RNSA

Rannsóknarnefnd samgönguslysa

LOKAÐ MEÐ BÓKUN

Málnr.: **23-073F024**

Dags: **10. nóvember 2023**

Staður: **Á Varanasi flugvellinum á Indlandi**

Lýsing: **Rak niður stél í lendingu**

Flugvél TF-LLL (Boeing 757-200) var að lenda, á flugbraut 27 á flugvellinum í Varanasi (VEBN) á Indlandi klukkan 05:38[1] þann 10. nóvember með flugnúmeri ICE1253, þegar hún rak niður stélið (tail strike). Flugstjóri flugvélarinnar var að fljúga flugvélinni (Pilot Flying).

Við það að reka niður stélið urðu umtalsverðar skemmdir neðarlega á burðarvirki flugvélarinnar aftan við jafnþrýstirými skrokksins, í kringum STA 1743.

Við skoðun á flugritagögnum kom í ljós að kerfi flugvélarinnar virkuðu sem skyldi í lendingunni.

Veður á flugvellinum var gott, mistur en laust við ský undir 5000 fetum, skyggni 2200 metrar, hiti 30° C, vindur breytilegur 2 hnútar og loftþrýstingur 1017 HPa. Engin ummerki

[1] Allir tímar eru GMT, nema annað sé tekið fram

fundust um vindhvörf (windshear) í lendingunni, né í lokaaðfluginu. Eftirfarandi METAR skeyti hafði verið gefið út fyrir flugvöllinn klukkan 05:30, eða átta mínútum fyrir atvikið:

- METAR VEBN 100530Z VRB02KT 2200 HZ NSC 30/17 Q1017 NOSIG=

Hvorki er talið að veður né umhverfi hafi verið áhrifavaldur í atvikinu.

Aðflug flugsins inn að flugbraut 27 á flugvellinum reyndist eðlilegt og fékk áhöfn flugs ICE1253 heimild frá flugumferðarstjórn til lendingar. Flugbrautin er í um 270 feta hæð yfir sjávarmáli (MSL).

Samkvæmt útreikningum út frá flugritagögnum flugvélarinnar, þá var lendingarþyngd flugvélarinnar 85.065 kg.

Á stjórnborði (mode control panel) var valinn flughraði (selected speed) í aðfluginu 136 hnútar (Vref+6). Samkvæmt handbók (FCOM)[2], þá er áætlaður lendingarhraði (Vref) 126 fyrir 80.000 kg lendingarþyngd og 134 hnútar fyrir 90.000 kg lendingarþyngd, miðað við 25° vængbörð. Fyrir 85.000 kg lengdingarþyngd og 25° vængbörð má því áætla Vref sem 130 hnúta.

VREF (KIAS)

WEIGHT (1000 KG)	FLAPS 30	FLAPS 25	FLAPS 20
120	157	158	167
110	149	151	159
100	140	142	151
90	132	134	143
80	124	126	135
70	115	117	125
60	106	108	116

Fyrir lendinguna hafði sjálfvirk bremsa nr. 2 (Autobrake 2) verið valin og lyftispillar (speedbrake) gerðir tilbúnir (armed).

Klukkan 05:37:20 var flugvélin stöðug (stable) í 1000 feta hæð yfir jörðu (radio altitude).

[2] Flight Crew Operations Manual, revision 78, issued May 15 2023, page PI.20.5

Klukkan 05:37:26 nefndi flugstjórinn að kink (pitch) flugvélarinnar væri hátt, eða 5°, en ekki urðu umræður um það og í staðinn ræddu flugmennirnir að þeir sæu ekki flugbrautina ennþá, en mistur var í kringum flugvöllinn.

Klukkan 05:37:46 sáu flugmennirnir flugbrautina, en þá var flugvélin í 680 feta hæð yfir jörðu.

Klukkan 05:37:50 voru bæði sjálfstýringin (autopilot) og sjálfvirka eldsneytisgjöfin (autothrottle) aftengdar, en þá var flugvélin í um 630 feta hæð yfir jörðu á 138 hnúta flughraða. Var flugvélinni handflogið eftir það.

Samkvæmt stöðluðum verklagsreglum flugrekandans[3], ef sjálfvirka eldsneytisgjöfin er aftengd, þá skal lágmarks skipaður hraði (minimum command speed) í lendingunni vera Vref+5 hnútar. Í þessu tilfelli var það 135 hnútar, þar sem Vref var 130 hnútar.

Klukkan 05:38:00, þegar flugvélin var í 500 feta hæð yfir jörðu, var flughraði hennar 136 hnútar. Þar mældu kerfi flugvélarinnar vindinn 250°/7 hnúta.

Klukkan 05:38:39, þegar flugvélin var í 40 feta hæð yfir jörðu, var flughraði flugvélarinnar 131 hnútar. Þar mældu kerfi flugvélarinnar vindinn 250°/5 hnúta. Þá var kink (pitch) flugvélarinnar 5,4°.

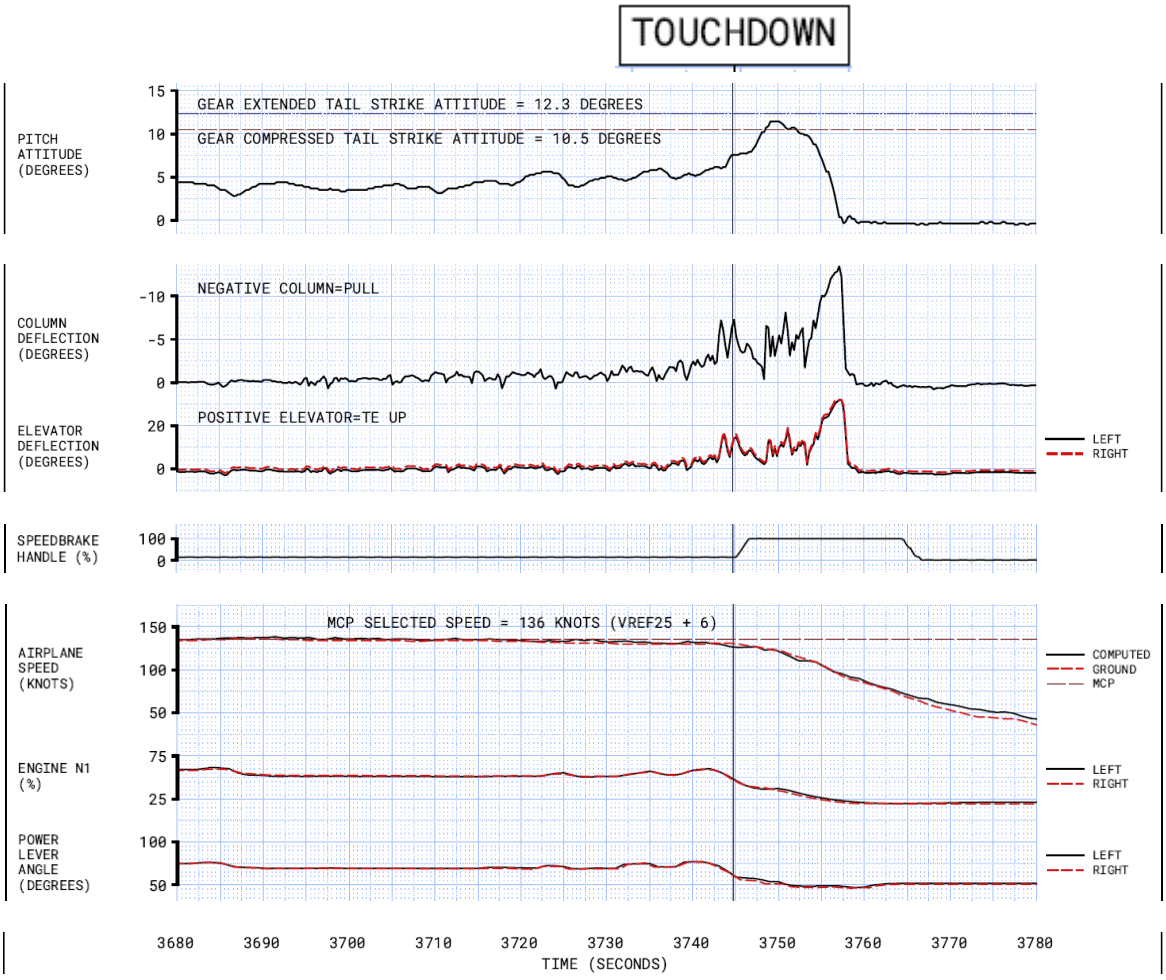
Í lokaaðfluginu hafði hæðarstýri flugvélarinnar að mestu verið í láréttri stöðu, en rétt fyrir lendingu var tekið í hæðarstýrið til að slétta úr (flare) fluginu fyrir lendingu. Við það jókst kink flugvélarinnar upp í 7,5° og flughraðinn lækkaði enn frekar.

Klukkan 05:38:44 snertu aðalhjól flugvélarinnar flugbrautina, en þá hafði flughraði flugvélarinnar lækkað í 127 hnúta, eða 3 hnúta undir Vref. Rétt fyrir það[4] höfðu kerfi flugvélarinnar mælt vindinn 240°/3 hnúta. Þá var kink (pitch) flugvélarinnar 7,7°.

[3] B757 767 Standard Operating Procedures (SOP) revision 5, issued 28-03-2023, page 6-4, Chapter 6.7 Command Speed for Landing

[4] Vindagögn flugvélar á jörðu eru ekki marktæk og því var notast við mælingu 0,5 sek fyrir lendingu.

Í þjálfunarhandbók flugmanna[5] er tekið fram að hjól flugvélarinnar ættu ekki að snerta flugbrautina (touchdown) á hraða sem er lægri en Vref-5 hnútar. Einnig[6] er tekið fram að við lendingu á hraða sem er 10 hnútum undir áætluðum lendingarhraða (Vref -10) sé hætta á að reka stél flugvélarinnar niður í flugbrautina við lendingu (touchdown). Flugvélin var hins vegar yfir þessum hraða þegar aðalhjól hennar snertu flugbrautina klukkan 05:38:44 (Vref-3).



Í þjálfunarhandbók flugmanna[7] er tekið fram að til að forðast það að stél flugvélarinnar rekist niður í flugbrautina skuli passa að kink (pitch) flugvélarinnar aukist ekki eftir að aðalhjólin snerta flugbrautina (touchdown).

[5] 757/767 Flight Crew Training Manual, Airspeed Control, pg 6.10
[6] 757/767 Flight Crew Training Manual, Normal Touchdown Attitude, pg 6.12 – 6.13
[7] 757/767 Flight Crew Training Manual, Landing Roll & Speedbrakes, pg 6.30 – 6.31

Einnig kemur fram að báðir flugmennirnir ættu að fylgjast með hvort að lyftispillar (speedbrakes) virkjast eftir lendingu og ef þeir gera það ekki sjálfvirkt þá þarf að virkja þá handvirkt. Samkvæmt þjálfunarhandbók flugmanna (FCTM) þá veldur sjálfvirk virkjun á lyftispillum (speedbrakes) ekki auknu kinkhorni (adverse pitch tendency), en hröð handvirk virkjun (rapid manual extension) á lyftispillum getur valdið hækkuðu kinkhorni (nose-up pitch tendency) sem getur leitt til þess að stél flugvélarinnar rekist í flugbrautina. Því ætti að lækka nefhjól flugvélarinnar rólega í átt að flugbrautinni (lower the nose wheels smoothly to the runway) á sama tíma og lyftispillarnir eru rólega virkjaðir (while slowly raising the speedbrake to the up position).

Klukkan 05:38:45 virkjuðust lyftispillar (speedbrakes) og kallaði flugmaðurinn (Pilot Monitoring) „SPEEDBRAKES UP“. Voru þeir að fullu komnir upp um 1,5 sekúndu síðar. Á þessu tímabili minnkaði ekki kinkhorn flugvélarinnar. Strax í kjölfarið að lyftispillarnir komu upp tók kinkhorn flugvélarinnar hins vegar að aukast.

11.4 Landing Roll Procedure

PILOT FLYING	PILOT MONITORING
After touchdown:	
Verify that the thrust levers are closed. Verify that the SPEEDBRAKE lever is UP. Maintain runway centerline and fly the nose wheel smoothly onto the runway. • Avoid increasing pitch after touchdown.	Monitor SPEEDBRAKE lever and when extended: **"SPEEDBRAKES UP"** If the SPEEDBRAKE lever is not UP: **"SPEEDBRAKES NOT UP"** • If the speedbrakes do not extend automatically, the Commander shall manually extend the speedbrakes.

Klukkan 05:38:47 virkjuðust hjólabremsurnar og fór þrýstingurinn í bremsukerfinu mest upp í 1200 psi um 8 sekúndum síðar (Autobrake 2).

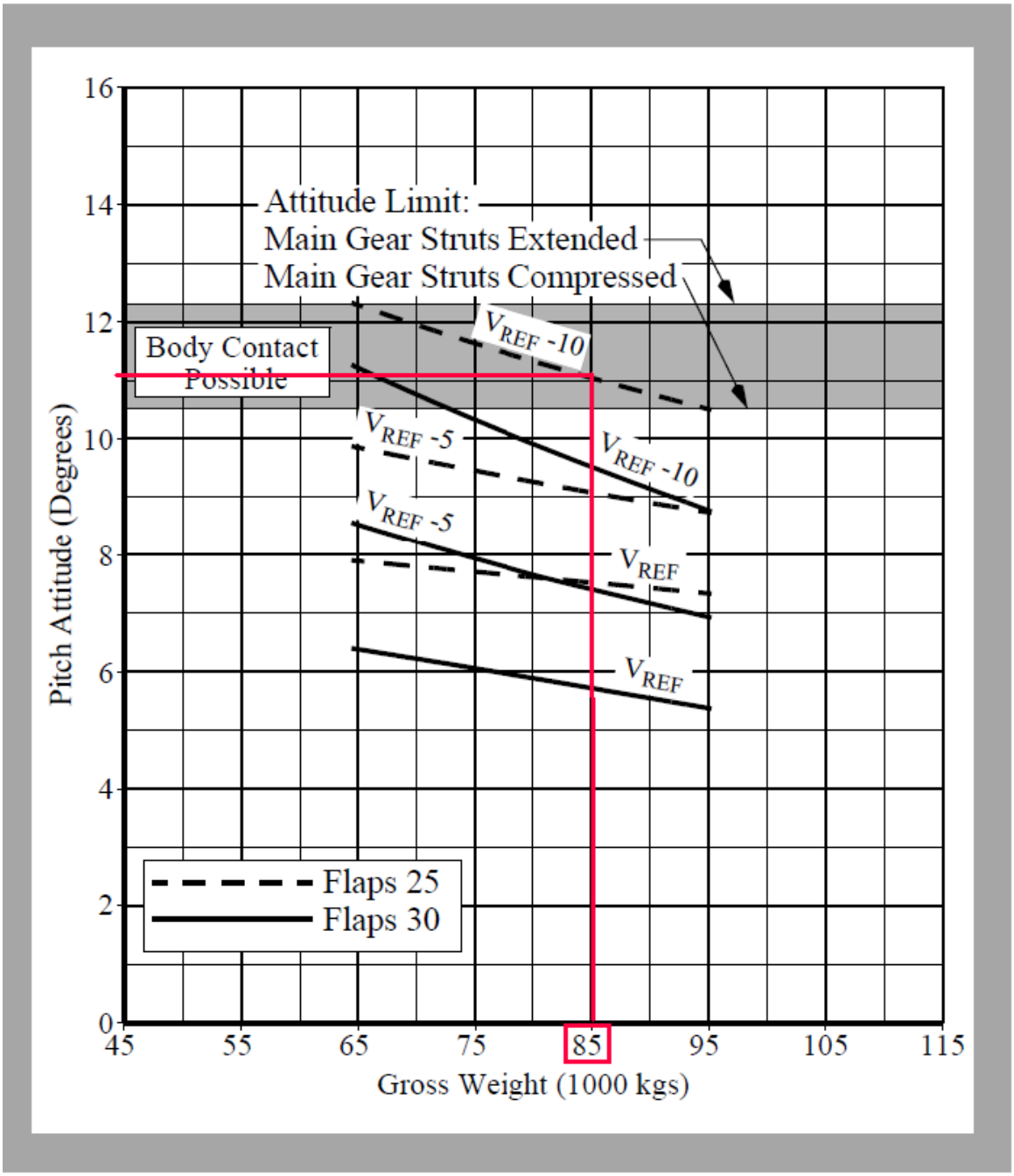
Var þá hæðarstýrið (control column) fært í lárétta stöðu, en jafnframt tekið strax aftur í það og það fært aftur (pulled) í 6,5° klukkan 05:38:48.

Klukkan 05:38:48 var flughraðinn kominn niður í 124 hnúta og hafði kink flugvélarinnar aukist upp í 10,5°, sem er hámarkshorn sem hægt er að ná með aðalhjólin þjöppuð saman í lendingunni án þess að flugvélin reki niður stélið.

Klukkan 05:38:49 var flughraðinn kominn niður í 120 hnúta og hafði kink flugvélarinnar þá aukist upp í 11,4° og hélst það horn í um eina sekúndu. Er það mat RNSA að þarna hafi flugvélin dregið stélið eftir jörðinni (tail strike).

Touchdown Body Attitudes - Kilograms

757-200



Klukkan 05:38:52 hafði kink flugvélarinnar minnkað aftur niður í 10,5° og nef flugvélarinnar kom að fullu niður (fully rotate) um 5,5 sekúndum síðar.

Klukkan 05:39:04 voru lyftispillarnir (speedbrake) settir aftur niður.

Samkvæmt flugplani þá var massi og vægi flugvélarinnar vel innan marka og ekkert óeðlilegt kom í ljós þegar flugvélin var afhlaðin.

RNSA telur að orsök atviksins megi rekja til þess að eftir að aðalhjólin snertu flugbrautina og lyftispillar virkjuðust sjálfvirkt, þá hafi aftur verið togað í hæðarstýrið (control column). Við það hafi kinkhorn flugvélarinnar tekið að aukast enn frekar, uns stél flugvélarinnar rakst í flugbrautina um fimm sekúndum eftir að aðalhjólin höfðu snert flugbrautina.

RNSA lokaði málinu með bókun á nefndarfundi þann 24. október 2024.

RNSA

Rannsóknarnefnd samgönguslysa

CLOSED WITH A BOOKING

This is a translation from the original report issued in Icelandic
In case of translation error(s), the Icelandic report is the correct one

Case number.: **23-073F024**

Date: **10. November 2023**

Location: **At Varanasi airport in India**

Description: **Tail strike during landing**

Aircraft TF-LLL (Boeing 757-200) was landing, at runway 27 at Varanasi airport (VEBN) in India at 05:38[1] on 10. November under flight number ICE1253, when it incurred a tail strike. The Commander of the flight was the Pilot Flying.

When the tail strike occurred, significant damage occurred in the lower aft fuselage, aft of the pressurized area, around STA 1743.

Inspection of the flight data recorder data revealed that the aircraft systems operated normally during the landing.

[1] All times are UTC, unless otherwise stated.

The weather at the airport was good, mist but clear of clouds below 5000 feet, visibility 2200 meters, temperature 30° C, 2 knot wind from variable direction and QNH 1017Hpa. No evidence was found of windshear during the landing nor on the final approach. The following METAR had been issued at 05:30, or eight minutes before the serious incident:

- METAR VEBN 100530Z VRB02KT 2200 HZ NSC 30/17 Q1017 NOSIG=

Neither the weather, not the environment, is believed to have contributed to the serious incident.

The final approach towards RWY 27 at the airport was normal and the flight crew received permission to land at the runway from air traffic control. The runway is located at 270 feet altitude above Mean Sea Level (MSL).

According to calculations based on the FDR data, the aircraft landing weight was 85,065 kg.

On the mode control panel the selected speed during the final apprach was 136 knots (Vref+6). According to the FCOM[2], the estimated landing speed (Vref) was 126 knots for 80,000 kg landing weight and 134 knots for 90,000 kg landing weight, assuming 25° flaps. For 85,000 kg landing weight and 25° flaps Vref can be estimated as 130 knots.

VREF (KIAS)

WEIGHT (1000 KG)	FLAPS 30	25	20
120	157	158	167
110	149	151	159
100	140	142	151
90	132	134	143
80	124	126	135
70	115	117	125
60	106	108	116

Prior to the landing, Autobrake 2 had been selected and the speedbrake armed.

At 05:37:20 the aircraft was stable at 1000 fet radio altitude.

[2] Flight Crew Operations Manual, revision 78, issued May 15 2023, page PI.20.5.

At 05:37:26 the Commander mentioned that the aircraft pitch was high, or 5°. Further discussion on this did not ooccurr and instead the pilots discussed that they still could not see the runway, but mist was present at and around the airport location.

At 05:37:46 the pilots noticed the runway, when the aircraft was located at 680 feet radio altitude.

At 05:37:50 both the autopilot and the autothrottle were disengaged, but then the aircraft was located at 630 feet radio altitude, flying at 138 knots air speed. The aircraft was manually flown after this.

According to the flight operator's SOP[3], if the auothrottle is disengaged, the minimum command speed during the landing shall be Vref+5 knots. In this case, that was 135 knots, as the Vref was 130 knots.

At 05:38:00, when the aircraft was located at 500 feet radio altitude, its air speed was 136 knots. At the same time the aircraft systems measured the wind 250°/7 knots.

At 05:38:39, when the aircraft was located at 40 feet radio altitude, its air speed was 131 knots. At the same time the aircraft systems measured the wind 250°/5 knots. Then the aircraft pitch was 5.4°.

During the final approach, the aircraft control column was mostly in level/zero position, but right before touch down the control olumn was pulled to flare the flight prior to landing. This resulted in the aircraft pitch to increase further and the air speed reduced even further than before.

At 05:38:44 the aircraft main wheels touched the runway, but then the aircraft speed had reduced down to 127 knots, or 3 knots below Vref. Right before that[4] the aircraft systems had measured the wind 240°/3 knots. Then the aircraft pitch was 7.7°.

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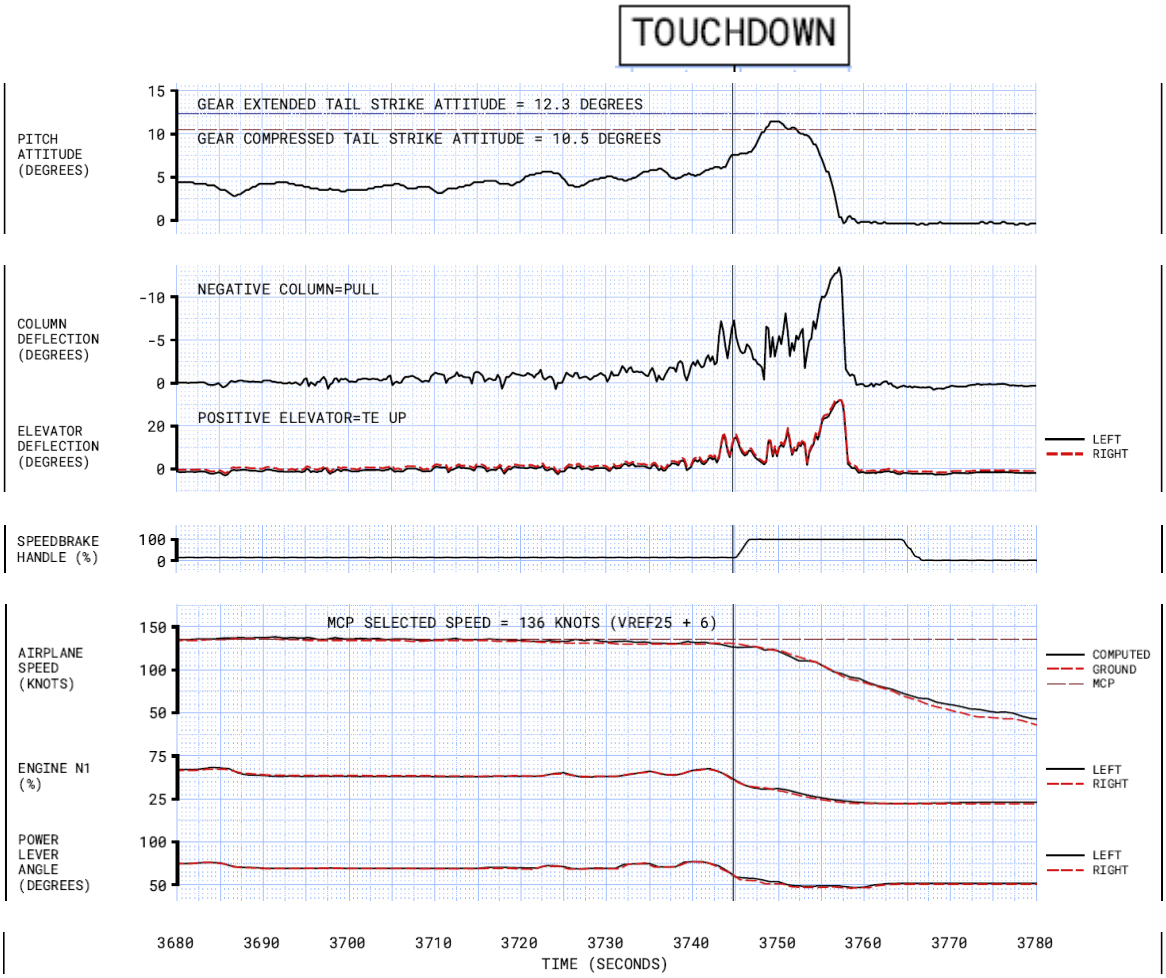
[3] B757 767 Standard Operating Procedures, revision 5, issued 28-03-2023, page 6-4, Chapter 6.7 Command Speed for Landing.

[4] The aircraft wind data, when the aircraft is on the ground is not valid and therefore a measurement from 0.5 seconds before the landing is used.

In the FCTM[5] it is discussed that touchdown should not occurr at air speeds below Vref-5 knots. In addition[6] it is discussed that landing at air speed that is 10 knots below Vref (or Vref -10), there is a risk of a tail strike during touchdown. The aircraft was however above this air speed (it was at Vref-3) when its main wheels touched the runway during the landing at 05:38:44.



In the FCTM[7] it is also discussed that to avoid a tailstrike, the pilot needs to ensure that the pitch attitude does not increase after touchdown.

In there it also states that both pilots should monitor automatic speedbrake extension after touchdown and in the event auto extension fails the speedbrakes need to be manually extended. According to the FCTM, automatic speedbrake extension produces no

[5] 757/767 Flight Crew Training Manual, Airspeed Control, pg 6.10.
[6] 757/767 Flight Crew Training Manual, Normal Touchdown Attitude, pg 6.12 – 6.13.
[7] 757/767 Flight Crew Training Manual, Landing Roll & Speedbrakes, pg 6.30 – 6.31.

adverse pitch tendencies, but rapid manual extension can produce a nose-up pitch tendency that could lead to a tail strike. For this reason, lower the nose wheels smoothly to the runway while slowly raising the speedbrake to the up position.

At 05:38:45 the speedbrakes extended and the Pilot Monitoring called "SPEEDBRAKES UP". The speedbrakes were fully extended 1.5 seconds later. During this time, the aircraft's pitch attitude did not reduce. Immediatelly thereafter the aircraft's pitch attitude started to increase.

11.4 Landing Roll Procedure

PILOT FLYING	PILOT MONITORING
After touchdown:	
Verify that the thrust levers are closed. Verify that the SPEEDBRAKE lever is UP. Maintain runway centerline and fly the nose wheel smoothly onto the runway. • Avoid increasing pitch after touchdown.	Monitor SPEEDBRAKE lever and when extended: **"SPEEDBRAKES UP"** If the SPEEDBRAKE lever is not UP: **"SPEEDBRAKES NOT UP"** • If the speedbrakes do not extend automatically, the Commander shall manually extend the speedbrakes.

At 05:38:47 the wheel brakes activated and the brake system pneumatic pressure increased to 1200 psi about 8 sekonds later (Autobrake 2).

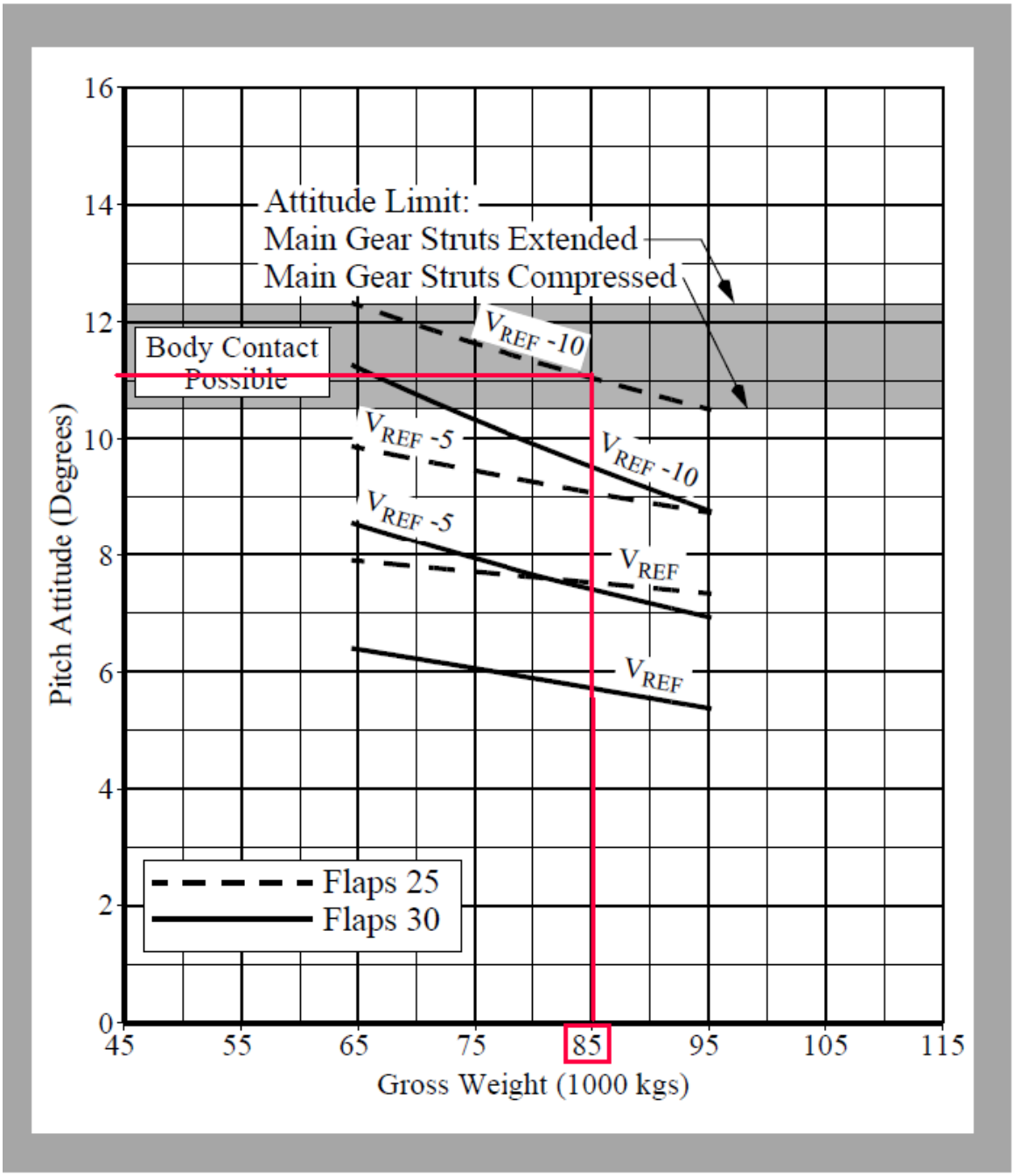
Then the control column was moved to level position, but then immediatelly pulled back to 6.5° at 05:38:48.

At 05:38:48 the air speed was down to 124 knots and the aircraft pitch had increased up to 10.5°, which is the maximum pitch attitude posible with the main gear struts compressed without encountering a tailstrike.

At 05:38:49 the air speed was down to 120 knots and the aircraft pitch attitude had increased up to 11.4° and that angle was maintained for about one second. SIA-Iceland determined that the aircraft dragged the tail along the runway during this period.

Touchdown Body Attitudes - Kilograms

757-200



At 05:38:52 the aircraft pitch attitude had reduced back down to 10.5° and the aircraft nose wheel was fully down to the runway about 5.5 sekonds later.

At 05:39:04 the speedbrakes were lowered again.

According to the flight plan, the aircraft weight and balance was well within limits and nothing unusual was discovered when the aircraft was unloaded.

SIA-Iceland determined that the cause of the serious incident was that after main wheels touchdown and the speedbrakes being automatically activated, the control column was pulled again. This caused the aircraft‘s pitch attitude to increase further, until a tailstrike occurred about five seconds after main wheel touchdown.

SIA-Iceland closed the case with a booking during a board meeting on 24. October 2024.