LANDING OPERATION

1. Introduction

The landing phase of a flight includes two phases:

- the flare
- the landing roll

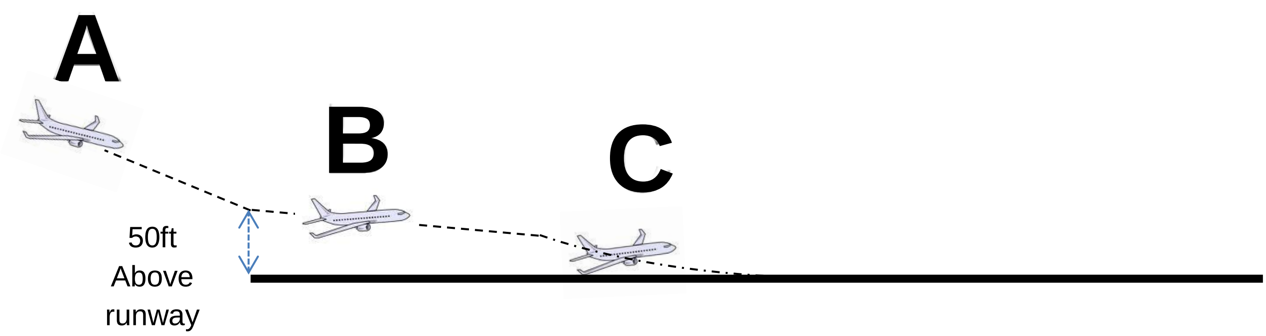
A detailed landing phase of a fixed wing aircraft can be presented with the following sequence

1. Final approach before the runway threshold
2. Flare after the runway threshold
3. Touchdown and de-rotation
4. Roll out and deceleration

It is assumed that the crossing height over the beginning of the usable length of the declared safe area is 50 ft.

2. Landing flare

The Landing Flare, in a fixed wing aircraft, is the transition phase between the final approach and the touchdown on the landing surface.



Position A: Aircraft is on final.
Position B: Aircraft power thrust is on idle and pilot will increase slightly aircraft pitch.
Position C: It is the flare phase of the flight.

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During the flare phase of the flight, you are approaching the ground as the speed decreases. Aircraft shall slow down your vertical velocity. The flare process requires that the pilot increases the aircraft pitch attitude when performing a reduction in engine power/thrust. This combination will create a decrease of both rate of descent and airspeed which are appropriate for landing.

Pilots are required to make a landing flare based solely on external visual clues.

If executed correctly, the flare will result in the aircraft achieving the appropriate landing attitude by:

- A power setting at or near idle,
- A reduced rate of descent
- A decaying airspeed

If not executed correctly, the flare could result in a hard landing with the possibility of the collapse of the landing gear, a tail strike or a runway overrun.

For light general aviation aircraft, the proper landing technique requires that the aircraft should be held off the runway in the landing attitude until the speed decays almost to the point of aerodynamic stall.

The majority of aircraft fall in between these extremes with touchdown occurring after the flare, power reduction and a brief hold off, at a speed well above stall speed.

Once the main landing gear is in contact with the runway, de-rotation should occur without delay. Appropriate deceleration procedures should be initiated immediately following the touchdown as dictated by the calculated stopping distance and the available runway.

3. Required landing distance

Landing distance is defined as the horizontal distance traversed by the aeroplane from a point on the approach path at a selected height above the landing surface to the point on the landing surface at which the aeroplane comes to a complete stop.

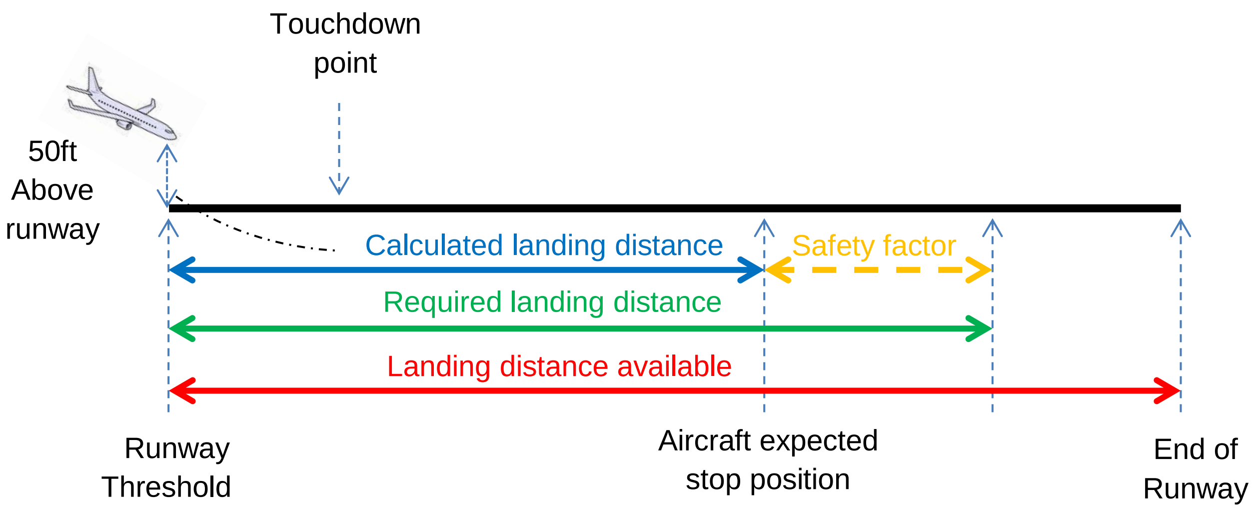
Landing distance is calculated by the pilots using printed tables or a computer.

The determination of landing distance required for aircraft to land is calculated by taking into account the effect of various influencing factors, including runway construction, surface conditions and the use of aircraft devices which are available to assist deceleration.

The required landing distance shall be less than Landing Distance Available (LDA).

The Landing Distance Available (LDA) is the length of the runway which is declared available by the appropriate authority and is suitable for the ground run of an aeroplane landing.

The landing distance available is given by aerodrome charts.



The required landing distance takes account of the normal landing factors, including the safety factor. Required landing distance = calculated landing distance + safety factor.

Safety factors will vary according to the aircraft type, the runway conditions (dry, wet or contaminated), and the runway construction and parameters (slope, altitude).

Note: Consult the landing distance documentation about the calculation of the safety factor

It is assumed for these calculations that the aircraft will be at a specified height, usually 50 ft, crossing the runway threshold at the correct speed and aircraft handling will be in accordance with normal procedures.

4. Deceleration on the Runway

The three primary methods of achieving deceleration on the runway during the landing roll or a rejected take off are:

- Reverse engine power
- Brakes
- Mechanical spoilers.

Deceleration procedures during roll out <u>should be initiated immediately</u> following main wheel touchdown.

The key to success is the properly co-ordinated use of all the available methods

4.1. Engine power and reverse thrust/propeller

The most important pilot action to achieve deceleration is to select all thrust/power levers to the <u>ground idle position</u> promptly.
If available, pilot can continue the action through to the selection of reverse thrust or reverse propeller pitch.

This is the first action to begin deceleration and must especially be achieved without delay when a high speed rejected take-off is initiated.

Note: pay attention that in some airfields, reverse thrust may be completely or partially forbidden
Note that at touchdown, the engines are still producing forward motion.

Thrust reversers and reverse propeller pitch are most effective at high speeds. Then, when the aircraft groundspeed has reduced sufficiently (typical value is 60kt), thrust/power levers should be returned to the ground idle position by the pilot.

Selection at these relatively high speeds must be symmetrical because otherwise, directional control may be prejudiced.

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4.2. Wheel brakes

Braking action at any speed depends upon sufficient friction existing between the tyres and the runway surface.

Braking effectiveness is affected by:

- The degree of brake wear created by wheel rotation When brake temperature indication is available on the flight deck, it must be within prescribed limits before a take-off roll is commenced so that effective braking is available if a take-off is rejected. System faults or inappropriate use of brakes during a long taxi out can raise brake temperatures into cautionary ranges where a delay for take-off may be required.
- The tyre parameters (inflation pressure, condition)
- The condition of the runway surface

Auto brake systems provide pre-selectable rates of deceleration which vary between 3 to 6 knots per second constant deceleration rate. Maximum manual braking can produce deceleration rates of up to 10 knots.

Aircraft brakes are almost exclusively located on the main wheels

4.2.1. Braking system

In small aircraft, the brake system can be a master cylinder and it does not need hydraulic pumps.
In larger aircraft, the brake system can be powered by hydraulic fluid using pump or in last designed aircraft by electric systems.

Historically, the pilots use a single lever to apply all brakes symmetrically and the brake control was mechanical.
Now, the pilots have the toe operated brake controls incorporated into the rudder pedals. The foot operated controls by the pilot through applying left or right brakes independently (differential braking) can maintain directional control during take-off or landing roll when the airspeed is too low for the aerodynamic controls to be effective.

4.3. Mechanical spoilers

The mechanical spoilers are activated with a mechanical deflection of parts of the wing upper surfaces.
These spoilers can assist deceleration in two ways:

- By increasing aerodynamic drag
- By increasing the effective downward load on the landing gear and thereby increasing the efficiency of wheel braking.

Pay attention that many aircraft do not have auto retract deployed spoilers function. When facing a rejected landing, the pilot shall need to manually retract spoilers for a safe initial climb away.

These systems can also be used in the air on some aircraft types as in-flight air brakes.

4.4. Runway Surface Conditions

The effectiveness of deceleration on the runway after a landing or a rejected take-off decision will be affected by the surface friction. The surface can be contaminated by water, ice, snow, oil … etc …

When the surface is contaminated, the landing distance or rejected take-off roll distance is increased. Regulation has made some recommendation with considering a safety factor different in function of the type of contamination. Consult the document about landing distance calculation in order to have these values.

5. Short landing operations

Some aircraft operations need a short landing operation due to the remoteness of the airport or to physical limitations relating to extending the runway.

The short landing operations will only be approved with considering the following criteria:

- The vertical distance between the path of the pilot's eye and the path of the lowest part of the wheels, with the aircraft established on the normal glide path, shall not exceed 3 m.
- The visibility/RVR must not be less than 1,5 km.
- Minimum pilot experience, training requirements and special aerodrome familiarisation must be specified
- The charts and country's regulation may impose additional conditions necessary for a safe operation (aircraft characteristics, orographic characteristics in the approach area, and missed approach landing considerations).

6. Defences against threats

On a typical flight with a duration of 1.5 hours, the landing phase accounts for approximately 1% of the total time. However, according to the Boeing Aircraft Aviation Safety department, landing accidents, in jet powered aircraft have resulted in approximately 20% of aviation fatalities.

The defences for landing operation are:

- Stabilised approach implies that the flight path would terminate within the touchdown zone. If the approach is not stable, a missed approach should be executed.
- Flare height should be at the height recommended in the aircraft flight manual. Adjustments for crosswind or wind gust conditions may be required.
- Pitch from approach attitude to landing attitude should be accomplished at a rate which prevents ballooning but ensures landing attitude is achieved prior to touchdown. Excessive pitch should be avoided.
- Power/thrust reduction should comply with the recommended values in the aircraft flight manual. Adjustments for crosswind or wind gust conditions may be required.
- Touchdown should be appropriate for the aircraft type and should avoid excessive float.
- Deceleration procedures during roll out should be initiated immediately following main wheel touchdown.

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