Thrust-reverse system

Wikipedia, http://en.wikipedia.org/wiki/Reverse_thrust

A KLM Fokker 70 rolling out with **flaps** fully extended, **spoilers** raised, and **reverse thrust** selected. The two reverse thrust buckets behind each engine can be seen in the deployed position, diverting the engine exhaust gases forward.

Spoilers (lift dumpers)

Wikipedia, http://en.wikipedia.org/wiki/Spoiler_(aeronautics)

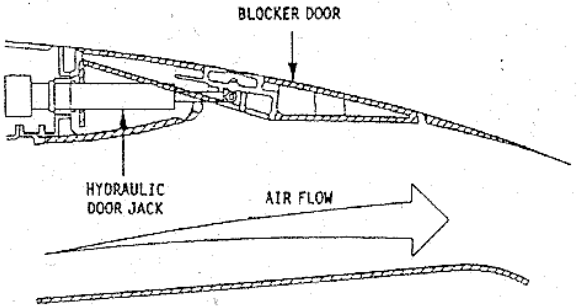
A close look at the inner workings of spoilers in lift dump deployment during the landing of an Airbus A320.

Lufthansa Flight 2904 (September 14, 1993) (3/9)

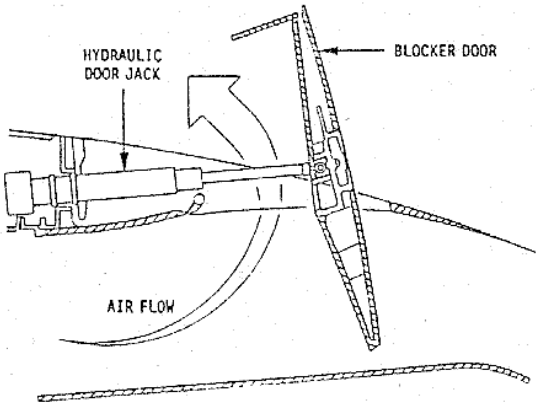
GENERAL

Reverse thrust is obtained by deflecting the fan airstream using four pivoting blocker doors on each engine.

FAN REVERSER (STOWED)



FAN REVERSER (DEPLOYED)

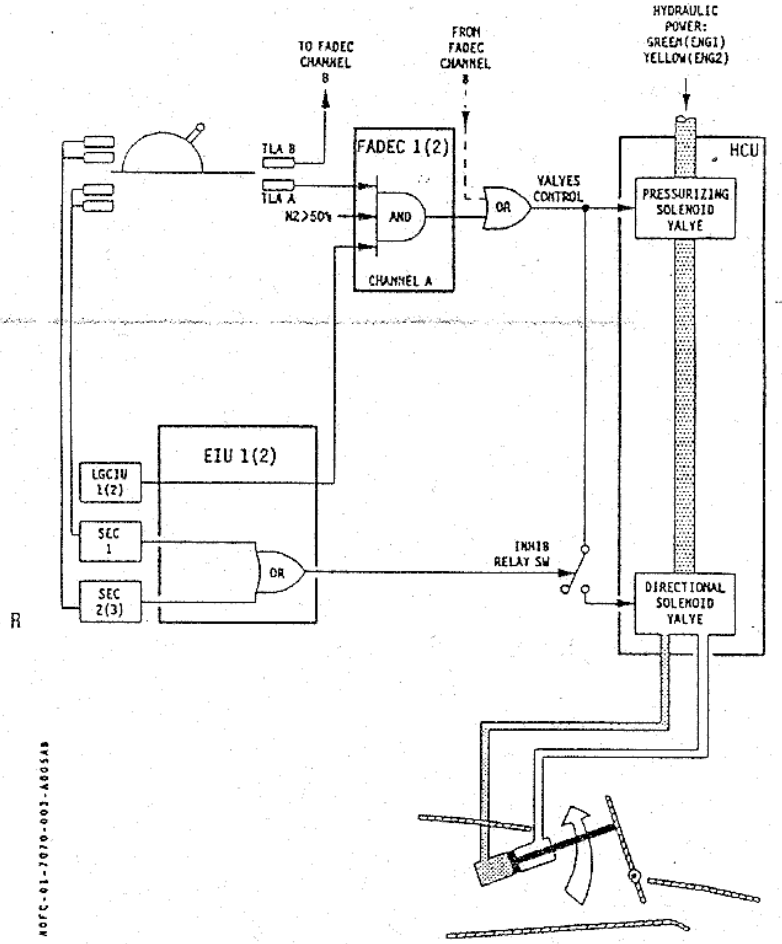


Each door is actuated by a hydraulic door jack :

— ENG 1 : Green circuit
— ENG 2 : Yellow circuit

CFM.Eng. : All

SCHEMATIC



CFM.Eng. : All

http://www.rvs.uni-bielefeld.de/publications/Incidents/DOCS/ComAndRep/Warsaw/appendices.html

Details about the design features of the aircraft

To ensure that the **thrust-reverse system** and the **spoilers** are only activated in a landing situation, the software has to be sure the airplane is on the ground even if the systems are selected mid-air.

The **spoilers** are only activated if either of these conditions are true:

- there must be weight of **over 12 tons** on each main landing gear strut
- the wheels of the plane must be turning **faster than 72 knots** (133 km/h)

The **thrust reversers** are only activated if the latter condition is true.

There is no way for the pilot to override the software decision and activate either system manually.

Wikipedia, http://en.wikipedia.org/wiki/Lufthansa_Flight_2904

Lufthansa Flight 2904 (September 14, 1993) (5/9)

From Frankfurt, Germany to Warsaw, Poland
Airbus A320-211

Wikipedia, http://en.wikipedia.org/wiki/Lufthansa_Flight_2904

Description of the incident

Lufthansa Flight 2904 was cleared to land at Okęcie International Airport Rwy 11 and was informed of the existence of wind shear on the approach. To compensate for the crosswind, the pilots attempted to touch down with the aircraft banked slightly to the right. Additionally they landed with a speed about 20 knots (37 km/h) faster than usual. According to the manual, this was the correct procedure for the reported weather conditions.

But the weather report was not up to date. At the moment of touch down, the assumed **crosswind** turned out to be a **tailwind**. Due to the tailwind of approximately 20 knots (37 km/h) and the increased speed the airplane hit the ground at approximately 170 knots (310 km/h) and far beyond the normal touch down point.

The aircraft's right gear touched down **770 m** from the runway 11 threshold.

The left gear touched down **9 seconds** later, **1525 m** from the threshold.

Only when the left gear touched the runway did the ground spoilers and engine thrust reversers deploy, these automatic systems depending on oleo strut (shock absorber) compression.

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Wikipedia, http://en.wikipedia.org/wiki/Lufthansa_Flight_2904

Description of the incident

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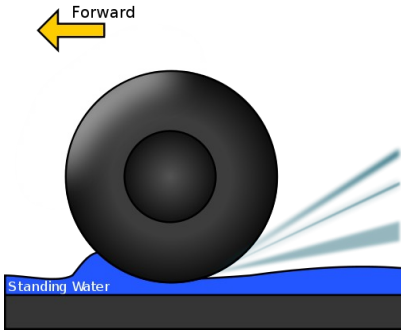
The wheel brakes, triggered by wheel rotation being equal to or greater than 72 knots (133 km/h) began to operate after about **4 seconds**.



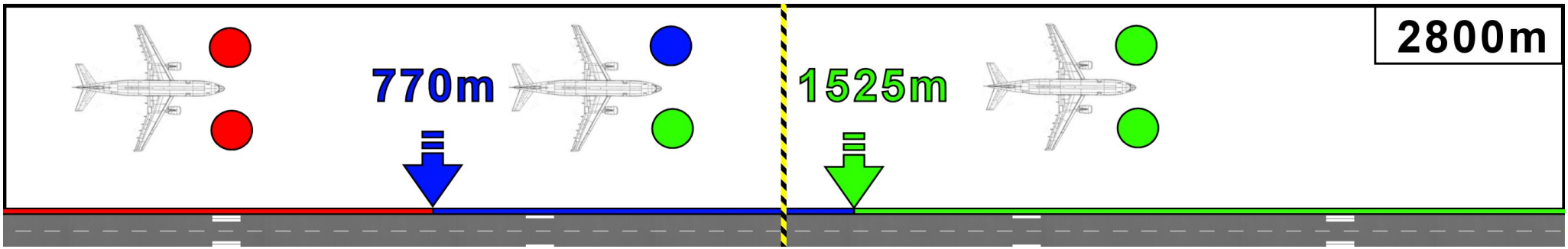


Illustration of distance relative to main strut touchdown. **The striped line** marks 1400 m, which divides the runway in half. **Red** indicates the landing gear have not touched down, **blue** indicates hydroplaning, and **green** indicates wheels on the ground.

In the case of the Warsaw accident neither of the first two conditions was fulfilled, so the most effective braking system was not activated. Point one was not fulfilled, because the plane landed inclined (to counteract the anticipated crosswind). Thus the pressure of 12 tons on both landing gears required to trigger the sensor was not reached. Point two was also not fulfilled because of a hydroplaning effect on the wet runway.

Only when the left landing gear touched the runway did the automatic aircraft systems allow the ground spoilers and engine thrust reversers to operate. Due to the braking distances in the heavy rain the aircraft could not stop before the end of the runway. The computer did not actually know the aircraft had landed until it was already 125 meters beyond the half way point of runway 11.

Wikipedia, http://en.wikipedia.org/wiki/Lufthansa_Flight_2904

Accident summary:

Passengers: 64, crew: 6.
Injuries: 68, fatalities: 2, survivors: 68.

Wikipedia, http://en.wikipedia.org/wiki/Lufthansa_Flight_2904

Red Wings Airlines Flight 9268 (December 29, 2012) (1/6)

From Pardubice, Czech Republic to Moscow, Russia
Tupolev Tu-204-100

http://www.airlines-inform.ru/russian_airlines/Red_Wings.html

Sequence of events

Approach was carried out on the runway 19 at Vnukovo Airport with length of 3060m. During preparation for landing the captain has determined the landing speed as 210 km/h, and specified that the speed of at least 230 km/h has to be maintained. End of the runway was passed at the height of 15 meters and airspeed of 260 km/h. 5 seconds after the throttle had been switched to the idle mode, the aircraft landed with the speed of 230 km/h, distance from the runway threshold of 900-1000m and left bank of 1... 1.5°.

At this point the signal of left gear strut compression was produced. During the landing the right side wind gusts reached up to ~11.5 m/s. The maximal value of the vertical acceleration speed during touchdown was recorded as 1.12g. About 10 seconds have passed from the moment of passing the 4m altitude point and the touchdown. 3 seconds after that the touchdown nose gear strut was compressed. At this stage the right gear strut compression signal had not yet been formed.

Almost simultaneously with the touchdown of the nose landing gear the crew moved in one motion the engine controls to the "maximum reverse" position and applied mechanical brakes. Actuation of the valves of reversing systems on both engines did not happen. Air brakes and spoilers also were not activated automatically and the crew did not attempt to activate them manually.

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Wikipedia, http://en.wikipedia.org/wiki/Red_Wings_Airlines_Flight_9268

Sequence of events

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After thrust levers were moved to the "maximum reverse" position an increase of forward thrust (up to 90% Nvd) was recorded with both engines. The pressure in the hydraulic system of wheel brakes of the left (compressed) landing gear was up to 50 kgf/cm², whereas there were no pressure in the wheel brakes of the right (not compressed) landing gear. The minimum airspeed to which the aircraft slowed 7–8 seconds after landing was 200–205 km/h at ~ 0° pitch and roll of 1° to the left. After that the speed began to increase.

2 seconds after the thrust levers were moved to the "maximum reverse" position the flight engineer reported that reversers had not been deployed. Thrust lever had been maintained in the "maximum reverse" position for about 8 seconds and was switched off after that.

During this time the airspeed increased to 240 km/h. The increase in speed led to further unloading of the main landing gear. With fluctuations in roll (from 4.5° to the left to 2.6° to the right) compression signals was produced alternately on the left and right landing gear struts. The signal of simultaneous compression of both struts (needed for thrust reversers deployment) was not produced.

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Wikipedia, http://en.wikipedia.org/wiki/Red_Wings_Airlines_Flight_9268

Sequence of events

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Almost simultaneously with the reversers being switched off, the brake pedal was pushed by the captain to 60°. As before, the braking was inefficient since by design the hydraulic pressure in the wheel brake is only applied after sufficient compression of the gear strut.

5 seconds after reversers were deactivated, after the words of the flight engineer "Reverse! Turn on reverse!" the pilots again moved the controls to the "maximum reverse" position. As in the first attempt, the deployment of reversers did not happen, both of the engines again started to produce direct thrust (at Nvd ~ 84%). Braking of the aircraft again did not happen, and the airspeed was increased to 230...240 km/h. The reversers were switched off 4 seconds after that.

At the time of reverser reactivation the aircraft was at the distance of about 950...1000 m from the exit threshold. 6 seconds after the switchoff of the reversers, the crew attempted to apply automatic braking.

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Wikipedia, http://en.wikipedia.org/wiki/Red_Wings_Airlines_Flight_9268

Sequence of events

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The aircraft skidded off the runway 32 seconds after landing, being almost on the axis of the runway with an air speed of about 215 km/h. In the process of skidding off at the command of the captain the flight engineer turned off the engines by means of the emergency brake. The plane continued to roll outside the runway slowly braking due to road bumps and snow cover. At this point the compression on both landing gear struts happened which led to the activation of air brakes and spoilers. The plane collided with the slope of a ravine at the ground speed of about 190 km/h.

Accident summary:

Passengers: 0, crew: 8.
Injuries: 3, fatalities: 5, survivors: 3.

Wikipedia, http://en.wikipedia.org/wiki/Red_Wings_Airlines_Flight_9268

Red Wings Airlines Flight 9268 (December 29, 2012) (6/6)

/home/vk/clases/mf/01/Flight_9268.flv

http://www.youtube.com/watch?v=LSJEe6VLvEw

Wikipedia, http://en.wikipedia.org/wiki/Red_Wings_Airlines_Flight_9268