



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 2, 2018

Attachment 10 – Flight Crew Training Manual Flare and Touchdown

OPERATIONAL FACTORS

DCA17LA145



A319/320/321 Flight Crew Training Manual FCTM Delta Air Lines, Inc.

Copyright © 2017
Delta Air Lines, Inc.
All Rights Reserved

Revision Number: 3
Revision Date: March 10, 2017

Flare and Touchdown

The techniques discussed here are applicable to all landings including one engine inoperative landings, crosswind landings, and landings on slippery runways. Unless an unexpected or sudden event occurs, such as windshear or collision avoidance situation, it is not appropriate to use sudden, violent, or abrupt control inputs during landing. Begin with a stabilized approach on speed, on glide path.

Note: When a manual landing is planned from an approach with the autopilot connected, the transition to manual flight should be planned early enough to allow the pilot time to establish aircraft control before beginning the flare. The PF should consider disengaging the autopilot and disconnecting the autothrust no later than 1 to 2 nm before the threshold, or approximately 300 to 600 feet above field elevation.

When the threshold passes under the aircraft nose and out of sight, shift the visual sighting point to the far end of the runway. Shifting the visual sighting point assists in controlling the pitch attitude during the flare. Maintaining a constant airspeed and descent rate assists in determining the flare point.

The flight control law changes to the landing mode at 50 feet RA. Below 30 feet, the flight control system blends in a nose down command which helps the pilot to “feel” the flare. Begin the flare at approximately 30 feet AGL by gently increasing the pitch angle with back stick pressure which counteracts the tendency for the nose to drop. When the pilot hears the “thirty” callout, he should raise the pitch attitude approximately 2° to slow the rate of descent. This should be done smoothly and slowly to prevent the aircraft from inadvertently leveling off or climbing.

Conditions permitting, reduce the thrust levers to idle at about 20 feet when the pilot hears “retard”. Hold sufficient back pressure on the side stick to keep the pitch constant. Avoid the tendency to float and land long. Make small pitch attitude adjustments to maintain the desired descent rate to the runway, but do not allow the aircraft speed to decay appreciably or the pitch attitude to increase above approximately 8° nose-up. The PM should make awareness calls if the pitch attitude approaches 10°. Fly the aircraft onto the runway.

A321

A "PITCH-PITCH" synthetic voice sounds when the pitch attitude becomes excessive and a tail strike pitch limit indicator appears on the PFD to indicate the maximum pitch attitude to avoid a tail strike.

DELTA
A319/320/321 Flight Crew Training Manual

After touch down, the pilot must “fly” the nosewheel smoothly, but without delay, on to the runway, and must be ready to counteract any residual pitch up effect of the ground spoilers. However, the main part of the spoiler pitch up effect is compensated by the flight control law itself. A small nose down trim on the elevators is introduced by the control law, which compensates the pitch up tendency with ground spoiler extension.

Prolonged flare increases aircraft pitch attitude 2° to 3° . When prolonged flare is coupled with a misjudged height above the runway, a tail strike is possible. Do not prolong the flare in an attempt to achieve a perfectly smooth touchdown. A smooth touchdown is not the criterion for a safe landing.

Airspeed Control

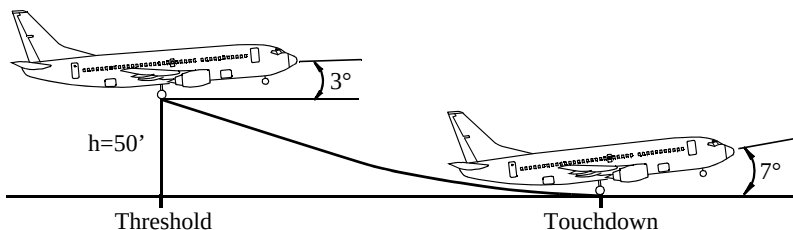
During an automatic landing, a “RETARD” callout is made at 10 feet RA as a reminder to retard the thrust levers to idle to match the A/THR commanded thrust and place the thrust levers in a position where reverse thrust can be activated. During manual landings, the SPEED mode remains active and the callout is generated at 20 feet RA as a reminder that the thrust levers should have already been retarded to idle for landing.

The autothrust system is normally used for all landings. Because thrust required during the approach is less than climb thrust, the initial movement of the thrust levers from the climb detent to the idle detent will have no effect on thrust. When the autothrust system is not used for landing (to maintain proficiency for instance) the initial movement of the thrust levers toward idle will have an immediate effect on thrust.

Landing Flare Profile

The following diagram uses these conditions:

- 3° approach glide path,
- flare distance is approximately 1,000 to 2,000 feet beyond the threshold,
- typical landing flare times range from 4 to 8 seconds and are a function of approach speed, and
- aircraft body attitudes are based upon typical landing weights, flaps FULL and VAPP (approach) and VLS (touchdown)



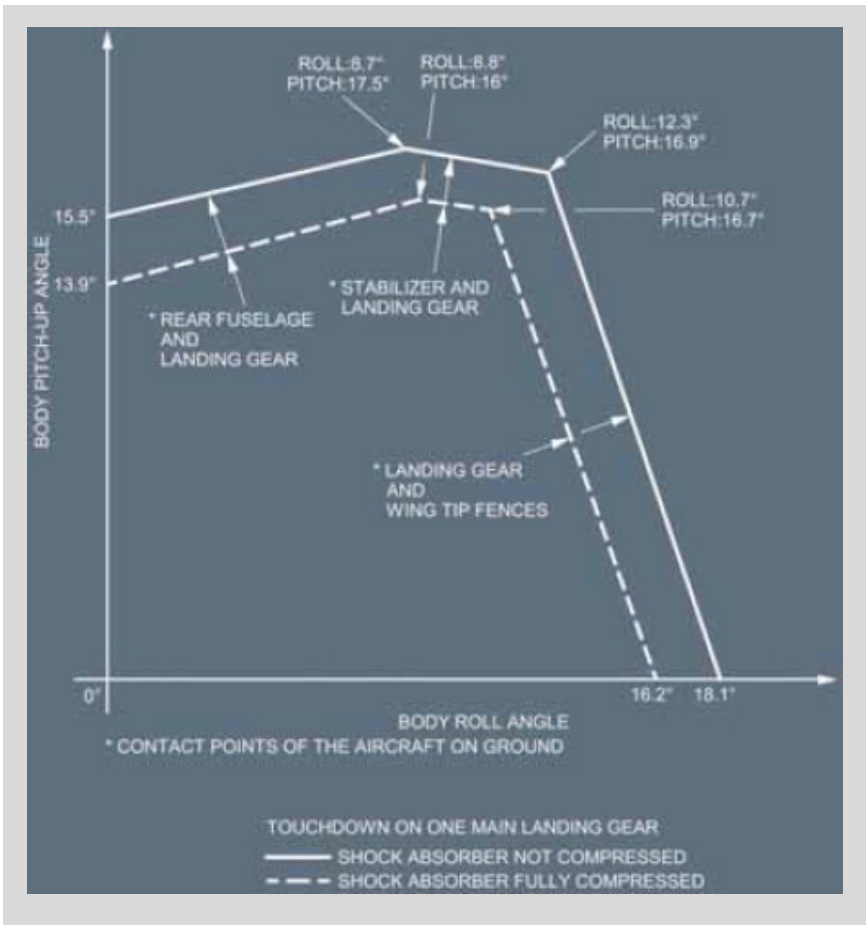
Pitch and Roll Limit Conditions

The Ground Contact Angles - Normal Landing figures illustrate body roll/pitch angles at which the aircraft structure contacts the runway.

Note: The figures are based on a rigid wing, however, dynamic maneuvering can reduce this envelope due to structural flexing of the airframe. Therefore, body roll/pitch angles within the envelope shown on the figures can result in aircraft structure contacting the runway.

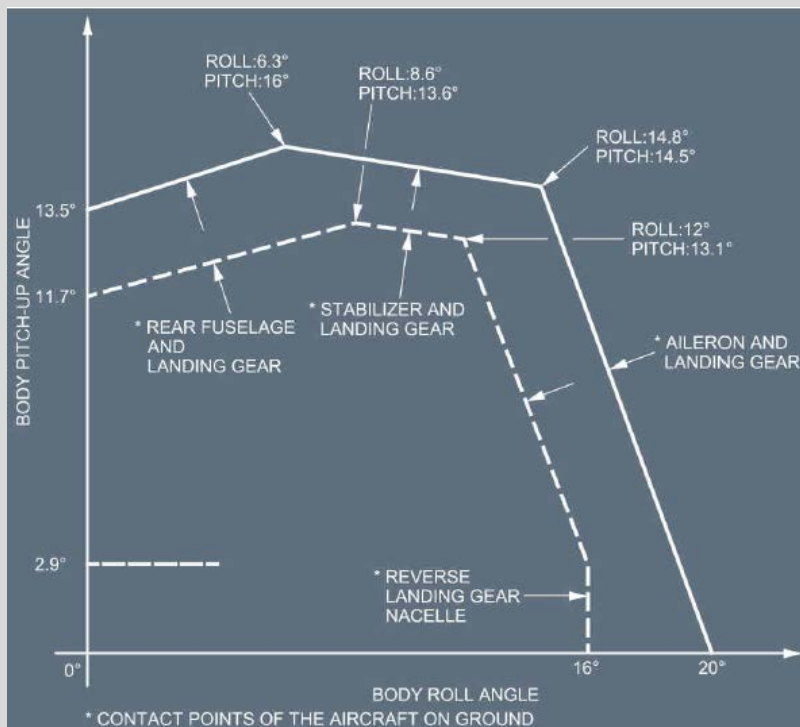
Ground Contact Angles - Normal Landing

A319

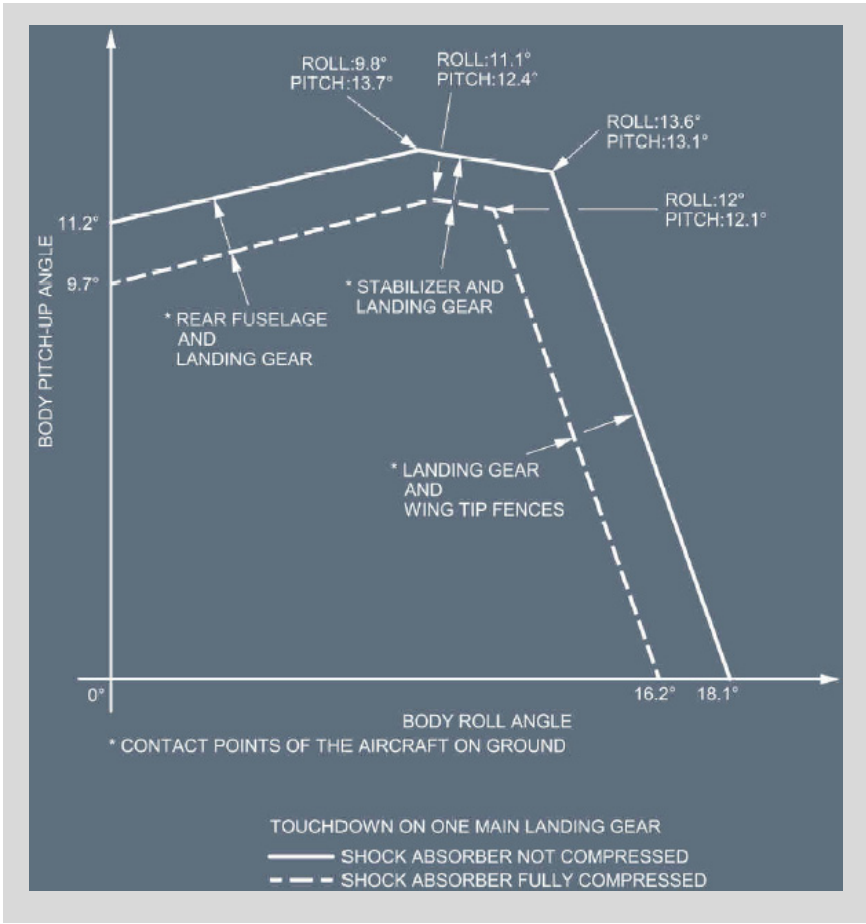


 DELTA
A319/320/321 Flight Crew Training Manual

A320



A321





Bounced Landing Recovery

Tailstrikes are most common following a firm landing with the thrust levers not at idle (because the spoilers do not deploy). If the aircraft should bounce, hold or re-establish a normal landing attitude and add thrust as necessary to control the rate of descent. Thrust need not be added for a shallow bounce or skip. When a high, hard bounce occurs, initiate a go-around. Apply TOGA thrust and use normal go-around procedures. Do not allow the pitch attitude to increase, particularly following a firm touchdown with a high pitch rate. Do not retract the landing gear until a positive rate of climb is established because a second touchdown may occur during the go-around.

Rejected Landing

A rejected landing is defined as a go-around initiated after the MAP or below MDA/DA. Refer to chapter 5, Go-Around and Missed Approach and Go-Around after Touchdown, for more information on this subject.

If the go-around is initiated below 50 feet RA, the initial sidestick “nose up” input forces will be greater than normal due to the fact that the flight controls have reverted to the landing mode of normal law. These forces will normalize above 50 feet RA as the flight controls transition back to the flight mode of normal law.