Aircraft Handling – ACP 34 vol 3

- Aircraft Maintenance
- Ground Handling
- Preparation for Flight
- General Flying
- Aerobatics and Formation Flying
- Aircraft Emergencies
Aircraft Maintenance

- Aircraft need effective maintenance.
- RAF maintenance organisation covers, aircraft, survival equipment, weapons, flight simulators and synthetic trainers, communication and control systems, motor transport, and servicing equipment for all of these.
- We will concentrate on aircraft maintenance.
RAF maintenance policy balances ‘preventive’ and ‘corrective’ maintenance.

Maintenance organisation has both operational and maintenance objectives to meet.
Aircraft Maintenance – Operational Objectives

- Generate aircraft needed to counter surprise attack
- Support intensive flying over sustained period in NBC environment
- Support NATO and National commitments
- Satisfy contingency plans
- Provide aircraft and equipment needed for peacetime roles (e.g. training and humanitarian aid)
Aircraft Maintenance – Maintenance Objectives

- Minimise costs (manpower and resources)
- Minimise faults that would have major safety, operational or cost implications
- Continuously improve reliability and maintainability
Aircraft Maintenance - Preventive

- Aim is to reduce the probability of failures, maintain aircraft reliability, and ensure that time and use do not affect aircraft performance.

- 4 types of maintenance –
  - Servicing
  - Scheduled Maintenance
  - Condition-based Maintenance
  - Out-of-phase Maintenance
Preventive Maintenance - Servicing

- Flight Servicing – between flight replenishment of fuel, oil, oxygen
- Checking for obvious signs of unserviceability – leaks, cracks, corrosion, excessive oil consumption
- Check wheels, brakes and tyres
- Analogous to weekly checking on a car
Preventive Maintenance – Scheduled Maintenance

- Carried out at regular intervals to –
- Keep aircraft in sound overall condition
- Minimise random faults
- Minimise requirement for routine day-to-day attention
- Analogous to yearly service on a car
Preventive Maintenance – On-condition Maintenance

- Aircraft components are continuously monitored (this has become more feasible with more computer-based systems)
- Maintenance action is triggered by measured parameters approaching limits, or by results from regular NDT or SOAP testing
Preventive Maintenance – Out-of-Phase Maintenance

- This is scheduled or condition-based maintenance which does not fit in with the normal maintenance cycle
Corrective Maintenance

- This is carried out as and when a fault occurs
- It is thus not possible to plan for
Contingency Maintenance

- Uses a planned programme to reduce the level of preventive maintenance to increase aircraft availability in war operations or transition to war.
Modifications

- Modifications are only made when authorised, and are strictly controlled to minimise cost and maintain aircraft safety.
- They may be required to remedy design faults, or to improve aircraft performance or safety.
This, the Aircraft Maintenance Data Form is a set of forms which stay with the aircraft through its life, and record the condition of the aircraft, and the maintenance activities carried out.

The main forms are – 701, 703, 705, 725 and 725A
Form 701 & Form 703

- F701 records the aircraft’s permitted fuels and oils, basic weight, tyre pressures, alignment record, aircraft dimensions etc.
- F703 is the Onboard Software Log, and records the identity of all software loaded into software dependent systems on the aircraft.
F725 is the Flying Log and Fatigue Data Sheet, and records details of each flight, including, where fitted, fatigue meter readings.

F725A cover Air-to-Air Transactions, recording details of all in-flight refuellings carried out on the aircraft.
Form 705

- F705 is the Flight Servicing/Fuel Certificate, which certifies the flight servicing and fuel states, and contains the Captain’s After-Flight Declaration, which reports any faults arising, and certifies that the ejector seat has been made safe.

- It returns responsibility for the aircraft to the ground engineers, who then record details of flight servicing for sign-off by the Flight Services Coordinator, and signature by the Captain for the next flight.
Maintenance Data System

- This takes data from the F700’s of RAF and FAA aircraft, to provide data on faults, modifications, manpower utilisation, task achievement, technical costs and logistics.

- This information aids analysis of fault trends, fleet management of fatigue life and management of maintenance.
A team of 2 tradesmen marshal the aircraft into a parking area cleared of FOD

When indicated by the Captain, the wheels are chocked, and ground power/ servicing equipment connected. Fire extinguishers are manned during engine shut-down, aircraft steps are positioned, and the crew assisted with unstrapping.

The team then fit safety devices (e.g. ejector seat safety pins), and any covers, blanks or plugs required (e.g. pitot head cover/static hole plug)

Above actions reversed for aircraft departures
Ground Handling - Marshalling

- Aim is to assist the pilot in manoeuvring the aircraft on the ground, communicating with the pilot by arm and hand signals.

- Extent of assistance required depends upon pilot’s familiarity with the airfield, obstructions, size of aircraft, and view from cockpit. ‘Follow Me’ vehicles may be used for long/complex taxiing.
In an unobstructed parking area, the marshaller will stand at the spot where the aircraft is to be parked and attract the pilot’s attention by waving his arms in a circular motion. The pilot then taxis the aircraft up to the marshaller, who stands with arms outstretched.

Two extra personnel may be needed, positioned ahead of each wing tip, if obstructions are present, to signal that there is sufficient clearance, especially for large aircraft.
Some of the marshalling hand signals –

**Hot Brakes**
- Day – as shown
- Night – wands held as extensions of arms

**Ground electrical power insert**
- Day – as shown
- Night – as day signal with left wand vertical and right wand horizontal

**Cut Engines**
- Day – Arms and hands as shown
- Night – with wands
Ground Handling – Marshalling by Night

- Aircraft navigation lights and taxi lights will be on.
- Detailed marshalling directions may be necessary in congested areas.
- Marshallers will carry illuminated wands or torches for identification.
- At all times the pilot is responsible for the aircraft, and is not required to comply with any marshalling instruction considered unsafe.
Ground Handling - Safety

- Chocks must be used and all safety devices, covers, blanks and plugs necessary fitted whenever an aircraft is stationary with engines shut down.

- Danger zones around aircraft must be avoided by all personnel. These are – engine intakes and exhausts, propellers, and helicopter rotors. Beware of ‘blade sailing’ when near helicopters in windy conditions.
Aircraft brakes absorb a lot of energy when slowing the aircraft on landing. This emerges as heat, which normally dissipates into the air. However, after a long taxi or abnormal landing brakes can overheat and catch fire.

Stand forward or to rear of the wheel, and operate the fire extinguisher at the limit of its range, aiming downward at the ground about 0.3m away from the wheels.

Avoid standing in line with the wheel axle, to avoid debris from any brake explosion.
Ground Handling – Manhandling and Towing

- Aircraft must not be taxied into or out of hangars – they must be towed or manhandled.

- When an aircraft is moved, a qualified handling party is used:
  a) an experienced supervisor
  b) Person in cockpit to operate brakes
  c) One at each wingtip to ensure obstacle clearance
  d) Towing vehicle driver, or enough people

Push only on strong areas of the aircraft.
Ground Handling – Parking Aircraft

- Park into wind, with aircraft clearly separated (no overlapping parts).
- Double chock wheels fore and aft.
- Release brakes.
- Check electrics, ignition and fuel cocks OFF.
- Apply control locks (if required).
- Fit pitot and static vent covers.
- For long term parking, lock canopies and doors, fit canopy covers, wheel covers, and engine covers, and set out drip trays.
Ground Handling - Refuelling

- Normally aircraft are refuelled after flight, which minimises condensation inside the tanks, and makes the aircraft ready to fly.
- Refuelling may be from cans by hand, from bowsers, from ground hydrants, or in-flight from a tanker. Mobile bowsers are most common, and are essentially a tanker with an engine-driven pump and delivery hose.
- To prevent sparking from static electricity, the aircraft and bowser are earthed, and the aircraft is bonded to the delivery hose, which in turn is bonded to the bowser.
Ground Handling - Refuelling

Fig 2-2 Open-Line Refuelling

- Earthing Chain
- Correct Position of Refueller
- Hose Booms
- Nozzle on Ground
- Components Bonded at Before Removing Aircraft Fuel Tank Cap

- Hose Bonding Wire
- Earthing Terminal
- Fuel Nozzle
- Bonding Plug
Ground Handling – Refuelling Orders

- Ensure correct grades of fuel and oil used
- Leave air space in oil tanks for expansion
- Never refuel in a hangar or with the engine running
- Always ensure fuel is filtered on way into tanks
- Refuelling crew must not carry lighters or matches, and must wear rubber soled shoes
- Avoid fuel spillage, but have any spillage washed away by fire crew
Ground Handling – Refuelling Orders

- No work on electrical equipment or R/T transmission whilst refuelling (or within 15m.)
- No refuelling within 40m of aircraft with engines running.
- Refuelling vehicles to be positioned to be easily moved in event of fire.
- Place fire extinguishers ready for use.
- Stand only on marked walkways on aircraft.
- Replace filler caps correctly.
- Enter details of refuelling/defuelling in MOD Form 705.
Pressure refuelling gives high rates of flow of fuel into the aircraft tanks, significantly reducing refuelling time, both on the ground and in air-to-air refuelling.

A self sealing fuel connection is used, with each tank having a high level shut-off valve. Over pressure protection is provided for the fuel lines.

Bonding is required, as indicated above.
Ground Handling – Fuel Types

- AVTUR – aviation turbine fuel (kerosene)
- AVGAS – aviation gasoline (petrol) – 2 grades depending on engine type
- AVTAG – aviation turbine widecut gasoline (‘emergency’ fuel for turbines - use defined by Aircrew Manual for type)
- AVCAT – aviation turbine fuel (lower flammability, used by RN on carriers)
Large aircraft have an Air Loadmaster, whose job is to ensure that the load does not exceed weight limits and is loaded to ensure that the aircraft C of G is within limits. Overloading:

- Increases stalling speed and landing and take-off runs.
- Reduces rate of climb, range and endurance.
- May make flight impossible in case of engine failure on multi-engined aircraft.
- Lowers aircraft ceiling.
One man must be in charge of the aircraft, the Captain. The Captain is normally the pilot, who must –

- Ensure crew are familiar with the aircraft and its systems and their roles.
- The crew understand the aim of the flight.
- The crew are fit.
- The relevant orders have been read and understood.
- All flying clothing and personal safety equipment is in good order.
- Thorough flight planning has been carried out.
Flight planning requires knowledge of current and forecast weather, ATC clearances, diversion airfields, restricted airspace, and navigation planning.

This is often self-briefing by the pilot and navigator using information displayed in the operations room.

A mass briefing of all aircrew may be held at the start of a day’s flying, with inputs from meteorological, ATC and other specialists.
Preparation for Flight – Passenger Briefing

- Captain is in command during flight.
- Correct use of seat belts, crash and ditching positions
- Operation of escape hatches, and dinghy positions
- Use of oxygen masks
- Fitting and operating parachutes/correct exits
- No smoking or naked lights rule
- Operation of intercom from passenger to pilot
General Flying – Take-off

- Unless on an operational “scramble”, the pilot will hold the aircraft at the holding position, at a white line across the taxiway, from which he has a good view of the runway and final approach. A light aircraft will turn 45 deg into wind here.

- Before taxiing on to the runway, the pilot must complete vital actions, receive permission from the controller, and check that the approach is clear. The runway controller will check for any loose panels, leaks etc at the holding position.
General Flying – Take-off

Fig 4-1 Holding Position

HOLDING POSITION BOARD

RUNWAY
CONTROLLER'S CARAVAN

HOLDING POSITION

CONTROL TOWER

AIRCRAFT SERVICING PLATFORM
General Flying – Take-off

- Full throttle is always used for take-off, checking engine instruments to ensure that engines are giving full power whilst working within limits. Use of reheat requires no special technique.
Factors affecting the length of Take-off run

- All-up weight – a heavier aircraft must generate more lift, which means an increased speed to become airborne, so the runway must be long enough.

- Amount of flap used – take-off flap settings increase lift without a large drag increase, reducing the speed to become airborne, and hence reducing take-off run.
General Flying – Take-off

Factors affecting length of the Take-off run

- Engine power – more thrust increases acceleration, reducing take-off run.
- Wind velocity – Take-off into wind gives an effective increase in speed, reducing the take-off run, climb angle after takeoff is steeper, initial directional control is improved, and an abandoned take-off occurs at a lower ground speed.
Fig 4-2 Advantages of Taking-Off into Wind

NO WIND

G/S ZERO I.A.S. ZERO
80 KT. GROUND SPEED (G/S)
80 KT. I.A.S.
90 KT. I.A.S. AND 90 KT. G/S
500 FT

1 MINUTE

20 KT. WIND

G/S ZERO I.A.S. 20 KTS.
60 G/S
80 KT. I.A.S.
90 KT. I.A.S. AND 70 KT. G/S
500 FT

1 MINUTE
Factors affecting length of Take-off run

- **Runway gradient** – an uphill take-off will reduce acceleration, increasing the run.

- **Condition of runway surface** – relatively small depths of snow or slush can prevent an aircraft reaching “unstick” speed.
Factors affecting length of Take-off run

- Air Temperature – High temperatures reduce air density, and hence lift, and engine power, increasing take-off run.

- Airfield elevation – also reduces air density, with the same effects. Both hot and high may require significant extra runway length.
Nose-wheel aircraft – the pilot lines up, straightening the nosewheel, and applies full throttle. He checks engine instruments, and commences the take-off run. Initially, he keeps straight using wheel brakes or nosewheel steering, then the rudder as it becomes effective. The nose is raised slightly as the elevators become effective, and as flying speed is reached, the aircraft is flown off the runway by a smooth backward movement of the control column.
Tail-wheel aircraft – pilot lines up aircraft, straightening the tail wheel. With the control column aft of central, throttle is opened to take-off power. Any tendency to swing is corrected with rudder. As speed increases, the aircraft is brought into flight attitude by progressive forward movement of the control column. A smooth backward pressure is used to unstick at the correct speed.
Actions when airborne – Brakes applied, undercarriage retracted, and a shallow climb maintained at initial climbing speed. Flaps are then retracted, and power reduced to normal climbing power. If using reheat, undercarriage and flaps must be raised before their limiting speeds are reached.
General Flying – The Circuit

For safety, the aircraft should enter the airfield circuit following standard procedure. To join the circuit visually, the following procedure is employed during flying training –

- Pre-joining checks
- Join overhead the airfield at 1000ft. above circuit height, reducing to circuit joining speed
- Let down on the “Dead” side in a wide curve, reaching the beginning of the downwind leg at circuit height and speed
- Call “downwind” when opposite the upwind end of the runway, carrying out pre-landing checks on downwind leg
- Gradual turn onto final approach to line up with the runway, calling “Finals” during the turn
Overhead Join at Minimum of 1,000ft Above Circuit Height

Down-wind Call

Down-wind Leg (Pre-landing Checks)

Runway

Dead Side

Finals Call

Descending Turn - Commenced From 1,000ft Above Circuit Height

Fig 4-3
General Flying – The Approach

- Engine-assisted approach is usual
- Jet engines respond more slowly to the throttle, so engine rpm should not be reduced below the Aircrew Manual level
- Flaps give – a steeper descent path
  - lower stalling speed
  - better view over the nose
- Full flap is used for approach and landing
- Commonly, the approach is at constant airspeed, with throttle used to correct deviations from the glide path
Nose Wheel aircraft — the rate of descent is checked by gentle backward pressure on the control column, closing the throttle gradually, and lowering the aircraft on to its main wheels (round-out). The nose wheel is lowered as speed reduces, when the brakes can be applied, and the aircraft kept straight.

Nose Wheel aircraft land in an attitude which reduces the tendency to ‘balloon’ off the runway.
Tail Wheel aircraft – a three-point landing is achieved by rounding out and reducing power approaching the threshold, moving the control column progressively back to increase angle of attack and hold the aircraft off the ground. Done correctly, the aircraft will sink on to all three wheels together. This gives –

- Lowest touch-down speed/shortest landing run
- Early use of brakes
- Less danger of nosing over under braking
Wheel Landing – is when the aircraft is landed on the main wheels first. It is –

- Easier to judge
- Has advantages in a cross-wind
- Safer when landing a laden aircraft

However, landing speed is higher, requiring a longer run.
Cross-wind Landing – The pilot yaws the aircraft into wind, straightening before touchdown

Fig 4-4 Cross-Wind Approach

Tracking down centre-line of runway, wings level, heading into wind

Wind
Aerobatics - Safety

Aerobatics are used in RAF pilot training to give confidence in handling the aircraft in all attitudes and under high accelerations.

The following checks must always be carried out before any aerobatic exercise, remembered by the mnemonic ‘HASELL’ -
‘H’eight – must be sufficient to avoid descent below prescribed minimum

‘A’irframe – check flaps and undercarriage UP, airbrakes retracted

‘S’ecurity – no loose articles/seat harness locked and tight

‘E’ngine – all indications normal and enough fuel for exercise

‘L’ocation – avoiding Active airfields, Built-up areas and Controlled airspace

‘L’ook-Out – keep clear of all other aircraft and cloud
Loop - This is the most basic manoeuvre, in the pitching plane. Keeping straight using a line feature as a reference, the pilot may go into a shallow dive, then raise the nose until the horizon disappears below his field of view. He then looks back and watches for the opposite horizon to come round, and checks that his wings are still level. He coaxes the aircraft over the top and down the other side, gaining speed, which could be used to enter another manoeuvre.
Aerobatics – Basic Manoeuvres

Barrel Roll - This is the simplest manoeuvre in the rolling plane. The aircraft is put into a shallow dive and banked 45deg in the opposite direction to the intended roll. It is then flown round the outside of an imaginary barrel, centred on a spot above the horizon. A line feature can be used to keep straight.
Aerobatics – Basic Manoeuvres

Fig 5-2 Barrel Roll
Aerobatics – Basic Manoeuvres

Slow Roll - This is a more difficult manoeuvre. The pilot rolls the aircraft keeping the nose on a point on the horizon, keeping a constant rate of roll and neither losing nor gaining height. A fast roll is easier to fly.
Stall Turn - this is the only manoeuvre in the yawing plane.

The pilot eases back the stick to bring the nose up to vertical, holding that position whilst speed falls off. Just before the stall, he applies full rudder to yaw the aircraft over to one side. Engine power is reduced as the nose comes over, and the aircraft falls sideways until nose down. As speed increases, the pilot raises the nose and the aircraft has turned through 180deg.
Aerobatics and Formation Flying

Fig 5.4 Stall Turn
Roll off the top - This is a half roll off the top of a loop.
Aerobatics – Advanced Manoeuvres

Half Roll and Pull Through. This is a roll into the second half of a loop -
Aerobatics – Advanced Manoeuvres

Upward Roll - This is a roll about a vertical axis, finishing with a stall turn as speed has dropped off.

Aileron Turn – a roll flown vertically downwards. Speed increases rapidly, and reduced power and airbrakes may be needed.
Fig 5-8 Horizontal Derry Turn (Plan View)

Start Roll (to left illustrated)

Roll continues through inverted position
Aerobatics – Advanced Manoeuvres

Fig 5-9 Vertical Figure Eight
- Full Loop
- Roll to the Inverted
- Half Roll off the Top Loop
- Pull Through to Straight and Level
- Start

Fig 5-10 Horizontal Figure Eight
- Half Roll and Dive
- Start
Aerobatics – Advanced Manoeuvres

Inverted Flight is –
- Time limited by fuel system
- ‘g’ limited by lower negative ‘g’ structural limit
- Requiring a higher angle of attack
- Requiring control movements in reverse
- Possibly laterally sensitive, dihedral now being destabilising
A formation is an ordered arrangement of aircraft, proceeding together under the control of an appointed leader (No. 1)

Two Types – Close formation, for take-offs, cloud penetration and landing, and for display and show purposes, and Tactical formation for tactical fighter operations. Only Close formations are considered here.
No 1 must fly in a position from which he can communicate with all his pilots, and must be replaceable by a deputy leader.

All pilots must know the object of the exercise, plan of formation changes, emergency procedures, and action to be taken in the event of deterioration of weather and airfield state.

The section (2 or more aircraft) is the basic unit.
Formation Flying – Section

Vic

Echelon

Line Abreast
Formation Flying - Section

Line Astern

Box
Emergency Procedures

Aircrew must know what action to take in emergency.

Internationally, 2 degrees of emergency are defined –

Distress – the aircraft is threatened by serious or imminent danger and needs immediate assistance.

Urgency – the aircraft has a very urgent message to transmit concerning the safety of an aircraft, or persons on board or in sight.
Emergency Procedures

Emergency Transmissions consist of the Emergency Call and the Emergency Message. The Emergency Call is -

<table>
<thead>
<tr>
<th>Degree of Emergency</th>
<th>Pro-word (R/T)</th>
<th>Pro-Sign (W/T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urgency</td>
<td>“Pan, Pan, Pan” Aircraft callsign (once)</td>
<td>“XXX, XXX, XXX” Aircraft callsign (once)</td>
</tr>
<tr>
<td>Distress</td>
<td>“Mayday, Mayday, Mayday” Aircraft callsign (3 times)</td>
<td>“SOS, SOS, SOS” Aircraft callsign (3 times)</td>
</tr>
</tbody>
</table>
Emergency Procedures

The Emergency Message Should include –

- Position and Time
- Heading and Airspeed
- Altitude
- Type of aircraft
- Nature of Emergency
- Intentions of Captain
- Endurance remaining
Emergency Procedure and Fixer Services

- If in contact with ATC, emergency call and message should be on frequency in use. If not use 243.0 Mhz with 121.5 MHz as back-up, or 500KHz HF.

- SSR can also be used, sending code 7700 (unless in contact with ATC). For total radio failure set code 7600.
Final Transmission – when ditching, crash landing or abandoning, the aircraft call sign should be left transmitting if possible.

UHF Emergency Fixer Service – The UK has a network of stations which can receive 243MHz signals, and feed a bearing for the aircraft back to ATCC. This is accurate above 5000ft. (8500ft in Scotland). Transmissions from ATCC are relayed through the forward relay system, extending the range of ATCC comms.

If Emergency ceases, calls MUST be cancelled.
Emergency Procedures

SARSAT – Search and Rescue Satellite Aided Tracking – detects transmissions on 406, 243, and 121.5 MHz. Any transmission on these frequencies will alert rescue services. Inadvertent transmissions must be reported to avoid wasted effort.
Emergencies involving other aircraft –
Other aircraft or personnel should be kept in sight, and IFF/SIF set to emergency.
At sea, guide a surface vessel to the position if possible.
If a distress message is not known to have been sent, or further help is needed, aircraft captain should send a message on the frequency in use.
Any special instructions should then be complied with, or the distressed personnel/aircraft kept in sight as long as possible.
If a message is heard, attempt to obtain a fix, listen out, acknowledge message, go to position given if possible.
Communications failure – If 2-way comms are lost, transponder is set to mode 3A, Code 7600. In VMC, continue flight to the nearest airfield. In IMC, if safe navigation possible, continue with flight plan. If not, reset transponder to code 7700, and fly one of the following patterns to alert a ground station -
Emergency Procedures

If transmitter only has failed, fly an equilateral triangle to the right whilst listening out for instructions. ATCC will attempt to contact on emergency frequency.

If both transmitter and receiver have failed, fly an equilateral triangle to the left. In this case ATCC will send a shepherd aircraft.

Triangles should be flown out of cloud, be flown for endurance and have anti-collision lights on.
Emergency Procedures

If necessary, when speech cannot be transmitted, a speechless code can be used to communicate with ATC. This uses the carrier wave transmitted when the transmit button is pressed to send signals observable on the ATC direction finding equipment.
When ATCC identifies an aircraft in distress, the emergency is handled by the Emergency Controller in the ATCC Distress and Diversion Cell, communicating on 243 MHz or 121.5 MHz. In the event of crash landing or abandonment, the Emergency Controller will advise the Rescue Coordination Centre, who will coordinate the appropriate emergency services. The two RCC’s are in Maritime Headquarters at Plymouth and Edinburgh.