Final Investigation Report on Serious Incident to M/s Jet Airways (India) Ltd. B-737-800 Aircraft VT-JGE on 14-01-2015 at Kolkata Airport

COMMITTEE OF INQUIRY VT-JGE

(N S Dagar)
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Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2012, the sole objective of the investigation of an accident shall be the prevention of accidents and not apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.

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FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT TO M/s JET AIRWAYS (INDIA) LTD. BOEING B 737-800 AIRCRAFT VT-JGE AT KOLKATTA AIRPORT ON 14-01-2015

1.	Aircraft	Type	Boeing 737-800
		Nationality	Indian
		Registration	VT-JGE
2.	Owner		Celestial Aviation Trading 1 Ltd., Ireland
3.	Lessor		GECAS Technical Services Ltd., Ireland
4.	Operator		M/s Jet Airways (India) Ltd., Mumbai
5.	Pilot – in –Command		ALTP Holder
	Extent of injuries		NIL
6.	Co- Pilot		CPL Holder
	Extent of injuries		NIL
7.	Date & Time of Serious Incident		14-01-2015; 0340 UTC
8.	Place of Serious Incident		Runway 19L, NSCBI Airport, Kolkata
9.	Last point of Departure		CSIA Airport, Mumbai
10.	Intended landing place		NSCBI Airport, Kolkata
11.	No. of Passengers on board		144
	Extent of injuries		NIL
12.	Type of Operation		Scheduled Passenger Flight
13.	Phase of Operation		landing
14.	Type of Serious Incident		Tail Strike
15.	Co-ordinates of Accident Site		Lat 22° 40 ' 13" N, Long 88° 26' 58 " E AMSL 23 feet

(All timings in the report is in UTC)

SUMMARY:

On 14th January 2015, M/s Jet Airways Boeing 737-800 aircraft VT-JGE was involved in a serious incident at Kolkata Airport. The aircraft was scheduled to operate flight number 9W615 from Mumbai – Kolkata- Bagdogra. While carrying out landing at Kolkata airport, aircraft suffered tail strike. The aircraft was under command of PIC having ATPL and Co-pilot CPL. There were 144 passengers, 06 Cabin crew and 02 ACM on board the aircraft.

The aircraft took off from Mumbai at 0141UTC and the flight from Mumbai to Kolkata was uneventful till touchdown. Visibility at the time of landing was 800 m and ATC assigned Runway 19 L. PIC decided to carry out dual auto pilot approach with the intention of carrying out a manual landing.During landing at 0340 UTC aircraft touched down with a pitch of 5.1 ° and speed V_{ref} -10 kts. The flare lasted for about 14 seconds and the aircraft pitch reaches 9.14°. The fuselage and tail skid contacted the Runway. During the post flight walk around inspection by the AME, damages were noticed to tail skid and scrapping of aft belly of the aircraft. There was no fire or injury to person on board the aircraft.

Ministry of Civil Aviation vide order No. AV 15018/150/2015-DG dated September 2015 constituted a committee of inquiry to investigate the cause of the Serious Incident under Rule 11 (1) of Aircraft (Investigation of Accidents and Incidents), Rules 2012. The committee consist of Sh. Amit Gupta Deputy Director-AED, DGCA as Chairman and Mr. N S Dagar Jt. GM (ATM), AAI as member.

The probable cause of Serious Incident is due to "decrease of airspeed below V_{ref} during landing process and increase in pitch attitude resulted into the Tail Strike."

1. FACTUAL INFORMATION.

1.1 History of flight

On 14th January 2015, M/s Jet Airways Boeing 737-800 VT-JGE was scheduled to operate flight number 9W615 from Mumbai – Kolkata- Bagdogra. The crew consisting of a PIC having ALTP & Co-pilot CPL and 06 Cabin crew. It was the first day of a work cycle for the pilots. There were 144 passengers (139 Adults + 3Child + 02 Infants) and 02 ACM on board the aircraft.

The aircraft took off from Mumbai at 0141UTC and the flight from Mumbai to Kolkata was uneventful till touchdown. The approach was normal and PIC at 6000 feet requested ATC (approach) for high speed descend. ATC allowed high speed descend and assigned Runway 19 L for landing. Landing Flaps were selected as 30°. However, there was discussion by PIC with co-pilot regarding Flap position to 40°. Visibility at the time of landing was 800 m and the crew decided to carry out dual auto pilot approach with the intention of carrying out a manual landing. V approach was 153 kts & V ref was 148 kts. The landing was carried out by PIC and co-pilot was monitoring the instruments. During landing at 0340 UTC aircraft touched down with a pitch of 5.1° and speed V_{ref} -10 kts. The Flare lasted for about 14 seconds (from 30 ft to MLG touchdown) and the aircraft pitch reached 9.14°. Aft fuselage and Tail Skid contacted the Runway. G recorded during touchdown was 1.36. On landing the aircraft taxied to the bay on its own power. Passengers and crew disembark from the aircraft normally. During the post flight walk around inspection by the AME, damages were noticed to tail skid and aft belly of the aircraft. There was no fire or any injury to person on board the aircraft.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
Minor	NIL	NIL	NIL
None	2+6+2	144	NIL

1.3 **Damage to aircraft.**

The aircraft sustained minor damage. Following main damages occurred to the aircraft.

1) Tail skid shoe rubbed but four dimples visible. Tail skid green decal was slightly visible
2) Rubbed mark of approx. 70" long found on fuselage bottom side between STA 867 & STA 967 and between Stringer 27 L & 27 R.
3) Rubbed mark at Frame 1016 (from 18" forward FR1016 to 18" aft of FR 1016).
4) Paint peeled off and 2 deep longitudinal gauges of approximately 9"length ahead of FR 1016.
5) Tail Skid Cartridge core assembly damaged (shortened by 0.5").
6) 07 Rivets sheared off at STA 967 and between Stringer 27L & 27 R.
7) Shear Tie at STN 887 cracked between Stringer 27L & 27 R
8) Stringer clip at STA 907 and STA 887 at Stringer 27L bend.
9) Deep Gauges of Length 44.5" between STA 867 and STA 927 Stringer 27 L & 27 R.
10) Bulge of fuselage skin of 3.5" aft edge of frame STA 867 between Stringer 27 L & 27 R.

1.4 Other damage: NIL

1.5 Personnel information:

1.5.1 Pilot – in – Command:

Age	33 Years
License	ATPL
Date of Joining Jet Airways	Jan 2008
Date of Issue/Renewal	29-07-2013
Valid up to	28-07-2015
Type endorsement	B-737-700/800/900
Endorsement as PIC	08-04-2013
Date of Medical Examination	12-09-2014
Medical Examination valid upto	11-09-2015
FRTO License issue	26-09-2012
FRTO License valid upto	25-09-2017
IR Test Done	30-10-2014
IR Test Due	29-10-2015

Total Flying Experience	5248:10 hrs
Total Flying Experience as P1 on Type	1583:24 hrs
Total Flying Experience as P2 on Type	3391:58 hrs
Total Flying Experience during last 01 year	973:23 hrs
Total Flying Experience during 90 days	204:17 hrs
Total Flying Experience during 30 days	62:02 hrs
Total Flying Experience during 07 days	14:23 hrs
Total Flying Experience during 24 hours	00:00 hrs
Rest period prior to duty flight	48 hrs.

1.5.2 Co-Pilot:

Age	43 Years
License	CPL
Date of Issue/Renewal	18-12-1998
Valid up to	16-05-2016
Date of Joining Jet Airways	July 2006
Type Endorsement	B 737-800
Date of Endorsement as Co-pilot	12-09-2007
Date of Medical Examination	27-11-2014
Medical Examination valid upto	26-05-2015
FRTO License issue	03-02-2011
FRTO License valid upto	02-02-2016
IR Test Done	17-11-2014
IR Test Due	16-11-2015
Total Flying Experience	4932:46 hrs
Total Flying Experience as P2 on Type	4557:00 hrs
Total Flying Experience during last 01 Year	597:14 hrs
Total Flying Experience during 90 days	94:42 hrs
Total Flying Experience during 30 days	40:06 hrs
Total Flying Experience during 07 days	12:17 hrs
Total Flying Experience during 24 hours	00:00 hrs
Rest period prior to duty flight	48 hrs.

1.6 Aircraft Information

1.6.1 General Description:

Boeing 737-800 is a Twin engine aircraft fitted with CFM 56-7B Engine. The aircraft is certified in Normal category, for day and night operation under VFR & IFR. The maximum operating altitude is 41000 feet. Aircraft length is 39.472 meters, wingspan is 35.8 meters and height of this aircraft is 12.459 meters. This airplane is certified in the Transport Category, FAR Part 25 and Part 36.

The airframe structure is fabricated in general, of high-strength aluminum alloys. Steel, titanium and other approved materials are also used. Aluminum alloy sheet stocks are clad for gages less than 0.063 inch thick. The fuselage is a semi-monocoque structure with zee-type frames and skin stiffened with hat-type stiffeners. The fuselage skin panels are made of longitudinal stiffeners mechanically fastened to sheets. Circumferential tear straps and doublers are used where necessary. A nacelle encloses each engine. A strut attached to the wing holds the engine and nacelle. A firewall made of corrosion-resistant steel and titanium alloy isolates each nacelle from its strut.

The wing is made into one piece which extends through the fuselage. The wing to body attachment is permanent. The primary wing structure is an aluminum alloy skin stiffened by stringers made of extruded aluminum alloy. The spars primarily carry the shear loads. The skin and stringers carry most of the bending loads. The wing is also an integral fuel tank. The trailing edge ribs are made of aluminum alloy. The upper surface is made of an aluminum alloy skin and reinforced honeycomb sandwich of fiberglass and graphite. The lower surface is made of an aluminum alloy skin with a reinforced honeycomb sandwich of aramid/graphite and fiber glass/graphite. There is access to inside of the trailing edge for inspection, maintenance, and repair. The fixed structure of the leading edge is made of aluminum alloy, fiberglass, or composite fiber glass and aramid, as necessary. Upward sweeping winglets are an optional and are installed for each wing tip. These winglets enhance airplane performance for some operations. The winglets are removable. Provisions are retained for the installation of the standard wing tips. The wing tip uses the same mounting provisions as the winglets. The total wing span including the winglets is 35.8 meters and the distance from centerline to wing tip is 17.9 meters. Winglets are installed in VT-JGE aircraft.

1.6.2 Aircraft Technical Information

1.	Manufacturer	Boeing Commercial Airplane Group , USA
2.	Type	B 737-800
3.	Aircraft Registration	VT-JGE
4.	Constructor Sl. No.	32663
5.	Year of Manufacturer	2004
6.	Certificate of Registration No.	3200/2
7.	Certificate of Registration valid upto	21-11-2016
8.	Certificate of Airworthiness No.	2609
9.	C of A renewed on	27-11-2014
10.	C of A valid up to	26-11-2016
11.	ARC issued on	27-11-2014
12.	ARC valid up to	26-11-2015
13.	Category of C of A	Normal
14.	Subdivision category of C of A	Passenger/ Mail/Goods
15.	Total Number of Seats VT-JGE	16 Premier +138 Economy
16.	Minimum Crew	Two
17.	Maximum AUW	79015 Kgs
18.	Total Aircraft Hours	38078
19.	Total Aircraft Cycles	16650
20.	Engine Manufacturer	CFM
21.	Engine Type	CFM 56 -7BM24
22.	Maximum Engine Thrust	26000 Lbs.
23.	Last Layover Inspection on	13-01-2015 at Mumbai
24.	Last Layover Inspection on	38069:54 Hrs, CSN 16643

Manual Load & Trim sheet was made for the flight**.** The Details of basic weight schedule were as follows:-

Weight	**Maximum Permissible (Kgs)**	**Actual Weight (Kgs)**
Take-off weight	79,015	71,034
Landing weight	66,360	65,526
Zero Fuel weight	62,731	58,986

To facilitate the calculation of the position of the center of gravity (CG), the passenger cabin is divided into six sections, 0A, 0B, 0C, 0D, 0E, 0F.

Zone	Row No.	Max Capacity	Actual Seating
0A	1-2	8	5
0B	3-4	8	1
0C	10-16	36	35
0D	17-22	36	35
0E	23-28	36	36
0F	29-33	30	30

However, the division between the sections was not visibly apparent in the cabin.

The Boeing 737 has two lower cargo compartments for Baggage & Cargo. A forward cargo compartment, which is divided in hold #1 and hold #2 and an aft cargo compartment consisting of hold #3 and hold #4.

Cargo Hold	Maximum Capacity (Kgs)	Actual (Kgs)
1	888	400
2	2670	1571
3	3467	1950
4	570	400

The Middle Aerodynamic Chord (MACTOW) was calculated as 29% and Stabilizer trim for takeoff was calculated as 4.60 °s.

Dry Operating weight for the flight was 43943 Kgs. Fuel available was 12048 Kgs.

CG was within the prescribed limit during takeoff and landing.

1.7 Meteorological information:

Weather at 0320 UTC was visibility 900 meters, runway 19L RVR 1200m, MID 1000m winds 360/5kts. , Temperature 17°, QNH 1018 hPa and Dew point 15 °.

Weather at 0350 UTC was visibility 900 meters, runway 19L RVR 1400m, MID 1100m and winds 340/5kts Temperature 17°, QNH 1018 hPa and Dew point 15 °.

At the time of approach 0336 UTC, ATC reported visibility of 800 meters, runway 19L RVR 1200m, MID 1000m, winds 350/05kts.

1.8 Aids to navigation:

Kolkata airport is equipped with VOR / DME (frequency 112.50 MHz) and NDB (frequencies 385 KHz & 404 KHz). PAPI & ILS Cat- II is installed on Runway 19L. ILS Cat-I is at 01R & SAPL at 01L.

1.9 Communications:

The aircraft was in contact with Kolkata ATC on frequency 118.1 MHz. From the tape transcript it was evident that there was no communication problem between the Flight Crew & ATC from initial contact till stopping the aircraft.

The Communication frequencies for Tower are 118.1 MHz, Approach is 127.9 MHz, SMC Controller 121.9MHz, Kolkata Radar 127.9 M Hz, and ATIS Broadcast is at 126.4 M Hz.

Tape transcript of SMC Controller 121.9MHz and Pilot have been analyzed. Perusal of Transcript reveals that PIC requested for high Speed descend from 6000 feet to 3000 feet which was approved.

1.10 Aerodrome information.

Netaji Subhas Chandra Bose International (NSCBI) Airport (IATA code: CCU, ICAO: code VECC) is an international airport located in Kolkata, West Bengal . The elevation AMSL of airport is 7.2M (23 FT) and reference temperature is 36°C. The airport is licensed by DGCA for both IFR and VFR traffic. The airport reference code is 4E. The airport has two parallel runways made of Asphalt.

- **01L/19R**, 3,270 m × 45 m
- **01R/19L**, 3,628 m × 45 m

The Airport Reference point is 223914.2N, 0882648.18E. Runway has marking for Designation, THR, TDZ, Centreline, Rwy Edge and is lighted for THR, Edge, End, TDZ, and Centreline. The Airport Rescue and Fire Fighting Services is Category '9' (Nine). Apron has parking capacity of 01 code F, 16 code E, 6 code D and 36 code C aircraft respectively.

1.11 Flight recorders.

The aircraft is fitted with Solid State CVR & DFDR. The CVR & DFDR was removed from the aircraft after the incident & data from both CVR & DFDR were downloaded and analyzed after the incident. A full analysis was carried out for the approach and landing phases of the flight. Salient observations made from the CVR tape transcript are given below:

Station	Relative Time (Hr: Min: Sec)	Transcript
P1	1:20:56	Dual Autopilot
P2	1:20:56	Checked
P1	1:21:46	Flaps 40 *Karnaa Chahiye thaa*
P2	1:22:13	500" stabilised
P1	1:22:14	checked
P2	1:22:22	Runway Visuals
P1	1:22:23	Okay field visual
NOISE	1:22:24	Stab trim trimming noise
Audio	1:22:26	Minimums
P1	1:22:31	Visual landing
Audio	1:22:36	Auto pilot disconnect audio tone and *stab trim noise*
P1	1:22:55	checked
P2	1:22:59	Speed brakes up, reversers normal
NOISE	1:23:07	Noise of nose wheel rolling on the runway
P2	1:23:24	60 knots auto brake disarm
P1	1:23:31	Look at the runway surface
ATC	1:23:33	Jet 615 vacate via delta cross runway 19R
P2		Delta cross runway 19R
P1	1:25:26	Runway Surface *Kitnaa Kharaabb hai yaar*
P2	1:25:28	I swear you keep bouncing up down, up down, up down.

- The landing was carried out by PIC.
- Co-pilot had informed PIC after landing that "aircraft was bouncing up down" after landing.
- There was no mention / recording of Co-pilot monitoring the aircraft attitude and speed during landing

The DFDR readout was analyzed and following are the salient findings.

S. No	GMT	Radio Altitude (Feet)	CAS (Kts)	Pitch	Stab Trim	Vert G	Winds	AP Status	Remarks
1.	3:36:19	2749	204	2.46	6.81	1.04	282/9	AP 1	
2.	3:37:20	2088	167	1.76	6.16	0.98	284/8.5	Both	
3.	3:37:47	2013	162	1.76	5	0.94	285/8	Both	
4.	3:38:19	1508	155	0.7	5.48	1	298/5	Both	

S. No	GMT	Radio Altitude (Feet)	CAS (Kts)	Pitch	Stab Trim	Vert G	Winds	AP Status	Remarks
5.	3:38:55	1001	154	1.05	5.48	1.02	324/4	Both	
6.	3:39:27	521	156	0.7	5.48	1.08	001/5.5	Both	
7.	3:39:46	243	154	0.7	6.72	1	343/5.5	Both	
8.	3:39:52	161	153	1.93	6.69	1.02	342/5	Off	
9.	3:40:00	59	154	2.46	6.07	1.02	345/6	Off	
10.	3:40:02	35	154	4.04	6.1	1.13	343/6	Off	
11.	3:40:16	0	138	5.1	6.07	1.36	346/7	Off	Touch down
12.	3:40:19	0	127	9.14	6.13	1.21	350/7	Off	Point of Tail Strike

- PIC engaged both auto pilot from AP 1 at Radio Altitude of 2088 feet.
- Both the auto pilot were disengaged at Radio Altitude of 161 feet.
- Aircraft flare lasted for about 14 seconds (from 30 ft to MLG touchdown).
- Distance from Threshold to touchdown approximately 1200m.
- Aircraft touched down with a pitch of 5.1 °s and speed V_{ref} -10 kts. (Vref was 148 kts)
- Vertical G recorded at touchdown was 1.36.
- 04 seconds after touch down, the aircraft pitch reaches 9.14 °s where aft fuselage and Tail Skid contacted the Runway.
- During high speed descends maximum vertical speed was 1095 feet/min.

1.12 Wreckage and impact information.

The tail skid & aft lower part of fuselage got scrapped on Runway 19L during landing.

1.13 Medical and pathological Information:

Prior to operating the flight both the Cockpit crew had undergone pre-flight medicals/Breath analyzer test at Mumbai and were found to be negative. After the incident both the cockpit crews were not subjected to Breath analyzer test.

1.14 Fire:

There was no pre or post impact fire.

1.15 Survival aspects:

The serious incident was survivable. There was no Injury to any passenger or crew.

1.16 Tests and research:

Nil

1.17 Organizational and management information:

M/s Jet Airways (India) Ltd. is a Scheduled Airlines having valid DGCA SOP No. S-6A in Category Passenger and Cargo which commenced operations on 5th May 1993. The airlines operates a fleet of aircraft, which includes 04 Boeing 777-300 ER aircraft, 08 Airbus A330-200 aircraft,68 next generation Boeing 737-700/800/900 aircraft and 18 ATR 72-212A turboprop aircraft. M/s Jet Airways operates 68 destinations (47 Domestic + 21 international) and having approx 13900 employees.

1.18 Additional information*:*

Tail Strike during landing is more critical than the tail strike during take- off. During 2012-2015, there have been three (03) serious incidents of tail strike during landing occurred to Indian Scheduled airlines excluding this serious incident.

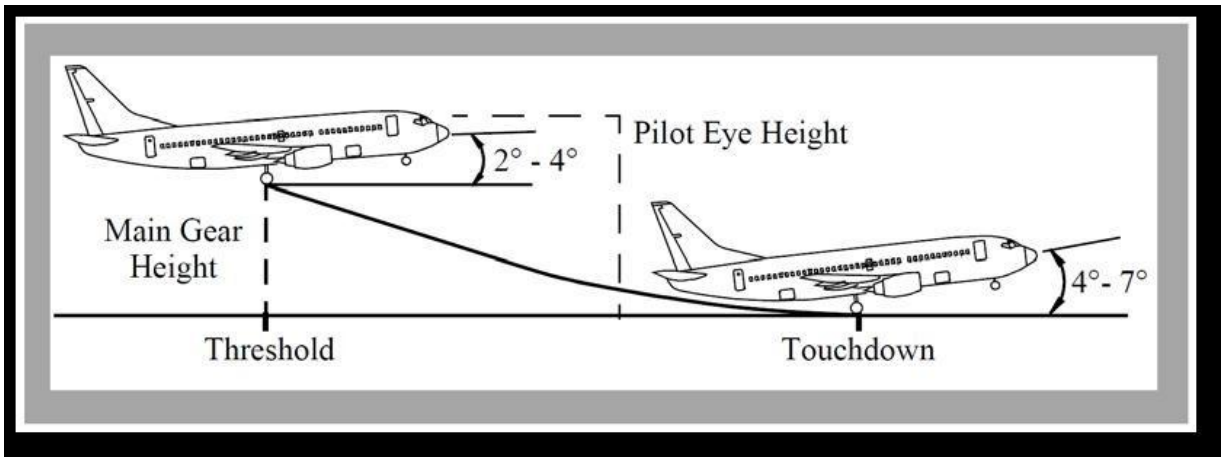
1.18.1 Flare and Touchdown Profile of B 737

The techniques mentioned 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 wind shear or collision avoidance situation, it is not appropriate to use sudden, violent or abrupt control inputs during landing. While carrying out Stabilized approach when the threshold passes under the airplane nose and out of sight, shift the visual sighting point to approximately 3/4 the runway length. 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. Initiate the flare when the main gear is approximately 15 feet above the runway by increasing pitch attitude approximately 2° - 3°. This slows the rate of descent. After the flare is initiated, smoothly retard the thrust levers to idle, and make small pitch attitude adjustments to maintain the desired descent rate to the runway. Ideally, main gear touchdown should occur simultaneously with thrust levers reaching idle. A smooth power reduction to idle also assists in controlling the natural nose-down pitch change associated with thrust reduction. Hold sufficient back pressure on the control column to keep the pitch attitude constant. A touchdown attitude as depicted in the figure below is normal with an airspeed of approximately V_{ref} plus any gust correction. Do not trim during the flare or after touchdown. Trimming in the flare increases the possibility of a tail strike.

1.18.2 Landing Flare Profile

The following diagrams use 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
- Airplane body attitudes are based upon typical landing weights, flaps 30, VREF 30 + 5 (approach) and VREF 30 + 0 (landing), and should be reduced by 1° for each 5 knots above this speed.
- Threshold height for main gear and pilot eye level is shown in two Bar/Three Bar VASI landing Geometry tables.



The pitch attitude increases slightly during the actual landing, but avoid over-rotating. Do not increase the pitch attitude after touchdown; this could lead to a tail strike. Shifting the visual sighting point down the runway assists in controlling the pitch attitude during the flare. A smooth power reduction to idle also assists in controlling the natural nose down pitch change associated with thrust reduction. Hold sufficient back pressure on the control column to keep the pitch attitude constant. Avoid rapid control column movements during the flare. Do not use pitch trim during flare or after touch down. Such actions are likely to cause the pitch attitude to increase at touchdown and increase the potential for a tail strike. Do not allow the airplane to float; fly the airplane onto the runway. Do not extend the flare by increasing pitch attitude in an attempt to achieve a perfectly smooth touchdown. Do not attempt to hold the nose wheels off the runway.

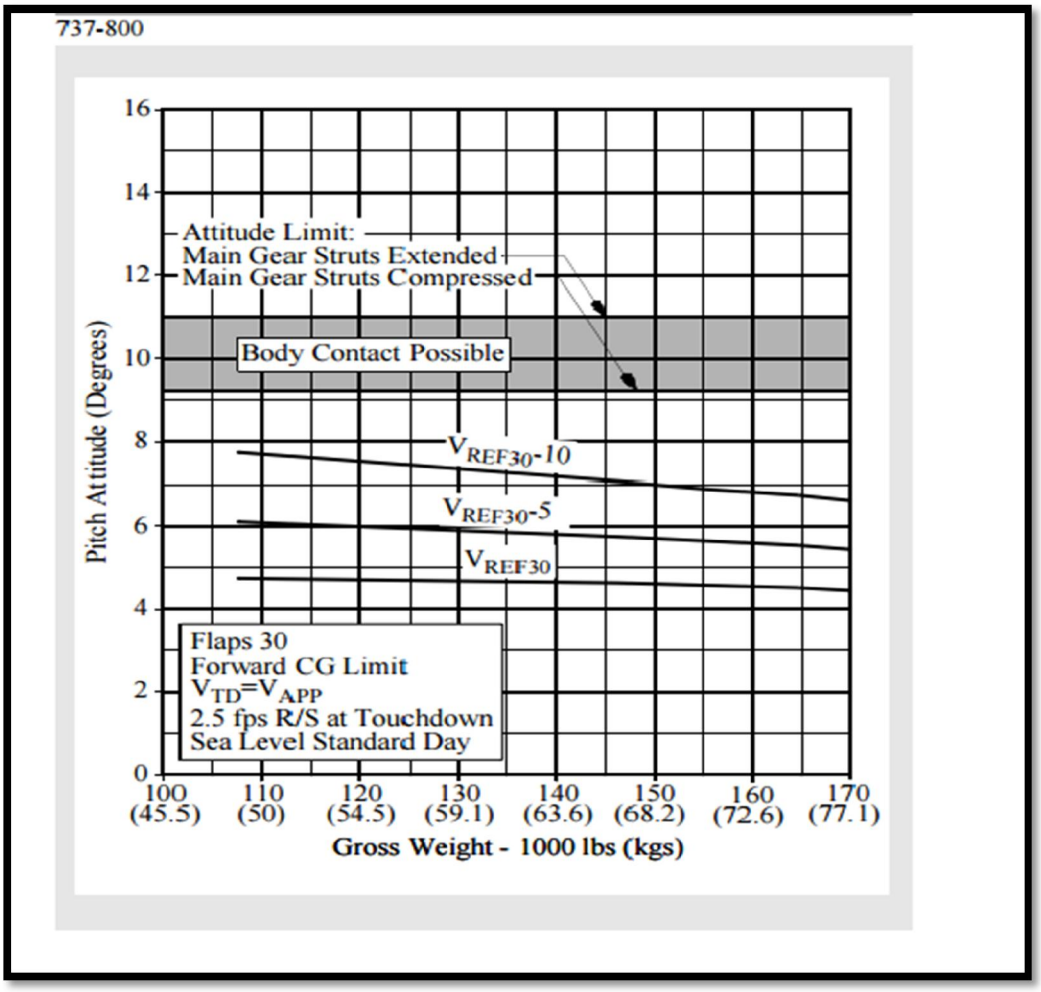
If the airplane should bounce, hold or re-establish a normal landing attitude and add thrust as necessary to control the rate of descent. Thrust need not be added for a shallow bounce

or skip. When a high, hard bounce occurs, initiate a go-around. Apply go-around thrust and use normal go-around procedures. Do not retract the landing gear until a positive rate of climb is established because a second touchdown may occur during the go-around.

Bounced landings can occur because higher than idle power is maintained through initial touchdown, disabling the automatic speed brake deployment even when the speed brakes are armed. During the resultant bounce, if the thrust levers are then retarded to idle, automatic speed brake deployment can occur resulting in a loss of lift and nose up pitching moment which can result in a tail strike or hard landing on a subsequent touchdown.

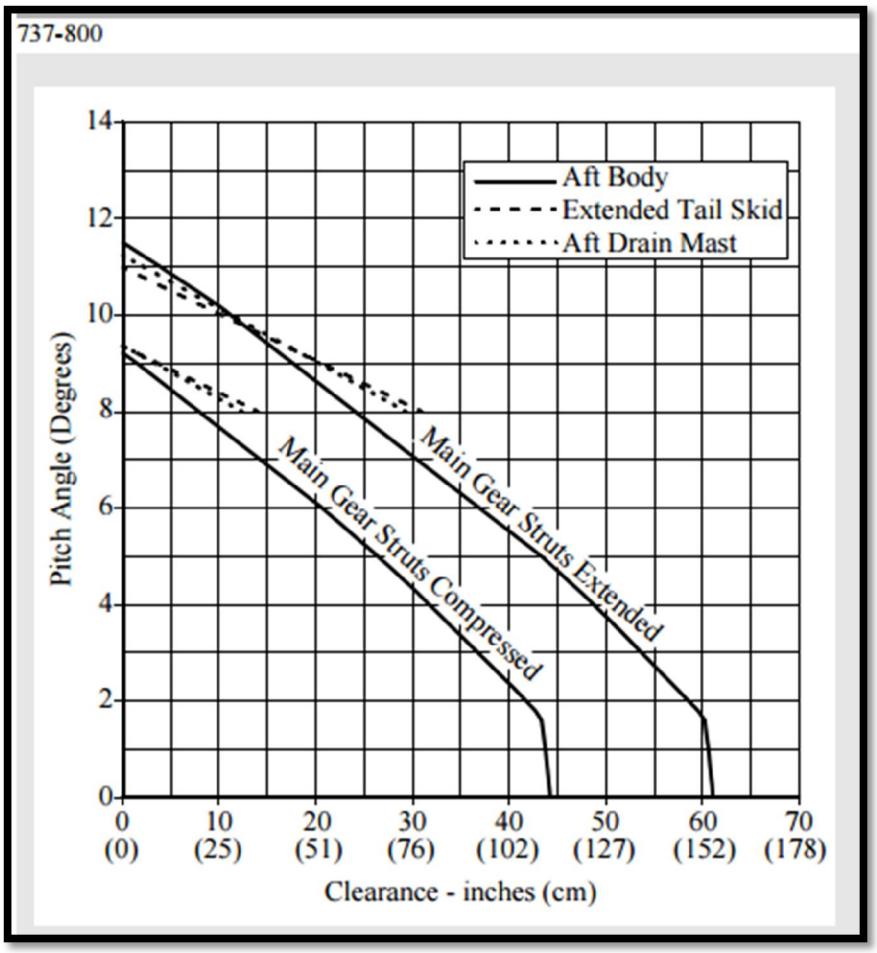
1.18.3 Normal Touchdown Attitude

The following figures illustrate the effect of airspeed on body attitude on touchdown. It shows normal touchdown attitude for flaps 30. If flare control and thrust are excessive near touchdown, the airplane tends to float in ground effect. With proper airspeed control and thrust management, touchdown occurs at no less than V_{ref} - 5. The illustration shows that touchdown at a speed significantly below V_{ref} seriously reduces aft fuselage-runway clearance.



1.18.4 Body Clearance at Touchdown

The following figures show aft fuselage-runway clearance in relation to pitch angle with all main gear tires on the runway.



Body Clearance above Ground

1.18.5 Landing of VT-JGE

The approach was normal and met the company stabilized approach criteria. The second autopilot was engaged at 2088 feet at a distance of 7.2 Nm ILS DME. Contrary to an approach mode with single auto pilot the Dual mode adds a stabilizer trim bias of nose up and this needs to be compensated for if the crew takes over manually. The following extract of Boeing 737 FCOM explains that:

"The stabilizer is automatically trimmed an additional amount of nose up. If the Auto pilot subsequently disengages, forward control column force may be required to hold the desired pitch attitude."

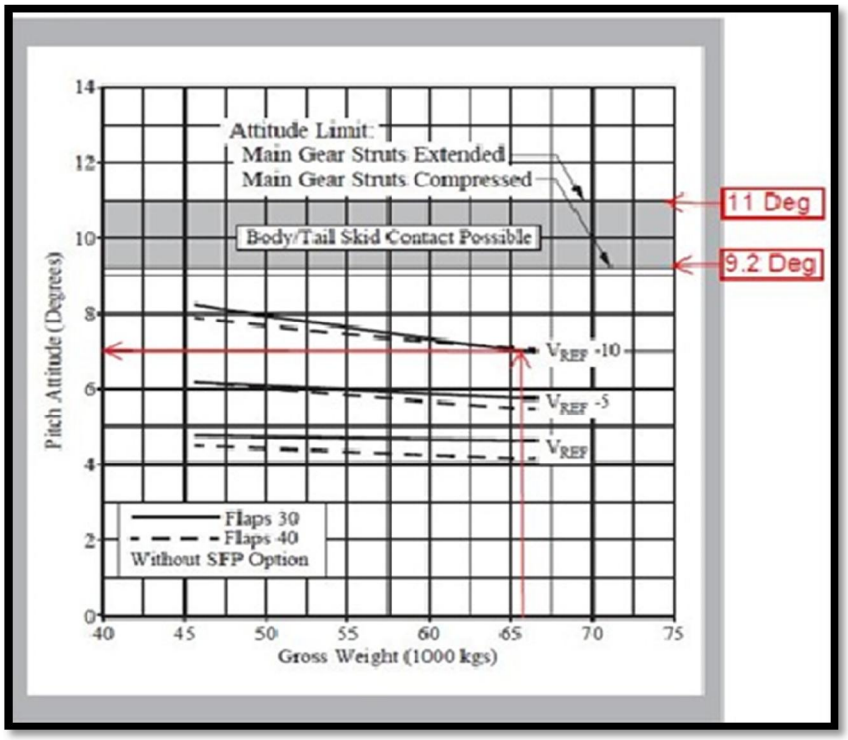
As per Boeing FCTM extracted below it is recommend to disengage autopilot at approximately 300 to 600 feet AFE if a manual landing is planned. This allows the pilot to establish airplane control before beginning the flare. The auto pilot was disengaged at 161 ft RA .The note mentioned in AFM is

"When a manual landing is planned from an approach with autopilot connected, the transition to manual flight should be planned early enough to allow the pilot time to establish airplane control before beginning the flare. The PF should consider disengaging the auto pilot and disconnecting the auto throttle 1 to 2 minutes before the threshold or approximately 300 to 600 feet above the field elevation."

Due to the late autopilot disengagement PIC did not have adequate time to apply sufficient nose down trim to counter the bias added by the autopilot. The DFDR and CVR audio confirm small amount of nose down trim applied after autopilot disengagement and prior to flare.

The FCTM extract below indicates a flare time of 4 to 8 seconds for a normal landing whereas this landing flare of VT-FGE lasted 14 seconds. This may have been influenced by the PIC attempting a smooth landing.

Speed at touchdown was 138kts which was 10kts below selected Vref (148kts). With the lower speed the aft body clearance is reduced thereby increasing the risk of tail strike as shown in the diagram below.



1.18.6 Tail Skid Assembly.

B-737-800 aircraft VT-JGE has a single position tail skid. It is used to protect the Fuselage during a tail strike. It will protect on rotation and during landing.

To protect the aft lower fuselage from over rotation damage the Boeing 737-800/900 is equipped with tail skid. It consists of a sort-of-shock absorber cartridge, a skid fairing and a skid shoe, where the last two parts are outside the fuselage.

A light touch of aircraft tail to runway causes the shoe to wear off, indicating the amount of wear and is an indication when the shoe needs to be replaced.

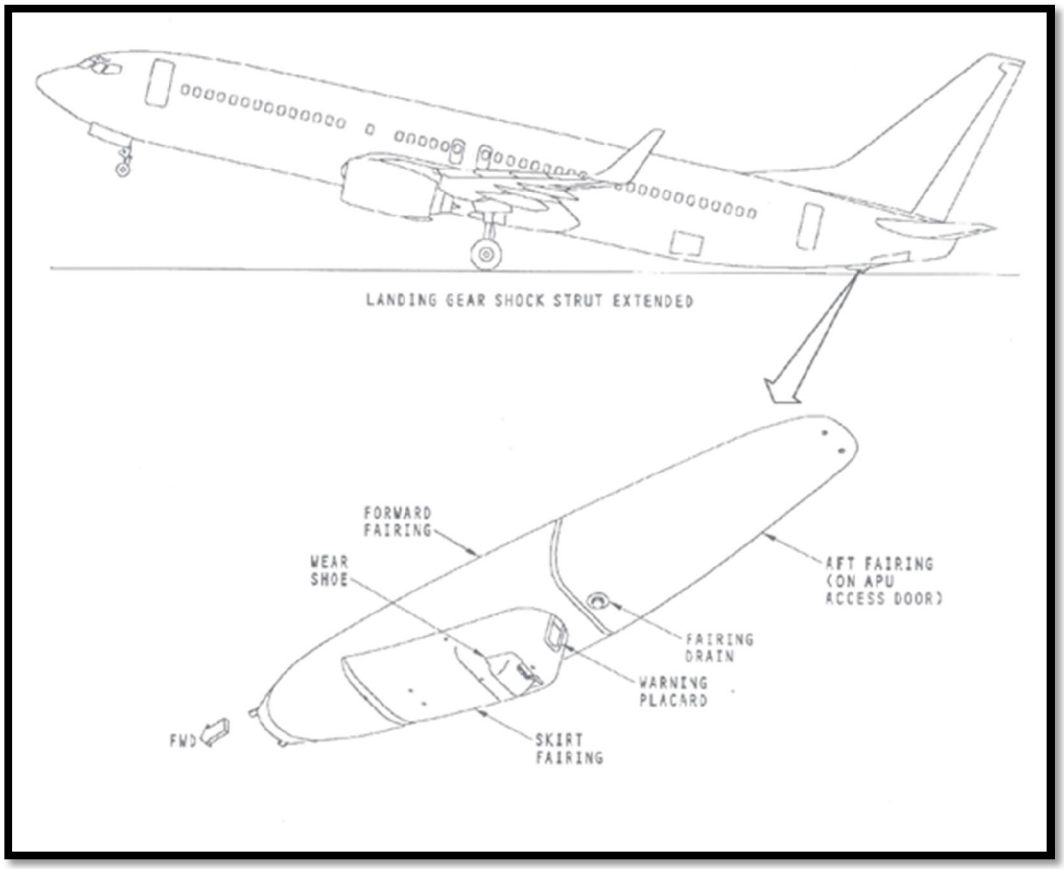
A firm touch crushes skid disappears indicated by colored decals. If the green decal is still visible the skid is still "serviceable" but if the green decal disappears inside the fuselage, the red decal indicates that the skid must be replaced.

When the touch is more than firm, the skid disappears totally inside the of fuselage and a safety pin (fuse pin) allows the cartridge to pivot inside (other than crushing) there by protecting the aircraft structure against massive loads.

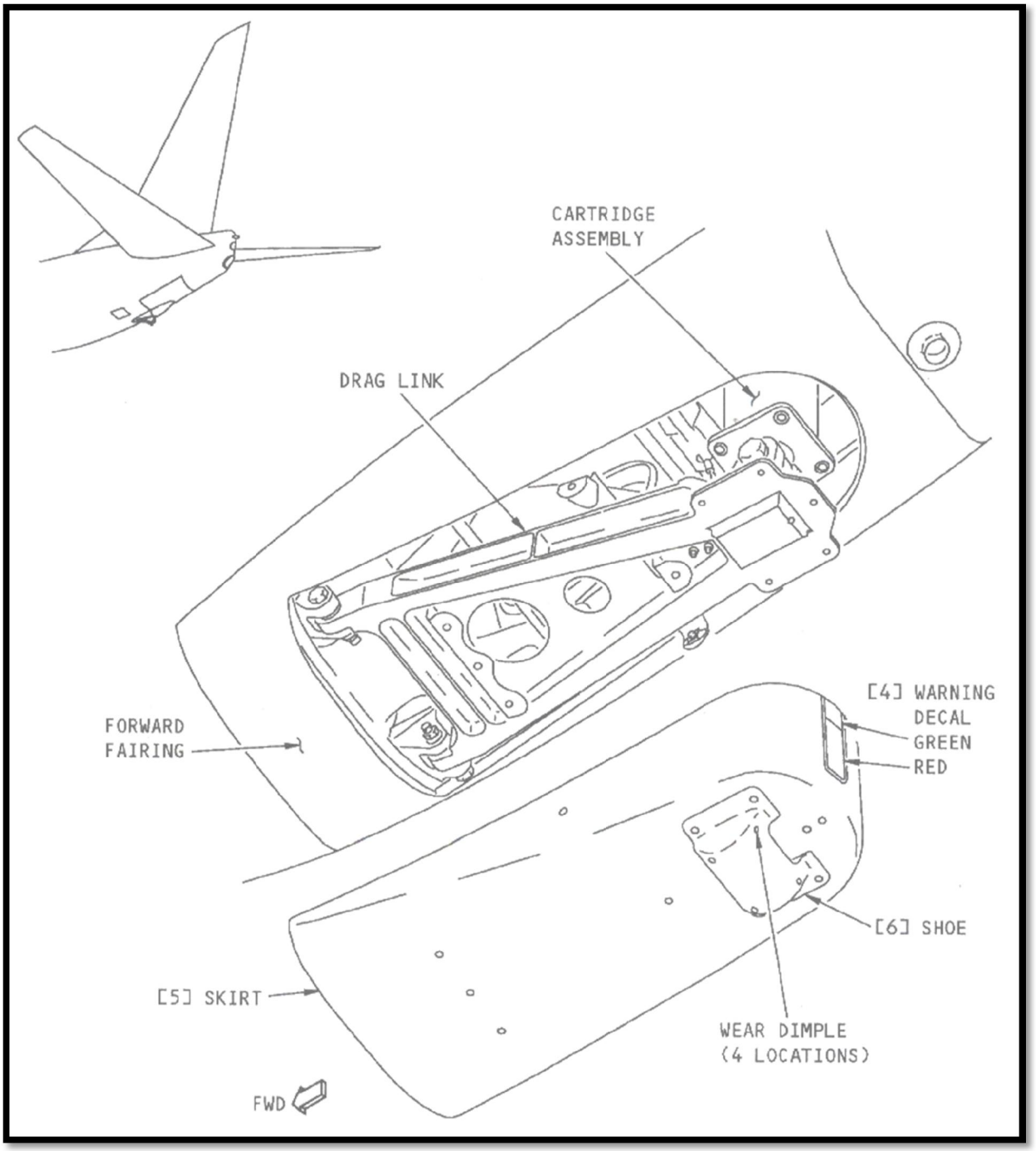
The red & green indicator is checked during every walk around inspection to ensure an inadvertent tail strike did not occurred on the previous takeoff or landing. Due to longer fuselage length B-737-400/800/900 series are prone to tail strike.

Other, B-737-800 SFP (Short Field Performance) has a two position tail skid. This has a hydraulic actuator that deploys when the plane is departing and on arrival so that it has extra performance

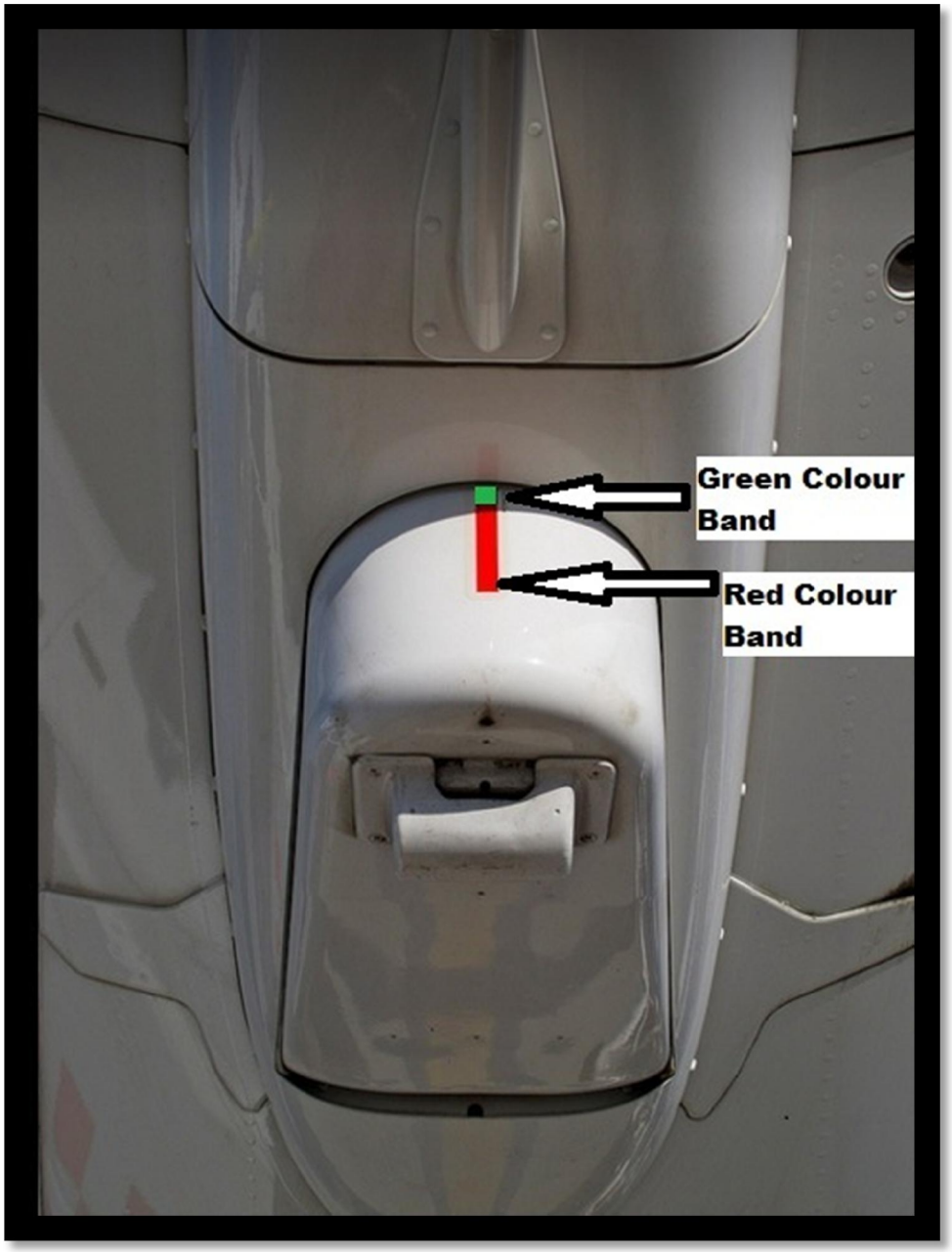
Retractable tail skid that extends on take offs and landings which is under control of the supplemental proximity sensing Electronic Unit (SPSEU) and operates with hydraulic system.


LANDING GEAR SHOCK STRUT EXTENDED
FORWARD FAIRING
WEAR SHOE
AFT FAIRING (ON APU ACCESS DOOR)
FAIRING DRAIN
WARNING PLACARD
SKIRT FAIRING
FWD

Tail Skid



Tail Skid Assembly



Tail Skid without damage

1.19 Useful or effective investigation techniques: NIL

2. ANALYSIS

2.1 SERVICEABILITY OF THE AIRCRAFT

B737-800 aircraft VT-JGE (MSN 32663) was manufactured in year 2004. On the day of incident, the aircraft VT-JGE had logged 38078 airframe hours and 16650 cycles and was holding a valid Certificate of Airworthiness and flight Release prior to flight. The Jet Airways is holding valid Scheduled Air Operator Permit (SOP).

The aircraft and engines were being maintained under continuous maintenance as per approved maintenance program consisting of calendar period based maintenance and Flying hours /cycles based maintenance.

The last layover inspection was carried out at 38069:54 Airframe hrs and 16643 cycles on 13-01-2015 at Mumbai.

The load and trim sheet was prepared before flight and C.G. of the aircraft was within the operating limits.

2.2 WEATHER :

At the time of approach 0336 UTC, ATC reported visibility of 800 meters, runway 19L RVR 1200m, MID 1000m, winds 350/05kts.Though visibility was less but it was above minima and aircraft carried out ILS approach at runway 19L.

2.3 ANALYSIS OF FLIGHT DATA RECORDERS

The aircraft is fitted with Solid State CVR & DFDR. Analysis of CVR reveals that

1) Autopilot was disconnected after Minimums warning and PIC was adjusting Stabilizer trim during landing.
2) PIC after landing mentioned to co-pilot that the runway surface was not good.
3) Co-pilot informed PIC that during landing aircraft was bouncing up & down.
4) There was no mention / recording of Co-pilot monitoring the aircraft attitude and speed during landing.

Analysis of DFDR reveals that

1) Autopilot was disengaged at 161ft RA and aircraft was landed manually.
2) Slight nose down trim was applied after taking over manual control prior to flare
3) The aircraft flare lasted 14 seconds (from 30ft to MLG touchdown).
4) Distance from Threshold to touchdown approximately 1200m.
5) Aircraft touched down with a pitch of 5.1° and speed of Vref (-10) Kts.
6) Four seconds after touchdown the pitch increased to 9.14 ° when the tail strike occurs at this point.
7) G recorded at touchdown was 1.36.
8) As per the DFDR readout the aircraft flare was for more time.

2.4 PILOT HANDLING OF THE AIRCRAFT:

PIC at 6000 feet requested ATC (approach) for high speed descend which was approved by ATC. DFDR reveals a maximum vertical speed of 1095 feet/min during high speed descend between 6000 to 3000 feet. The landing was carried out by PIC at Runway 19L. As visibility was less, PIC engaged both Auto-pilots at Radio Altitude of 2088 feet. Autopilot was disengaged at 161ft RA whereas as per As per Boeing FCTM it is recommend to disengage autopilot at approximately 300 to 600 feet AFE if a manual landing is planned. This allows the pilot to establish airplane control before beginning the flare. During dual mode autopilot approach, stabilizer trim automatically added nose up and this needs to be compensated for if the crew takes over manually.

PIC applied small amount of nose down trim after autopilot disengagement and prior to flare. The flare lasted for 14 seconds and aircraft touched approximately 1200m from threshold .As per FCTM a flare time of 4 to 8 seconds is for a normal landing .The speed at touchdown was 138kts, which was 10kts below selected Vref (148kts). The aircraft touched down with a pitch attitude of 5.1°. However after three seconds the attitude increased to 9.14 ° when tail strike occurred.

2.5 CIRCUMSTANCES LEADING TO THE INCIDENT:

The flight from Mumbai to Kolkata was uneventful till touchdown. The visibility at the time of landing was 800 m and ATC assigned Runway 19 L for landing, PIC decided to carry out dual auto pilot approach with the intention of carrying out a manual landing. During landing auto pilot was disengaged at 161ft RA and PIC applied small amount of

nose down trim after flare. Aircraft touched down with a pitch of 5.1° and speed of 138 kts, which was 10kts below selected Vref (148kts). The flare lasted for about 14 seconds and the aircraft pitch reached 9.14° resulted into tail strike.

3. CONCLUSIONS:

3.1 FINDINGS:

1) The certificate of Airworthiness, Certificate of Registration, and CRS of the aircraft was valid on the date of incident.
2) The aircraft was certified and maintained in accordance with prescribed procedures. There was no evidence of defects or malfunction in the aircraft which could have contributed to the incident.
3) The flight crew was certified and qualified to conduct the flight. They had undergone the requisite pre-flight medical examination and were certified as not being under the influence of alcohol.
4) The CG of the aircraft was within the prescribed limits.
5) All navigation and approach aids were functional and were operating normally at the time of incident.
6) The PIC had a total flying experience of 5248:10 hrs of which 1583:24 hrs were as PIC on type. Co-Pilot had a total flying experience of 4932:46 hrs and 4557:00 hrs as P2 on type.
7) As visibility was less, PIC engaged both Auto-pilots at Radio Altitude of 2088 feet. Autopilot was disengaged at 161ft RA whereas as per as per Boeing FCTM autopilot to be disengaged at approximately 300 to 600 feet AFE if a manual landing is planned. This allows the pilot to establish airplane control before beginning the flare.
8) During dual mode Autopilot approach, stabilizer trim automatically added nose up and this needs to be compensated if the crew takes over manually.
9) PIC applied small amount of nose down trim after autopilot disengagement and prior to flare which was not adequate.
10) The flare lasted for 14 seconds and aircraft touched approximately 1200m from threshold. As per FCTM a flare time of 4 to 8 seconds is for a normal landing.
11) Speed at touchdown was 138kts which was 10kts below selected Vref (148kts). The aircraft touched down with a pitch attitude of 5.1°. However, after three seconds the attitude increased to 9.14°.

12) The landing technique used by the PIC resulted more time during flare which lead to a touch down with a speed of Vref (-10) and pitch angle increased from 5.1° to 9.14° leading to tail strike.

13) The co-pilot failed to monitor the instrument references and callout of pitch attitude during touchdown, which resulted into tail strike during landing on Runway19L.

14) During the post flight walk around inspection by the AME, damages were noticed to tail skid and scrapping of aft belly of the aircraft. There was no fire or injury to person on board the aircraft.

15) During last 04 years, there had been 03 more cases of Tail strike during landing occurred to the other scheduled airlines.

3.2 PROBABLE CAUSE OF THE SERIOUS INCIDENT:

The probable cause of Serious Incident is due to "decrease of airspeed below V_{ref} during landing process and increase in pitch attitude resulted into the Tail Strike."

4. SAFETY RECOMMENDATIONS :

1. DGCA may review the Scheduled Airlines tail strike awareness program for the pilots.

2. DGCA shall issue a circular to emphasize the importance of following the recommended guideline as laid down in FCTM for transitioning from Auto pilot to manual flying.

(N S Dagar)
Jt. GM (ATM), AAI
Member, COI – VT- JGE

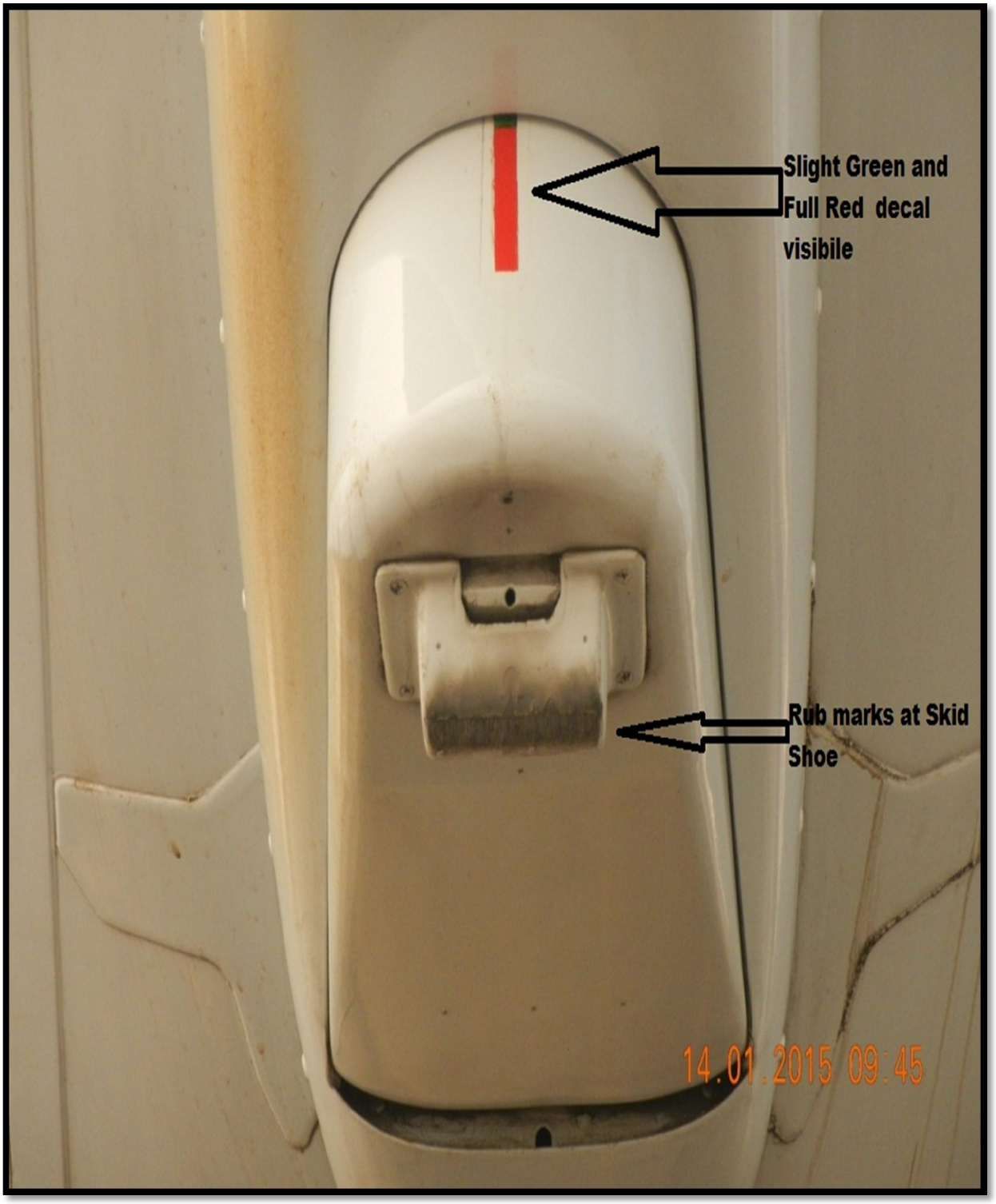
(Amit Gupta)
Director (AED),
O/o Dy. DGCA, Bengaluru-17.
Chairman, COI – VT- JGE

Date: 9th June 2016
Place: New Delhi

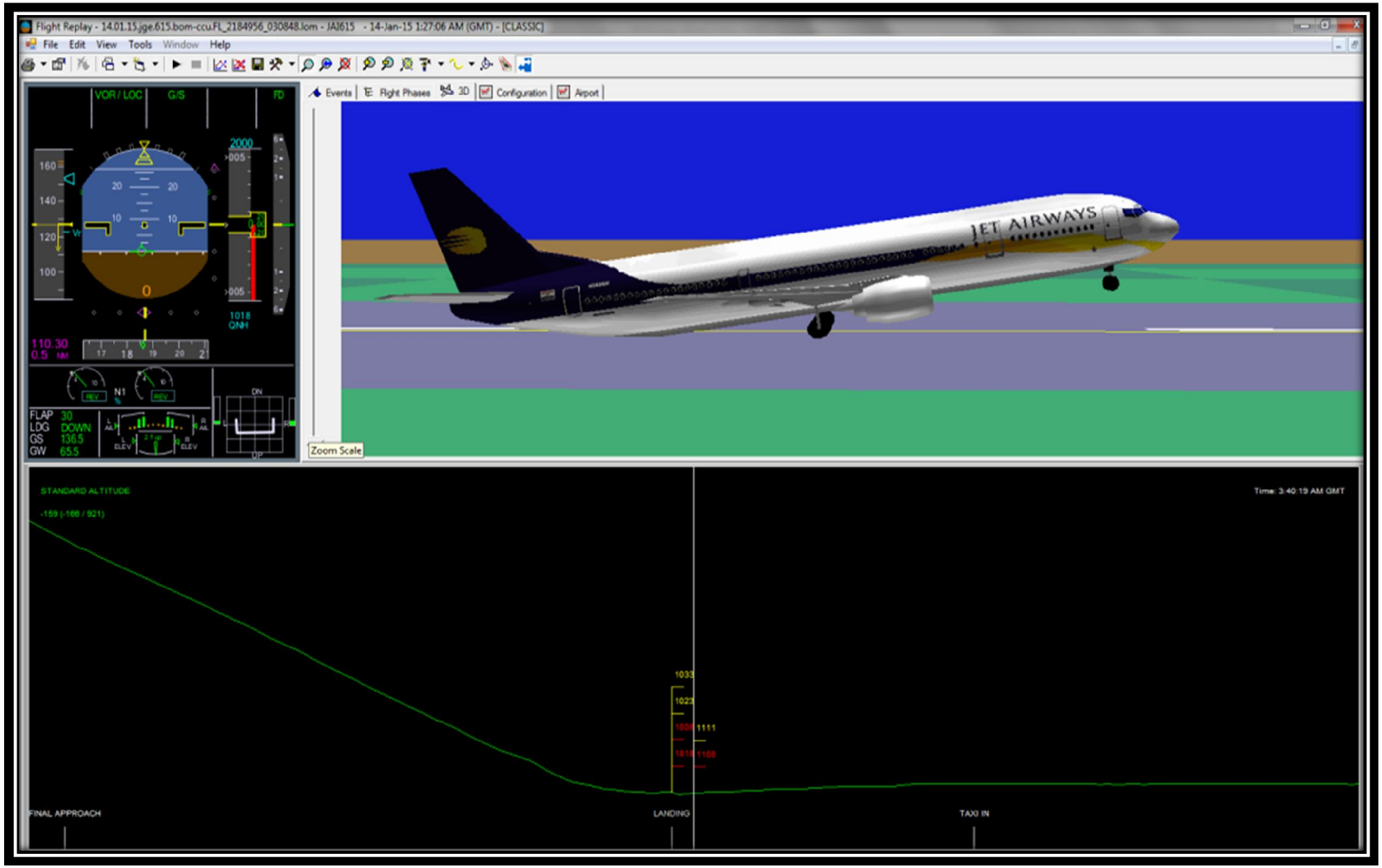
Damage to Belly of aircraft

Damage to Belly of aircraft

Damage to Belly of aircraft



Damage to Tail Sid Shoe and decal markings



Screen shot Image of VT-JGE landing using Airfase Software