# REPORT

*AAIU Report No. 2001-006*
*AAIU File No. 1999/0059*
*Published. 11/04/01*

| | |
|---|---|
| **Name of Operator:** | World Airways |
| **Aircraft Type and Registration:** | MD-11, N-272 WA |
| **No. and Type of Engines:** | Three, P&W PW 4462 |
| **Aircraft Serial Number:** | 48437 |
| **Year of Manufacture:** | 1993 |
| **Date and Time (UTC):** | 18 September 1999, 0524 hours |
| **Location:** | Shannon Airport, Co. Clare |
| **Type of Flight:** | Public Transport - Passenger |
| **Persons on Board:** | Crew - 14 Passengers - 317 |
| **Injuries:** | Crew - Nil Passengers - Nil |
| **Nature of Damage:** | Minor Damage to Right Main Wheel Tyres |
| **Commanders Licence:** | Airline Transport Pilot (FAA) |
| **Commanders Age:** | 52 years |
| **Commanders Flying Experience:** | 8307 hours (incl 2672 hours as Captain on type)<br>Last 90 days - 150 hours<br>Last 28 days - 78 hours<br>Last 24 hours - 5.3 hours |
| **Information Source** | ATC Watch Manager, Shannon Airport.<br>AAIU Field Investigation. |

# REPORT

## SYNOPSIS

Formal notification of the incident was transmitted to the USA National Transportation Safety Board (NTSB), the Irish Aviation Authority (IAA) and the aircraft Operator by the Irish Air Accident Investigation Unit (AAIU) on 20 September, 1999. Under the provisions of ICAO, Annex 13 (Aircraft Accident and Incident Investigation), State of Occurrence, the Chief Inspector of Accidents, Mr Kevin Humphreys, appointed Mr. Frank Russell and Mr. John Hughes, Inspectors of Accidents, to carry out an investigation into the circumstances of this incident and to prepare a Report for publication.

The incident followed an uneventful Trans-Atlantic flight and approach to Runway (RWY) 24 at Shannon Airport. On landing, the aircraft bounced a number of times and the ground spoilers did not deploy. While the pilot applied maximum thrust reverse and maximum manual braking, complete deceleration was not achieved in sufficient time to stop the aircraft departing the end of RWY 24 and rolling some 230 ft into the grass over-run area. Once stopped, the aircraft commander shut down the engines and the aircraft was evacuated in an orderly fashion through the normal entry/exit doors. Consequently, the airport was closed to commercial operations until 1245 hours, when the aircraft was towed back to the ramp.

## 1. FACTUAL INFORMATION

### 1.1 History of the Flight

The United States registered aircraft was on a scheduled passenger flight between JFK Airport, New York and Shannon Airport, Ireland, with London Heathrow Airport as its alternate destination. It was operating on a seasonal lease on behalf of an Irish operator. The cockpit crew consisted of two pilots. A relief First Officer occupied the rear cockpit seat.

The First Officer was the handling pilot out of JFK and, as the aircraft approached Ireland, part of the normal cockpit conversation centred on the weather at Shannon, where wind gusts of 37 kt were being reported from a south-easterly direction. The general meteorological situation showed that the area lay in a strong south-easterly airstream, with a deep depression of 946 hPa centered some 200 miles west of Valentia. There were two other aircraft ahead of the MD-11 on approach to Shannon that morning, a B747 and an A330. Both of these aircraft, in turn, carried out a missed approach to RWY 24 and diverted to their alternates, at 0509 hours and 0514 hours respectively. These two missed approaches were discussed in the MD-11 cockpit, the crew assuming that the weather was the main factor, as, at that stage, the wind was still gusting up to 37 kt. Some 30 miles out from Shannon the First Officer, after some consultation with the Captain, requested that he, the Captain, should take over control for the landing. The Captain acceded to this request. He recalled mentioning on taking over control that if the wind remained gusting up to 37 kt, then they too would prepare for a missed approach.

In the event the weather abated somewhat and, as the aircraft continued with an ILS approach to RWY 24, the Captain elected to fly the first part of the approach with 35° flaps set and increased this setting to 50° at about 300 ft AGL, with the airfield in sight. ATC advised that the wind was continuing steady at 150/25 kt, with the runway wet and no standing water.

In an interview with the AAIU, the Captain recalled his recollection of the events as follows. After consultation with his crew and conscious of the earlier reported wind gusts to 37 kt, Vref (landing reference speed with wind and gusts corrections applied) of 165 kt for 35º flap setting and 162 kt for 50º flap setting was agreed. The touchdown, which was at 0524 hours, (approximately 1,600 ft beyond the normal touchdown point), was 'firm' on the left main gear initially for the cross-wind correction. This led to a bounce with the aircraft bouncing onto the right main gear and then back into the air, momentarily. A further one or two bounces followed as finally both main gear and nose wheel gear grounded and full reverse thrust was applied. The automatic breaking system was over-ridden by the Captain as he applied maximum manual breaking, due to the decreasing amount of runway remaining. While the aircraft seemed to decelerate 'fairly normally', it became obvious to the Captain that the aircraft would roll to the end of the runway. He recalled a speed of 80 kt with 1000 feet to go. However, while the distance to travel diminished, the speed did not drop off as quickly as anticipated, even with maximum braking applied. As the speed reached 50/60 kt the braking action seemed ‘to be minimal or not at all’, and, as the end of the runway was in sight, the Captain manoeuvred the aircraft along the centre line so that the nose gear would run onto a narrow asphalt service pathway that extended into the grassy area from the middle of the runway edge. This manoeuvre was successful and the nose gear did not dig into the grass. The aircraft finally came to a halt and the engines were shut down.

The Captain assessed the situation and briefed the passengers. There was no visible damage to the aircraft from the cockpit, the Cabin Manager confirmed that there was no damage in the cabin, so the Captain called ATC for the steps and an orderly evacuation was carried out. The passengers were then bussed to the terminal.

## 1.2 Injuries to Persons

No injuries were reported by either passengers or crew.

## 1.3 Damage to Aircraft

There were superficial tyre cuts on the right main wheel bogie, caused by the aircraft running over the vertically protruding metal holders of the runway end lights. Three of the bogies four tyres were replaced by the operator's technicians prior to the next departure of the aircraft.

## 1.4 Other Damage

Two runway end lights destroyed. Superficial damage to the grass overrun area as two shallow paths were cut out of the ground by mechanical diggers to facilitate the recovery of the aircraft, on wood and steel matting, back onto the runway.

## 1.5 Personnel Information

Captain — Valid FAA Airline Transport Pilot Licence
Total Time: 8307 hours, including 2672 hours as Captain on the MD-11
Date last medical: 12 April 1999
Date last sim check: 13 April 1999

First Officer — Valid FAA Airline Transport Pilot Licence
Total Time: 12500 hours, including approximately 3000 hours as Captain on the MD-11

## 1.6 Aircraft Information

Aircraft records show that the aircraft was dispatched on the incident flight with no deferred maintenance items (DMI's).

Routine maintenance was carried out at an approved maintenance facility, an 'A2' check on 23 August, 1999 in the U.K. and the next 'A3' check was scheduled for 27 September 1999 in Switzerland.

Per the Boeing FCOM and based on the aircraft landing weight of 424,000 lbs, the reference landing speed was 145 kt (flap 50º) or 149 kt (flap 35º). Steady winds of 150/25 kt were reported as the aircraft approached and landed, so Vapp (Vland + wind additive) should have been 158 kt or 163 kt for 50º or 35º flap setting respectively.

### 1.6.1 Ground Spoilers Systems

The M.D. 11 is equipped with ground spoilers. These are large panels which open out from the wing upper surface during landing. Their purpose is to reduce the landing roll. This is achieved by:

- Increasing aerodynamic drag, thereby slowing the aircraft.
- Reducing lift created by the wings.

This increases the percentage of the aircraft weight carried by the main undercarriage, thereby increasing the braking force that can be applied to the main wheels without wheel lock-up (skidding).

Both these effects of the ground spoilers are more pronounced at high speed, i.e. immediately after touch-down.

The ground spoilers can be deployed manually. However, to hasten their deployment immediately after touch-down, when they are most effective, they can be armed, before landing, to deploy automatically at touch-down.

For the Automatic Ground Spoilers (AGS) deployment to commence on the MD11, the system must be armed during the approach. When spin-up of the main wheels, as result of ground contact, is detected, the AGS will automatically extend to 30°. Then when compression of the nose strut is detected, which results from the nose wheel coming into contact with the Runway, the AGS will deploy to the full 60° position.

Once the AGS has been armed, it can only be disarmed by either :

- "Knocking down" the spoiler lever in the cockpit from its armed (extended) position. This is a crew action.

Or

- Advancing the No. 2 throttle lever 1.05 inches forward of the idle position. This corresponds to the Throttle Resolver Angle (TRA) of 46° to 50°. This is to provide for automatic closure of the ground spoilers in the event of a "go-around" situation.

### 1.6.2 Autobrake System

The MD11 is fitted with an autobraking system. The purpose of this system is to optimise braking performance and reduce tyre wear. The system on the MD11 has three settings, MIN, MED, or MAX. The auto brake deploys 3 seconds after deployment of the ground spoilers, when set to MIN or MED, or in 1 second when set to MAX, when all the following criteria are met:

- Autobrake armed at MIN, MED or MAX setting
- Brake pedal position < 40° of full travel
- Flaps > 28°
- No pressure detected by servo valve pressure switches or shut-off valve pressure switches in the Integrated Brake Control Valves (IBCV's)
- Both servos pass the continuous electrical integrity test
- Antiskid operative (ON, with no Fail condition)
- Ground Spoiler handle position indicates spoiler deployment commanded, either manually or by AGS

Whenever the brake pedal position is pushed beyond 40° of full travel, the system automatically reverts to manual mode.

### 1.6.3 Auto Throttle System

The MD11 is fitted with an auto throttle system. This system when engaged during an approach will normally maintain a pre-selected air speed until entering the auto retard mode. The criteria for auto retard mode are:

- Filtered radio altitude ≤ 50 ft AGL, and
- Flaps are extended to landing configuration (> 31.5°)

When these conditions are met, the throttles are retarded at 6°/sec of TRA until they meet the mechanical idle stop. The pilot may, at any time, override the autothrottles to prevent entering the auto retard mode.

## 1.7 Meteorological Information

(a) The meteorological conditions, available initially on Volmet and subsequently from Shannon ATS, for 0520 UTC were as follows:

| | | |
|---|---|---|
| Wind | : | 140/23kt gusting 34 kt |
| Visibility | : | 10 km |
| Weather | : | Light to moderate rain |
| Cloud | : | Few 700 ft<br>Bkn 1700 ft<br>Bkn 2700 ft |
| Temperature | : | 15ºC |
| Dewpoint | : | 13ºC |
| QNH | : | 980 hPa |
| Freezing Level | : | 8000 ft |

There were no Sigmet warnings or Windshear warnings in operation at the time.

## 1.8 Aids to Navigation

The ILS to RWY 24 was fully serviceable.

## 1.9 Communications

Normal radio communications existed between the aircraft and Shannon ATS.

## 1.10 Aerodrome Information

(a) RWY 24/06, Accelerate Stop Distance Available : 10,500 ft

(b) A Friction Test was carried out on RWY 24 on 18 July, 1999, by the Airport Authorities, using a GripTester. The result obtained was considerably in excess of the maintenance planning level as per Table A-1, ICAO, Annex 14.

## 1.11 Flight Recorders

Two flight recorders were retrieved by the AAIU from their station in the rear baggage compartment of the aircraft. They were both fully serviceable. One, a Digital Flight Data Recorder (DFDR), S/N 11368, manufactured by Allied Signal, and the other, a Cockpit Voice Recorder (CVR), S/N 57610, manufactured by L3.

Both of these recorders were sent to the NTSB laboratories in Washington, USA, where they were replayed in the presence of an AAIU Inspector.

The quality of the down-loaded information from both the recorders was excellent.

### 1.11.1 D.F.D.R. Data

On the approach to Runway 24 at Shannon, the aircraft was flown by the Captain, using Flight Management System (FMS) No.1. The auto pilot was engaged which maintained a normal stabilized approach, with the exception of a deviation of ½ dot above the glideslope just before touchdown.

The approach was initially conducted at a flap setting of 35°, with the autopilot selected to ON and the autothrottle selected to ON. The ground spoilers were ARMED, and the autobrake set to MED.

At a radalt altitude of 300 ft, 27 seconds before touchdown, flaps 50° was selected. The F.D.R. recorded an ASI indication of 170 kts and a GSI reading of 166 kts. Aircraft pitch was approximately 2° nose up at this point.

The flaps reached 50° deployment at a radalt altitude of 110 ft, 15 seconds before touchdown. The nose up pitch angle increased to 5°. ASI was 156 kts and GSI was 162 kts. In the last 10 seconds of the approach the aircraft rolled laterally, with maximum values of 5° left and 3° right being recorded. There were aileron inputs of 10° left and 10° right during this period. There were also elevator inputs varying from 10° nose up to 6° nose down at this time. 5 seconds before touch down there was a 15° left rudder input.

The aircraft touched down initially on the left mainwheels at a pitch angle of 5° nose up, 1,600 ft beyond the normal 1,000 ft touchdown point of the Runway. At touchdown the aircraft had 2° left roll and 1.6 G was recorded. The throttles had been retarded in the final flare to 40° TRA, but were then advanced during the final seconds before touchdown, and were at 52° TRA at touchdown.

The ground spoilers did not deploy. The aircraft then bounced and landed again on the main wheels, 3 seconds after the initial touch-down, and 1.7 G was recorded The nose wheel compressed one second later. During this bounce, the aircraft pitch angle reduced from 5° to 0°. The undercarriage struts unloaded and then compressed again, and a loading of 1.4 G was then recorded. The maximum lateral G recorded in the touch-down sequence was 0.2 G initially to the left and then followed by 0.2 G to the right during the roll-out, as the engines went into thrust reverse. No significant longitudinal G was recorded during the touch-down, and the maximum longitudinal G recorded was 0.35 G which occurred during the action of the thrust reversers.

At the second touch down the throttles were advanced to 60° TRA. This setting was maintained until 11 seconds after the initial touchdown, when reverse thrust was selected. The aircraft's ground speed increased from 150 kts to a maximum of 164 kts, which was reached 13½ seconds after the initial touchdown. No braking pressure was applied until 8½ seconds after the initial touchdown. This braking action was as a result of an input on the pilot's brake pedals as the autobrake could not function as the ground spoilers had not deployed.

At 13½ seconds after the initial touch down, the aircraft started to decelerate. The ground spoilers did not deploy during the entire landing sequence.

The landing run then continued, with the aircraft decelerating due to thrust reverser and braking action, until the aircraft stopped.

The data obtained from the F.D.R. is shown in graphical form in Annex A.

**1.12 Wreckage and Impact Information**

Not applicable

**1.13 Medical and Pathological Information**

Not applicable

**1.14 Fire**

Not applicable

**1.15 Survival Aspects**

Not applicable

**1.16 Tests and Research**

Not applicable

**1.17 Organisation and Management Information**

Not applicable

## 1.18 Additional Information

Subsequent to this event, and after a technical inspection and tyre changes at Shannon Airport, the aircraft was next flown to JFK, New York. The F.D.R. read out of the landing at JFK was also obtained by the AAIU. This showed that the auto-ground spoilers did function correctly on this landing, i.e. they deployed, at touchdown, to 30° for approx 4 seconds, and then deployed to the full 60° position, with the full compression of the nose landing gear.

## 2. ANALYSIS

The flight from JFK to Shannon Airport was routine and unremarkable except for the change of handling pilot from the First Officer to the Captain at about 30 miles from Shannon, at the request of the First Officer. En route, the crew had assiduously monitored the weather conditions prevailing at Shannon. With winds gusting to 37 kt across the landing runway they were quite aware that a diversion to their alternate was a possibility, as the aircraft's demonstrated cross wind capability was 35kt. The Captain tasked the relief pilot in the jump seat to closely monitor the weather conditions at Shannon and the other approach traffic. Discussion on the weather continued among the three pilots as they monitored the two aircraft ahead of them also preparing to land at Shannon. All procedures and events during the approach were standard until the selection of 50° flap at 300 ft. The two heavy jets ahead of N272WA both carried out missed approaches and were cleared by ATC to their alternates. The reason for these missed approaches was discussed in the subject cockpit, it was assumed that they were due to the cross winds.

In the event the wind gusts moderated during their ILS approach, as ATC maintained continuous readouts on the wind direction and strength. As they crossed the threshold of Runway 24 the relief pilot noted cockpit indications of 23 kt wind and ground speed 162 kt. By this stage flap 50º had been selected and flap extension was only completed some 15 seconds before the initial touchdown. The Captain later recalled that the selection of flap 50º late in the approach was to shorten the landing roll, in the wet conditions and to reduce the deck angle to have a better field of view.

The landing itself was not normal as the aircraft bounced not once but four times before it finally settled on the runway. It then accelerated from a ground speed of 156 kt, reaching 162 kt some 13 seconds after this initial touchdown, after which deceleration commenced with the selection of thrust reverse and manual breaking by the Captain.

The following events led to the runway excursion:

a. the late selection of 50° flap,
b. the threshold airspeed of 162 kt
c. touchdown 1,600 ft past the normal 1000 ft touch down point
d. application of power during the initial touchdown and landing roll; and
e. the non-deployment of the ground spoilers which, in turn, precluded the use of the autobrakes.

## 3. CONCLUSIONS

## (a) Findings

**3.1** The crew were properly qualified and licensed, in accordance with FAA Regulations, to undertake this flight.

**3.2** The aircraft had a valid Certificate of Airworthiness and had been maintained in accordance with an approved Schedule.

**3.3** No evidence was found of any technical problem on the aircraft, or its systems.

**3.4** The aircraft commander was the flying pilot in the final stages of the flight from JFK. At the request of the First Officer he took over control with about 30 miles to run to Shannon.

**3.5** Cross winds at Shannon gusting up to 37 Kt caused two heavy jets to divert to their alternates, at 16 minutes and 11 minutes respectively, prior to the arrival of N-272WA. However, subsequent to this last diversion the wind strength abated and remained steady at 150/25 Kt for the next seven to ten minutes. Having been made aware by ATC of this relatively steady wind flow, the aircraft commander decided to proceed with the landing.

**3.6** An ILS approach was flown to RWY 24. DFDR data show that the localiser and glideslope were captured, with the exception of a deviation of ½ dot above the glideslope just before touchdown.

**3.7** The approach was initially flown with a flap setting of 35°, with the autopilot selected to ON and the autothrottle selected to ON. The ground spoilers were ARMED and the autobrake set to MED.

**3.8** With the decision to land, flap 50° was selected. The flap extension was completed at a height of 110 ft, 15 seconds before the initial touchdown. The approach was somewhat destabilized in the final phase by this late extension of the flaps. There were significant inputs of aileron, elevator, rudder and throttle.

**3.9** The initial touch down was approx. 1,600 ft past the normal 1000 ft touch down point of Runway 24.

**3.10** The aircraft bounced after the initial touchdown. This was the first of four bounces.

**3.11** The aircraft touched-down initially at a ground speed of 156 kts, but then accelerated to reach 162 kts 13½ seconds after the initial touchdown.

**3.12** The throttles were advanced up to 60° TRA during the landing sequence and remained at this setting for 11 seconds after the initial touchdown.

**3.13** The automatic ground spoilers system (AGS) which was armed during the approach did not deploy during the landing. This was caused by the advancement of the throttles during the touch down phase.

**3.14** The ground spoilers were not manually deployed during the entire landing. The non-deployment of the automatic or manual spoilers, severely compromised the landing distance. (Normal deployment of the ground spoilers to the full 60º position has the effect of putting approximately 70% of the aircraft's weight on the main landing gear, thus facilitating aircraft braking. Whereas, with spoilers not deployed only approximately 30% of the aircraft weight acts on the main wheels thereby reducing braking efficiency. The remaining weight is carried by the wings.)

**3.15** The autobrake system, which was set during the approach, did not operate during the landing. This was as a result of the non-deployment of the ground spoilers.

**3.16** Manual braking action was not initiated until 8½ seconds after the initial touch-down.

**3.17** Thrust reverse action was not initiated until 11 seconds after the initial touch-down.

**3.18** The aircraft had travelled approximately 3570 ft beyond the initial touch-down point before it started to decelerate. At this point only 3,800 ft of wet runway remained.

**3.19** With deceleration commencing late on the runway, and the non-deployment of the spoilers, an overrun was inevitable.

**3.20** The maximum vertical G recorded in the event was 1.7G, and the maximum lateral G was 0.2 G.

**3.21** The cockpit environment prior to the landing at Shannon was characterised by continuous professional discussion on the conditions at Shannon as the crew prepared for a landing or a possible overshoot due to the weather. The Captain made use of all his resources, including the relief First Officer, in reaching his decision to land. However, once the landing was effected the cockpit environment could only be characterised by its silence, the only call out was "80 kt" with about one thousand feet to run. There was no call out of "spoilers" when the AGS did not deploy correctly on landing. Such a call is an MD-11 FCOM requirement that would have alerted all three pilots of the diminished braking ability of their aircraft.

**3.22** Post incident comments by some passengers in the national media indicated that they considered the landing to have been very hard and bumpy. However, as the aircraft completed its landing run on the runway and rolled gently onto the grass area, most passengers were unaware of the aircraft's final stop position until they saw the boarding steps being manoeuvred alongside.

**3.23** There were no injuries reported by either crew or passengers.

## (b) Causal Factors

The late selection of 50º flap destabilized what had otherwise been a stabilized approach, placing the aircraft in a position from which a normal touchdown and landing roll-out could not be effected within the remaining landing distance available.

## 4. SAFETY RECOMMENDATIONS

It is recommended that:

The Operator reviews its flight training programme to re-emphasize the following points;

a. The stabilized approach concept, definition and requirements,

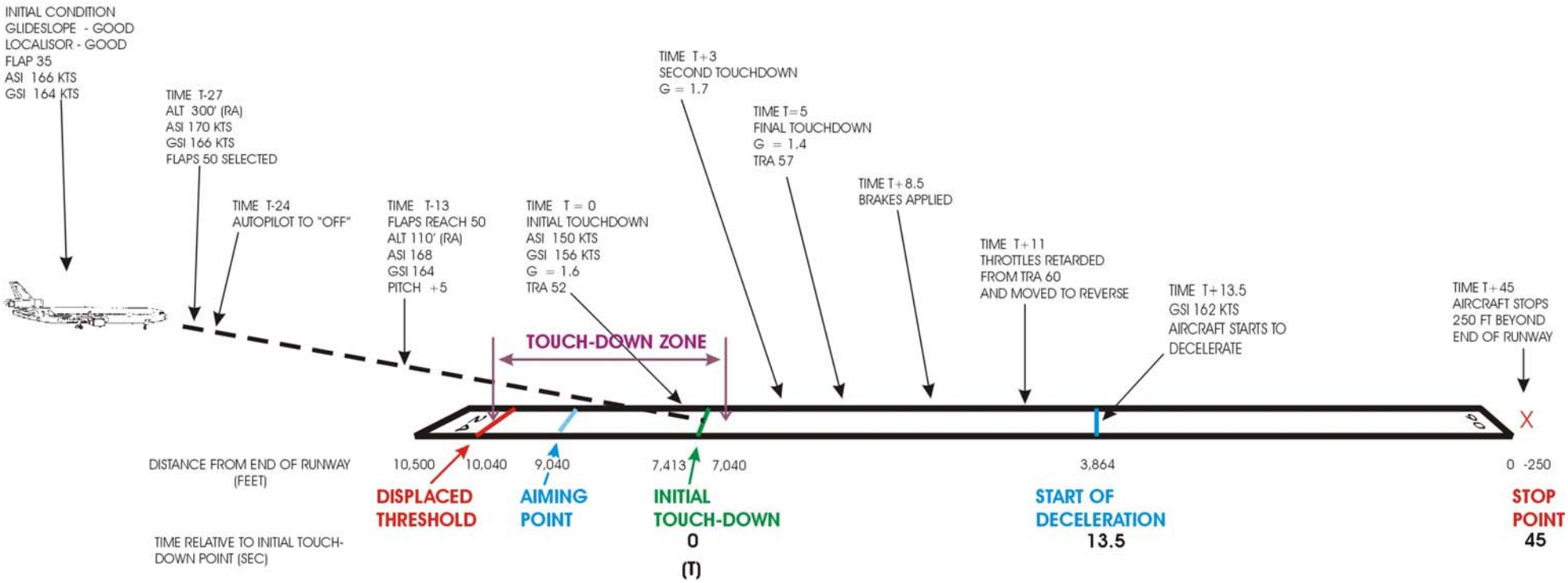
The importance of executing a missed approach if the approach becomes destabilized; and

b. The PNF's role in assuring that ground spoilers are deployed after touchdown. **(SR 13 of 2001)**

***The Operator accepts this recommendation.***

VISUAL REPRESENTATION OF LANDING OF MD-11 N-272WA
ON RUNWAY 24/06 AT SHANNON 18 SEPT 1999

**(NOT TO SCALE)**




# ANNEX A

REPORT