected communications.

Chase Plane Briefing

DRAFT

Pilot qualification requirements

Crew composition

Crew responsibilities

Formation positions

Hand signals

Emergency procedures

Test profile

Emergency Procedures

Objective

Develop a complete set of in-flight emergency procedures while calm and on the ground at zero knots that are designed to make unmanageable 100+ knot airborne situations manageable

General

The first step in any emergency procedure is FLY THE AIRPLANE. To quote the United States Air Force approach to emergency procedures, “Maintain aircraft control, analyze the situation, and take the appropriate action”. It doesn’t get more straight forward than that.

Specific EP’s to be addressed:

Brake Failure

Blown Tire

Engine Failure on Take Off

Engine vibration increases with RPM

Smoke in the cockpit

Fire in the cockpit

Engine fire

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Flight controls jammed

Out of rig condition

Canopy open in flight

Unusual Attitude Recovery

Spin Recovery

Electrical System Failure

Lost communication

Throttle stuck/unresponsive

Oil on windshield

Oil System Malfunction

Propeller throws a blade

Flight Procedures

General

Maintain a disciplined and professional approach to testing the aircraft at all times. All discrepancies discovered during flight testing will be fixed before the next flight is conducted – NO EXCEPTIONS!

Clearing turns will be accomplished before the start of in-flight maneuvering. On the first flight, the chase plane will be responsible for clearing the area for traffic.

First Flight

Objective

Determine engine reliability and flight control characteristics, particularly in the landing regime of flight. Test Duration - One sortie, 1 hour long.

Data Points to be Collected

Engine performance

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oil pressure within limits

oil temperature within limits

Fuel pressure within limits

EGT within limits

CHT within limits

Effect of carburetor heat

Flight Control Effectiveness and Handling Qualities

Yaw characteristics

Roll characteristics

Pitch characteristics

Speed brake effects

Landing regime parameters

Approximate stall speed

Low speed stability and handling characteristics

Procedures

Thorough review of all emergency procedures with the support crew and chase aircraft crew

Thorough preflight according to preflight checklist

Preflight data collection equipment

Perform all checklist items through Engine Start, and allow the engine to warm up to operating temperature.

Perform a complete check of all aircraft systems

Engine operation and engine instruments

Flight controls - free and clear, proper movement

Brakes

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Flight instruments

Avionics

Lights (strobes)

Advise tower/Unicom that an experimental aircraft is on it's first test flight, taxi to the active runway and request take off instructions.

Once cleared for take off, release the brakes and slowly advance the throttle to full power, listening for any abnormal sounds or other indications of engine trouble. Confirm that the tach, manifold pressure and oil pressure are "in the green". If any abnormality is noted on engine performance, ABORT THE TAKE OFF.

Keep the tail wheel on the runway until the rudder is effective (approximately 35 mph).

As the aircraft approaches the expected lift off speed (should be at the green flag you positioned during taxi tests), gently ease the stick back. Strive to make the first take off gentle and well-controlled, allowing the aircraft to fly itself off the runway.

If the aircraft does not want to rotate, unusual stick forces are encountered, you reach the "go/no-go" red flag, or any other unusual or unexpected event occurs, ABORT THE TAKE OFF. Do not attempt to "pull" the aircraft into the air. If you DO become airborne after this maneuver, the flight will very likely terminate with a crash landing precipitated from a stall or pilot-induced oscillation (PIO) immediately after the pitch-up.

Once airborne and a safe climb angle is established, do not make any throttle changes or excessive control inputs until above 1,000 feet.

Climb to 3,000 feet AGL and level off.

Execute Cruise checklist.

Reduce power slowly to maintain no more than 75 mph (approximately 1.5 the anticipated stall speed). This speed will reduce the chance of control surface flutter. Reference Flight Testing Homebuilt Aircraft for a more detailed discussion of flutter.

Monitor engine performance

If the engine is not operating smoothly or parameters are out of limits, land immediately and trouble shoot.

If the engine is operating smoothly and within ops limits, continue with flight control tests.

Execute flight control tests

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All initial flight control inputs will be smooth and small. Any abrupt or abnormal response to initial control inputs may indicate a rigging problem. Control pressures should increase in proportion to control deflection. If control pressures do not change or stick forces lighten as deflection increases, the aircraft may have a stability problem. If the aircraft is unstable at any point in the test sequence, set up for a straight-in landing as soon as possible, avoiding large control inputs. The tests executed during this flight are primarily designed to prepare the test pilot to land the aircraft by identifying any control problems in the approach to landing flight regime.

Neutral Stick Stability - stabilize the aircraft in unaccelerated level flight and release the stick, noting aircraft response.

Rudder - yaw the aircraft 5 degrees to the left and right and release rudder pressure. Note rudder pedal deflection required and aircraft handling qualities. Yaw should dampen out within 5 oscillations. Arrest oscillations if necessary by resting feet on rudder pedals to maintain neutral rudder.

Elevator - raise the nose 3 degrees, stabilize the climb, and trim. Note stick deflection. Level off and retrim. Lower the nose 3 degrees, trim, and note stick deflection. Level off and retrim.

Ailerons - bank 5 degrees to the left and then to the right. If the aircraft is operating smoothly, perform several 90 degree clearing turns at no more than 10 degrees of bank. Follow this with two 360 degree turns at 10 degrees of bank, one to the left and one to the right. Increase the bank angle for succeeding turns to 20 degrees.

Execute Climb Checklist and climb to 5,000 feet AGL. Closely monitor engine instruments during the climb.

Simulate a traffic pattern at 5,000 feet. Test the flaps/speed brake effectiveness. Note changes in trim/attitude/power required to maintain level flight. Confirm at least 25% of aft stick travel remains.

Execute the Descent and Before Landing Checklists, and practice an approach to landing at 4,000 feet AGL, and then again at 3,000 feet AGL. Use an approach speed of 65 mph (approximately 1.3 times the expected stall speed).

Clean up the aircraft, execute the Climb Checklist, and climb back to 5,000 feet AGL.

Fly straight and level at 75 mph for about 10 minutes, trimming the aircraft as well as possible. Note the trim position and use it as your new take off trim position. Use this time to rest a bit, collect and record your thoughts, and observe the level flying characteristics of your aircraft. Note any required changes to rudder and aileron trim tabs. The stick should be slightly forward of the mid position in level flight.

Execute an approach to stall maneuver. The purpose of this maneuver is to further demonstrate the low speed handling characteristics of the aircraft, and to determine a reference speed to be used as the preliminary stall speed to calculate the approach speed for the first approach to landing.

Execute clearing turns.

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Stabilize airspeed, heading, and altitude.

Apply carb heat

Establish landing configuration

Reduce power to about 1000 RPM and trim.

When the airspeed reaches 70 mph (1.4 times predicted stall speed), raise the nose slowly so as to maintain altitude, and keep the ball/turn coordinator centered. Note the rate of deceleration, which should be approximately 1/2 mph per second, and observe the changes in attitude, stick forces, and rudder required.

Make small control inputs during the deceleration at about 5 mph intervals to confirm proper aircraft response, particularly in negative pitch, as the aircraft slows down. Discontinue the test if elevator authority decreases to an unacceptable level (i.e. you exceed 75% of the total stick travel range or your ability to recover from the nose-up attitude becomes questionable).

At the onset of pre-stall indications (i.e. buffet, loss of aileron effectiveness, nose rise, etc.) or upon reaching 50 mph, discontinue the test, recover the aircraft, and record the indicated air speed at which the buffet occurred. This is the reference stall speed for the first landing.

Recovery from the stall onset should be a smooth and quick forward stick movement.

Be prepared to counter any wing drop with rudder, not aileron. In a near-stalled condition, aileron input may induce a stall or sudden entry into a spin.

(Insert discussion of the five phases of flight that evolve into a spin, and how to recover from each)

(Stall warning)

(Stall)

(Departure)

(Post-stall gyration)

(Incipient phase)

(Fully developed spin)

Practice recoveries from pre-stall buffet until the test pilot is comfortable with his ability to recognize the pre-stall characteristics and recover the aircraft in the landing configuration.

Execute the Descent and Before Landing Checklists, and enter the traffic pattern for several low approaches to familiarize the test pilot with the aircraft's handling characteristics in ground effect.

Use a final approach speed between 1.3 and 1.4 times the reference pre-stall speed. Using 50 mph as a reference speed, this would be between 65 and 70 mph (nominally 70 mph). Have your chase plane crew back up your calculations. You DO NOT want to be too slow on final approach!

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Land the aircraft

Plan a touchdown point within the first 1,000 feet of the runway.

Plan to go around. If the landing conditions are not ideal, or you reach the red flag (go/no-go) before you are able to apply the brakes, or you don't like the situation for ANY reason, GO AROUND.

*After landing, **FLY THE AIRCRAFT ALL THE WAY TO THE CHOCKS**, and be sure to execute the After Landing, Before Engine Shut Down, and Engine Shut Down Checklists.*

Secure the aircraft, perform a detailed post-flight inspection, and debrief the flight with the ground and chase plane crews. Note any squawks, no matter how minor, and ensure they are all fixed prior to the next flight. Get a clean flight suit!

Congratulations, it actually flies!!! Pop the champagne, and celebrate your accomplishment! Do NOT plan to fly the second flight on the same day (popping the champagne assures this won't happen!). Use the rest of the day to analyze the data you collected, make any necessary adjustments or repairs, assess the aircraft performance and make any necessary adjustments to your flight testing approach. Prepare yourself and the aircraft for the second flight.

(Insert section on data analysis – define method of collating/reducing/recording data and findings. Begin squawk record)

Second Flight

Objective

Reaffirm the first flight findings and verify adjustments and corrections made as a result of first flight data analysis.. Test Duration - Minimum of one sortie, one hour long.

Data Points to be Collected

Same as first flight

Test Procedure

Confirm all squawks from the first flight are fixed

Perform a complete engine run-up series if adjustments/alterations were made to the engine, propeller, baffling, or fuel system.

Perform low/high speed taxi tests if adjustments/alterations were made to the engine, propeller, landing gear, brakes, flight controls, flight control rigging, canopy latching mechanism, cowling, or anything else that may affect ground handling or in-flight control.

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Execute first flight procedures, concentrating on areas where discrepancies were noted on the first flight. If discrepancies are repeated, halt further testing until a solution can be found. Apply a root cause analysis process to aid in discrepancy resolution. Reference Appendix XYZ for root cause analysis methods.

Perform a detailed post flight inspection, and correct ALL squawks before proceeding to the next flight test.

Confirm or reject the data collected on the first flight. Evaluate the need to gather more data on the "first flight" parameters before progressing further in the flight test plan. Repeat the "first flight" procedures on the next flight and subsequent flights if required to collect all the necessary data points..

Engine Performance Validation Tests

Objective

To validate engine performance parameters and reliability. Test Duration - Minimum of 1 sortie, one hour long.

Data Points to be Collected

Oil pressure

Oil temperature

Fuel pressure

CHT

EGT

Manifold pressure

Fuel flow

Test Procedure

Confirm all squawks from the previous flight are fixed.

Do not exceed 80% of max cruise speed (nominally $.8 \times 180 = 146$ mph) to avoid control surface flutter.

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Collect data on the following parameters in 5% increments from 55% to 75% RPM, not to exceed 80% of cruise speed, with the mixture full rich. Stabilize for a minimum of 2 minutes at each increment before recording data, and also record the airspeed and pressure altitude (or outside air temperature and indicated altitude to calculate pressure altitude during post flight analysis).

(see "Data Points to be Collected" section above)

Repeat the above procedure with the mixture leaned to max EGT.

Repeat the above procedure with the carb heat on.

Conduct a thorough post flight inspection, and record fuel and oil consumption.

Make adjustments as needed. The test pilot should make an initial determination on the aircraft stability and engine reliability.

Fix all squawks before the next flight. Evaluate the progress of the flight test program and make any necessary modifications.

Engine Reliability Validation

Objective

To build on the data established in previous tests and start expanding on the flight test envelope in a thorough and cautious manner. This operational data will be added to the Flight Manual. Duration - Minimum of six sorties, one hour per sortie.

Data Points to be Collected

Climb and descent from and to a preselected altitude (monitor engine parameters)

Test Procedure

General

These tests are focussed on engine performance. It is not intended to gather reliable aircraft performance data (best rate of climb, best angle of climb, etc.) at this time. These tests will be conducted using a stair step method of climbs and descents from a baseline altitude. The climb and decent procedures are described separately below, but will be performed in an alternating manner in flight.

Climb Tests

Climb to 1,000 feet AGL, reduce power, trim for and maintain straight and level flight so as to maintain 80% of max cruise speed, for a minimum of 10 minutes to stabilize oil pressure and temperature.

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Apply full power, raise the nose 5 degrees, trim and maintain climb for 1 minute. Record (expand this section to include a table to record data) airspeed and all engine temperatures and pressures. DO NOT EXCEED RECOMMENDED MAXIMUM TEMPERATURE/PRESSURE

Reduce power, trim for level flight, and allow temperatures and pressures to stabilize.

Repeat climb test at 5 degrees, this time for 2 minutes. Record temperature and pressure data.

Repeat test, increasing climb time by 1 minute each time until temperatures and pressures reach a maximum value (i.e. stop increasing) or 5 minutes of climb time at full power is reached.

Increase climb angle to 10 degrees and incrementally increase climb times until temperatures and pressures reach a maximum value or 5 minutes climb time at full throttle is reached.

Increase climb angle to 15 degrees and repeat procedure.

Descent Tests

Stabilize the aircraft at 5,000 feet AGL. Clear the airspace below the aircraft, execute the Descent Checklist, and set power so as to descend at a maximum airspeed of 1.5 times the expected stall speed (nominally 75 MPH) at a shallow (< 5 degrees) descent angle. Continue for 30 seconds and record engine data.

Repeat as in the climb test, incrementally increasing the descent duration in 30 second increments and the descent angle as appropriate.

NOTE: If a significant drop in CHT occurs (>30 F degrees), increase RPM and decrease descent angle to avoid shock cooling the cylinder heads.

Record all temps, pressures, altitudes and airspeeds for inclusion in the Flight Manual. (expand to include data recording table)

Perform a "Condition Annual Inspection" using the following checklist after all flights in this phase have been completed.

Check torque on engine mount, prop, and landing gear bolts.

Check hinges and rod end bearings for attachment and play.

Check cable installations and tension, as well as control travel.

Check oil and fuel systems for metal or other contaminants

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Perform a CO inspection to ensure operational vibration has not opened any leaks.

Stability Tests and Control Checks

Objective

To determine the aircraft's stability limits and range of control. Test Duration - Minimum of fifteen sorties, one hour each.

Data Points to be Collected (to be expanded on)

Test Procedure

General

All tests will commence from a state of equilibrium (straight and level, unaccelerated flight)

Test for Static Longitudinal Stability

Test for Static Longitudinal Stability

Trim for zero stick forces with the aircraft in equilibrium at a low cruise speed (100 mph would work well).

Without trimming again, pull slightly on the stick and stabilize at a speed 10% lower than starting speed (90 mph). Back pressure should be required to maintain this speed. If it is, apply further back pressure and stabilize at 20% below starting speed (80 mph).

If back pressure is still required, the aircraft exhibits positive static longitudinal stability (GOOD). If no force is required, static longitudinal stability is neutral (MARGINAL). If a push on the stick is required, static longitudinal stability is negative (BAD), and you must stop the test program and correct this condition (i.e. IT'S DANGEROUS!)

Test for Dynamic Longitudinal Stability

Short Period Test

Trim for zero stick forces with the aircraft in equilibrium at a normal cruise speed.

Without trimming again, push the nose down about 3 degrees with a smooth but fairly rapid motion.

Quickly pull on the stick to bring the pitch attitude to 3 degrees above the original trimmed attitude.

Push the stick forward toward the original trimmed attitude.

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As the attitude approaches the trim attitude, release the stick (but continue to guard it).

Observe and record the pitch oscillation. An aircraft with positive dynamic longitudinal stability will dampen the pitch oscillation and return to the originally trimmed attitude. Look for this to happen in less than 10 oscillations.

Long Period Test

Trim for zero stick forces with the aircraft in equilibrium at a normal cruise speed.

Without trimming again, push the nose down until a speed about 5 mph above the trimmed speed is reached, then release the stick (again guard it).

Positive stability will dampen the oscillations to the trimmed airspeed, neutral stability will continue to oscillate with constant magnitude, and negative stability will continue to oscillate with increasing magnitude (diverging oscillation). None of these conditions are dangerous, but an aircraft with divergent dynamic longitudinal stability will require constant attention and will be difficult to trim.

Test for Lateral-Directional Stability

Lateral Stability Test

Climb to 5000 feet AGL and trim for low cruise in straight and level flight.

Slowly enter a side slip. The aircraft should be able to hold heading with rudder at a minimum bank angle of 10 degrees. Control forces and deflections should increase steadily, but not necessarily in proportion with one another, until either the rudder or ailerons reach full deflection or the maximum side slip angle is reached.

Release the ailerons while still holding full deflection on the rudder. The aircraft should roll towards wings level.

Record lateral stability observations.

Repeat process for side slips in both directions.

(Discuss Dutch roll and what it indicates)

Directional Stability Test (this is written more as a procedure, need to expand into plan verbage.)

Climb to 5000 feet AGL and trim for low cruise in straight and level flight.

Slowly yaw the aircraft using the rudder, keeping the wings level with aileron.

Release the rudder. The aircraft should tend to return to straight flight.

Record directional stability observations.

Repeat process for both left and right yaw.

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Test for Spiral Stability

Climb to 5000 feet AGL and trim for low cruise in straight and level flight.

Enter a 15 to 20 degree banked turn in either direction and release the controls.

Bank angle decreases - positive spiral stability

Bank angle constant - neutral spiral stability

Bank angle increases - negative spiral stability

As with negative dynamic longitudinal stability, negative spiral stability is not necessarily dangerous, but the aircraft will require constant attention and will be more difficult to fly.

Airspeed Indicator In-Flight Accuracy, "V" Speed Determination and Slow Flight Tests

Objective

To determine airspeed indicator accuracy, and determine/validate Best Rate of Climb, Best Angle of Climb, and explore slow flight handling characteristics. Test Duration: Minimum of ten sorties, one hour per sortie.

Data Points to be Collected

Airspeed indicator in-flight accuracy

Stall speed

Best rate of climb

Best angle of climb

Slow flight handling and performance

Test Procedure

Airspeed In-flight Accuracy Test

The most accurate way to measure the airspeed indicating system accuracy is to time how long it takes to fly a triangular course of equal legs at a constant altitude and indicated airspeed. Use an E6B or other computer to convert this ground speed to true indicated speed (you will also need to know the altitude and OAT to perform this calculation.) The difference between the calculated airspeed and the indicated airspeed is the installation and indicator error.

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Start the test at the lowest safe airspeed and repeat it in increases of 10 mph/knot increments until reaching cruise speed. Errors will be greatest at low speeds due to the angle of attack of the pitot mast.

GPS may be used to validate the data collected while flying the course.

Record all of the data and prepare an airspeed calibration table for the Flight Manual.

Conduct a thorough post flight inspection and assure all squawks are fixed before the next flight.

Best Rate of Climb/Best Angle of Climb Tests (need to expand this section, state separate objectives, data to be collected, and procedures)

Perform a series of vertical "S" maneuvers before beginning these tests to get a feel for maintaining airspeeds in climbs and descents. This will aid in hitting and holding accurate test points.

Stabilize the aircraft in straight and level flight at 1000 feet AGL, 90 degrees to the wind, at a speed 15 mph/knots faster than the predicted best rate of climb speed.

Apply full power and begin a climb at an attitude that will maintain your starting airspeed.

Passing through 1100 feet AGL (or any other convenient reference altitude), hack a stopwatch and time your climb for one minute.

Level off and record the altitude gained in one minute at the target airspeed.

Descend to 1000 AGL, stabilize at a speed 5 mph/knots slower than the first test, and repeat the procedure.

Repeat this process, decreasing the speed by 5 mph/knots each time, until the rate of climb shows a decreasing trend.

Plot this data on a graph of Rate of Climb vs. Airspeed to determine the best rate of climb airspeed.

Best Angle of Climb is determined using the same graph from the best rate of climb test. Draw a line from the origin (zero point) of the graph tangent to the best rate of climb curve. The point of intersection is the best angle of climb speed.

Slow Flight Tests (to be expanded on)

The primary purpose for these tests at this point in the test program is for the test pilot to become familiar with the aircraft's handling qualities at minimum airspeeds and power settings. The "real" slow flight and stall speeds will be determined later in the test program at full gross weight.

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Climb to 6000 feet AGL and set the speed at 1.3 times the stall speed. Once stabilized, reduce the airspeed 5 mph/knot increments until you are 5 knots above the predetermined stall speed.

Observe, qualitatively evaluate, and record the slow flight characteristics. Maneuver as required, keeping bank angles at 5 degrees or less to avoid unplanned stalls.

Repeat the process with flaps/speed brake extended.

Perform a "Condition Annual Inspection" in accordance with the following checklist.

Check torque on engine mount, prop, and landing gear bolts.

Check hinges and rod end bearings for attachment and play.

Check cable installations and tension, as well as control travel.

Check oil and fuel systems for metal or other contaminants

Perform a CO inspection to ensure operational vibration has not opened any leaks.

Envelope Expansion

Objective

To develop aircraft performance data across the weight and CG ranges. Test Duration - Minimum of ten sorties, one hour each.

Data Points to be Collected (to be expanded on)

Airspeed indicator accuracy

Determine all of the following at full gross weight:

CG range

All "V" speeds

Stability characteristics

Slow flight characteristics

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Test Procedures

General

Repeat the applicable test procedures defined in earlier phases of the test plan at increasing gross weight until full gross weight is achieved. All ballast must be attached securely to the airframe (define specific points where ballast will be loaded). If using bags of shot or sand, secure each bag individually and then cover all the ballast with a cargo net. Once maximum gross weight is achieved, explore the CG envelope by incrementally moving the CG back and repeating the tests again. **DO NOT EXCEED THE ADVERTISED CG RANGE OR CONTINUE PAST A STOP POINT. FAILURE TO HEED THIS WARNING MAY LEAD TO AN UNRECOVERABLE FLIGHT CONDITION.**

Maximum Gross Weight Tests

Increase weight in 20% increments for each flight.

Change CG to aft by 20% of CG range for each flight after reaching full gross weight.

STOP POINTS

Neutral or negative stability develops

Unsatisfactory stall characteristics develop

Exceed 75% stick travel range deflection non-maneuvering

Service Ceiling Tests

Coordinate with the local Flight Standards District Office to amend the Operating Limitations to permit a climb above 18,000 feet MSL if you think you can get that high. Also get a waiver if you don't have a transponder.

Coordinate with the local Flight Service Station or ATC facility to schedule airspace to make the test.

Install a portable oxygen system if you plan to go above 12,000 feet MSL

Review the engine manufacturer's mixture leaning procedures.

Conduct the test

Climb in a series of 1000 foot steps until you can no longer maintain a 100 foot per minute climb rate.

At each altitude step, thoroughly examine the engine instruments and evaluate aircraft control capability. Stop the test if either becomes suspect.

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Stall Tests (define stall, departure, go into excruciating detail about methodology to use and procedures to follow.)

The first series of stall tests should be started with the aircraft in a forward CG condition to reduce the potential for spins. Successive testing will be done at full gross weight with the CG moved progressively further aft until the entire CG range has been tested or you reach a safety of flight stop point. Begin the tests at a minimum of 6000 feet AGL to allow ample room for recovery from inadvertent spin entry or unusual attitudes. While performing the stall tests, look for the ideal of a “warning buffet” 5 -10 knots above stall speed, and then a clean break with the nose falling straight forward with no tendencies for pitch up or wing drop during the departure. Any deviation from the ideal should be noted for inclusion in the Flight Manual.

Execute the power on stall tests with an incremental approach, starting at low power settings and incrementally increasing the power for each successive stall until full power is reached. Remember to keep the ball centered, and be prepared to counter wing drop WITH RUDDER during the stall recovery as it is more likely for this condition to occur during power on stalls. WARNING: USING AILERON TO COUNTER WING DROP IN A POWER ON STALLED CONDITION MAY LEAD TO SPIN ENTRY! KEEP THE STICK CENTERED Laterally until flying airspeed is regained. Use the highest stall speed determined during these tests to set the aircraft stall warning system, if so equipped. The stall warning should be set to sound 5 mph/knots above the highest stall speed encountered.

Review out of control flight and recovery procedures. (Detail expected recovery procedures)

Power off stalls

Stabilize the aircraft in level flight.

Reduce speed to 1.3 times the expected stall speed, trim, and look for indications of the approaching stall (buffet, loss of aileron effectiveness, nose rise, nose slice, wing drop, etc.). CAUTION: IT IS VERY IMPORTANT NOT TO TRIM INTO THE STALL. LEAVE THE AIRCRAFT TRIMMED TO 1.3 VS TO AID IN RECOVERY AFTER THE STALL.

Pull the throttle to idle and apply back pressure to the stick so as to maintain altitude as the speed bleeds off at about ½ mph/knot per second. If the aircraft is slowing too quickly for accurate observation of speeds and handling characteristics, allow the aircraft to descend while slowing at a more controlled rate. Expect things to happen very quickly, especially the first time this procedure is executed.

Confirm that the turn and bank indicator is centered (needle and ball).

Observe and record the power off stall warning indications and the speed at which they start.

Observe and record the aircraft stall characteristics and the speed at which the stall occurs.

Recover from the stall by relaxing stick back pressure, apply power, and execute a dive recovery once the aircraft has flying airspeed.

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Observe and record recovery characteristics and altitude lost during the recovery..

Record all observations for inclusion in the Flight Manual.

Repeat the above test procedures for all possible configurations and gross weights and record stall speed data.

Power on stalls

Stabilize the aircraft in level flight at a low cruise power setting.

Increase the pitch attitude at this power setting until the stall buffet is reached, then hold the pitch attitude with the ball centered.

Observe the speed at which the stall occurs and the power on stall characteristics.

Recover from the stall by relaxing back pressure, reduce power, stop any rotation WITH RUDDER ONLY, and recover from the dive.

Record observations for inclusion in the Flight Manual..

Spins - NOT PLANNED AT THIS TIME

Accelerated Stalls - NOT PLANNED AT THIS TIME

Data Analysis (to be expanded on)

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The data you are planning to painstakingly collect is of little value unless you take the time and make the effort to thoroughly analyze it and draw conclusions about your aircraft's performance. Here are some of the parameters you will be analyzing and some suggestions on how to perform that analysis.

Engine performance parameters vs RPM and Altitude - tabulate and graph data points

Fuel flow vs RPM and Altitude - tabulate and graph data points, include in Flight Manual

Airspeed vs RPM and Altitude - tabulate and graph data points, include in Flight Manual

Climb Rate vs Airspeed and Altitude - tabulate and graph data points, include in Flight Manual

Other "V" speeds - tabulate data points, determine average nominal values, include in Flight Manual

Airspeed Calibration - tabulate and graph data, include in Flight Manual

Stability Parameters - Tabulate quantitative and qualitative data points, save for comparison with future modifications and the performance of other aircraft

All of the above data lends itself to analysis with a computer spreadsheet, but as yet I have not developed the spreadsheets. The important thing to remember is to hang on to all of the data cards you use during your test program so that you can refer to the original test data if the need ever arises.

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Appendix 1. Aircraft Condition Inspection Checklist (Airworthiness Inspection)

AIRCRAFT IDENTIFICATION				
Type/serial number.		Engine model/ser #		
N number		Engine total time		
Airframe total time		Propeller model/ser #		
Owner		Propeller total time		
GENERAL				
S = SATISFACTORY, U = UNSATISFACTORY			Builder	
			Inspector	
Correct all unsatisfactory items prior to flight			S	U
Registration/airworthiness/operation limitations				
Aircraft identification plates installed				
Experimental placard installed				
Weight and balance/equipment list (updated for each flight)				
Radio license				
WINGS				
Remove inspection plates/fairings				
General inspection of the exterior/ interior wing				
Flight controls balance weights for security				
Flight controls proper attachment (no slop)				
Flight control hinges/rod end bearings serviceability				
Flight controls properly rigged/proper tension				
Inspect all control stops for security				
Trim control properly rigged				
Trim control surfaces/hinges/rod end bearings servicing				
Frayed cables or cracked/frozen pulleys				
Skin panels delaminate/voids (coin test)				
Popped rivets/cracked/deformed skin				
Fabric/rib stitching/tape condition				
Lubrication				
Wing attach points				
Flying/landing wires/struts for security				
Corrosion				
FUEL SYSTEM				
Corrosion				
Fuel lines for chafing/leaks/security/condition				
Sump all fuel tanks for water or debris				
Fuel caps for security				
Fuel placard				
Fuel valve/cross feed/for operation and security				
Clean fuel filters/gasolator/flush system				
Inspect fuel tank vent system				
LANDING GEAR				
Inspect struts/torque links for attachment				
Inspect struts for proper extension				
Inspect for hydraulic leaks				
Check all bushings for wear/free play				
Check lubrication				
Inspect wheels for alignment				

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Wheel/tires for cracks and serviceability				
Wheel bearings for lubrication				
Inspect for corrosion				
Inspect nose gear for cracks and travel				
Inspect tail wheel for cracks and travel				
Perform gear retraction test/check indicator lights				
Emergency gear retraction system				
Check tire pressure				
Brake lining within limits				
Brake disks for cracks, wear, and deformity				
Brake hydraulic lines for leaks and security				
FUSELAGE				
Remove inspection plates and panels				
Inspect bulkheads and stringers for popped rivets and cracked skin				
Inspect for delaminated skin/voids (coin test)				
Inspect the security of all internal lines				
Inspect windows/canopy for cracks and fit				
Inspect door or canopy latching mechanism				
Inspect fire wall for distortion and cracks				
Inspect rudder pedals and brakes for operation and security				
Inspect behind firewall for loose wires and chafing lines				
Check control stick/yoke for freedom of movement				
Check flap control operation				
Check cable and pulleys for attachment and operation				
Perform flood-light carbon monoxide test				
Ensure the cockpit instruments are properly marked				
Inspect instruments, lines, for security				
Check/clean/replace instrument filter				
Inspect cockpit fresh air vents/heater				
Vents for operation and security				
Inspect seats, seat belts/shoulder				
Harness for security and attachment				
Corrosion				
Check ballistic chute installation per manufacturer recommendations				
EMPENNAGE/CANARD				
Remove inspection plates and fairings				
Inspect canard attach points for security				
Inspect vertical fin attach points				
Inspect elevator/stabilizer attach points				
Inspect hinges/trim tabs/rod ends for attachment and free play (slop)				
Inspect empennage/canard skin for damage/corrosion				
Inspect all control cables, hinges and pulleys				
Inspect all control stops				
ENGINE				
Perform compression test #1 #2 #3 #4				
Change oil and filter (check for metal)				
Inspect ignition harness for condition and continuity				
Check ignition lead cigarettes for condition/cracks				
Clean and gap spark plugs				
Check magneto timing/points/oil seal/ distributor				
Inspect engine mount/bushings				
Inspect engine mount attachment bolt torque				

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Inspect alternator/generator attachment				
Check alternator/generator belt condition				
Inspect cylinders for cracks/broken fins/exhaust stains				
Inspect engine baffles for cracks/condition				
Check for oil leaks inspect vacuum pump and lines				
Inspect oil vent lines				
Inspect all cabin heat/carb heat/defroster ducts for condition				
Inspect carburetor for security & clean inlet screen				
Inspect intake hoses/seals for security/leaks				
Inspect throttle/mixture/carb heat/ control for proper travel and security				
Inspect carb heat air box for cracks/ operation				
Inspect condition of flexible fuel and oil lines				
Inspect oil cooler for leaks and condition				
Check exhaust system for attachment and condition				
Check muffler/internal baffle/for security				
Check exhaust pipes/flanges for security & attachment				
Repack exhaust gaskets as required				
Check cowling for cracks and security				
PROPELLER				
Check spinner and back plate for cracks				
Inspect for cracks/stone damage/nicks				
Check for delamination (wood/composite blades)				
Check prop bolts torque/safety wire				
Check for oil leaks (crankcase nose seal)				
Grease leaks (constant speed prop)				
Check propeller governor for leaks and operation				
Check prop track				
Check prop balance (wood prop)				
ELECTRICAL				
Spare fuses available				
Battery serviced and free from corrosion				
Battery box free from corrosion				
ELT battery free from corrosion and				
Current battery				
Check landing light operation				
Check position lights operation				
Check anti collision light for operation				
Inspect all antenna mounts and wiring for security				
Check all grounding wires (engine to airframe, wing to aileron/flap, etc.)				
Inspect radios/leads/wires for attachment & security				
Inspect circuit breakers/fuses panels for condition				
OPERATIONAL INSPECTION				
Visual inspection of the engine/ propeller				
All inspection panels and fairings secure				
Personnel with fire bottles standing by				
Brake system check				
Proper fuel in tanks				
Engine start procedures				
Oil pressure/temperature within limits				
Vacuum gauge check				
Magneto check/hot mag check				
Idle rpm/mixture check				

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Static rpm check				
Electrical system check				
Cool down period/engine shut down				
Perform oil, hydraulic, and fuel leak check				
PAPERWORK				
Airworthiness directives				
Record findings and sign off inspection and maintenance in aircraft log books				

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Appendix 2. Aircraft Normal Procedures Checklists

PREFLIGHT

The aircraft should be given a thorough visual inspection prior to each flight.

1. Open canopy.
2. Check canopy for cracks and nicks
3. CHECK:
 - a. Magneto Switches - OFF.
 - b. Master Switch - OFF.
 - c. Fuel quantity - As required.
4. Drain fuel sample from the sump drain.
5. Check left aileron for freedom of movement. Check lateral free play (3/32" Max.)
6. Inspect left wheel pant and tire for general condition (wear, cuts, abrasions, and proper inflation).
7. Check left wing surface for damage, fuel cap secure
8. Drain fuel sample from left wing tank sump.
9. Check header tank fuel cap secure.
10. Check oil level . **DO NOT OPERATE ENGINE WITH LOW OIL LEVEL.**
CAUTION Overfilling the sump may lead to high oil temperature.
11. Check propeller for cracks, nicks, and security. Check cowling for damage and security.
Check air inlets and outlet for obstructions.
12. Check right wing surface for damage, fuel cap secure.
13. Check pitot tube for obstructions.
14. Drain fuel sample from right wing tank sump.
15. Inspect right wheel pant and tire for general condition (wear, cuts, abrasions, and proper inflation).
16. Check right aileron for freedom of movement. Check lateral free play (3/32" Max.).
17. Inspect fuselage for damage. Check static port clear
18. Check right horizontal stabilizer for damage. Check ~~right~~ elevator for freedom of movement. Check lateral free play (3/32" Max.)
19. Check vertical stabilizer surface for damage. Check rudder for freedom of movement.
Check rudder vertical free play (3/32" Max.)
20. Inspect tailspring for damage. Inspect rudder/tailwheel cables and attachments for security and damage. Inspect tailwheel and weldments for general condition (wear, cuts, abrasions).
21. Check left horizontal stabilizer for damage. Check ~~left~~-elevator for freedom of movement. Check lateral free play (3/32" Max.)
22. Inspect fuselage for damage. Check static port clear

BEFORE STARTING ENGINE

1. Seat Belts and Shoulder Harnesses - buckled and adjusted
1. Check all controls for operation.
2. Check toe brakes - ON.
3. Mixture - IDLE CUTOFF.
4. Fuel Valve - ON.

NORMAL ENGINE START

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1. Engine Monitor - BATTERY
2. Throttle - Cracked 1/4".
3. Carburetor heat - OFF.
4. Master Switch - ON.
5. Magneto Switches - ON.
6. Mixture - FULL RICH for 3 seconds, then IDLE CUTOFF.
7. Starter Button (on throttle) - Push
8. Mixture - FULL RICH when engine catches
9. After engine is running, check to verify oil pressure within 20 seconds.
10. Engine Monitor - ON
11. Warm up engine at 1000 RPM.

FLOODED ENGINE START

1. Master Switch - OFF
2. Magneto Switches - OFF.
3. Mixture - IDLE CUTOFF.
4. Throttle - FULL ON.
5. Aircraft - TIED DOWN and CHOCKED.
6. Turn engine through backwards by hand 10 to 20 revolutions.
7. Mixture - IDLE CUTOFF
8. Starter Switch - Turn to "Start" .
9. Mixture - FULL RICH when engine catches.
10. After engine is running: Check to verify oil pressure within 20 seconds.
11. Warm up engine at 1000 RPM.

BEFORE TAXI

1. Seat belts and shoulder harnesses - Checked
2. Strobes/Beacon - On
3. Avionics Master Switch - On
4. Radios - Set and Checked

TAXI

1. Check tailwheel steering and brakes.
2. Check ammeter.
3. Verify correct operation and settings of all instruments and gauges.

BEFORE TAKEOFF

1. Seat belts - checked
2. Canopy - Locked, secondary latch in place
3. Altimeter - set
4. Controls - free, with control surface movement in the proper directions with no binding
5. Trim - set for takeoff
6. Fuel valve - on
7. Mixture - full rich
8. Engine runup - 1700 RPM
 - a. check left and right mags
 - b. Carb heat - on, check for RPM drop, then carb heat - off
9. Engine - check idle

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TAKEOFF - NORMAL

1. Throttle: Full open.
2. Controls: Ease stick forward to lift tail, rotate and lift off at 65 mph.
3. Climb speed 90 mph.

CLIMB This one isn't a checklist, needs to be rewritten.

1. Normal - 100 mph.
2. Best Rate - 85 mph at S.L. full throttle.
3. Best Angle - 70 mph at S.L. full throttle.

CRUISE

1. Power setting: 2700 to 3200 RPM.
2. Trim - As required.
3. Mixture - Lean to peak RPM/EGT.
4. Cowl Flap As required.

DESCENT CHECK

1. Boost Pump - On
2. Mixture - full rich
3. Carb heat - on
4. Airspeed - as required
5. Flaps/Speed brake - as required

BEFORE LANDING

- 1 Fuel selector valve - ON
1. Mixture - Full rich.
2. Carburetor heat - As required.
3. Airspeed: 85 mph.

LANDING

1. Touchdown main wheel first.
2. Maintain directional control with the rudder/tailwheel steering.
3. Brake - as required

LANDING - OBSTACLE CLEARANCE

1. Airspeed: 80 mph on final.
2. Touchdown main wheel first.
3. Maintain directional control with the rudder/tailwheel steering.
4. Brake - as required-

AFTER LANDING

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1. Carburetor heat - OFF
2. Speed Brake - UP

SHUT-DOWN

1. Avionics master switch - OFF.
2. Mixture - IDLE CUTOFF
3. Magneto Switches - OFF.
4. Master Switch - OFF.
5. Fuel Valve - OFF.
6. Chock wheels and tie down aircraft.

POST-FLIGHT INSPECTION

Same as preflight except for draining fuel sumps and with the additional step of securing the aircraft.

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Appendix 3. Aircraft Emergency Procedures Checklist (to be expanded on)

Ground Emergencies

Provide a copy of this plan to the ground support crew, the FBO/tower, and emergency response team at the field. The ground emergency procedures should be tailored to the specific operation of N415RJ and its aircraft systems.

Canopy latching/removal (to be expanded on)

Safety harness release procedures (to be expanded on)

Location and operation of the fuel shut off valve(s) (to be expanded on)

Master switch location/OFF position (to be expanded on)

Cowling removal procedures (to be expanded on)

Battery location/access/disconnect procedures (to be expanded on)

Fire extinguisher location and use (to be expanded on)

How to safe up ballistic recovery system/other pyrotechnic safety devices
(to be expanded on)

Engine Failure (to be expanded on)

Runaway Throttle (to be expanded on)

Fire (to be expanded on)

Smoke in the Cockpit (to be expanded on)

Brake Failure/Stuck Brake (to be expanded on)

Wheel/Tire Failure (to be expanded on)

In-Flight Emergencies

Engine failure on take off (to be expanded on)

Engine failure in flight (to be expanded on)

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Flight control malfunction/out of rig (to be expanded on)

Engine/cockpit fire (to be expanded on)

Engine Overheat (to be expanded on)

Structural Failure (to be expanded on)

Excessive Engine/Prop Vibration (to be expanded on)

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Appendix 4. Test Cards (to be expanded on)

Test cards are nothing more than the test procedures in checklist format. They help the test pilot keep organized in his airborne operations, and allow the chase aircraft and ground support team to stay with and anticipate the needs of the test pilot. The ground support team should do all the manual recording of data so that the test pilot can concentrate on flying the airplane without having to go “head down” to write data points.

Airport Selection	Yes	No
Runway headings/lengths acceptable		
Obstructions acceptable		
Runway condition acceptable		
Airport facilities acceptable		
Airport traffic volume acceptable		
Fire fighting equipment available		
Emergency response team available		
Emergency landing fields acceptable		

Distance to take off at minimum smooth lift off speed, fly for 5 seconds without climbing, land and stop straight ahead	2,800 feet.
Distance to reach smooth lift off speed	700 feet
Distance covered in 5 seconds of flight at minimum lift off speed	550 feet
Distance to stop from minimum smooth lift off speed (including air and ground distance)	1600 feet
Distance to take off at slow approach speed and climb at 1 foot per 20 feet lateral to 50 feet	1900 feet

Test Pilot Qualifications	
	Physically fit
	No alcohol or drugs within the 24 hours prior to the test
	Rated, current, competent
	Current medical and biennial flight review
	Flight time requirements
	At least 100 hours solo time
	At least 50 take-offs and landings, 10 in the last 30 days
	Familiar with airport and emergency fields
	Has flown in similar/same type
	Has had recent instruction/experience in same/ like-type
	Has conducted flight test profile in same/ like-type
	Has logged one hour of unusual attitude recoveries within 45 days of flight
	Has studied and practiced all in-flight and ground emergencies with ground crew
	Has reviewed expected performance characteristics and studied all available material on the aircraft
	Has reviewed NTSB reports on past accidents in same type aircraft
	Has become completely familiar with the cockpit.

Transporting the Aircraft	
	Confirm weather forecast
	Verify hangar/storage space available
	Contact crew
	Get trailer/truck
	Secure aircraft to trailer/truck
	Secure wings to trailer/truck
	Brief route/convoy procedures
	Move to airport
	Brief unload procedures
	Unload aircraft and wings
	Secure aircraft in storage area

Required Documents		
	Registration	"EXPERIMENTAL"
	Weight & Balance	Passenger Advisory
	Airworthiness Application	Aircraft ID Plate
	Airman Rating Application	Builder's/Aircraft Log
	Notarized Affidavit	Engine Log
	3-D Cutaway Drawing/Pics	Prop Log
	Placards	Avionics Log
	Ops Limits (on instruments)	Flight Manual
Checklists		
	Preflight Inspection	Descent/Before Landing
	Before Engine Start	After Landing
	Engine Start	Before Engine Shut Down
	Before Taxi	Engine Shut Down
	Before Take Off	Securing Aircraft
	Take Off/Climb/Cruise	Emergency Procedures

Engine Tests	
	Pre-oil and cold compression test
	Run-in procedures
	Pre-run-in checks
	<i>Confirm all fuel and oil connections are tight.</i>
	<i>Confirm adequate torque on engine mount bolts.</i>
	<i>Confirm all tools, rags, hardware, or other foreign objects have been removed from the engine and engine compartment.</i>
	<i>Confirm the correct amount of oil is in the engine.</i>
	Test and support equipment
	<i>Operating CHT gauge to confirm proper flow of cooling air.</i>
	<i>Calibrated external oil pressure and temperature gauges</i>
	<i>At least 50 feet of tiedown rope</i>
	<i>Tiedown stakes</i>
	<i>Two chocks for each wheel</i>
	<i>Fire extinguisher</i>
	<i>Assorted hand tools</i>
	<i>Safety wire</i>

	<i>Cotter pins</i>
	<i>Ear and eye protection</i>
	<i>Grease pencils</i>
	<i>Logbooks</i>
	<i>Clip board</i>
	<i>Pen and paper</i>
	<i>Watch to time tests</i>
	<i>Rags</i>
	<i>Engine manufacturer's instructions</i>
	Safety Precautions
	<i>Ensure aircraft is tied down, brakes on, and wheels chocked</i>
	<i>All test personnel must wear eye and ear protection</i>
	<i>All personnel must be checked out on the operation of the fire extinguisher(s)</i>
	<i>Establish a "Hazard Zone" beside the engine, in line with and near the prop, and do not allow anyone in this zone while the engine is running</i>
	The first engine run (engine manufacturer's recommendations)
	Engine cool down (engine manufacturer's recommendations)
	After shut down (engine manufacturer's recommendations)

	Record engine run data
	Mixture & Idle speed check
	Warm up engine until all readings are normal
	Adjust engine RPM to the recommended idle RPM
	Slowly pull the mixture control to idle cut-off
	Observe 50 RPM increase just before the engine quits <ul style="list-style-type: none"> No increase in RPM – idle mixture is too lean More than 50 RPM increase – idle mixture is too rich
	Ignition check
	Select single magneto – observe 50 RPM drop
	Select other magneto – observe 50 RPM drop
	Turn both magnetos off – engine should quit IF ENGINE DOES NOT STOP, SHUT DOWN AND CHECK MAGNETO GROUNDING BEFORE ANY FURTHER ENGINE RUNS
	Cold cylinder check (if engine is running rough)
	Run engine on suspect magneto for 30 seconds at 1200 RPM
	Shut down engine with magneto switch on suspect magneto
	Immediately mark exhaust flanges 1 inch from cylinders with a grease pencil
	Observe grease pencil marks – any mark not burned to a grayish-white color indicates a cold cylinder

	Swap both spark plugs from cold cylinder with another cylinder and repeat test <ul style="list-style-type: none"> If the new cylinder is cold, the plugs are bad If the original cylinder is still cold, the problem is with the ignition lead or mag
	Carburetor heat check
	Verify carb heat provides a 90 degree increase for normally aspirated engines and a 120 degree increase for turbos.
	Verify corresponding RPM drop when carb heat is applied
	Fuel flow and usable fuel check
	Ensure minimum known quantity of fuel in the tanks and raise the nose 5 degrees higher than highest anticipated climb angle
	Disconnect fuel line from carburetor
	Time how long it takes for fuel to drain from tanks
	Calculate flow rate and remaining unusable fuel
	Post run-in compression check
	Perform a differential compression check on each cylinder
	Verify all cylinders have better than a 60/80 compression
	For any cylinder with less than 60/80: <ul style="list-style-type: none"> Have someone hold the prop at TDC for the weak cylinder Apply compressed air to cylinder and listen for leaks Air coming out of exhaust indicates a bad exhaust valve seat Air coming out of air cleaner indicates a bad intake valve seat Air coming out the dip stick hole indicates bad piston rings
	Last check (before taxi tests)

	Change oil and oil filter, check old oil and filter for metal
	Visually inspect engine and perform a run up check

Slow Speed Taxi Test Card	
	Confirm weight and balance calculations, CG within limits
	Confirm 18 gallons of fuel on board
	Execute Preflight Inspection Checklist
	Execute Before Engine Start Checklist
	Start video camera
	Execute Engine Start Checklist
	Record engine parameters at idle power 1 minute after start
	Execute Before Taxi Checklist
	Record engine parameters at idle power 10 minutes after start
	Taxi straight ahead, verify neutral tail wheel position
	Smoothly apply brakes, verify even braking action
	Execute 90 degree left turn without brakes, observe performance and flight instrument operation
	Execute 90 degree right turn, compare with left turn performance
	Execute 180 degree left turn, observe performance
	Execute 180 degree right turn, compare with left turn performance
	Execute 360 degree left turn, measure and record turn radius

	Execute 360 degree right turn, measure and record radius
	Execute 360 degree left turn with brakes, record radius
	Execute 360 degree right turn with brakes, record radius
	Record engine parameters at idle
	Execute slow speed S-turns, verify smooth and even tail wheel steering
	Practice slow speed taxi maneuvers until comfortable
	Execute After Landing, Before Engine Shut Down, and Engine Shut Down Checklists.
	Execute Post Flight Inspection Checklist
	Thoroughly inspect engine plumbing for leaks
	Thoroughly inspect hydraulic plumbing for leaks
	Thoroughly inspect landing gear
	Thoroughly inspect propeller
	Examine fuel system screens and filters for metal
	Examine oil system screens and filters for metal
	Fix all squawks before continuing test program.

High Speed Taxi Test Card	
	Confirm weight and balance calculations, CG within limits
	Confirm 18 gallons of fuel on board
	Confirm "First Flight Test Card" is available in cockpit
	Execute Preflight Inspection Checklist
	Execute Before Engine Start Checklist
	Start video camera
	Execute Engine Start Checklist
	Record engine parameters at idle power 1 minute after start
	Execute Before Taxi Checklist
	Record engine parameters at idle power 10 minutes after start
	Perform slow speed taxi maneuvers to reaffirm operation of steering and brakes
	Increase speed in 5 mph increments and perform S-turns, observing controllability
	Attempt to raise the tail starting at 35 mph
	Record speed at which tail comes up _____
	<ul style="list-style-type: none"> Trim to zero stick pitch forces with tail raised Mark trim control with "Take Off Trim" as appropriate
	Observe rudder effectiveness with tail raised
	Attempt to rock the wings SLIGHTLY starting at 35 mph with the tail on the ground
	Execute heavy braking (incrementally increased), note any propensity to nose over
	Record engine parameters at idle power
	Extend speed brake and accelerate to tail wheel lift off speed
	<ul style="list-style-type: none"> Observe any induced instability
	Determine distance required for high speed abort

	<ul style="list-style-type: none"> Accelerate to tail wheel lift off speed and maintain till preplanned execution point
	<ul style="list-style-type: none"> Chop throttle to idle and apply heavy braking to bring aircraft to a complete stop
	<ul style="list-style-type: none"> Mark distance from execution point to stop point
	<ul style="list-style-type: none"> Repeat test at least 3 times and measure worst case (longest) distance _____
	Execute After Landing, Before Engine Shut Down, and Engine Shut Down Checklists.
	Execute Post Flight Inspection Checklist
	Thoroughly inspect engine plumbing for leaks
	Thoroughly inspect hydraulic plumbing for leaks
	Thoroughly inspect landing gear
	Thoroughly inspect propeller
	Examine fuel system screens and filters for metal
	Change oil and filter, examine old oil and filter for metal
	Perform run-up check and inspect for leaks
	Calculate takeoff speed - Tail lift speed X 1.25 = _____
	Calculate High Speed Abort Distance
	<ul style="list-style-type: none"> Max stop distance X 1.3 = _____
	Measure this distance back from departure end of runway and mark with a red flag – This is your "Go/No-Go" decision point
	Fix all squawks before continuing test program

First Flight Test Card	
	Confirm 18 gallons of fuel on board (4 times hourly consumption rate)
	Confirm CG will remain in the forward half of the CG range for the entire flight

Execute Preflight Inspection Checklist
Execute Before Engine Start Checklist
Start video camera
Execute Engine Start Checklist
Record engine parameters 1 minute after engine start
Execute Before Taxi Checklist
Verify operation of all aircraft systems:
<ul style="list-style-type: none"> • Engine instruments and engine operation
<ul style="list-style-type: none"> • Flight controls
<ul style="list-style-type: none"> • Brakes
<ul style="list-style-type: none"> • Flight instruments
<ul style="list-style-type: none"> • Avionics
<ul style="list-style-type: none"> • Exterior lights (not mandatory)
<ul style="list-style-type: none"> • Interior lights (not mandatory)
Record engine parameters 10 minutes after engine start
Call for taxi, inform tower/Unicom that an experimental aircraft is on it's first test flight
Execute slow speed S-turns during taxi to confirm steering
Execute Before Take Off Checklist
Record run-up engine parameters
Call for clearance, line up on runway centerline, and execute first flight take off procedure

Climb to 3000 feet AGL and trim for level flight
Slowly reduce power to maintain airspeed at 75 mph
Flight Control Checks
Yaw aircraft 5 degrees left and right and observe aircraft response
Raise nose 3 degrees, stabilize and trim, and observe aircraft response
Level off and trim
Lower nose 3 degrees, stabilize and trim, and observe aircraft response
Level off and trim
Bank aircraft 5 degrees left, then 5 degrees right, observe aircraft response
Execute clearing turns at no more than 10 degrees of bank
Execute two 360 degree turns at 20 degrees of bank, one in each direction, and observe aircraft response
Execute Cruise Climb Checklist, level at 5000 feet AGL and trim for level flight
Simulate Traffic Pattern
Establish pattern airspeed (75 mph)
Extend speed brake and observe effectiveness
<ul style="list-style-type: none"> • Note changes in trim, attitude and power to maintain level flight
Execute Descent and Before Landing Checklists

Establish an approach speed of 65 mph
Practice an approach to landing at 4000 feet AGL
Practice an approach to landing at 3000 feet AGL
Clean up aircraft, execute Cruise Climb Checklist, and climb back to 5000 feet AGL
Execute an approach to stall maneuver
<ul style="list-style-type: none"> • Execute clearing turns • Stabilize altitude, airspeed, and heading • Apply carb heat • Establish landing configuration • Reduce power to 1000 RPM and trim • Raise nose as required to maintain altitude, note control inputs required to maintain level coordinated flight • Discontinue maneuver at onset of buffet, recover and record the reference pre-stall speed _____
Practice recoveries from approach to stall until comfortable
Establish and maintain level flight and trim
Calculate final approach speed – ref speed X 1.3 = _____
Execute Descent and Before Landing Checklists
Execute low approaches as required
Land with a planned touchdown point within the first 1000 feet of the runway
Fly the airplane all the way to the chocks

Execute After Landing, Before Engine Shut Down, and Engine Shut Down Checklists
Execute Post Flight Inspection Checklist
Post Flight Data Collection (from video/audio/computer)
Record engine performance parameters during take off roll
Record engine performance parameters during climb
Record engine performance parameters during cruise at 3000'
Record engine performance parameters during cruise at 5000'
Record engine performance parameters during descent
Record reference stall speed in Flight Manual
Record any pertinent comments (notes, cautions, warnings) regarding aircraft handling in the Flight Manual
Post Flight Actions
Engine cooling changes
Flight control rigging changes
Aileron trim changes
Rudder trim changes
Evaluate propeller performance/suitability, change if required
Repair/Replace any damaged components
Perform thorough Airworthiness Inspection, concentrating on:
<ul style="list-style-type: none"> • Engine/fuel plumbing leaks • Hydraulic plumbing leaks

	<ul style="list-style-type: none"> Landing gear and brakes
	<ul style="list-style-type: none"> Flight control cables and attach points
	<ul style="list-style-type: none"> Propeller bolt torque
	<ul style="list-style-type: none"> Engine mount bolt torque
	Pitot-Static system modifications

Fuel Pressure							
Oil Pressure							
EGT							
CHT							
Oil Temperature							

\Flight Parameter\Phase	1 min after start	10 min after start	Run-up	Take Off	Climb	Cruise	Descent
Altitude							
Airspeed							
OAT							
RPM							

Appendix 5. Aircraft Squawk Record

A very important part of any test program is disciplined documentation. It is just as important to document what DIDN'T work, and how it was fixed, as it is to document what DOES work. Here is a format, patterned after the format the US Air Force uses, for you to use to keep track of all of your squawks during your flight test program and beyond.

As an aside, I had a Beech Super Musketeer for a few years. I used a squawk record like this one from the day I bought the airplane until the day I sold it. It was interesting to me to see how the potential purchasers of my airplane regarded my record. Every one of them reviewed it, smiled, asked about some of the things that hadn't been fixed (I logged everything, like loose carpet, scratch in paint, etc.), and asked if they could take a copy of a blank form with them. I'm convinced the squawk record helped sell my airplane. Just something to think about.

Appendix 6. Glossary

May not need this, probably not worth the effort.

Appendix XXX. Instrumentation Drawings and Schematics

This section will contain the details of how my instrumentation systems are mounted and wired. The additional equipment to be used during testing is a video camera mounted on the back shelf, a palm or notebook computer for collecting serial output from my micro encoder and micro monitor, a backup tape recorder, and a yaw string attached to the canopy. More to follow....

Appendix YYY. Weather minimums

The weather will be VFR with winds <10 knots within 30 degrees of the runway, no gusts. The ceiling will be 1000' above the highest planned altitude, and visibility will be >5 miles.

Add a detailed list of weather minimums for each test flight.

Appendix XYZ. Root Cause Analysis Methods

This section will explain root cause analysis and how to use it to remedy deficiencies. Get copy of academics from work.

Appendix ZZZ. Flight Manual Preparation and Publication (to be expanded on)

Do you need a flight manual for the airplane you built and tested yourself? You may feel like it's a lot of extra effort for nothing. After all, you put every piece of the airplane together, installed all the systems to operate just as you want them to, and flew off every hour of the flight test requirements. However, it is in your best interest to do a professional job of preparing the Flight Manual for your aircraft for several reasons. First, it will make it easier for you to find all the information you have amassed on your aircraft if it is in one well organized document. Second, a well thought out Flight Manual draft will go a long way in convincing a hard nose FAA inspector that you did a conscientious job of building and your aircraft deserves to be certificated. And third, if anyone has detailed questions about your airplane and it's performance, you have a document that contains all the information needed to answer any question. The basic outline of the manual should follow the standard convention used for production aircraft. The manuals are organized as follows:

Section 1 - General

Introduction

Descriptive Data

Engine

Propeller

Fuel

Oil

Maximum Certified Weight

Cockpit and Entry Dimensions

Baggage Compartment Dimensions and Capacity

Specific Loadings

Symbols, Abbreviations and Terminology

Section 2 - Limitations

Airspeed Limitations

Airspeed Indicator Markings

Power Plant Limitations

Power Plant Instrument Markings

Weight Limits

Center of Gravity Limits

Maneuver Limits

Flight Load Factor Limits

Fuel Limitations

Noise Levels

Placards

Section 3 - Emergency Procedures

Section 4 - Normal Procedures

Section 5 - Performance

Performance Graphs

Airspeed Calibration

Stall Speeds

Takeoff Distance

Rate of Climb

Time, Fuel, Distance to climb

Cruise Performance

Range Profile

Endurance Profile

Landing Distance

Section 6 - Weight and Balance/Equipment List

Section 7 - Description and Operation of the Airplane and It's Systems

Detailed operating instructions for all aircraft systems

Section 8 - Airplane Handling, Servicing and Maintenance

Airplane Inspection Periods

Ground Handling

Servicing

Cleaning and Care

Section 9 - Supplements (probably not applicable)

Section 10 - Operating Tips

Obviously, your manual can be as detailed or as brief as you would like, and doesn't need all the information above, but again, it is in your best interest to have some sort of flight manual for your creation.