ANDREWSFIELD AVIATION LIMITED

MULTI ENGINE INSTRUCTOR COURSE NOTES

Carol Cooper

TECHNICAL NOTES FROM THE FLIGHT MANUAL AND CHECK LIST.

The student should be aware of

The mass and balance limitations
The engine limitations
The airframe limitations
The flying and engine controls
The prop controls
The fuel system
The oil system
The vacuum system
The electrical system
The hydraulic system
The braking system
The heating and ventilation system
The flaps and undercarriage emergency system
The fire extinguisher and first aid kit, and other emergency drills

MULTI-ENGINE PRE-FLIGHT BRIEF
GENERAL FLYING I

Aim: To learn the general flying characteristics of a multi-engine aeroplane

T **Head in cockpit**
E **Not Lowering the Gear Infringe CAS**
M: **Lookout** **Check Green lights** **Local Flying Area/Anchor point**

If possible leave student with Cx list and aircraft for familiarisation

Taxi

Aircraft is heavier than a single-engine and hence greater care must be taken and taxi speeds must be slow. Note reduced prop clearances.
The throttle should be used together and individual brakes or throttle should only be used sparingly.
The aircraft cannot be turned when stationary by using one engine.

Undercarriage

When it is no longer possible to land back on the runway, stop the wheels rotating with the foot brake and retract the undercarriage (blue line speed).

Propellers

When airborne and undercarriage retracted, reduce power to 24" MP and 2400 RPM. If the engine noise is not steady, move one pitch lever slightly until the engine noise is steady. The propellers are then synchronised.

Climb

With a constant speed propeller the power is gauged by the Manifold Pressure. In the climb, the MP will reduce and should be increased with the throttle to maintain required power setting up to full throttle altitude. Note increased rate of climb = CAS

Cruise

Note that as there is no engine in front the pilot tends to fly with a nose up attitude, hence the aircraft climbs. Initially frequent checks on the altimeter and VSI required. Leaning the fuel engine noise dose not change because of CSU and use of cowl flaps

Descent

Reduce power but remember as the aircraft descends, power will increase, hence you must reduce power with the throttle as altitude reduces to maintain the required setting.

Circuit and landing

The aircraft has more inertia than a single-engine aircraft, hence start slowing down to limiting speeds (undercarriage, flap, etc) in good time. Also increased speeds = catching up slower aircraft possible slow cruise.

MULTI-ENGINE PRE-FLIGHT BRIEF
GENERAL FLYING II

Aim: To learn the characteristics of the aircraft in stall, and to practice steep turns

T
E
M: **H.A.S.E.L.L. & HELL CHECKS**

Stall

Reduce power and hence airspeed to show symptoms of slow flight. Speed not below V_{SSE} …………

(a) Stall and recover with or without power – do not hold the aircraft in the stall. SSR beware of opening the throttles too quickly, in case one engine does not reapond.

(b) Stall in approach configuration and in a turn.

(c) Stall in landing configuration.

(d) Stall in departure configuration.
NOTE: Beware that a heavier aircraft will lose more height, Emphasis should be on early recognition

Steep Turns.

To practice level turns in each direction using 45 and 60 degrees angle of bank. Note it may not be necessary to add additional power to maintain entry speed

ASYMMETRIC part one

Aim: To learn to recognise and identify and control an engine failure

T **A/C not capable of Flying on one engine** **Real Engine failure**
E **Using Aileron instead of rudder**
M: **Cx Performance** **Check Balance Ball** **Monitor Ts & Ps**

Feather and unfeathering drill ***Engine Failure*** Simulated by closing one throttle. Note yaw and roll, and descent. Repeat showing instrument indications **Control** either: close other throttle to stop yaw or: use rudder to stop yaw Straight and level flight again. Engine failure maintain straight and level by rudder and selecting higher nose attitude. Note speed! Identify by Dead leg/Dead engine Trim Engine fails in a turn (lookout) Note: If inside engine has failed, the aircraft wants to develop a rapid roll rate and enter a spiral descent. If the outside engine fails, the aircraft roll rate is slower but again a spiral descent develops. Recover using rudder to control yaw and ailerons to level wings. Elevators to maintain altitude.	**Effect of varying speed at a constant power setting** **From normal cruise** Simulate engine failure and pitch up nose to reduce speed and note increase rudder input to keep aircraft straight. **Effect of varying power at a constant speed** **From normal cruise** **Simulate Engine failure** Maintain speed but increase power Note increased amount of rudder needed to keep aircraft straight. To determine zero thrust From normal cruise feather one engine Use rudder trim note speed. Restart engine find manifold pressure = speed 12” approx

Asymmetric Part Two

Aim: To learn the significance of Critical speeds and EFATO drill and feathering/unfeathering drill Critical speed is the airspeed at which directional control is lost for a prevailing set of conditions. It varies according to these conditions

MINIMUM CONTROL SPEED – VMC (VMCA IS A CERITIFIED SPEED WHICH ASSUMES THE CERTAIN CONDITIONS)

Aim: To show minimum control speed and significance of critical engine

T **Loss of Control** **The stall**
E **Loss of SA**
M: **Minimum Height** **Anchor point** **Monitor Performance**

1. Reduce power on one engine to idle.
2. Maintain a constant heading with rudder.
3. Increase power on other engine (pitch max rpm, mixture rich).
4. Reduce airspeed by pitching nose up slightly. Note increasing requirement for use of rudder to maintain direction.
5. Note reduction in speed.
6. Keep control column central.
7. Aircraft yaws in spite of full rudder deflection.
8. Note speed which is V_{MC} for that engine.

Repeat with other engine. Engine with highest V_{MC} is the critical engine.

Clockwise props – left engine critical.
VMCA - assumes full power live engine, and dead engine windmilling, Most reward Cof G, Flaps in take off position, gear up, max weight, sea level, max 5 deg of bank to live engine

To Demonstrate how 5 degrees of bank can reduce critical speed

Set zero thrust and climb power, maintain heading, keep wings level and ball in middle, gradually rise nose, keep straight with rudder. Note speed when you run out of rudder. Then bank 5 degrees using ailerons to live engine, and note lower airspeed than can be achieved before you run out of rudder.

To demonstrate why it is critical to feather a propeller and not leave it windmilling

Close throttle on one engine, set climb power on the other, maintain heading, keep ball in the middle and wings level, gradually raise the nose, note speed at which you run out of rudder.
Repeat with zero thrust set on one engine and climb power on the other. Note lower airspeed that can be achieved.

Asymmetric part three

ENGINE FAILURE AFTER TAKE OFF OR LOW LEVEL′

V2 or TOSS they are the same, giving a margin over VMCA either 1.1 x vmca or 1.2 x stall speed in take off configuration. For practicing an engine failure should not be simulated below either of these speeds. For training Blue line often replaces TOSS

Aim: To learn what to do in the event of an engine failure at any ime below 1000′

T **Real EF**
E **Reducing Power on wrong engine**
M: **Simulate above 500Ft** **Touch Drills $V_{2/TOSS}$ Inform ATC**

Engine failure on take-off run

If you experience unusual yaw on take-off, close the throttles and stop.

If you cannot stop before the end of the runway – mags off, fuel off, use rudder to steer. If an engine fails between VMC and TOSS the take off should be abandoned

Engine failure – ground to TOSS

Land back on runway if possible – make safe.

Checks – do not raise undercarriage if you can land back on.

(If engine fails below 300′ consider closing both throttles and treat as a single-engine aircraft).

Above TOSS

Engine failure after Take Off

C Correct yaw and reduce pitch attitude
H Heave everything forward
R Retract undercarriage and flaps
I Identify and feather dead engine
S Speed – climb at blue line
T Trim and tidy up – cowl flaps, etc.

NB

Climb must be at V_2 or Vyse – whichever is greater.
If nose has been pitched down at “C”, the speed should be above Vyse.
An engine will not be failed for training purposes below 500 agl

UNFEATHERING DRILL

Note
An engine should only be re-started and a propeller unfeathered if the shut-down was made for training or practice reasons. Should the shut-down and propeller feathering have been made due to mechanical or other operational causes,
DO NOT attempt to re-start the engine and unfeather the propeller unless **ABSOLUTELY ESSENTIAL**.

General unfeathering- use POH for aircraft

Fuel	Main tank selected – On Check contents Cross-feed – Off	
Magnetos	On	
Mixture	Fully rich	
Propeller	Line up with live engine (2400RPM)	
Electric Fuel Pump	On	
Prime Engine	Pump throttle about 5 strokes	
Throttle	Set 1” open	
Electric Fuel Pump	Off	
Starter Switch	Press	Engine should start in a few seconds and the propeller begin to unfeather, then:
	Release starter switch	

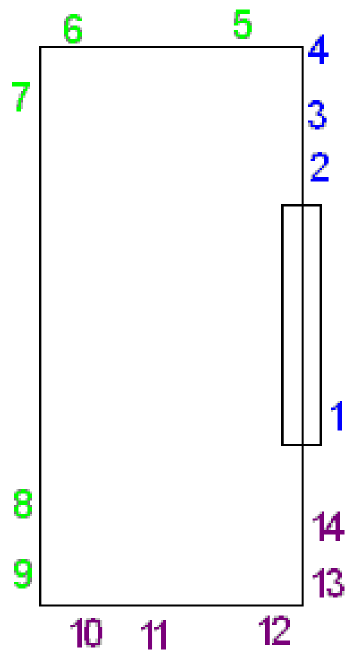
When engine starts, check:

Starter warning light	Out
Oil pressure	Rising into Green Arc within 30 seconds
Fuel pressure	Green Arc
Suction	Doll’s eye disappeared, 4” Hg minimum
Ammeter	Light out, positive charge
Power	Idle at 1000 – 1500 RPM until oil temperature is above 15°C/60°F, then: Set both engines to desired power
Fuel	Balance as required (see Fuel Management Section)

SINGLE ENGINE CIRCUIT

Aim: To learn how to fly and circuit and land with one inoperative engine

T **Other A/C** **Real Engine problems**
E **Not lowering gear** **Not selecting Neutral Rudder trim**
M: **Lookout/RT** **Ts and Ps** **cowl flaps** **ACH - Correct Checks**



1) Carry out normal take-off.
2) Above TOSS engine fails.
3) Carry out CHRIST checks.
.
   C Correct yaw and lower nose
   H Heave everything forward
   R Retract undercarriage + flap
   I Identify and feather failed engine
   S Speed – climb V_{YSE}
   T Trim and tidy up
4) Safe height, turn crosswind (gentle turn)
5) Level out as required.
6) Lookout Turn downwind.
7) RT call and pre-landing checks as usual, except undercarriage up and rudder trim (neutral).
8) Extend downwind.
9) Lookout Turn base.
10) Undercarriage down and keep speed above V_{YSE}
11) Greens Blues Red
12) Lookout Turn finals.
13) ACH decide.
14) Full Flap as required.
15) Close both throttles to land.

ENGINE FAILURE IN CRUISE

Aim: To learn what to do in the event of an engine failure in the cruise

T **Engine does not restart – Ts & Ps**
E **Identify wrong engine**
M: **Height sufficient to restart engine in the event of malfunction of other engine.Check aircraft capable of flying on one engine. Drift down**

"PAID OFF STAR"

P Prevent yaw
A Airspeed > or = best single-engine climb speed
I Identify (dead leg – dead engine)
D Decide (flames etc feather straight away)

O Open up good engine if necessary
F Find fault (same as single engine) (left to right)
F Feather (close throttle first to verify)

S Secure the dead engine. Check alternator output and suction.
T Trim
A Airframe (cowl flaps)
R Report to ATC

DO NOT RUSH

DO NOT BE ENGROSSED IN THE COCKPIT WORKLOAD.

MULTI-ENGINE ASYMMETRIC EFATO

EFATO

Factors

1. Weight – possible max – performance
2. Airspeed – climb Vx Vy. Vyse. VMC
3. Altitude – Time – obstacles – obstructions
4. Power – full power, climb power
5. Drag – undercarriage, flaps, cowl flaps, windmilling prop

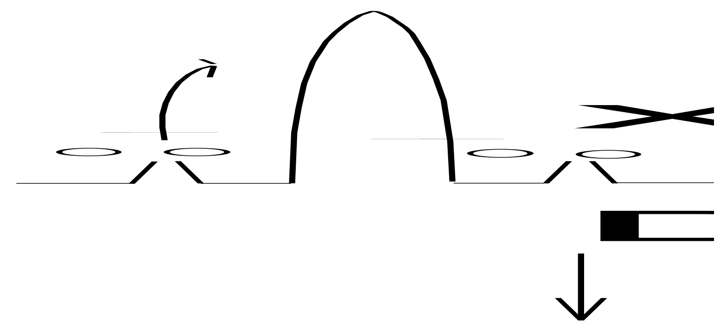
Other Factors

Take-off airspeed not reached. Vyse / TOSS – S/E

C of G

Partial power – keep engine running if above 17”

Runway TORA – land back on.



1. Yaw towards dead engine
2. Roll – loss slipstream – to dead engine
3. Drag – reducing airspeed

Possible stall/spin situation.

Action

1. Rudder – control yaw
2. Aileron – control roll and 5° bank to live engine.
3. Full power.
4. Attitude – Vyse (82)
5. Drag – reduce – undercarriage up – flaps up – cowl closed – feather dead engine.

MULTI ENGINE PATTER NOTES

Asymmetric Part One

N.B. If your student has very little multi experience and you feel would benefit from seeing an engine shutdown at the very beginning of the exercise to get rid of the mystery and also prove that the aeroplane will actually fly on one a shutdown and restart purely as a demo has merits and is often taught this way, but obviously depends on the weather etc.

I have control I am going to start by carrying out a hasell check. **Height** I must be above 3000 feet to shutdown as engine and **airframe** should not be too heavy so that performance is not critical if it will not restart. **Security** make sure seat is in a good position and full rudder is available. **Engine** cowl flaps as appropriate and familiar with restart procedure. **Location** it would be sensible to be within the vicinity of an airfield and the weather should be acceptable. **Lookout** for aircraft and don't get too involved in cockpit indications.
I am now going to feather one engine I have shut down the left engine you can see that the prop is stationary and feathered and the aircraft is flying quite safely. I have trimmed out the aircraft and I would now like you to fly the aircraft and try some turns. I have control I will now restart the left engine.

Back in normal cruise I am going to start the rest of the exercise.

From normal cruise I am now going to show you the symptoms of an engine failure. I am going to simulate it by closing one throttle, and not doing anything on the controls, as always before I do anything a lookout, it is all clear, so closing the left throttle and you can see yaw followed by roll towards the left engine and a spiral descent. Now opening the left throttle and recovering to normal cruise. Repeat with the right engine.

Now I am going to repeat the exercise, but looking at the instrument indications, so lookout, closing the left throttle, the nose yaws to the left confirmed by the turn indicator and AI, look at the balance ball out to the right, an increasing airspeed and a high rate of descent, shown on the VSI and Altimeter. Recovering now by opening both throttles. Repeat with the right engine.

I am now going to show you how to control an engine failure. Firstly, simulating an engine failure by closing the left throttle. Now one way of controlling the aeroplane is to close the other throttle and select the glide attitude you can now see that the aeroplane is in a steady glide, and there is no yaw and no rate of turn.
Another way of controlling the aeroplane if an engine fails is to control the yaw using the rudder and keep the wings level using the ailerons and maintain this altitude with the elevators.
So pick a point straight ahead and follow thru on the controls. I am simulating an engine failure, and using the controls to keep the aircraft straight and the wings level and this altitude.
How can I identify which engine has failed? Remember we talked about dead leg dead engine. Can you feel how I am applying right rudder to keep the aircraft straight so my left leg is dead or not doing anything, so it is the left engine that has failed.
Repeat with the other engine.

Now I want you to practice controlling an engine failure and identifying the failed engine by dead leg dead engine.

Now I want to show you what the symptoms of an engine failure in a turn is, so I am putting the aeroplane into a medium turn to the left and now I close the outside throttle or the right throttle, you can see how the aeroplane rolls its self out of the turn and enters a spiral descent to the right if left unchecked. Restoring equal power and recovering now Again putting the aeroplane into a medium turn to the left and this time simulating an engine failure of the inside or left engine, watch how the roll rate rapidly increases, and the aircraft rapidly enters a spiral descent to the left if left unchecked. Opening the throttle again and recovering now. Clearly you can see the inside engine is the worst to fail IN a turn.

Now let's have a look at how to control an engine failure in a turn. Putting the aircraft into a turn to the left and simulating an engine failure, again controlling the yaw by using the rudder to keep the ball in the middle, and levelling the wings using the ailerons and maintaining the altitude by using the elevators. If the engine fails in a turn always control the aeroplane and recover to straight and level flight. Don't try and recover using aileron as you may well run out of aileron and the controls will be badly crossed.
Practice using both inside and outside engines and identify by dead leg dead engine. I must emphasise check the ball is in the middle.

I would now like to examine how airspeed and power effect the controllability of an aircraft on one engine.
First lets have a look at the effect of airspeed. The aircraft is in cruise at 120 knots I am going to simulate an engine failure and select 24/24 on the live engine that gives us 115 knots. Follow me through on the rudder pedals and pick a point ahead. I am now going to reduce speed by selecting a higher nose attitude can you feel how to maintain straight flight and the ball in the middle I am having to apply more rudder. If 1 now lower the nose so the speed increases can you feel how I am applying less rudder to keep the aircraft straight.
So for a given power setting I need more rudder if the speed reduces to keep the aircraft straight, and less if the speed is increased.

Now let's have a look at the effect of power. I will set 22 inches on the live engine and maintain 105 knots(It does not matter if you climb or descend slightly so long as the airspeed stays the same) now I am going to open up the good engine and keep the aircraft in balance using rudder. Following through, can you feel how the rudder load increases as I open up the throttle? Now as *I* throttle back can you feel how I need to reduce the rudder load to keep straight.

Zero Thrust

To work out zero thrust Above 3000 feet you need to close down one engine and note speed for a particular power setting. Restart the engine and reset same power on the live engine and then find the power setting on the dead engine to achieve the same speed usually about 12/14 inches of MP. It will be stated in the flight manual.

Realistically zero thrust from the flight manual will only be good for a certain density altitude and speed as will anything you demonstrate.

Asymmetric Part Two - Critical Speeds,

To show significance of critical engine

Demonstration Of VMC which is the lowest speed on one engine for any given power setting and configuration from which it is possible to maintain control

Having determined the worst combination is high power and low speed, I am now going to demonstrate minimum control speed. From cruise I close one throttle to simulate an engine failure and keep the aircraft straight using rudder and now I start opening up the live engine slowly to full power. If you follow through you can feel how I am having to increase the amount of rudder I use as I increased the power on the good engine. I keep the wings level and now I have applied full power so now I can start pitching the nose up to reduce the airspeed and again you can feel I am having to increase the amount of rudder needed to keep straight. Now even with full rudder I cannot maintain directional control note the speed it is VMC. If I were to climb the aircraft to a higher level I could demonstrate that VMC would be a reduced airspeed as the live engine will not produce so much power and therefore not as much yaw but because of CAS it is difficult to demonstrate.

Repeat for other engine and show that higher VMC is critical engine although in turbulent conditions it is difficult to demonstrate.

Demo 2 - To show why it is essential to feather the prop.

Lets close the throttle on one engine,and set climb power on the other, maintain a constant heading. Wings level and ball in the middle. Gradually raise the nose to reduce airspeed prevent yaw with rudder, note the speed when you run out of rudder.

Now repeat the exercise but set zero thrust on the failed engine, note that a lower airspeed can be achieved when doing this, showing that extra drag is caused by a windmilling prop.

Demo 3- to show how 5 degrees of bank to the live engine can reduce the critical speed.

Set zero thrust of one engine and climb power on the other maintain a constant heading, ball in the middle and wings level. Gradually raise the nose and note the speed when you running out of rudder, roll on 5 degrees of bank towards the live engine and note the lower speed that can be achieved.

Demo 4 – Take off safety speed (V2) demo.

Above 3000 feet, put the aircraft into the take off configuration**.**

Climb the aircraft on full power at TOSS, throttle back the critical engine to simulate a windmilling prop, keep the ball in the middle and 5 degrees of bank to the live engine, show you can maintain directional control at TOSS, reduce the airspeed and directional control is lost.

Ensure student understands that if and engine fails below TOSS the take off must be abandoned.

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Asymmetric Three – EFATO And Asymmetric Circuit and Landing

(The purpose of practicing this exercise with75% power approx is to impress on the student the importance of opening the live engine to full power) Also remember if you practice this above 3000 feet the live engine will not produce so much power so rate of climb will be reduced and so will the rudder loads.

Lets set the aircraft up in the same configuration it would be in after take-off. We will simulate 25/25 climb at 90 knots with the gear down.
Follow through Now I will simulate an engine failure and carry out the EFATO drill.

C Correct yaw and reduce the pitch attitude

H Heave everything forward

R Retract undercarriage and flaps (touch drills or do it)

I Identify and feather the dead engine (Feather Feather Feather touch drill Zero Thrust)
If above 3000feet for training purposes practice the full shutdown

S Speed climb at Blue line

T (Trim) and secure dead engine.

Note The student must not let the speed go below TOSS

Single engine circuit from the downwind position

Established downwind make the RT call and carry out the pre landing checks (when considering when to lower the gear consider whether-the a/c is capable of flying level on one engine with the gear lowered. Eg is the a/c at max weight etc) If the answer is yes don't lower the gear until base when you will then have to descend. Otherwise carry out the checks as normal (remembering to put rudder trim to neutral unless the pilot is not capable of holding the rudder loads.) The flaps would stay up until base leg. Also note that you normally need to increase the mp by one inch or more on the live engine to compensate for the extra drag of the gear.
On base leg lower gear and reduce power on live engine check three greens and lower one stage of flap. Keep the ball in the middle.
Turn final at 500 to 600 feet and remember that any change of power or speed will require a change in rudder.
Final Approach Green Blues red and remind yourself of ACH - You need a stable

Approach, ATC clearance, and a clear runway to descend below ACH. Do not lower full flap until ACH (if at all)
Discuss closing both throttles, Anticipate using rudder when closing the throttle to land, and after landing close zero thrust throttle brake as necessary.

Asymmetric Go Around

On final with gear down, half flap one engine on zero thrust

Remember below 300 feet ACH we are committed to land.
ACH is coming up and I assume a blocked runway, so smoothly applying full power to the live engine also using appropriate rudder to balance select a shallow climb attitude. Now retract the gear and the flap,climbat blue line speed. Make an RT call, and fly the circuit as before

Things to remember when going around on one engine keep the speed above blue line and retract gear and flap asap.

Next lets practice a simulated engine failure just after a two engine go around. Aircraft configured with full flap, gear down full power Approaching at 90 knots now going around now full power, engine fails, carry out the CHRIST checks as applicable but retract the gear and flap without undue delay

Multi Engine Take Off brief

Before take off check approach taxy out if clear and line up being sure to get the a/c straight.

Lets run through the emergency drills before take-off.
If we have any problem or failure below TOSS, I will close both throttles bring the aircraft to a stop using maximum braking if necessary. (Possibility of ground looping to avoid obstructions if not enough runway left) If I am airborne, and I have a minor problem I will fly the circuit and land, if I have an engine failure below TOSS I will close both throttles and land ahead, and again use maximum braking if necessary to stop. If airborne and I have attained TOSS and I have an engine failure and there is no runway remaining I will raise the gear and climb carrying the EFATO drill.
Before take off check approach, taxy out if clear and line up being sure to get the a/c straight
My take off speed is ….. knots and TOSS…. now holding the a/c on the brakes open the throttles to 20 inches check ts and ps and now release the brakes and apply full power check airspeed is increasing and fly off at …. knots then let the speed increase above TOSS and touch brakes gear up established in the climb at ….. reduce power to 25/25 at 300 agl carry out the after take off checks.

Feathering and unfeathering Drill

Check Aircraft capable of Flying on one engine

Stress to student unfeathering a prop is something used in training only and the chances of unfeathering a prop for real are minimal. Therefore unfeathering can be considered as a training exercise.

During training it should be briefed carefully whether or not feathering is actually going to take place or touch drills and zero thrust, otherwise confusion could occur and the prop could end up being feathered in an unsafe environment (below 3000 feet etc)

To Feather Prop

Close appropriate throttle Feather appropriate Prop Lean appropriate mixture (or as flight manual)
Secure engine Mags off one at a time, (if you hear a reduction in power student has gone for wrong mags) fuel pump and fuel off alternator off (not always necessary during training and also avoids any risk of turning off the incorrect engine)

Unfeathering Drill

In General

Use Checklist and help student I would suggest
In General
Mixture Rich
Prop level with live prop on quadrant (2400)
Open throttle half inch
Mags, fuel, fuel pump on
Prime as per Aircraft type (know your a/c)
Start
Let the engine warm up on low power setting check oil pressure and alternator on as appropriate to type.
Reset cruise power trim etc.