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ACCIDENT INVESTIGATION & RESEARCH'S INDEPENDENT INVESTIGATION INTO THE MARTINAIR DC-10, PH-MBN ACCIDENT AT FARO, PORTUGAL ON 21 DECEMBER 1992

Report Date 23 July 2013

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This copy includes a limited number of comments by Harry Horlings/ AvioConsult, inserted with PDF-XChange Viewer.

Harry Horlings is graduate Flight Test Engineer of the USAF Test Pilot School Class (19)85A, for which the entry level was an MSc in engineering and many flight hours. He has over 15 years of (experimental) flight-test experience. The USAF Test Pilot School provides the highest level of flight and flight-test training available in the world.

AIR File #7355, 23 July 2013

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1. Introduction

Conclusions in the introduction...

This AIR Report will explain how AIR was able to extract and integrate all of the considerable data sources available to explain what happened, and how the flight crew encountered a sudden and unexpected external weather circumstance (i.e. a lone convective microburst cell just to the South of Runway 11) with no ATC information about the critical wind shifts that were beyond their ability to control in the very limited time available. The data clearly shows that the microburst activity in the vicinity of the Runway had caused the approaching aircraft to first enter significant horizontal windshear at the approach end of the Runway, and second to enter catastrophic vertical windshear over the Runway; resulting in an uncontrollable descent and crash onto the Runway.

What data?

The Martinair FCOM definition of windshear (Vol II page 05-60-04) was: "Severe windshear may be defined as a rapid change in wind direction and/or velocity that results in airspeed changes greater than 15 knots or vertical speed changes greater than 500 feet per minute". Neither of these ever happened to MP495.

The Official Portuguese Investigation into this accident focused on many issues; but did not explain the actual dynamic sequence that occurred to the aircraft during the final part of the approach, and particularly during the final 20 seconds of the flight as the aircraft entered a zone of horizontal windshear, and then during the final 5 to 6 seconds when the aircraft entered a zone of dangerous vertical windshear. This vertical windshear was due to an encounter with the downflow at the edge of the microburst's peripheral vortex. This 5 to 6 seconds of downflow changed the approach profile from what was (at 50 feet above the runway height) an acceptable stable flight envelope (from which the crew could initiate normal actions for landing) to a catastrophic, unstable

Because there were no actual dynamic sequences.

There was no windshear, except in the mind of the airplane and airline owner. The weather was bad; the crosswind and runway condition both exceeded not only the airplane but also the pilot-flying limits. The Portuguese investigators rightfully never concluded a windshear. The Dutch Safety Board, under direction of Martinair, tried to convince the Portuguese chief investigator, who fortunately did not surrender.

descent. The resulting uncontrollable high descent rates, as well as the resultant abnormal aircraft attitude, led to a runway impact that was beyond the engineering design capabilities of the aircraft landing gear. The severe ??? environmental conditions, and their effects on the aircraft flight parameters, will be shown in this AIR Report in a series of Figures, Schematics and associated Data Tables.

The Horlings' Report attempts to blame the crew for causing, or allowing the aircraft to develop, sufficiently adverse aircraft performance (i.e. adverse flight parameters) to cause the accident. This AIR Report assesses Horlings' key claims. It is clear to AIR that Horlings' opinions and conclusions are **not** based upon his completing a detailed and independent scientific analysis of the available recorded data. Horlings did not even attempt to scientifically determine the sequence of events leading to the accident. He simply came to a series of what he considers to be significant conclusions without completing a proper scientific analysis to support each conclusion. AIR studied Horlings' "conclusions" and, after comprehensive review, considers them to be totally erroneous. Specifically, Appendix "A" to this AIR Report addresses a number of Horlings' erroneous and unsupported conclusions.

When is an analyis "scientific"? When it is written by a metallurgical engineer?
Horlings used his airplane knowledge and his experience in reading, interpreting and understanding data out of airborne Data Acquisition Systems that are widely used during experimental flight testing, which knowledge originates from his high level of training at the USAF Test Pilot School; refer to the textbox on the first page.
A Test Pilot School graduate is authorized and capable of conducting first flights with airplanes and, if he is not satisfied, order airplane design scientists to return to the drawing board to improve their products. Accident investigators are not. Anybody can call him- or herself accident investigator.

This AIR Inc. report is not the report of an investigation, because it focusses only on windshear, the presence of which cannot be proven using objective data, simply because there was no windshear. At Faro Airport, there never ever was any windshear (SKYbrary).
This AIR investigation is using fabricated data, and is not solely based on objective data; the writers obviously interpreted data (some of which were not included in the Portuguese accident investigation report - are of uncertain origin) to fit whatever client Martinair wanted them to write, probably to make a quick buck.
This AIR Inc. report is deceiving.
To support this conclusion, many comments are included below in text boxes next to inappropriate text or errors in the paragraphs, tables and figures.

Horlings recommends AIR Inc. to withdraw this investigation report, because Martinair and AIR Inc. might be called to appear in a higher court, and should therefore realize beforehand:

"Oh! What a tangled web we weave,
when first we practice to deceive."
(Walter Scott in 1808)

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2. Data and Information Sources for the AIR Investigation

1. The following material provides a description of the data / information sources, and the processes and procedures followed by A.I.R. Inc., which are the bases for AIR's independent findings with respect to this accident investigation.

2. The following constitutes a listing of the primary sources of data utilized by A.I.R. Inc.

    a. Radar Data - Aircraft positional time/location data from the available radar data is the source of the demonstrative graphic FIGURE 1. The source radar with the positional/time data was integrated with the DFDR / AIDS data (as defined below) for the last three minutes of flight to produce the Data Tables I, II and III, and FIGURES 2 through 5.

    Source of these data? DGAC report?

    Intergrated?

    b. Magnetic floppy disc of A.I.D. System Files (AIDS Data)

    c. Magnetic floppy disc of DFDR Files (DFDR Data)

    These data carriers were not available to the lawyers. Are these authentic?

    d. Hard Copy Listings of AIDS Data with selected DFDR parameters appended. Note that the AIDS Data Dump ended 3.5 seconds prior to impact, but parameter entries extend beyond the AIDS Data termination point within the Accident Report. The DFDR Data Dump, however, extended beyond the AIDS Data by some 13 seconds

    e. Hard Copy Listings of DFDR Data recovered by the NTSB

    f. Additional NTSB Data Dump of Parameters – NTSB Data Sheets

    g. CVR Copy Tape and Transcript (plus translations) (CVR Data)

    h. Extracts from the DC-10 Aircraft Operating Manual and Flight Crew Reference Guide

i. Faro Airport Charts (ICAO 1985 thru 1990; Jeppersen 1991 thru 1999) - source of the VOR / PAPI / Runway 11/29 (designated as Runway 10/28 today in 2013 due to drift of the Magnetic North Pole) detailed in the demonstrative graphics FIGURES 1 through 7

j. PH-MBN Investigation Wreckage Scatter Distribution Diagrams are the source documents for the current demonstrative graphic FIGURES 6A/6B attached

The runway layout and the location of the PAPI changed following the accident.

k. A current Google Image of the #11 (now #10) Runway End of FARO Airport which is the source of the demonstrative graphics FIGURE 6B and FIGURE 7 attached

l. The prevailing weather at the time of the accident is comprehensively documented by the Portuguese Meteorological Service Report; the Faro Airport Meteorological data from the Integrated Observation System (SIO); copy sets of timed readings from Wind Display Units; Meteosat Photographs and other METARs

m. Additionally, translated statements of farm worker eyewitnesses testifying as to severe local wind damage close to the location and time of the PH-MBN accident; provides further hard data evidence of the presence of the microburst in the immediate vicinity/time of the landing accident to PH-MBN

This occurred many minutes after the accident. You call that hard data evidence?

3. AIR Integration of Available Data Sources

- The integration of all the data required a synchronization of the various "times" associated with each independent data source to ATC clock time. Having this synchronized data allowed AIR to study the final approach second-by-second and the final six-second portion of the flight down to 1/8-second intervals (See TABLES I, II and III). The time synchronization was accomplished by coordinating all of the Radar / CVR / DFDR / AIDS and ATC clocks to Key Events, which we call "Benchmarks"; and then converting all of the clocks to the selected ATC clock.

- The actual (known) initial impact point on the runway was used as an "anchor point" to integrate and line up the Radar, CVR, FDR and AIDS Data. This allowed the precise Flight Track and Flight Profile to be produced, second-by-second, (see FIGURES 2, 3, 4 and 5) and allowed all details of the aircraft's final approach into Faro's Runway 11 to be established. It is important to note that only through this comprehensive scientific process, as completed at AIR, that the Flight Track and Flight Profile could be determined.

Scientific or calculative?

- The consolidated integrated data is attached as TABLES I, II and III.

?? Is this precise? Don't believe so. Please present detailed insight into the method before this can be accepted.

Working back from this anchor point? You believe this to be accurate? An airplane doesn't fly backward.
Is like writing the conclusions that you need or like, and then come up with an analysis that fits these conclusions. This is weird, not scientific at all.

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4. The Approach to FARO Airport – Runway 11

FIGURE 1 (attached) gives an overview of the accident DC-10 aircraft (Flight 495) flying South to Faro and then following a VOR Approach and Descent to FARO Runway 11, where it crashed on the Runway. This Overview Track is based on an integration of the Radar and the AIDS Data. FIGURE 1 indicates that as they flew over the airport to join the approach to Runway 11, the Flight 495 flight crew could see Runway 11; they also saw Flight 461 (another Martinair aircraft) on approach to Runway 11. The Flight 495 pilots heard ATC provide information to Flight 461 – the winds for Runway 11 were benign – 130 at 18G21. These winds were similar to the winds they expected at Faro, based on their pre-flight briefings on the actual and forecast weather at Faro. For clarity, it is important to note that all of the wind information provided to the accident pilots for their approach to Runway 11 at Faro, both prior to and during the accident flight, indicated benign winds at Faro, with no hint of any dangerous winds or windshear.

... but doesn't agree with the radar data in the DGAC accident report.

At 07:31:00, the accident aircraft was established on the approach to Runway 11 at Faro (as shown in FIGURE 1). The aircraft was following the 291° radial of the VOR (111° inbound), at a nominal airspeed of 145 knots CAS ± 5 knots, at a nominal rate of descent of 670 feet per minute and at a nominal power setting. To follow the published ~~instrument~~ approach to Runway 11, the aircraft was to follow the 291° radial and then make a ≈five degree turn to align with the runway centerline on 106° magnetic – this was completed normally by the accident aircraft, as shown in FIGURE 2.

Not accurately, not within 2.5° as required for a stabilized approach at 500 ft, as shown by radar data. Power setting was not stable either as required for a stabilized approach.

No, this was not completed normally, as neither DFDR data shows, nor heading data in AIR Table I .

The integrated data confirms that the accident aircraft was conducting a standard and stable approach to Runway 11 until the aircraft entered the runway environment. The detailed recorded data clearly shows that the aircraft then encountered significant low-level horizontal windshear, followed by entry into a severe down-flow, i.e. a vertical windshear, associated with a microburst adjacent to the runway (See SCHEMATICS A and B).

The approach was not stable to FCOM definitions, was not within 2.5° of runway centerline/ VOR radial and not with stabilized thrust.

What data? Horizontal windshear? Or just some gusts. To what altitude did the "horizontal windshear" reach?
Ever heard of flight path stability flight-testing?
How often does windshear occur at Faro? Never! (SKYbrary)
Refer to the Martinair DC-10 windshear definition on page 1; no large airspeed fluctuations, no vertical speed changes.

These data not in the Portuguese accident investigation report.

At 07:32:00, the airspeed was 140 kt

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This is not an analysis, but only an attempt to prove windshear. It is not a professional scientific analysis as should have been expected from the company. Very amateuristic. Only a few comments are presented below.

This analysis assumes the airplane to follow exactly the VOR approach radial and, from 1 nm in front of the runway threshold, the extended runway centerline. The radar data, as presented in the Portuguese accident investigation report, and the control inputs made by the pilot during the final approach prove that the airplane was not on the radial and extended centerline, and that no "windshear" was encountered that required corrective control inputs.

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5. The Final Approach to Runway 11

Note that the tabular data presented in TABLEs I, II & III are derived from detailed analysis of the integrated DFDR, AIDs and CVR data, the RADAR positional/time data and the known first impact location on Runway 11, and are used to create the demonstrative FIGURES referred to in the following material.

Is this a scientific analysis? Working back from the impact point on the runway?

(a). The Last 90 seconds of Final Approach into Runway 11

a1. The attached TABLE I documents the last 90 seconds of flight for PH-MBN from ≈1,000 feet altitude through to its encounter with the microburst and subsequent uncontrollable runway impact. TABLE I lists the ATC clock time in hours/minutes/seconds UTC; CAS and Ground Speed in knots, Magnetic Heading and Crab Angle, distance to impact in nautical miles, and Pressure or Radio Altitude; and includes the delineated Zone of Horizontal Windshear encountered by PH-MBN over the final 20 seconds of approach to impact, and also includes the delineated Zone of Vertical Windshear encoutered by PH-MBN over the final 5-6 seconds prior to impact.

Crab angle? Windshear? See comments with Table 1. Table 1 confirms that the airplane was not on the prescribed approach track, but north of it.

a2. The attached demonstrative FIGURE 2A/2B introduces the accident related microburst (as illustrated in SCHEMATICs A & B) to illustrate its interaction with the PH-MBN's Non-Precision Approach's flight track and profile into Runway 11 landing at Faro during the last 90 seconds of flight. Note that the aircraft is not directly influenced by the microburst's core zone major downdraft, which is South of its approach path; and also that the microburst itself is moving approximately East (roughly parallel to Runway 11/29), and so FIGURE 2A/2B represents "transient snapshots" of the moving core center. Note also that the profile view is looking "through the core" towards the approach path, which is well to the North of the microburst's core center. A benign wind of 150 at 15G20 was given to PH-MBN by the ATC Controller; although FIGURE 2B indicates the Runway 11 wind sensor was enveloped by the microburst outflow at minimum up to at least one minute before impact, no

"Not directly influenced"? So doubts? "How do you know the microburst is moving east (with strong southerly winds"? Assumption!

Benign? The crosswind component was close to the limit for a wet runway, much too high for a flooded runway. Not really "benign".

None of the other objective data out of the DFDR confirms the presence of any wind-shear, which is also confirmed by the NTSB in their letter of 26 Oct. 1994: "If the commission feels that windshear was present, then consideration should be given to recommending implementation or review of crew training for windshear recovery".

Not true. Not reported in the Portuguese report! There is a difference between turbulence and microburst.

Confusing, this happened during the last 25 sec. of flight, not from 90 sec.

10 sec. before touchdown.

wind updates were provided to the flight crew by the Controller. As the aircraft enters the microburst, shortly after the aircraft lines up with the Runway from the VOR Approach heading, some effects can be seen; the speed drops and is corrected, rain comes from the right side of the aircraft and is countered by the wipers, the descent rate increases and is also corrected, and the Captain calls wind (at altitude) 190 at 20.

5.2% glideslope.
Scientists are very accurate with numbers; pseudo-scientists are not.
Refer to the Faro approach plate in the Portuguese report.

a3. The attached demonstrative FIGURE 3A/3B illustrates a similar profile and track of the PH-MBN approach to Runway 11 as seen in FIGURE 2A/2B, but introduces the PAPI 3° Glide Slope Approach for the PH-MBN flight profile; and the VOR / DME (111°M) Approach beam and the transition from it to line up with the Runway Centerline approximately 6,000 feet from the Runway 11 threshold for the PH-MBN flight track (note that the VOR ~~Centerline~~ is offset 5° from the ~~Runway 11 Centerline~~ for this runway's approach).

approach radial

runway bearing 106°

(b). The Last 45 seconds of Flight

b1. The attached demonstrative FIGURE 4A/4B is similar to FIGURE 3A/3B, but focusses on the final 45 seconds of flight prior to impact on Runway 11; showing the PH-MBN flight profile compared to the PAPI ~~3°~~ glideslope, and the PH-MBN flight track compared to the Runway 11 Extended Centerline. FIGURES 3A/3B and 4A/4B depict the aircraft flying into the edge of the microburst at about 07:32:50, initially enountering the microburst's horizontal vortexes' outflow (and its associated rapidly varying transient local wind vectors), and then at about 07:33:12 approaching the microburst's leading edge vortex's catastrophic vertical downflows.

Same as above.

Has AIR Inc. considered the effect of the southern 15 - 20 kt winds striking the shore-line/ coast and dunes on the aircraft? Would there not have been any induced turbulence? There were no outflows.

(c). The Final 20 seconds of Flight

c1. The attached TABLE II documents the last 20 seconds of flight for PH-MBN through to runway impact. TABLE II lists the ATC clock time in hours/minutes/seconds UTC; CAS and Ground Speed in knots, Magnetic Heading, Engine #2 N_2 (%), Rudder, Roll and Elevator position, Radio Altitude (feet) and Rate of Descent in ft/sec.; and includes a delineated Zone of Vertical Windshear (downflow) encoutered by PH-MBN over the final 5 seconds prior to impact.

Downflow that close to the ground? Was there a hole in the ground? The radalt altitude shows a linear descent during the last 5 sec.
Also look at the airplane's accelerations graphs in the DFDR data. See comments in Table II.

c2. The attached demonstrative FIGURE 5A/5B is similar to FIGURE 4A/4B but focusses on the final 20 seconds of flight prior to impact on Runway 11, and adds narrative comments on transient aircraft conditions occurring during this period of time.

Tail wind vectors? Not shown in acceleration graph.

But not on the extended runway centerline, as the pilot control inputs illustrate.

c3. The demonstrative FIGURES are intended to dramatically illustrate in detail the final 20 seconds of flight, and the effects of the dangerous edge vortices' downdrafts and increasing tail wind vectors on the flight. The Controller never called at any time to inform PH-MBN of the shifting winds. We can see the aircraft was in a proper landing configuration at about 50 feet. The microbursts' edge vortex now drove the aircaft downward because of its downflow. The result is shown in the data as a sudden decrease below 1G on the aircraft (and crew), which the crew immediately responded to in an attempt to arrest the catastrophic descent. TABLE II takes us through each of these key events second-by-second; and clearly illustrates the aircraft attitude and state of the aircraft controls at each second due to environmental effects and due to reactive piloting inputs as the aircraft enters first horizontal windshear and then vertical windshear.

Pitch decreased 5 sec. before touchdown, hence vert. g less than 1. Just before impact, vertical g was 1 g again. Vert. g was within the ICAO definition for light turbulence during the whole final approach.

The pilot never decrabbed the airplane before touchdown, which was required because of the crosswind. He wanted to, as shown by the rudder input, but he had not yet reached the extended runway centerline. Improper rudder inputs and the consequences thereof for control and performance, should not be confused with the occurrence of windshear (by a scientist).

c4. TABLE III dramatically shows the aircraft parameters for the last six seconds of flight; and demonstrates how quickly the crew reacted to the suddenly decreasing G and sudden accelerating descent towards the Runway. We can see that this acceleration downwards had been somewhat arrested before impact due to the quick elevator input and power application by the crew.

The radar altitude data show a perfect straight line, no sudden accelerating descent towards the runway. On the contrary, the turbulence and pitch decrease caused g to decrease to 0.75, but during the last 2.5 sec, g increases again, also proving that the vertical motion was not accelerating downwards. (DFDR data).

All of the control inputs show that the airplane on final approach must have been to the left of the extended runway centerline, and not on it. The pilots were desperately trying to reach the runway from that side and to line up the aircraft. They just did not make it. They didn't make it bacause at 500 ft, the approach was not yet stable, i.a.w. the definition in the FCOM.

6. The Runway 11 Upset Sequence

The attached TABLE III documents the last 5-6 seconds of flight for PH-MBN through to runway impact. TABLE III lists the ATC clock time in hours/minutes/seconds UTC, together with Aircaft Vertical "G" readings at successive 1/8th second intervals; plus Radio Altitude (feet) and Rate of Descent in ft/sec.; Elevator Position and Engine #2 N_2(%). All of this is further illustrated in FIGURE 5.

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The left landing gear touched down left of the white line showing the left runway edge... This was obviously also a hardened area. The left landing gear touched down even left of runway edge lighting.

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7. Crash & Breakup / Runway Touchdown Zone

The attached demonstrative FIGURE 6A/6B first illustrates (in FIGURE 6A) the recorded Ground Scarring and final Wreckage Scatter / Distribution derived from the original site investigation, and illustrates PH-MBN's initial Runway 11 impact was with the right-hand main landing gear, and was near to the left edge of the runway proper's hard surface (but not the soft shoulder); with PH-MBN crabbed significantly to the right, rolled significantly right wing down, and at a high enough transient descent rate for these combined factors to cause structural failure of the right-hand main landing gear. The associated FIGURE 6B shows the same data, plus the rubber-wheel-skid-defined most common real touchdown zone for all aircraft using Runway 11 in 2013, as defined in FIGURE 7's GOOGLE image of the (now Runway 10) end of the FARO Airport's main runway. FIGURE 6B thereby illustrates that the Martinair DC-10 PH-MBN touchdown on 21 December 1992 was longitudinally well within the nominal aircraft touchdown location zone along Runway 11, and was also within the lateral constraints of the hard-surfaced runway

Significantly? Right wing down did not exceed 6° at touchdown. In the seconds before, the wings were level.

Well within the nominal touchdown zone... So no sign of an early touchdown, forced by any downdraft, isn't it?

A DC-10 landing gear is designed to fail if overloaded, to avoid the fuel tanks in the wings from getting ruptured. Why did AIR not include the required forces to fail?
Was checked whether the gears were not overdue? Replacement was postponed three times (to save cost, because the aircraft was sold).
An analysis including this research would be more scientific.

The left main landing gear touched down even left of runway edge lighting. AIR Inc. calls that within lateral contraints?

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Wishful thinking. There was no microburst, this never happened at Faro airport before either. Faro is not in the windshear danger zone. Not on list, still not even in 2013 (Skybrary)

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8. The Microburst Activity

The attached SCHEMATIC A is a demonstrative Google image overlaid by a schematic of the local 21 December 1992 microburst involved in this accident (courtesy of GOOGLE / McCarthy). It is important to remember that the microburst is moving laterally (as shown by the arrow indicative of its moving more or less East and parallel to Runway 11/29); and thus the image is in essence a "snapshot" in time of this moving phenomenon. Note also that the microburst is NOT centered over the Runway, and so PH-MBN (on its approach to its Runway 11 touchdown) flew through the peripheral horizontal vortex of the microburst (this phenomenon is illustrated in the attached SCHEMATIC B) rather than its core zone's major downdraft; meaning that PH-MBN was thus exposed to varying significant (and unexpected) transient horizontal and vertical winds in the last few seconds prior to runway impact.

There is no evidence whatsoever that windshear was present. Not even in the objective DFDR data.The Portuguese accident investigation report does not conclude the occurrence of windshear as cause or contributing factor to this accident; the Dutch TSB did, under direction of Martinair.

Vertical winds so close to the ground? Why did AIR Inc. scientists not stick to the facts?

Also attached are demonstrative sketches (SCHEMATICs C and D) courtesy of NASA to illustrate the microburst and windshear phenomenon, and the danger that such a weather phenomenon can represent to an airplane if the aircraft encounters a microburst during an approach to landing. As noted in the top left narrative block of SCHEMATIC D, the crew of such an endangered aircraft needs at least a 15 to 40 second pre-warning in order to be able to deal with such a hazard.

Not applicable to MP495 arrival.

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The crash did not occur because the pilots were not aware of the dangerous wind shifts and down flow (there were none), but because the approach was not flown as required by the Martinair procedures under the prevailing strong and gusty crosswind and the flooded runway condition, which both exceeded the airplane limits, and obviously also the personal limits of the pilot flying.

Microburst was obviously concluded before analysing the accident using objective flight data. Nor very scientific.

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9. DC-10 Faro Accident Sequence of Events

The crash of the DC-10 on Runway 11 occurred because the pilots were not aware of the dangerous windshifts and downflow associated with the presence of a convective microburst cell in the proximity of Runway 11 at the time of the aircraft's approach to a planned landing on Runway 11. Air Traffic Control should have alerted the pilots that the cell was present, and that it was clearly demonstrating dangerous windshift and downflow activity. The proximity of the cell on the approach led to the aircraft being subjected to environmentally induced, uncontrollable catastrophic descent rates during the last five seconds of the flight – descent rates ~~that could not be counteracted by pilot actions~~. The Sequence of Events described in the following material is supported by a series of demonstrative graphic Figures providing Plan and Profile views of the Flight. Analysis of the DFDR data / AIDS data / Radar Data / CVR and ATC data disclosed the following Sequence of Events during the final 90 seconds of the flight.

There was nothing to alert! In addition, MP495 was on the same frequency as other departing and approaching traffic and could have understood the bad weather at Faro Airport (which they already confirmed 17 min. prior to landing - CVR).

Cannot be confirmed by data out of the DFDR, CVR and AIDS.

demonstrative? No misleading... Not made by an aviation professional. See comments in the Figures.

1. About 90 seconds before runway impact, (at 07:31:50), the aircraft was descending at a normal 600 ft/min average descent rate on track for Runway 11 (on radial 291). The wind for a Runway 11 landing had previously been reported by the Air Traffic Controller as an acceptable 130 @ 18 knots, gusting to 21 knots.

Data of 90 sec. before impact was not included in the DFDR data report in the Portuguese accident report. The only data were ground radar data showing that at 90 sec, approach track was 7° at 5 DME to 4° north of the VOR approach track.

Autopilot was set at vert. speed mode with approx. 850 fpm (DFDR data).

Analysis of heading data also reveals that the aircraft was definitely not on track for runway 11 (on radial 291), otherwise a heading of 125° would not have been required for the approach.

2. About 80 seconds before runway impact, (at about 07:32) the DC-10 encountered heavy rain associated with a spawning microburst centered South-West of the Runway 11 Threshold – the microburst had heavy rain and significant downflow at its center.

3. The outflow from the microburst's downflow produced varying and significant winds that radiated out from the center of the microburst at the surface – the data indicates a

DFDR data of accelerations, airspeed, heading, flight controls activity, etc. do not confirm this microburst and downflow. No remark on CVR either. Wishful thinking, not objective.

The captain confirmed to the Portuguese police that he understood the meaning of 'flooded' (standing water) which info was reported by ATC 4.5 min. prior to touchdown. The crew never recalculated approach data with actual wind and runway condition data, but continued to rely on meteo data that was at least 35 min. old (CVR).

This wind was passed to MP461, 7 min. before landing of MP495! The MP495 crew must have heard this wind data, and was made aware of a flooded runway, 3 min. earlier; hence this wind was not acceptable. A Go Around should have been initiated already at this point.

When? Not during the approach. The DFDR data do not show any excessive accelerations, IAS changes, etc. to confirm that the aircraft was subject to sudden winds. This wind was mentioned in the accident investigation report (§ 1.7.2.4) to have occurred 8 minutes after the accident! In addition, this was a calculated wind, not measured. Science? Deception!

sudden wind shift at the Threshold of Runway 11 to a value of about 220 @ 20G35.

This wind was also mentioned as being "valores calculados" in Annex 5 pages 116, 117 of the Portuguese accident report. Was not recorded!

4. The center of the microburst was South of Runway 11/29, but was moving towards the East relatively parallel to the Runway – this movement continued to produce varying outflow winds that changed in direction at the Threshold to Runway 11 – as the DC-10 approached the threshold the wind was shifting in the 200 degree range.

No evidence at all for this statement. Wishful thinking - unscientific.

5. About 65 seconds before runway impact, (at about 07:32:15) the Approach Controller cleared the DC-10 to land, reporting the winds as 150 @15G20 - in fact the winds had to have been closer to 210 @ 20G35 – winds that are beyond the limits of the aircraft to land on a wet runway (i.e. on a wet runway no tailwind component is allowed). As the Controller did not report the winds accurately, it is apparent that he was not monitoring his wind indicators (as required).

Had to have ... With the DFDR heading 125°, and if at the 111 VOR radial, the wind correction angle would be 8° - 14°, so this calculated wind results. However, heading and roll did not vary; no gusts. So, in fact, the airplane needed not 111°+ calc. 8°=119°, but factual 125° to get to the runway. Hence, it was not on the 111 VOR approach radial, but ~7° north of it.

The tailwind limit for a wet runway is 5 kt, for a flooded 0 kt (AOM 3.7.3 - 04). On wet or flooded runways also a crosswind limit exists.

Wrong conclusion. The Portuguese report writes about wind data of the other runway end. A controller doesn't have to monitor his wind indicators all the time - is not required.
The wind displayed by the AINS, as read by the captain 9 sec. before touchdown, was 190 @ 20. Martinair procedures tell the pilot to monitor that wind data!

Had the pilots been provided with accurate wind information during the final segment of their approach they would have realized the danger of continuing, and they would have aborted the attempted landing. It was the responsibility of the Controller to provide accurate wind information, and he failed to do so. When the Controller failed in his responsibility, there were no other significant "cues" to warn the pilots of the danger ahead.

The captain knew the reported wind was exceeding the limit for landing on a flooded runway; as he told the Portuguese police. The INS wind even exceeded the limit for a wet runway. The approach should have been aborted at several instants.

Yes, there was: the INS wind read by the captain. Martinair standard procedure.

7. About 57 seconds before runway impact, (at 07:32:23) the aircraft was on autothrottle and on autopilot. The Flying Pilot (Co-Pilot) selected Control Wheel Steering (CWS) Mode for the Autopilot.

The aircraft was in the vertical speed mode of the autopilot (NTSB DFDR report). At 54 sec. before touchdown, the airplane obviously descended below PAPI, upon which the pilot switched to CWS, and flew level for 12 sec. to again intercept the PAPI glideslope. The copilot then mentioned "PAPI hè", as an excuse for the too late glideslope correction.

54 seconds. Time not right! 7:32:06 UTC.

The crew was initially set up for the approach, and on the very final part of the approach they started to unknowingly fly along the North side of a microburst, which meant the DC-10 was flying through rapidly varying winds, from a right quartering head wind to a direct right crosswind to a right rear quartering tail wind. No updated winds for Runway 11 were ever given by the Controller. If the Controller had been continuously monitoring the winds, he would have observed the windshear effects on his monitor,

No evidence for this. DFDR data do not confirm.

Why monitoring if nothing is wrong? Is that procedure? He would have seen nothing, there were no windshear effects.

?? By whom or what?

During approach, airspeed needs to be maintained. The autothrottle took care of this. Ground speed results from airspeed and wind.

i.e. dramatic and rapid changes.

At 07:32:45, 36 seconds before impact ... "PAPI hè", as an excuse that he descended below the glideslope, but adjusted.

9. In the DC-10, during final approach, ground speeds were maintained at ≈140 knots, but airspeeds and the approach angle were being adjusted. At 07:32:~~34~~ (46 seconds before runway impact) the Co-Pilot stated -*"PAPI"*-, and at 07:32:50 (30 seconds prior to ground impact) the Captain stated -*"speed a bit low"*-. Parameters show that the Co-Pilot made appropriate adjustments.

Line-up at 1 nm from runway threshold not mentioned. Data in Table I do not show a succesful line-up though.

DFDR data do not show a starting rapid descent. The aircraft continued the descent.

10. During the final seconds, at 07:33:00 (20 seconds prior to ground impact) the aircraft started a rapid descent, and heavy rain hit the windshield ~~from the microburst to the right~~, with the Flight Engineer putting the wipers on "Fast". The Captain called -*"a bit low …"*- at 07:33:05 (15 seconds prior to ground impact). The aircraft leveled momentarily, and then the descent resumed.

from a shower in the flight path. There was no microburst.

No sideward and longitudinal accelerations recorded on the DFDR. No heading corrections either.

11. The aircraft was ~~now~~ encountering significant right crosswinds that were rapidly changing to right quartering tailwinds as the aircraft approached the Runway 11 threshold at 07:33:10 (10 seconds prior to ground impact). This change in right-wind component (from a direct crosswind where the pilot had to correct for the direct crosswind to a quartering right tailwind where less "correction" would be required), caused the aircraft to start to move to the right of the centerline.

From 14 sec prior to impact, the pilot started to deflect the rudder to the left for lining up with the runway. 6 sec before impact he reduced rudder. He never reached runway heading, not because he was right of the centerline, but because he was still left of the centerline and wanted the aicraft to continue wandering to the right, to the centerline.

Because the captain started interfering with his own controls. He would not do this if the airplane was just a little to the right.

12. At 07:33:10 UTC (10 seconds prior to ground impact) at 130 feet altitude, the Captain advised wind (from the INS) of 190 @ 20. The Autopilot disconnected from CWS to Manual. The aircraft was moving right of the Runway centerline as the winds were shifting more and more past crosswind to tailwind components. Starting at time 07:33:11, the Airspeed started to decrease. Despite the dramatic change in the landing wind for Runway 11, with the presence of a significant tailwind, the Controller did not advise the DC-10 – it is apparent that the Controller was not monitoring the Runway 11 winds.

off

??? How do you know? No objective data.

No evidence for this, neither in meteo data nor in aircraft DFDR data. Was the Controller required to monitor? No. He already advised the crew of the wind (150/15-20) and the state of the runway (flooded). It is not his task to step in the aircrews' shoes.

Because the throttles were closed.

13. Left rudder was applied and the aircraft rolled left – this was obviously an attempt to get back to being lined up with the

Significant tailwind? How do you know. Wishful thinking.

A roll to the left is a side effect of yawing (left rudder), and should be corrected by a right aileron control input, which was not given. Hence, this was obviously not an attempt to get back to being lined up with the centerline, but an attempt to line up because the rudder input (near max.) was insufficient to line up, as the approach was from the side.

Threshold was passed at a lower altitude (PAPI 5.2% glideslope).

Runway centerline.

14. As the DC-10 passed over the Runway Threshold at 75 feet above ground level at about 07:33:13.5 UTC (6.5 seconds before ground impact) the pilots were dealing with the horizontal windshear effects. The aircraft's airspeed was decreasing rapidly (i.e. it decreased by 19 knots in the final 10 seconds before ground impact), while the groundspeed continued at 140±2 knots. The descent rate was normal, initially at 10 feet/second.

Where is this data from?

How do you know?
Was not lined up, heading at touchdown was 117° (10° right).

15. The aircraft rolled to wings level and was lined up tracking down the runway, but was to the left of the runway centerline. The crew had initiated corrective action to regain the centerline, and the aircraft was in a stable envelope for landing as it passed through 58 feet above the runway. If the aircraft had not encountered the severe downflow, the aircraft was in a stable condition from which a normal landing could have been accomplished, with the descent rate decreasing as the aircraft would have flared for the touchdown.

With what? The throttles were already pushed forward for GA. No evidence for severe downflow. Why was the GA initiated? Not because of the severe downflow, but because they did not make it to the runway centerline from an unstabilized approach.

16. The aircraft then entered the leading edge vortices of the microburst outflow, and it rapidly descended to the runway surface in the following 5 seconds; the downflow effects caused the aircraft to literally plummet down towards the Runway, developing a descent rate of 16 feet/second just prior to impact.

No evidence. DFDR Radalt shows straight descent. From where this rate of descent data?

17. The crew immediately responded to the rapid descent by pitching the aircraft's nose up and slamming the throttles to Full Power while calling -*"Throttles!"*-. However, the significant vertical downflow continued to force the aircraft down. Although the airspeed continued to decrease, the aircraft **did not stall –** it maintained flying speeds (above stall speed) at all times while airborne.

No, the DFDR radalt data do not show a rapid descent; the aircraft did not stall, but the wings lost a great deal of lift due to the decrease of the airspeed below the required threshold speed. Pilot error. Following the increase of thrust, the rate of descent decreased (DFDR normal g data)

18. The GPWS wailer came on as the aircraft passed through 50 feet altitude AGL, indicative of the prevailing high descent rate.

19. At the moment of impact with the Runway, the aircraft was

Where is this stated? The airplane was in the proper landing configuration. GPWS then not wailing!

only 2 - 3°!
Runway cambered? Pictures showed a flat runway with standing water/ flooded.
Does camber really affect the rate of descent?

Several g-meters in the airplane recorded different g-levels. During the last 2 sec. of flight, the normal g graph shows an increasing g level, meaning that the downward motion decreased, not increased!

rolling to the right - the Runway was cambered, which resulted in an effective rate of descent at right gear impact of approximately 20 feet /second. The aircraft itself was subject to a ≈2G impact.

20. The Right Main Landing Gear impacted the Runway at approximately twice the design maximum descent rate of 10 ft/sec – the right landing gear fractured and collapsed, causing the right wing to fail at the root and the right roll to continue.

This "twice" is not right. The landing gear can withstand higher ROD's. The shear pin in the right MLG (to prevent puncturing the fuel tank in the wing) might have done its job because of landing with the brakes applied. Not all wheels have anti-skid protection.

21. There was no significant lateral drift at the time of ground impact - the impact gouges and wreckage trail show that aircraft momentum was tracking down the runway.

Wrong. The crab angle at touchdown was 11°, nose right (DFDR). The aircraft was indeed tracking the runway (half outside of the left side). Hence, there was indeed a significant lateral drift (11°) to the left.

Accident Investigation & Research Inc.
The Air Group
• Accident Investigation and Research
• Applied Informatics and Research
• Failure Analysis Investigation and Research

Below, AIR Inc. uses headwind and tailwind, the source of which is not specified; no such data were in the Portuguese accident report. When the wind direction and speed change, this has to have effect on the heading of the aircraft that was to arrive at a fixed destination, the Faro runway 11 approach end. However, the heading during the last 60 sec. of flight did not change, was 125° except during inappropriate application of rudder; this heading change is therefore fully explainable and is not caused by changing winds. The indicated airspeed varied during the approach, but is also fully explainable because of pitch and N1 changes. During the last 7 sec. of flight, when the throttles were closed but the pitch increased, the airspeed - of course - slowly decreased. Lateral and longitudinal accelerations didn't change noticeable either, hence there were no significant changes in the wind direction and speed; no changes that resulted in an increasing tailwind during the last 8 sec. of flight. The wind data used by AIR Inc. is therefore fabricated wind data, to make believe that the airplane was on a correct approach path, while all control inputs prove that this definitely was not the case.

UTC?

10. Time Line of the Last 20 Seconds of Flight

The following timeline explains in detail the last 20 seconds of flight and how the aircraft had flown into the influence of the microburst, and how the microburst had affected the aircraft in the final seconds starting at time 07:33:00. The key data parameters detailed in the narrative below are extracted from the attached Tables II and III, and FIGURES 3, 4 and 5.

Can't say "crabbing" here: the heading was 118, which is 12° right from runway heading, however, if wind = 120/20: WCA 6°: hdg req'd=112; if wind = 190/20: WCA 8°: hdg req'd=114.
Heading was 118, with some rudder deflection, so heading without rudder would be larger. So either the wind was above limits, or the aircraft was obviously north of approach path, not on the required path for a stabilized approach.
10 sec before touchdown, full rudder was not adequate to decrab the airplane completely. This also proves that the airplane was not on the runway centerline.

Seconds to Impact	Clock Time	
20	07:33:00	• The aircraft is ~~established~~ on a ~~stabilized~~ approach, holding basically on the extended runway centerline ~~crabbing~~ 12° to the right (heading 118° vs. 106°) • There is a 5 knot headwind component • Radio Altitude is 230 feet • Rate of Descent is 15 ft/sec (this will soon be significantly reduced – within the next 5 seconds ft/sec)
19	07:33:01	• ~~Stabilized approach is being maintained~~ • ~~Crab~~ is now 13° to the right • Headwind component is now 2 knots • Engine speed is at 65.58% N_1 • Radio Altitude is 215 feet
18 17 16	07:33:02 to 07:33:04	• ~~Stabilized~~ approach is being maintained by correcting for "slightly low" on the "normal" glideslope • ~~Crab angle~~ is varying between 13° and 16° to the right • Headwind component is now between 1 and 3 knots • Over 4 seconds, Engine speed is increasing from 65.58% N_1 to 99.46 N_1 • Radio Altitude is now down to 165 feet • ~~Pilot flying~~ has reduced the rate of descent by using increased engine speed and "up" elevator (from 16 ft/sec descent to 7 ft/sec descent); ~~this was done to~~ correct for a slight "below 3° glideslope" condition (the

This is not in agreement with ground radar data and with the recorded flight control inputs and heading data. These data do not prove being established on the extended centerline. The approach was not stable as defined and required in the FCOM.

Source? ATC wind was 120/15-20: headwind max. 14 kt. AINS wind 190/20: headwind max. 2 kt. Crosswind is more relevant than headwind. Avg ROD from 1000 ft = 12 fps = 705 fpm.

Approach was not stable as defined in the Martinair FCOM.

From where the wind data in this table? Why not crosswind? Or wind in degrees and kt? Trying to hide something?

Hardly any rudder, so no decrabbing! Aircraft heading is 120. WCA 8°. Ground track = 114, not 106. Again evidence that airplane is north of approach path.

Approach was not stable. Heading too large, pitch increased - leading to N1 increase + not on extended runway centerline, read below.

7

Not PF but AT increased N1. N1 was already increasing because pitch increased.

Approach was not stable as defined in the Martinair FCOM. Heading not right, N1 not stable.

		correction was successful)
15	07:33:05	• ~~Stabilized approach is being maintained~~ • Headwind component is transiently 6 knots • "Up" elevator is decreasing • Captain declares (to co-pilot flying) "A bit low…" • Pilot Flying is inputting right-wing-down aileron sufficient to counter (what will be 2 seconds later) his input of left rudder – this is a normal "line-up" correction action for landing when there is a cross-wind from the right • Engine speed is ~~increasing (~~now at 99.46% N_1~~)~~ • Radio Altitude is now 158 feet

Earlier, at 16 sec.

No, just a little aileron to the right; but after 2 sec the rudder to left, and aileron to the other side. Bank angle increases to left, which is definitely not a normal "line-up". Bank should have been to the right. This also proves that the aircraft still was not on the extended centerline, but north of it.

14	07:33:06	• ~~Stabilized approach is being maintained~~ • Headwind component remains at 6 knots • Rate of Descent now at 2 ft/sec • Engine speed peaks at 100.92% N_1 • Radio Altitude is now 151 feet

Is not stabilized. pitch increased, rudder started to increase to left from nearly centered. Aileron control to left a little, should be right if decrabbing.

13	07:33:07	• ~~Stabilized approach is being maintained~~ • Headwind component starts to continually decrease – now at 5 knots (wind will shift quickly only 5 seconds from now to a tailwind component) • ~~Pilot flying has now inputted sufficient right aileron to achieve 10.8° of right-wing-down – he is countering this with 7.3° of left rudder input (correcting to align the aircraft with the runway so that the aircraft will track along the centerline in this right crosswind condition)~~ • Rate of Descent is now at 4 ft/sec • Engine speed decreases to 97.99% N_1 • Radio Altitude is now 149 feet

At 14 sec, rudder input to left (for decrabbing). Aileron control force went to left rather than to right which would be required to compensate the roll due to yaw and prevent sideslip. Roll control input is not steady (CWS is actuating the ailerons). The aileron control force to left was obviously not to counter roll due to yaw. Bank angle starts to change from right to left, which is not consistent with correct decrabbing. Just prior to rudder input, heading was 125 following releasing rudder control. This was much larger (11°) than the heading required to maintain the approach path after line-up. This again supports the analysis that the airplane was still north of the approach path.

Normal lining-up: First rudder, then 'counter' adverse roll and sideslip with aileron.

12	07:33:08	• ~~Stabilized approach is being maintained~~ • Headwind component now reduced to 4 knots • Pilot flying is now inputting ~~more~~ left rudder (now 13°) ~~while maintaining right aileron input to achieve 8.4° of bank to the right~~ • Engine speed stays constant – (~~determined by trend - no recorded value~~) • Radio Altitude is now 145 feet

What was the crosswind?

16°

Rudder input is increasing to left. Aileron control force (for CWS) is moving from left to right. Aileron control force is moving from left to right. Bank angle is increasing from right to left though. The limited aileron control input was obviously not intended for attaining a bank angle to the right as would be required for lining-up.

DFDR data show 3 recorded N1's. Two of them already decreased.

11	07:33:09	• ~~Stabilized approach is being maintained~~ • Headwind component is now reduced to 3 knots • ~~Aircraft is still maintaining 17° of crab to the right~~ • Pilot flying is inputting even more left rudder (now 19°) attempting to cause the aircraft to yaw left to align

Heading continues to decrease due to rudder deflection.

Bank angle is passing wings level to the left. Pilot did not stop rolling to the left with adequate roll control input to the right. He obviously was not decrabbing; this is definitely not a stablilized decrab.

Are you sure, or is this tailwind an assumption?
A crab angle proves that a crosswind is acting...

Rudder was passing 20° left, increasing to 23°.

		with the runway for touchdown) ~~– while at the same time the pilot was allowing the wings to roll "level" by reducing right aileron input –~~ wings are now at 1.4° banked right • Pilot flying also adds "down elevator" ~~(-2.4°)~~ which results in a rate of descent increase to 13 ft/sec • Engine speed starts decreasing from 97.44% N_1 • Radio Altitude is now 142 feet

Roll control input is not steady. Bank angle was increasing from right to left (the wrong direction for decrabbing) and "paused" a few seconds at wings level while the control input was a bit to the right. For a stable decrab, bank angle should have been larger. A large required decrab angle means that a large crosswind is present.

At 10, elevator control force is zero!

Heading 120. Ground track not runway heading.

19,9° (incl. damper input), 76.2% pedal left

10	07:33:10	• ~~Stabilized approach is being maintained~~ • Headwind component remains at 3 knots (will become a tailwind component within the next 2 seconds) • Crab angle is now 15° crab to the right • Pilot flying is maintaining left rudder input ~~(15.6°)~~ ~~countered by right aileron input sufficient to hold the aircraft at 0.4° left bank~~ • There is a momentary input of "down elevator" (-6.7°) • The rate of descent remains at 13 ft/sec • Engine speed is decreasing – now at 85.66% N_1 • Interpolated Altitude is 129 feet

50%

		• ~~Stabilized approach is being maintained~~ • Headwind component is reduced to 1 knot • ~~Crab angle is reduced to 12° to the right~~ • Left rudder input is temporarily reduced to ~~10.0°~~ • Elevator down input is reduced to -2° down • The rate of descent is now 11 ft/sec • Engine speed is still decreasing (determined by trend - no recorded value) • Radio Altitude is now 116 feet

What was the crosswind? Heading was 117, not runway heading.

Heading still decreasing. So the pilot is not really decrabbing, despite near max. rudder. The aircraft cannot reach runway heading without banking to left.

Throttles were closed.

8	07:33:12	• Wind component is now a tailwind component (1 knot tailwind component) • ~~Crab angle is reduced to 11° to the right~~ • Left rudder input is increased to 22.5° with the bank angle at 1.8° left • Elevator down input is reduced to -0.6° and in the next second will turn to "up" input • Engine speed is still decreasing ~~(determined by trend - no recorded value)~~ • The rate of descent remains at 11 ft/sec

Bank angle would have been to the right during decrabbing.

7	07:33:13	• Wind component is now a 2 knot tailwind component • ~~Crab angle is reduced to 9° to the right~~ • Left rudder input remains at 22.5° with the bank angle at 6.7° left • There is a momentary "elevator up" input of 5.8° • The aircraft begins to roll to the left

continues a "paused" roll to the left but only temporarily.

<table>
<tr><td></td><td></td><td>• Engine speed continues decreasing – now at 54.02% N_1
• Radio Altitude is now 94 feet</td></tr>
<tr><td>6</td><td>07:33:14</td><td>• Wind component is relatively unchanged – a 1 knot tailwind component
• ~~Crab angle is further reduced to 7° to the right~~
Pilot and CWS were successfully countering this roll.
• The left rudder input is reduced to 6°
• The left bank angle rapidly reaches 14.4° before the aircraft begins to roll back towards “wings level” (See next boxes)
• Elevator input is ~~at 1.1°~~ up
• Radio Altitude is now 83 feet
• The rate of descent is now at 12.2 ft/sec
• Engine speed continues decreasing – now at 46.02% N_1
• Radio Altitude is 83 feet (the aircraft passes over the runway threshold at 75 feet)</td></tr>
<tr><td colspan="3">CWS switches itself off due to conflicting inputs ftom left and right seat..
For the remainder of the flight (in the Tables below) Aircraft Vertical “G” Readings are inserted – available for 1/8 second intervals – from 07:33:15 to the time of impact at 07:33:20.5 (for reference see Table III)
Which g data were used? DFDR?</td></tr>
<tr><td>5</td><td>07:33:15</td><td>• The tailwind component is increasing to a 2 knot tailwind component, airspeed ~~is 139~~ knots
133 kt (DFDR)
Heading is 112°.
Rudder pedal force = zero but increasing to left, increasing rudder deflection to 12.5°.
Elevator input force was up and varied, one DFDR elevator deflection trace after decreasing was 0, the other bottomed at 3,5°.
Left bank angle already started decreasing to zero, to wings level.
Throttles were being held to idle.
For a PAPI approach of a big DC-10 on Faro, the altitude is less than 50 ft AGL when crossing the runway threshold.
• ~~Right crab angle is relatively unchanged – it is now at 6° to the right (the crab angle will remain little changed for the final 5 seconds of the flight)~~
• Left rudder input is relatively unchanged – now at 5.5° left
• Elevator input is unchanged at 1.1° up
• ~~The left bank now starts to decrease – presently at 10.2° left wing down – the aircraft is now rolling out of the left bank towards neutral, and will achieve a slight right wing down condition for the remainder of the flight~~
• The rate of descent is now 11 ft/sec
• Engine speed now at 43.49% N_1
• Radio Altitude is 70.8 feet
• The aircraft is over the Runway ??
• Vertical speed (down) is stable at 12.2 ft/sec
• Aircraft Vertical “G” Readings are as follows:
<table>
<tr><td>07:33:15</td><td></td><td>1.0396</td></tr>
<tr><td></td><td>.125</td><td>1.0488</td></tr>
<tr><td></td><td>.25</td><td>1.0625</td></tr>
<tr><td></td><td>.375</td><td>1.0831</td></tr>
<tr><td></td><td>.5</td><td>1.0717</td></tr>
<tr><td></td><td>.625</td><td>1.0373</td></tr>
<tr><td></td><td>.75</td><td>1.0556</td></tr>
</table></td></tr>
</table>

	.875	1.0419

4 — **07:33:16**

- The tailwind component has increased to a 4 knot tailwind component
- Airspeed is ~~137~~ knots
- ~~Right crab angle is relatively unchanged – now at 7° to the right~~
- Left rudder input has now increased from 5.5° to 13.3° ~~(then within the next 1 second it decreased back to 9.1° and then within the next second back to 1.2° left rudder)~~
- ~~Elevator input is relatively unchanged at 0.9° up~~
- Radio altitude is 58.6 feet
- The wings are level
- Aircraft Vertical "G" Readings are as follows:

133 kt according to DFDR data.

Heading increased to 115.

Then in next 2 sec. the rudder deflection decreased to 5° right.

Deflection of the elevators increased until impact to 15 resp. 22.5° up.

Wings level, hence no proper decrab!

07:33:16		1.0282
	.125	1.0465
	.25	1.0167
	.375	1.0076
	.5	1.0007
	.625	0.9938 (less than 1 "g" condition)[1]
	.75	1.0282
	.875	1.0213

- ~~At 07:33:16.625 (3.875 seconds before impact) the aircraft is entering a less than 1 "g" condition caused by a severe down-flow associated with a microburst adjacent to the runway (See Schematics A and B)~~

This cannot be proved/ confirmed. 0,9938 is 0.0062 less than 1 g; really caused by severe down-flow? What a difference! ICAO defines the light turbulence limit (0.5g) to be more than 80 times higher than this difference (0.0062).

It is not a down-flow, but just a continuation of the light turbulence that was experienced during the whole approach.

3 — **07:33:17**

- The tailwind component has increased to a 7 knot tailwind component
- Airspeed is ~~134~~ 131 knots
- ~~Right crab angle is relatively unchanged – now at 8° to the right~~
- Left rudder ~~input has now decreased from 13.3° to 9.1° (then within the next 1 second it decreased back to 1.2°~~
- Elevator input is increasing – now at 3.1° up
- Engine speed is down to 41.23% N_1
- Radio altitude is 47.3 feet
- Aircraft Vertical "G" Readings (all are less than 1 "g") are as follows:

Need to know the wind speed and direction to determine whether the wind is exceeding aircraft limits.

Airspeed is 130 kt (DFDR)

Heading was 115, 9° to right.

Rudder control input is not available due to damaged AIDS data carrier; where are these data from? Rudder deflection decreased from 12.5° left to 6° to the right in less than 2 sec. (DFDR).

Elevator input not available due to damaged data carrier. The elevator deflection is 3° up, and continues to increase (DFDR).

Note:- In flight, an undisturbed aircraft would nominally be at 1 "g" (occupants of the aircraft would feel their "normal" weight). A reading of less than 1"g" is produced by an "acceleration down" force created by something ~~in addition to~~ less than normal gravity – the occupants of the aircraft would feel a "floating" sensation – "0 g" would be complete weightlessness.

07:33:17		0.9938
	.125	0.9778
	.25	0.9755
	.375	0.9411
	.5	0.9160
	.625	0.8793
	.75	0.8790
	.875	0.8908

- All of the above readings are less than 1 "g" as the aircraft remains under the influence of the ~~severe vortex down-flow~~
- The rate of descent has increased to 14.1 ft/sec

severe? Only light turbulence

Not shown on radalt graph.

2 **07:33:18**

Heading is still 115, 9° to the right of runway heading; decrab not yet completed at this time.

Rudder input not available at this time because of damaged data carrier. Rudder deflection started to increase at this time from 5° right (wrong side) to 10° to the left at impact (DFDR).

Up elevator continues to increase while passing 8° up at this time.

- The tailwind component has increased from 7 knots to 13 knots
- Airspeed is now 128 knots
- ~~Right crab angle is unchanged at 9° to the right~~
- Left rudder ~~input has now decreased from 9.1° to 1.2°~~
- "Up" elevator input is rapidly increasing – from 3.1° to 8.1° (within the next second it reaches ~~18.6°~~ up)
- Engine speed starts increasing from 40.77% N_1
- Radio altitude is 33.2 feet
- Aircraft Vertical "G" Readings (all are less than 1 "g") are as follows:

126

I.a.w. DFDR data, the vertical g increases this whole second and is again 1.0 g at 1 sec. prior to impact.

This table is not i.a.w. DFDR data.

No evidence of severe downflow. Also keep in mind that the aircraft is now 33 ft high, ~10 m. Little room for a severe downflow.

07:33:18		0.8954
	.125	0.8954
	.25	0.8954
	.375	0.8976
	.5	0.8931
	.625	0.8931
	.75	0.9205
	.875	0.9228

though increasing, meaning the aircraft' rate of descent is reversing.

- All of the above readings are less than 1 "g" ~~as the aircraft remains under the influence of the severe down-flow~~
- The rate of descent has now reached 16.2 ft/sec

1 **07:33:19**

Heading is 117 (DFDR), hence increased to 11° to the right of runway heading; decrab still not completed at this time.

Left rudder input data not available. Left rudder deflection was only 6.5°, less than 25% available, though increasing. This proves no attempt was made to fully decrab the airplane.

- The tailwind component has increased to a 17 knot tailwind component
- Airspeed is now 125 knots
- ~~The right crab angle is relatively unchanged – now at 8° to the right~~
- Left rudder input has now increased from 1.2° to 4.4°

(then within the next 1 second it increased to 10.5°)

- Elevator input has increased rapidly – now at 18.6° up
- Engine speed has increased to 50.26% N_1
- Radio altitude is 17.0 feet
- Aircraft Vertical "G" Readings are as follows:

07:33:19		0.9343
	.125	0.9457
	.25	0.9549
	.375	0.9801
	.5	0.9961
	.625	1.0144 (return to positive "g")
	.75	1.0259
	.875	1.0305

- The aircraft has returned to positive "g" because of the significant input of "up" elevator (18.6° up) and increasing thrust
- The rate of descent continues to be very steep at 15.8 ft/sec, ~~showing the continuing influence of the severe downflow~~

a positive g means the rate of descent was decreasing. There was no downflow!

0 — 07:33:20

Aircraft touched down with a heading of 117, at an airspeed of 126.0 (DFDR, NTSB). The decrab maneuver was not completed succesfully. The airspeed had decreased 9 kt below the FCOM listed safe touchdown speed of 135 kt (page Vol II 06-87-09).

Rudder deflection to left was only less than 50% available, with a slight difference between the upper and lower rudder.

On or near the ground, there can be no down-flow (unless there is a very deep and wide hole). g's were positive, rate of descent was decreasing!

Meaning that the decrab was not completed. This was obvious during at least the last 10 sec. of flight, leaving little time for a safe go-around.

- The tailwind component is relatively stable at 16 knots
- Right crab angle is relatively unchanged – now at 10° to the right
- Airspeed is now 12~~7~~ knots
- Left rudder ~~input~~ has increased ~~from 4.4°~~ to 10.5°
- "Up" elevator ~~input~~ has now reached 20.4°
- Engine speed is rapidly increasing to a value approaching 85.69% N_1
- Radio altitude is 1.2 feet
- The aircraft is banked right (5.6° right wing down)
- Aircraft Vertical "G" Readings are as follows:

07:33:20		1.0831
	.125	1.0923
	.25	1.1083
	.375	1.2343
	.5	(Time of Impact) 1.9533
	.625	No Data
	.75	No Data
	.875	1.5320

- The aircraft struck the runway in unstable flight ~~under the influence of the severe vortex down-flow~~
- The aircraft was at a vertical speed of ~~greater than~~ 15 ft/sec, banked right by some 6°, and with a right crab angle of some 10°

DFDR presents exact data!

- These values are beyond the engineering design capabilities of the landing gear

No, a DC-10 landing gear can withstand at least 2 g (other incidents proved this). What you might not know is that the replacement of the right MLG of this DC-10 was postponed already three times, as asked by Martinair and approved by the authorities, because the airplane was already sold to the State (Air Force); a landing gear replacement is expensive. There was something wrong with this MLG. Landing with an 11° crab angle with brakes applied was obvious beyond the limits of this landing gear, leading to shear forces that could have led to shear pin failure in the landing gear. Not all DC-10 aircraft have locked-wheel touchdown protection (anti-skid) on all wheels, but on rear bogie wheels only.

Accident Investigation & Research Inc.

The Air Group
• Accident Investigation and Research
• Applied Informatics and Research
• Failure Analysis Investigation and Research

AIR File #7355, 23 July 2013

Not confirmed by available DFDR data. Not confirmed by the accredited NTSB investigators either. Wishful thinking. Not a scientific conclusion.

11. Conclusions

1. The integration of the available hard data (Initial impact point, Radar/DFDR/AIDS, etc.), clearly shows that the aircraft, while approaching the Runway 11 threshold, ~~flew into significant horizontal windshear, and subsequently into catastrophic vertical windshear which caused the aircraft to plummet to the runway surface~~. The Air Traffic Controller did not inform the pilots of the significant changes in the winds on the approach to Runway 11, even though the wind speeds and directions would have been readily apparent on his wind-monitoring instruments.

There was no reason, he didn´t have to. There were no changes.The Captain in the cockpit did read the increasing wind himself. This wind should have been used, i.a.w. Martinair procedures.

The wind data as reported by the Air Traffic Controller meant there was a crosswind component that exceeded the limits of a DC-10 aircraft for a wet and for a flooded runway. The requirement for windscreen wipers 9 second prior to touchdown should have convinced the pilots that the runway was flooded, at least very wet, making a safe landing impossible.

2. The ~~dramatic~~ weather phenomena that affected the aircraft in the last seconds before runway impact (starting at an altitude of approximately 50 feet), ~~and in particular the sudden downflow in the final 5 to 6 seconds of flight,~~ caused the aircraft to descend at a rate from which it was not possible to recover before runway impact. ~~The presence of this downflow is confirmed by the change from the normal G load on the aircraft (+1G) to a condition where there was less than 1G (the downflow was powerful enough to force the aircraft towards negative G). The dramatic downflow prevented the pilots from taking normal pilot actions to arrest the descent rate and flare the aircraft for a normal touchdown.~~

During the whole approach, only light turbulence was experienced. No dramatic change during the last seconds of flight. No objective sign of dramatic downflow. No lower g than normal for the light turbulence.

~~When they encountered the dramatic downflow, the crew reacted immediately and dramatically to counter the sudden extreme descent rate, but the rate of descent was beyond the performance capability of the aircraft, making it impossible for the pilots to recover before impact with the runway.~~

If indeed the descent rate was extreme, the aircraft would have touched down earlier. The reversal of the descent to a climb (go-around) might have been hampered by the reduced airspeed, i.e. reduced wing lift (~V²) and the delay of thrust increase (spool up delay) because the Auto Throttle System was overruled by the pilot, who kept the throttles in idle.

4. The aircraft struck the runway ~~at such a high descent rate, and at such an abnormal attitude,~~ that ~~massive~~ loads were created; ~~loads that were beyond the design capabilities of the landing gear.~~ When

the right landing gear failed, it led to a series of additional structural failures that caused the aircraft breakup.

no loss of control, while still in-flight

5. The sudden ~~loss of control~~ of the aircraft was caused entirely by ~~environmental factors~~; it was ~~not~~ the result of ~~any~~ actions or mishandling by the pilots. Even with the windshear conditions, the aircraft was at all times well above the aerodynamic stall speed of 107 knots – this confirms that there was no contribution to the dramatic descent rate from an aerodynamic stall condition.

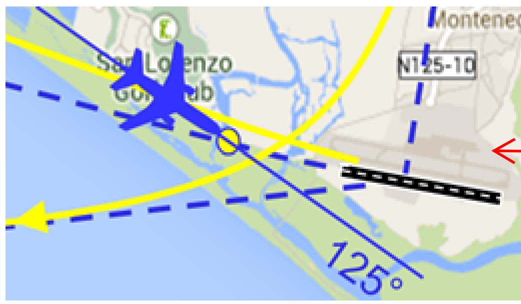
... who were not operating in accordance with the standardized approach procedures prescribed in Martinair Manuals. The whole approach was not stable as defined in the manuals.
If pilots are not following procedures then the company and the pilots are to be blamed, not the weather.

By mentioning the stall speed, the writer must have realized that a decrease of airspeed reduces the wing lift (≡ V^2). To compensate for this loss, the angle of attack needs to increase (pitch increase) and thrust is required to compensate for the increased drag. But thrust was not readily available, because the pilot held the throttles in idle, which should never be done with big turbofan engines, because it takes 7 to 8 seconds for the engines to spool up from idle and develop maximum thrust after moving the throttles forward. A well trained pilot knows this; an Auto Throttle System is even programmed accordingly. The go-around, initiated during the last seconds of flight, failed because the throttles were kept in idle by the pilot flying.

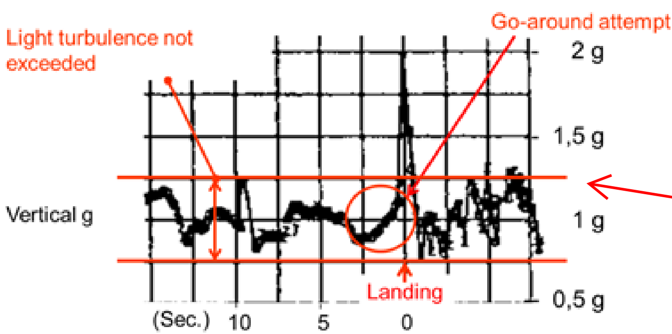
The continuation of the approach while the reported wind was exceeding the aircraft limits for a wet and flooded runway, the approach not being stable i.a.w. the requirements in Martinair manuals, the large deviation from the required approach path, the closing of the throttles, the decreasing approach airspeed, and not being able to decrab the aircraft in time are all evidence of mishandling by the pilots.

This AIR Report addresses a number of erroneous and unsupported conclusions

Calibrated Air Speed (CAS)? CAS is alright, but were you aware of the instrument errors? The DFDR data lists Indicated Air Speed (IAS)! How and what did you correct?



Required heading proves that the airplane was not on the required approach path. Refer to larger figure in Figure 1 below.



The downward vertical motion decreased, rather than increased during the last 2.5 sec. before touchdown.

TABLE I - Last 90 seonds of flight for DC10-30CF, PH-MBN - Approach and Crash at Faro, Portugal (AIDS / DFDR data)

Seconds to Impact (secs)	ATC Clock Time (h:mm:ss)	C.A.S. Air Speed (knots)	Area Nav Ground Speed (knots)	Magnetic Heading (°M)	Crab Angle (to Right) (°)	*Interval Distance (n.miles)*	Distance to Impact (n.miles)	Pressure or Radio Altitude (feet)
90	07:31:50		129	127	16	*0.0358*	3.47	1,042
89	07:31:51		129	127	16	*0.0358*	3.43	1,034
88	07:31:52		130	126	15	*0.0361*	3.40	1,028
87	07:31:53		130	126	15	*0.0361*	3.36	1,014
86	07:31:54		130	126	15	*0.0361*	3.32	1,008
85	07:31:55		130	125	14	*0.0361*	3.29	998
84	07:31:56		130	125	14	*0.0361*	3.25	994
83	07:31:57		131	124	13	*0.0364*	3.22	986
82	07:31:58		131	124	13	*0.0364*	3.18	972
81	07:31:59		132	124	13	*0.0367*	3.14	962
80	07:32:00		132	124	13	*0.0367*	3.11	952
79	07:32:01		133	124	13	*0.0369*	3.07	940
78	07:32:02		133	124	13	*0.0369*	3.03	924
77	07:32:03		133	125	14	*0.0369*	2.99	908
76	07:32:04		134	125	14	*0.0372*	2.96	892
75	07:32:05		135	125	14	*0.0375*	2.92	874
74	07:32:06		136	125	14	*0.0378*	2.88	858
73	07:32:07		136	125	14	*0.0378*	2.84	844
72	07:32:08		137	125	14	*0.0381*	2.81	824
71	07:32:09		137	125	14	*0.0381*	2.77	802
70	07:32:10		138	125	14	*0.0383*	2.73	776
69	07:32:11		138	125	14	*0.0383*	2.69	758
68	07:32:12		139	125	14	*0.0386*	2.65	752
67	07:32:13		140	125	14	*0.0389*	2.61	748
66	07:32:14		141	124	13	*0.0392*	2.57	732
65	07:32:15		141	124	13	*0.0392*	2.54	718
64	07:32:16		141	123	12	*0.0392*	2.50	692
63	07:32:17		141	123	12	*0.0392*	2.46	678
62	07:32:18		141	123	12	*0.0392*	2.42	670
61	07:32:19		140	122	11	*0.0389*	2.38	664
60	07:32:20		140	122	11	*0.0389*	2.34	662
59	07:32:21		139	122	11	*0.0386*	2.30	650
58	07:32:22	145	139	122	11	*0.0386*	2.26	646
57	07:32:23	143	138	123	12	*0.0383*	2.22	630
56	07:32:24	145	139	123	12	*0.0386*	2.19	618
55	07:32:25	147	139	125	14	*0.0386*	2.15	604
54	07:32:26	149	141	125	14	*0.0392*	2.11	588
53	07:32:27	149	143	125	14	*0.0397*	2.07	560
52	07:32:28	150	143	126	15	*0.0397*	2.03	530
51	07:32:29	150	143	125	14	*0.0397*	1.99	510
50	07:32:30	151	143	125	14	*0.0397*	1.95	500
49	07:32:31	149	142	125	14	*0.0394*	1.91	480
48	07:32:32	148	142	125	14	*0.0394*	1.87	460
47	07:32:33	146	139	125	14	*0.0386*	1.83	452
46	07:32:34	146	138	124	13	*0.0383*	1.79	450
45	07:32:35	146	137	124	13	*0.0381*	1.76	448
44	07:32:36	145	136	124	13	*0.0378*	1.72	444
43	07:32:37	142	135	124	13	*0.0375*	1.68	440
42	07:32:38	141	134	125	14	*0.0372*	1.64	436
41	07:32:39	142	134	125	14	*0.0372*	1.61	430
40	07:32:40	143	135	124	15	*0.0375*	1.57	434
39	07:32:41	141	136	123	16	*0.0378*	1.53	428
38	07:32:42	140	137	122	16	*0.0381*	1.49	430
37	07:32:43	146	138	120	14	*0.0383*	1.45	440
36	07:32:44	147	140	118	12	*0.0389*	1.42	436
35	07:32:45	150	141	118	12	*0.0392*	1.38	434
34	07:32:46	150	142	117	11	*0.0394*	1.34	418
33	07:32:47	150	143	117	11	*0.0397*	1.30	404
32	07:32:48	148	142	118	12	*0.0394*	1.26	398
31	07:32:49	144	142	118	12	*0.0394*	1.22	394
30	07:32:50	142	142	117	11	*0.0394*	1.18	384
29	07:32:51	139	142	117	11	*0.0394*	1.14	380
28	07:32:52	138	142	117	11	*0.0394*	1.10	364
27	07:32:53	139	142	118	12	*0.0394*	1.06	350
26	07:32:54	144	143	118	12	*0.0397*	1.02	332
25	07:32:55	150	144	119	13	*0.0400*	0.98	314
24	07:32:56	151	145	119	13	*0.0403*	0.94	296
23	07:32:57	150	144	118	12	*0.0400*	0.90	272
22	07:32:58	149	143	119	13	*0.0397*	0.86	254
21	07:32:59	146	142	118	12	*0.0394*	0.82	236
20	07:33:00	145	140	118	12	*0.0389*	0.78	230
19	07:33:01	141	139	119	13	*0.0386*	0.74	215
18	07:33:02	140	138	119	13	*0.0383*	0.71	199
17	07:33:03	139	138	119	13	*0.0383*	0.67	180
16	07:33:04	141	138	119	13	*0.0383*	0.63	165
15	07:33:05	144	138	120	14	*0.0383*	0.59	158
14	07:33:06	145	139	122	16	*0.0386*	0.55	151
13	07:33:07	145	140	123	17	*0.0389*	0.51	149
12	07:33:08	145	141	124	18	*0.0392*	0.47	145
11	07:33:09	145	142	123	17	*0.0394*	0.43	142
10	07:33:10	146	143	121	15	*0.0397*	0.39	129
9	07:33:11	144	143	118	12	*0.0397*	0.35	116
8	07:33:12	142	143	117	11	*0.0397*	0.32	105
7	07:33:13	141	143	115	9	*0.0397*	0.28	94
6	07:33:14	141	142	113	7	*0.0394*	0.24	83
5	07:33:15	139	141	112	6	*0.0392*	0.20	70.8
4	07:33:16	137	141	113	7	*0.0392*	0.16	58.6
3	07:33:17	134	141	114	8	*0.0392*	0.12	47.3
2	07:33:18	128	141	114	8	*0.0392*	0.08	33.2
1	07:33:19	125	142	115	9	*0.0394*	0.04	17.0
0	07:33:20	127	143	116	10	*0.0397*	0.00	1.2
		Zone of Horizontal Windshear						Vertical Windshear

Effective 27/5/2013

Data seems not accurate, not in agreement with the DFDR data in the Portuguese accident report

To calculate distance, you need ground speed (calculated using airspeed and wind data). How did you calculate this distance?

This is not the crab angle. Calculated seems the angle between the aircraft magnetic heading and the approach radial/ runway heading. The data in this column would be valid only if the aircraft would accurately follow the approach radial (ground track). This was definitely not the case as the ground radar plot in the Portuguese accident investigation report and the DFDR heading data prove. Useless and fabricated data.

Where can these data be found and verified? Not in the Portuguese accident report!

At 1 nm, no heading change of 5°! Hence, aircraft was not on prescribed approach path.

Where are these data from? Not DFDR. The AIDS (if applicable) recorded only up to 3 sec. before touchdown.

Vertical windshear so close to the ground? The vertical acceleration data of the DFDR do not show any increasing downward vertical (normal) acceleration beyond that for the light turbulence (i.a.w. the ICAO definition) during the last 4 seconds.

Refer to previous page for comments on the data.

Why N2. Want to hide that the PF closed the throttles?

Data not accurate

Roll or aileron? Inaccurate data. Where is this data from?

dh/dt. How calculated? Not reliable.

Bank angle increased to left over 8 sec, because of left rudder and no appropriate roll control.

but no accompanying aileron to the right. So it was no line-up. Table I shows no heading cange.

windshear? Only 2 kt decrease!

hardly

rudder released

TABLE II - Last 20 seconds of flight for DC10-30CF, PH-MBN - Final Approach into and Crash at Faro, Portugal (AIDS / DFDR data)

Seconds to Impact (secs)	ATC Clock Time (h:mm:ss)	C.A.S. Air Speed (knots)	Area Nav Ground Speed (knots)	Magnetic Heading (°M)	Engine 2 N2 (%)	Rudder (Left -ve) (Right +ve) (degrees)	Roll (LWD -ve) (RWD +ve) (degrees)	Elevator (Ndwn -ve) (Nup +ve) (degrees)	Radio Altitude (feet)	Rate of Descent (ft/sec)	Comments
20	07:33:00	145	140	118	87.1	-2.0	+2.0 RWD	+1.0	230	15	~~No wind shift update by Controller~~
19	07:33:01	141	139	119	88.6	-3.0	+2.4 RWD	+1.0	215	16	
18	07:33:02	140	138	119	91.8	+2.2	+0.6 RWD	+2.0	199	19	
17	07:33:03	139	138	119	94.9	+1.0	+2.4 RWD	+5.0	180	15	
16	07:33:04	141	138	119	96.4	+3.1	+5.2 RWD	+5.0	165	7	
15	07:33:05	144	138	120	101.3	+1.6	+6.9 RWD	+3.0	158	7	*"A bit low ..."* (PAPI)
14	07:33:06	145	139	122	101.8	+0.3	+7.4 RWD	-2.1	151	2	Power comes up
13	07:33:07	145	140	123	100.6	-7.3	+10.8 RWD	-1.5	149	4	Left Rudder input for Runway line-up
12	07:33:08	145	141	124	99.1	-13.0	+8.4 RWD	+1.8	145	3	
11	07:33:09	145	142	123	97.8	-19.0	+1.4 RWD	-2.4	142	13	
10	07:33:10	146	143	121	95.2	-15.6	-0.4 level	-6.7	*129*	13	*"Wind is ... 190 with 20"* (INS)
9	07:33:11	144	143	118	91.6	-10.0	-0.4 level	-2.0	116	11	Airspeed decreasing (horizontal windshear)
8	07:33:12	142	143	117	86.2	-22.5	-1.8 LWD	-0.6	105	11	
7	07:33:13	141	143	115	82.5	-22.5	-6.7 LWD	+5.8	94	11	~~Sudden~~ LWD, increasing to 15° of bank
6	07:33:14	141	142	113	80.3	-6.0	-14.4 LWD	+1.1	83	12.2	Pilot countering LWD
5	07:33:15	139	141	112	80.0	-5.5	-10.2 LWD	+1.1	70.8	12.2	Aircraft rolling back right
4	07:33:16	137	141	113	79.7	-13.3	-0.4 level	+0.9	58.6	11.3	Wings level, aircraft prepared for flare; ~~entering microburst vortex~~
3	07:33:17	134	141	114	79.4	-9.1	+3.2 RWD	+3.1	47.3	14.1	~~Sudden vertical windshear~~
2	07:33:18	128	141	114		-1.2	+1.8 RWD	+8.1	33.2	16.2	~~Acceleration down~~ / *"Throttles!"*
1	07:33:19	125	142	115		-4.4	+0.4 level	+18.6	17.0	15.8	Aircraft pitching up rapidly
0	07:33:20	127	143	116		-10.5	+5.6 RWD	+20.4	1.2		Impact at 07:33:20.5
Effective 27/5/2013											Yellow indicates area of Vertical Windshear

117 kt (NTSB)

AIDS data was not recorded during the last seconds of flight. Where is this data from? Where is all of this ground speed data from? Not valid.

Again, this close to the ground? Was there a big hole?

Are you sure the data are accurate to 4 decimals? The requirements in ICAO Annex 6 - Operation of Aircraft, Part I Table D-1 are ± 1% of max. range (-3 to +6g), excl. datum error of ± 5%.

Why N2 used?
Want to hide something? N1 shows engine thrust, not N2.

TABLE III - Last 6 seconds of flight for DC10-30CF, PH-MBN - Final Descent and Crash at Faro, Portugal (AIDS data)

Seconds to Impact (secs)	ATC Clock Time (UTC) (h:mm:ss)	Aircraft Vertical "G" Readings at 1/8th second intervals (>1G / <1G) 0.125 sec	0.25 sec	0.375 sec	0.5 sec	0.625 sec	0.75 sec	0.875 sec	1.00 sec	Radio Altimeter Altitude (feet)	Rate of Descent (ft/sec)	Elevator (Ndwn -ve) (Nup +ve) (degrees)	Engine 2 N2 (%)
5.5	07:33:15	1.0488	1.0625	1.0831	1.0717	1.0373	1.0556	1.0419	1.0282	70.8	12.2	+1.1	80.0
4.5	07:33:16	1.0465	1.0167	1.0076	1.0007	0.9938	1.0282	1.0213	0.9938	58.6	11.3	+0.9	79.7
3.5	07:33:17	0.9778	0.9755	0.9411	0.9160	0.8793	0.8790	0.8908	0.8954	47.3	14.1	+3.1	79.4 (Start of "kettle tone")
2.5	07:33:18	0.8954	0.8954	0.8976	0.8931	0.8931	0.9205	0.9228	0.9343	33.2	16.2	+8.1	"Throttles"
1.5	07:33:19	0.9457	0.9549	0.9801	0.9961	1.0144	1.0259	1.0305	1.0831	17.0	15.8	+18.6	
0.5	07:33:20	1.0923	1.1083	1.2343	1.9533			1.5320	1.3076	1.2		+20.4	
Effective 27/5/2013				Runway Impact at 07:33:20.5						Yellow indicates area of Vertical Windshear			

Notice that the vert, g never decreases below 0,87 g. The ICAO lower limit for light turbulence is 0,5 g.

Rate of descent increase due to decreasing airspeed and increasing pitch angle should have been included.

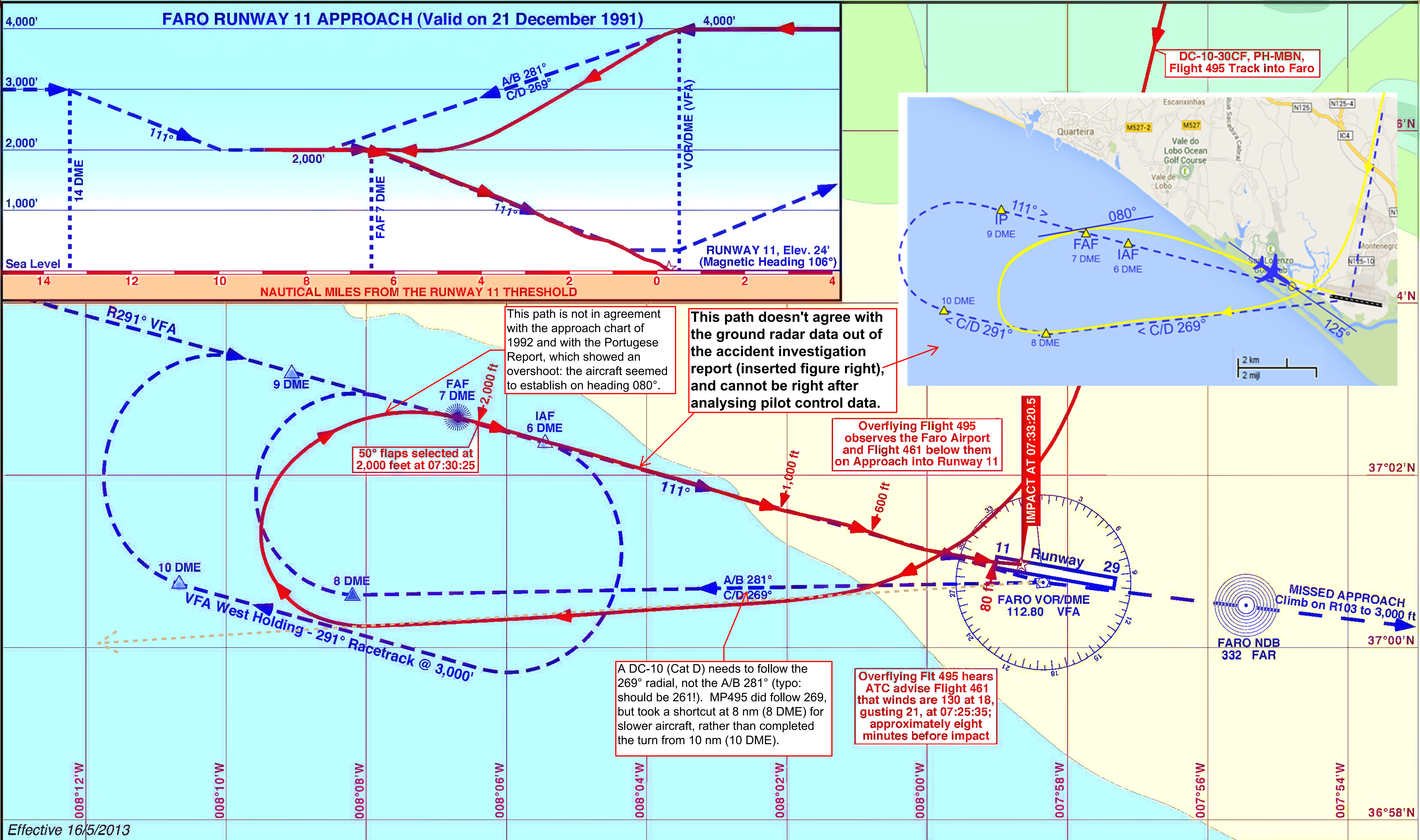


FIGURE 1 - DC-10-30CF PH-MBN Accident at Faro, Portugal - showing the AIDS / Radar-based Inbound Track through FAF and Approach to Runway 11

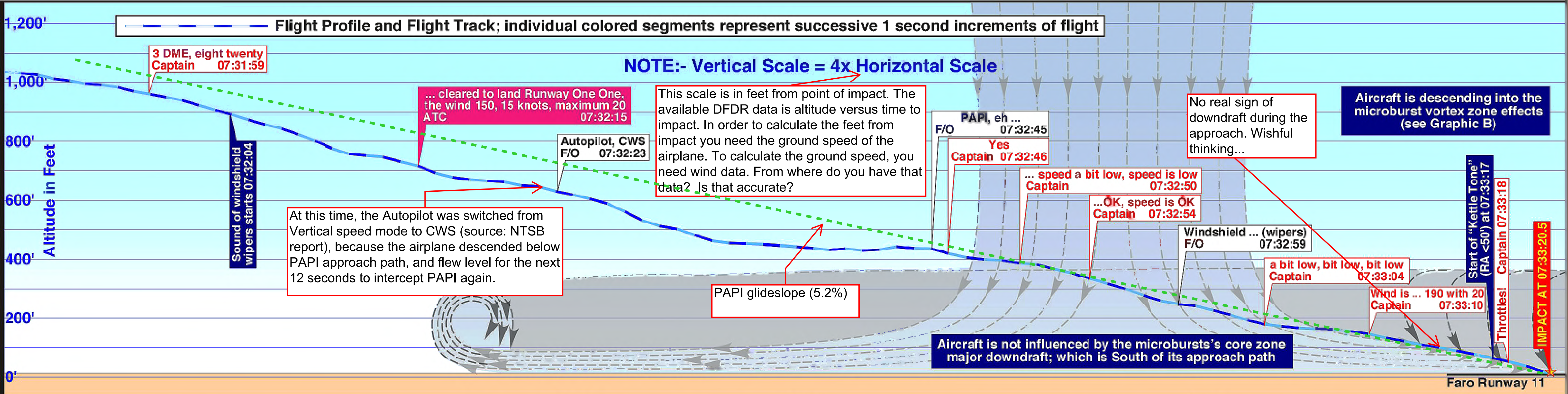


FIGURE 2A - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic of the Flight Profile for the Final 90 seconds of Flight viewed from the Microburst Core

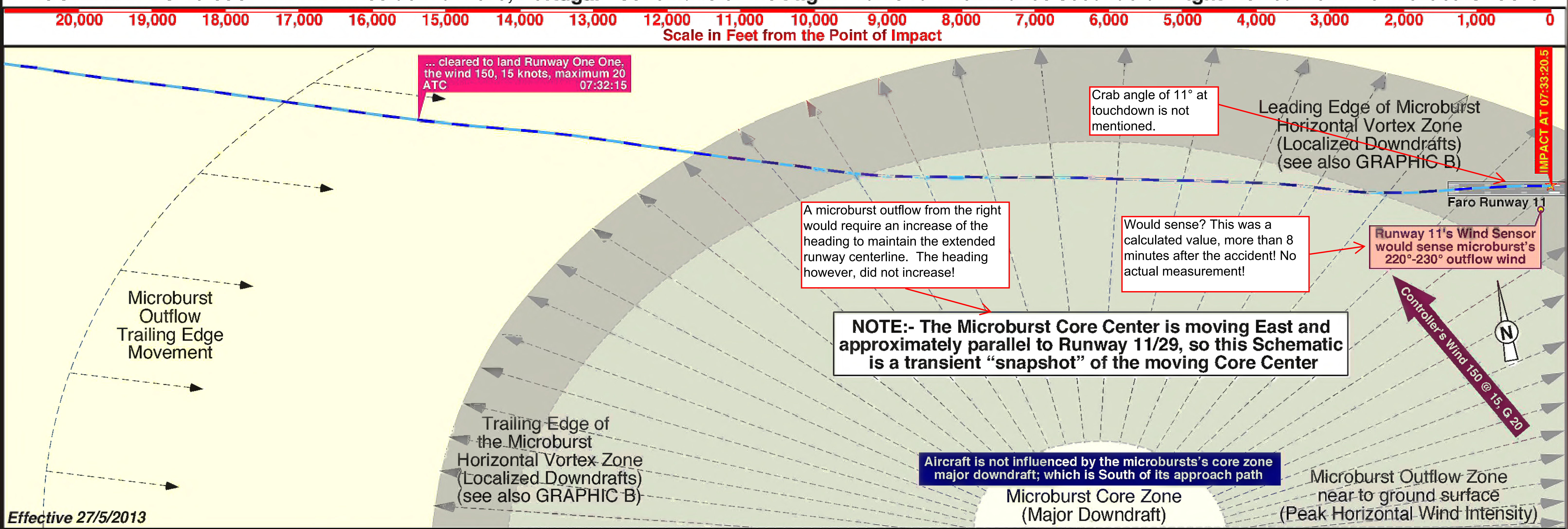


FIGURE 2B - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic showing the Microburst Interaction with the Flight Track during the Final 90 seconds of Flight

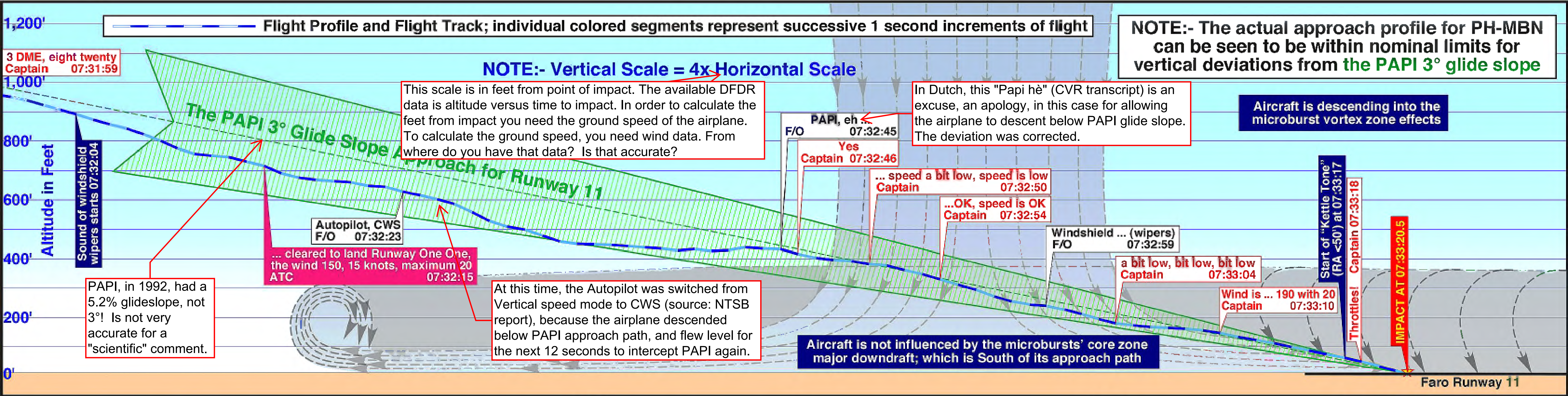


FIGURE 3A - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic showing PH-MBN's actual inbound flight profile relative to the 3° approach glide slope

18,000 17,000 16,000 15,000 14,000 13,000 12,000 11,000 10,000 9,000 8,000 7,000 6,000 5,000 4,000 3,000 2,000 1,000 0

Scale in Feet from the Point of Impact

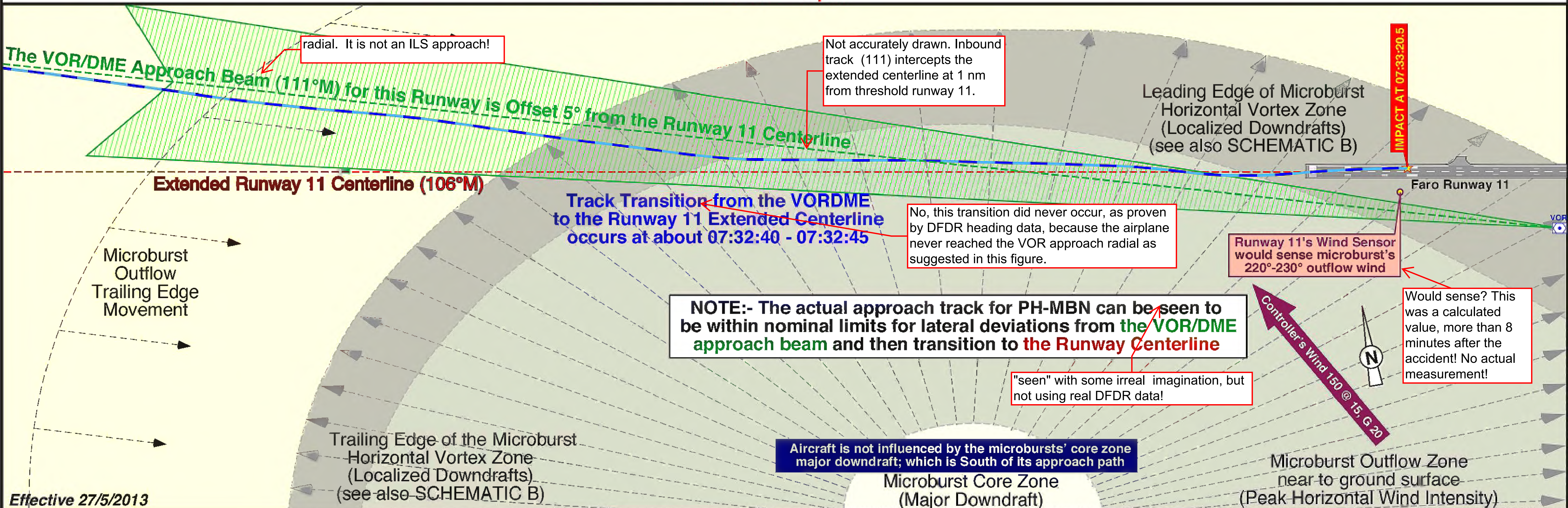


FIGURE 3B - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic showing PH-MBN's actual inbound track relative to the VOR/DME approach

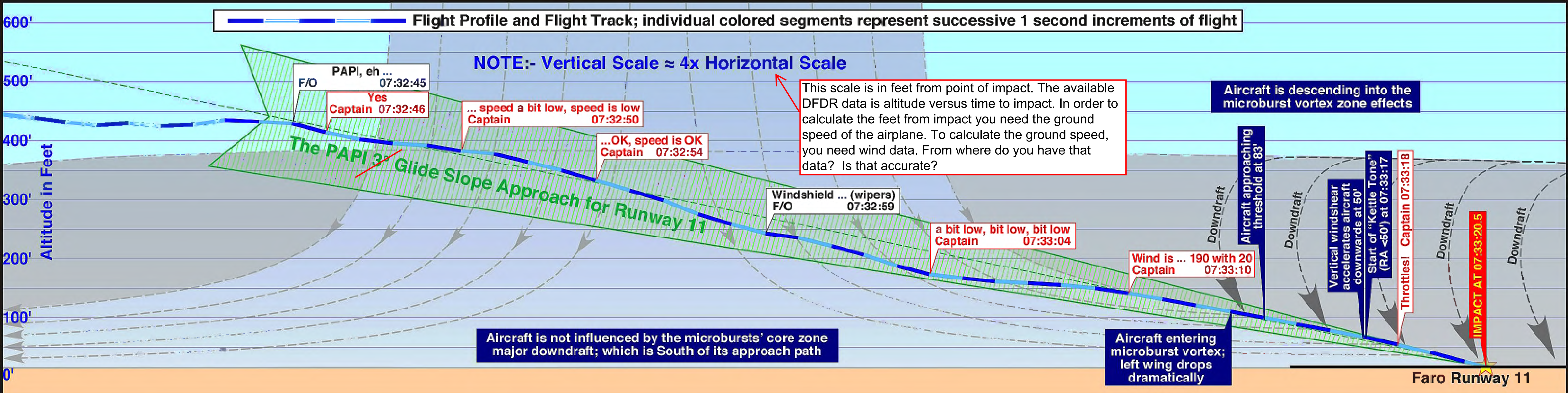


FIGURE 4A - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic of the Flight Profile for the Final 45 seconds of Flight viewed from the Microburst Core

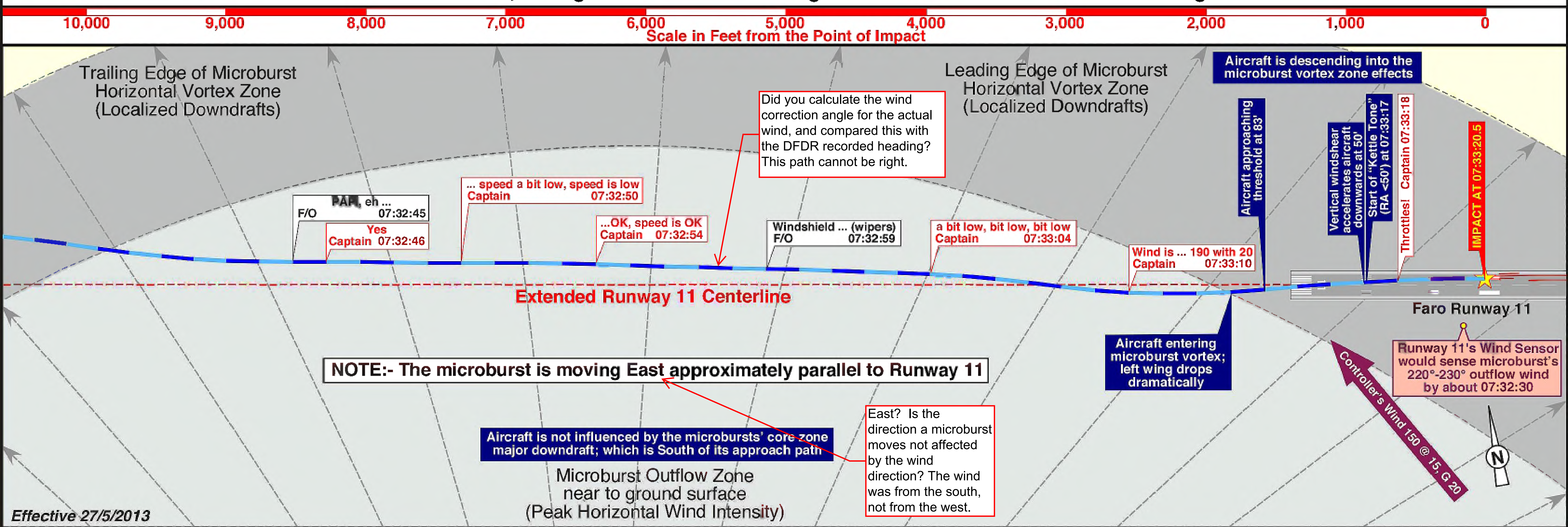


FIGURE 4B - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic showing the Microburst Interaction with the Flight Track for the Final 45 seconds of Flight

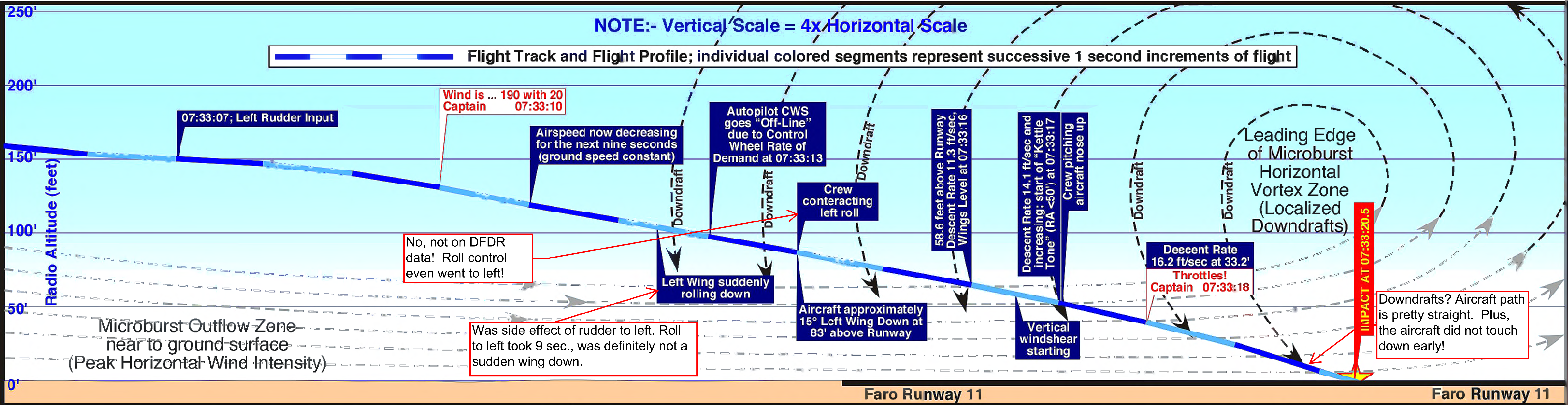


FIGURE 5A - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic showing Microburst Leading Edge Vortex Interaction with the Flight Profile - Final 15 Seconds

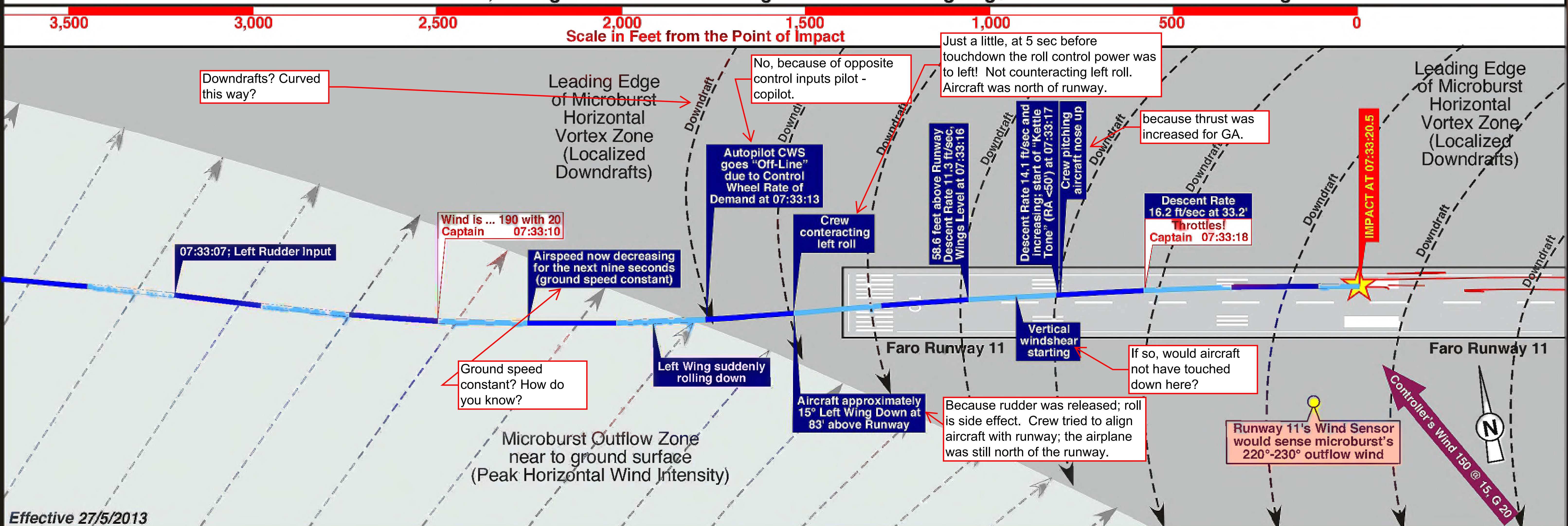


FIGURE 5B - DC-10-30CF PH-MBN Accident at Faro, Portugal - Schematic showing Microburst Leading Edge Vortex Interaction with the Flight Track - Final 15 Seconds

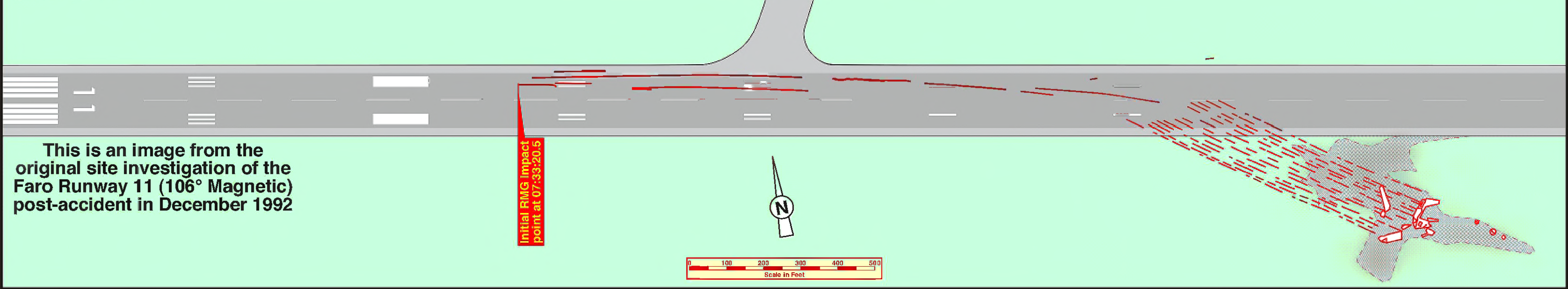


FIGURE 6A - DC-10-30CF PH-BMN Accident at Faro, Portugal - showing recorded Ground Scarring and Wreckage Scatter/Distribution on Runway 11 / 29

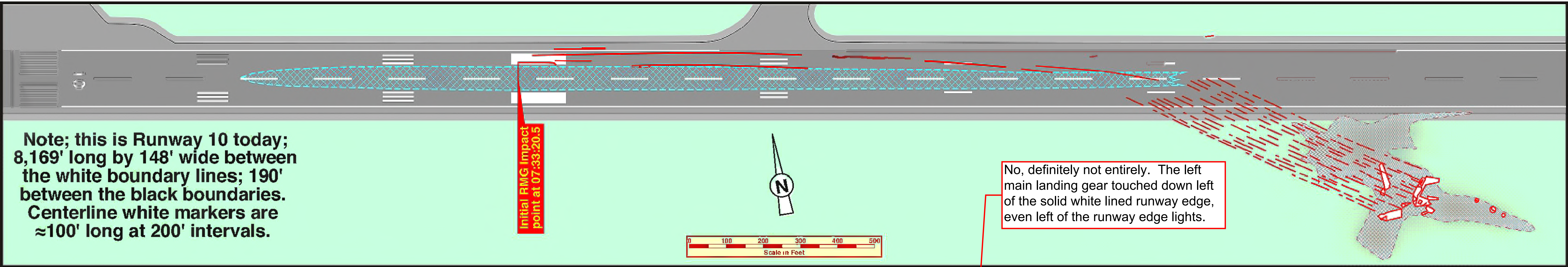


FIGURE 6B - This is Runway 10 / 28 in 2013 (see the Google image FIGURE 7). This shows the rubber-wheel-skid-defined most common real landing zone as identified in FIGURE 7. Further note that in the December 1992 accident PH-BMN landed entirely on the runway and within the typical landing zone

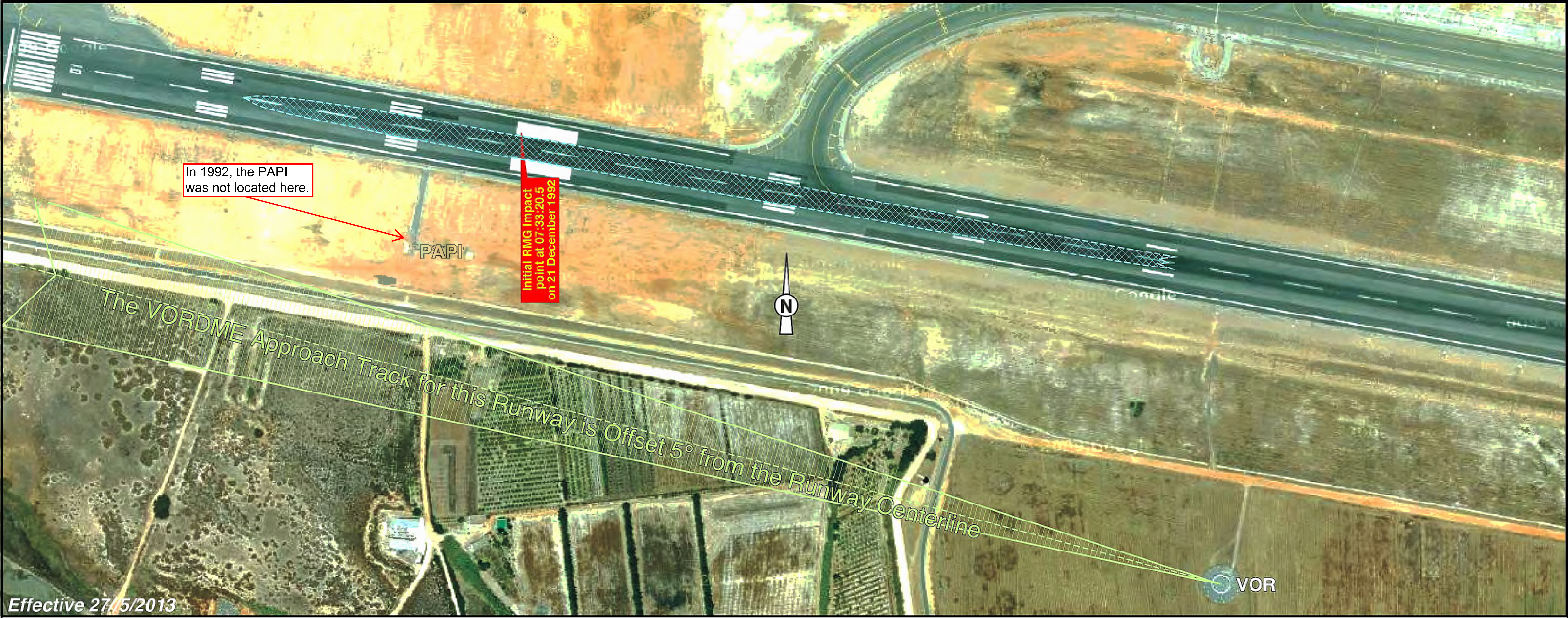


FIGURE 7 - DC-10-30CF PH-BMN Faro Accident - A current 2013 Google image of the approach end of Runway 10 / 28 at Faro Airport, including the locations of the VOR and the PAPI. This schematically shows the rubber-wheel-skid-defined most common real landing zone on the Runway, and PH-BMN's initial RMG impact location during the December 1992 accident, as also identified in FIGUREs 6A & 6B

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12. Data Tables, Schematics and Demonstrative Figures

1. The attached TABLE I documents the last 90 seconds of flight for PH-MBN through to runway impact. TABLE I lists the ATC clock time in hours/minutes/seconds; CAS and Ground Speed in knots, Magnetic Heading and Crab Angle, distance to impact in nautical miles, and Pressure or Radio Altitude; and includes the delineated Zone of Horizontal Windshear encoutered by PH-MBN over the final 20 seconds of approach to impact, and also includes the delineated Zone of Vertical Windshear encoutered by PH-MBN over the final 5-6 seconds prior to impact

2. The attached TABLE II documents the last 20 seconds of flight for PH-MBN through to runway impact. TABLE II lists the ATC clock time in hours/minutes/seconds; CAS and Ground Speed in knots, Magnetic Heading, Engine #2 N2 (%), Rudder, Roll and Elevator position, Radio Altitude (feet) and Rate of Descent in ft/sec.; and includes a delineated Zone of Vertical Windshear encoutered by PH-MBN over the final 5 seconds prior to impact

3. The attached TABLE III documents the last 5 seconds of flight for PH-MBN through to runway impact. TABLE III lists the ATC clock time in hours/minutes/seconds, together with Aircaft Vertical “G” readings at successive 1/8th second intervals; plus Radio Altitude (feet) and Rate of Descent in ft/sec.; Elevator Position and Engine #2 N2 (%)

4. Note that the tabular data presented in TABLEs I, II & III are essentially derived from detailed analysis of the integrated DFDR, AIDs and CVR data and the pre-existing radar positional/time data
5. The attached SCHEMATIC A is a demonstrative Google image overlaid by a schematic of the local 21 December 1992 microburst involved in this accident (courtesy of GOOGLE / McCarthy). It is important to remember that the microburst is moving laterally (as shown by the arrow indicative of its moving more or less East and parallel to Runway 11/29); and thus the image is in essence a “snapshot” in time of this moving phenomenon. Note also that the microburst is NOT centered over the Runway, and so PH-MBN (on its approach to its Runway 11 touchdown) flew through <u>the peripheral horizontal vortex</u> of the microburst (this phenomenon is illustrated in the attached SCHEMATIC B) rather than its core zone’s major downdraft; meaning that PH-MBN was thus exposed to varying significant (and unexpected) transient horizontal and vertical winds in the last few seconds prior to runway impact. SCHEMATICS C and D are Sketches courtesy of NASA further illustrating the Microburst and Windshear phenomenon
6. The attached demonstrative FIGURE 1 illustrates PH-MBN (Flt. 495)’s nominal inbound approach to passing over the Faro Airport, then turning West, and then looping back to intercept the Faro VOR / DME approach to Runway 11 at the FAF 7DME fix, and then descending towards the planned Runway 11 landing
7. The attached demonstrative FIGURE 2A/2B introduces the 21 December 1992 microburst (as schematically illustrated in SCHEMATICs A & B) to illustrate its interaction with the PH-MBN descending approach flight track and profile into its planned Runway 11 landing at Faro during the last 90 seconds of flight

pre-impact. Note that the aircraft is not influenced by the microburst's core zone major downdraft, which is South of its approach path; and also that the microburst itself is moving approximately East (roughly parallel to Runway 11/29), and so FIGURE 2A/2B represents "transient snapshots" of the moving core center. Note also that the profile view is looking "through the core" towards the approach path, which is well to the North of the microburst's core center.

8. The attached demonstrative FIGURE 3A/3B illustrates a similar profile and track of the PH-MBN approach to Runway 11 as seen in FIGURE 2A/2B, but introduces the PAPI 3° Glide Slope Approach for the PH-MBN flight profile; and the VOR / DME (111°M) Approach beam and the transition from it to line up with the Runway Centerline approximately 6,000 feet from the Runway 11 threshold for the PH-MBN flight track (note that the VOR Centerline is offset 5° from the Runway 11 Centerline for this particular runway's approach)

9. The attached demonstrative FIGURE 4A/4B is similar to FIGURE 3A/3B, but focusses on the final 45 seconds of flight prior to impact on Runway 11; showing the PH-MBN flight profile compared to the PAPI 3° glideslope, and the PH-MBN flight track compared to the Runway 11 Extended Centerline

10. The attached demonstrative FIGURE 5A/5B is similar to FIGURE 4A/4B but focusses on the final 20 seconds of flight prior to impact on Runway 11, and adds narrative comments on transient aircraft conditions occurring during this period of time

11. The attached demonstrative FIGURE 6A/6B first illustrates (in FIGURE 6A) the recorded Ground Scarring and final Wreckage Scatter / Distribution derived from the original site investigation, and illustrates PH-MBN's initial Runway 11's impact was via the right-hand main landing gear, and was near to the left

edge of the runway proper's hard surface (but definitely not the soft shoulder); with PH-MBN crabbed significantly to the right, rolled significantly right wing down, and at a high enough transient descent rate for these combined factors to cause structural failure of the gear. The associated FIGURE 6B shows the same data, plus the rubber-wheel-skid-defined most common real touchdown zone for aircraft in 2013, as defined in FIGURE 7's GOOGLE image of the (now Runway 10) end of the FARO Airport's main runway. FIGURE 6B thereby illustrates the PH-MBN touchdown on 21 December 1992 was longitudinally well within the typical aircraft touchdown location zone along Runway 11, and was also within the lateral constraints of the hard-surfaced runway

Accident Investigation & Research Inc.

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• Accident Investigation and Research
• Applied Informatics and Research
• Failure Analysis Investigation and Research

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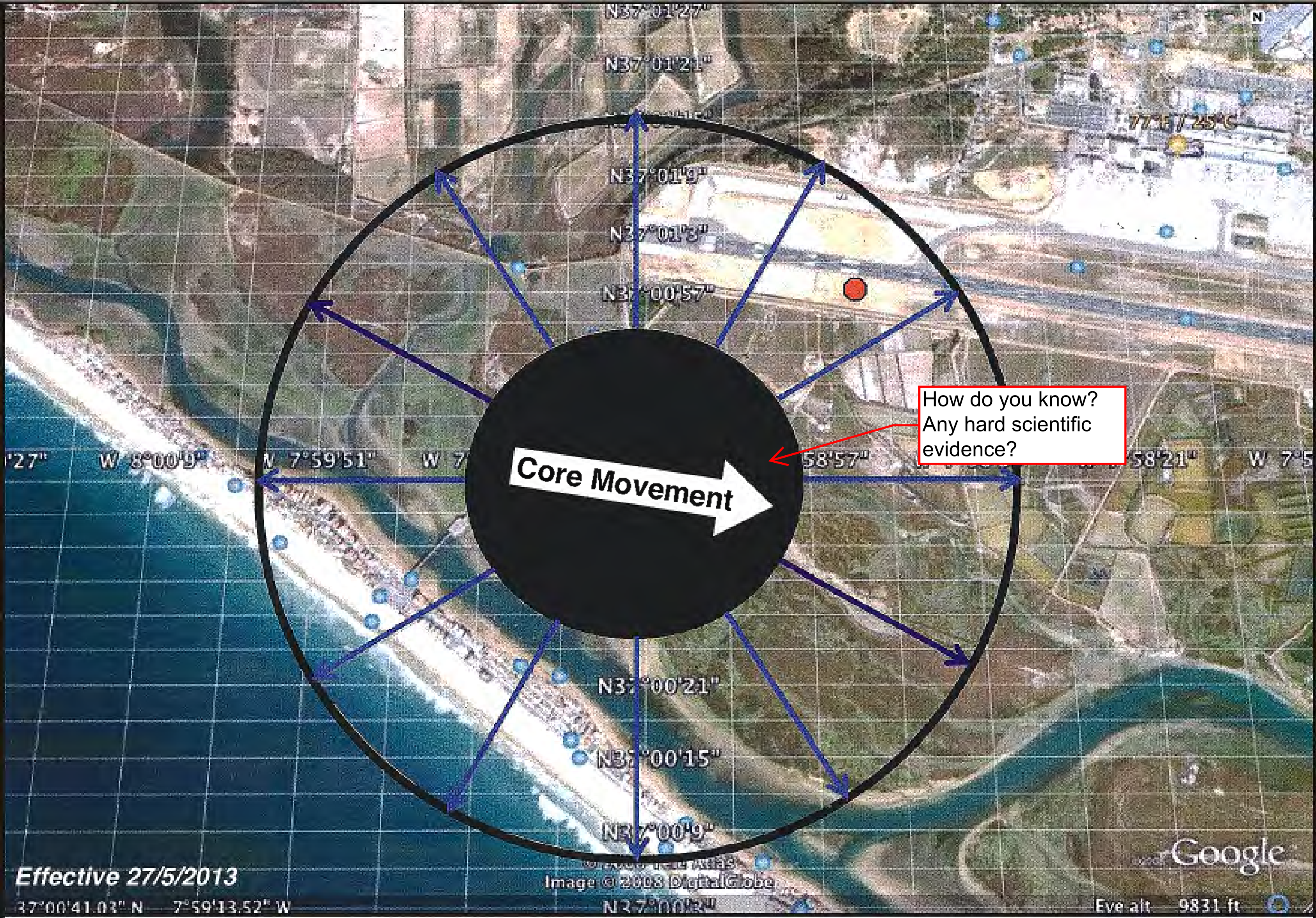
A.I.R. LIST OF THE REPORT'S DEMONSTRATIVE

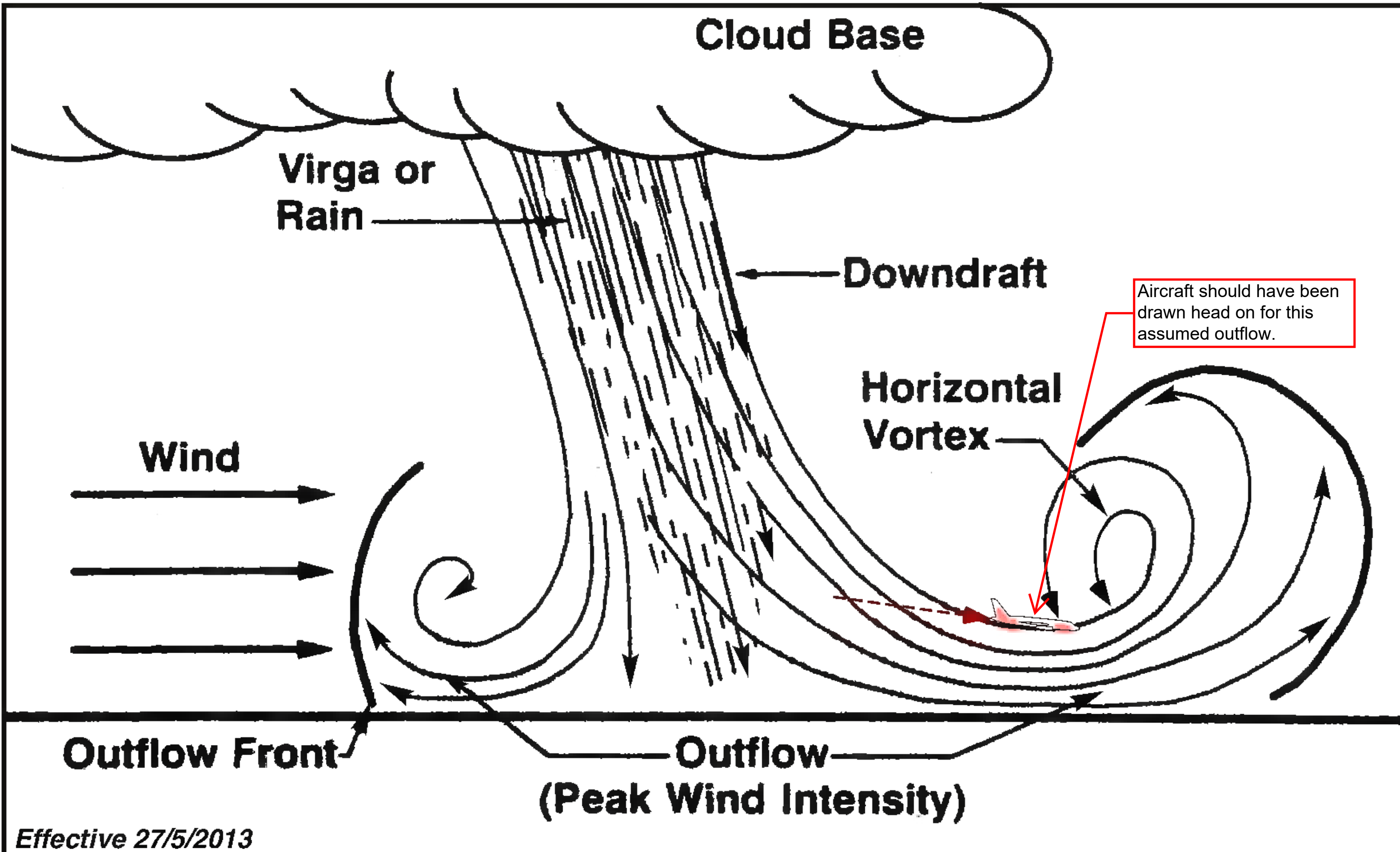
DATA SPREADSHEETS / SCHEMATICS AND FIGURES:-

DC-10, PH-MBN, 21 DECEMBER 1992

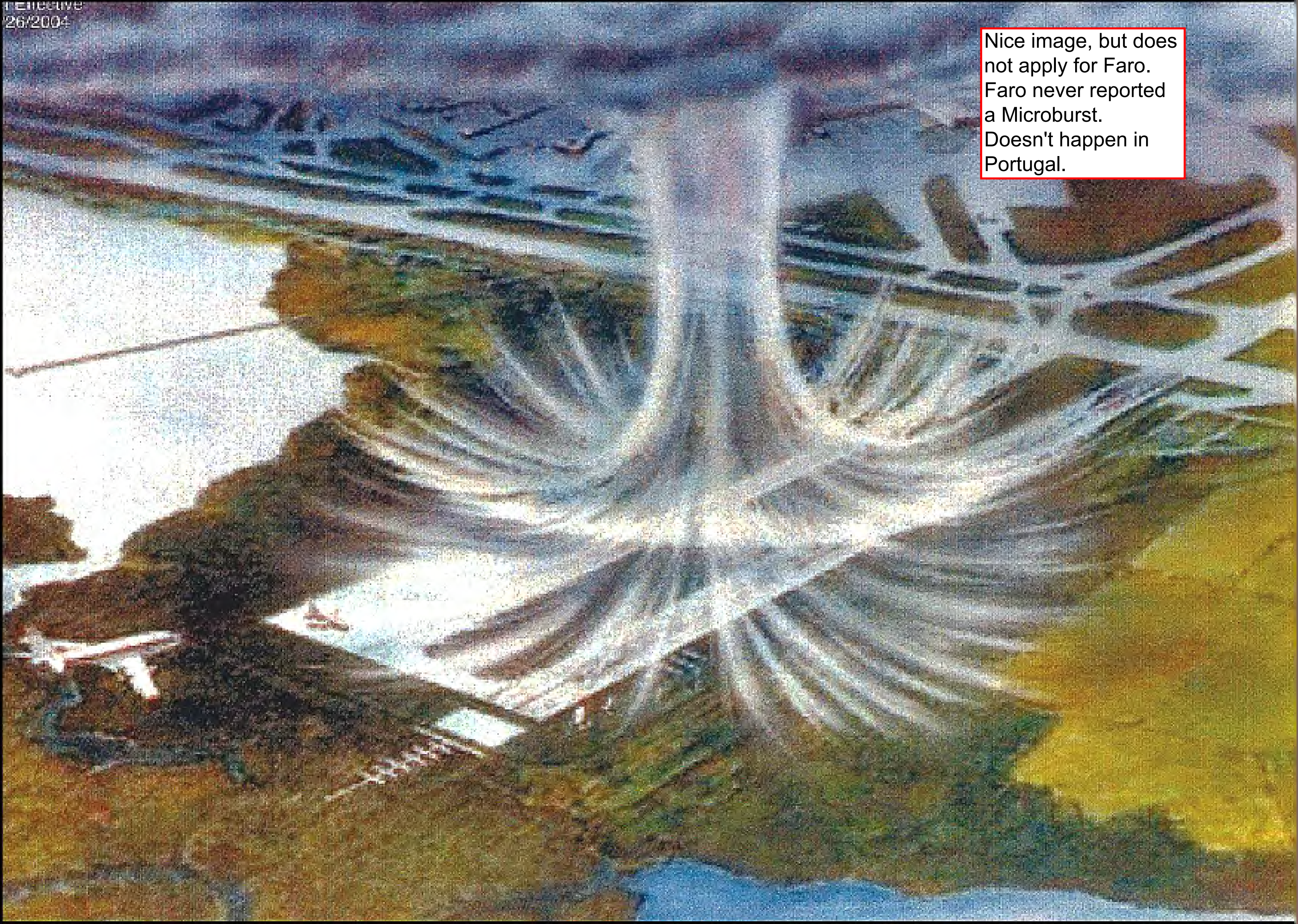
1. TABLE I - Last 90 seconds of flight data for PH-MBN
2. TABLE II - Last 20 seconds of flight data for PH-MBN
3. TABLE III - Last 6 seconds of flight data for PH-MBN
4. SCHEMATIC A - Schematic of the Microburst in the vicinity of Faro Runway 11
5. SCHEMATIC B - Demonstrative Schematic of a Microburst's Peripheral Vortex
6. SCHEMATIC C – NASA Illustration of a Microburst located over a Runway
7. SCHEMATIC D – NASA Illustration of a Microburst and Windshear Phenomenon
8. FIGURE 1 - PH-MBN's Inbound Track & Approach to Runway 11 / 29
9. FIGURE 2A/2B - Microburst's interaction with last 90 seconds of flight
10. FIGURE 3A/3B – Inbound Profile/Track c/w VOR/DME track and Glide Slope
11. FIGURE 4A/4B - Microburst's interaction with final 45 seconds of flight
12. FIGURE 5A/5B - Microburst LE Vortex interaction with final 15 seconds of flight
13. FIGURE 6A/6B - Ground Scarring and Wreckage Scatter Distribution on R11
14. FIGURE 7 - Current Google image of Runway 10/28, plus VOR/DME & PAPI



SCHEMATIC A - Schematic of the moving microburst in the vicinity of Runway 11 on 21 December 1992 - [Image courtesy of GOOGLE / McCarthy] - **(see also FIGURES 2, 3 & 4)**

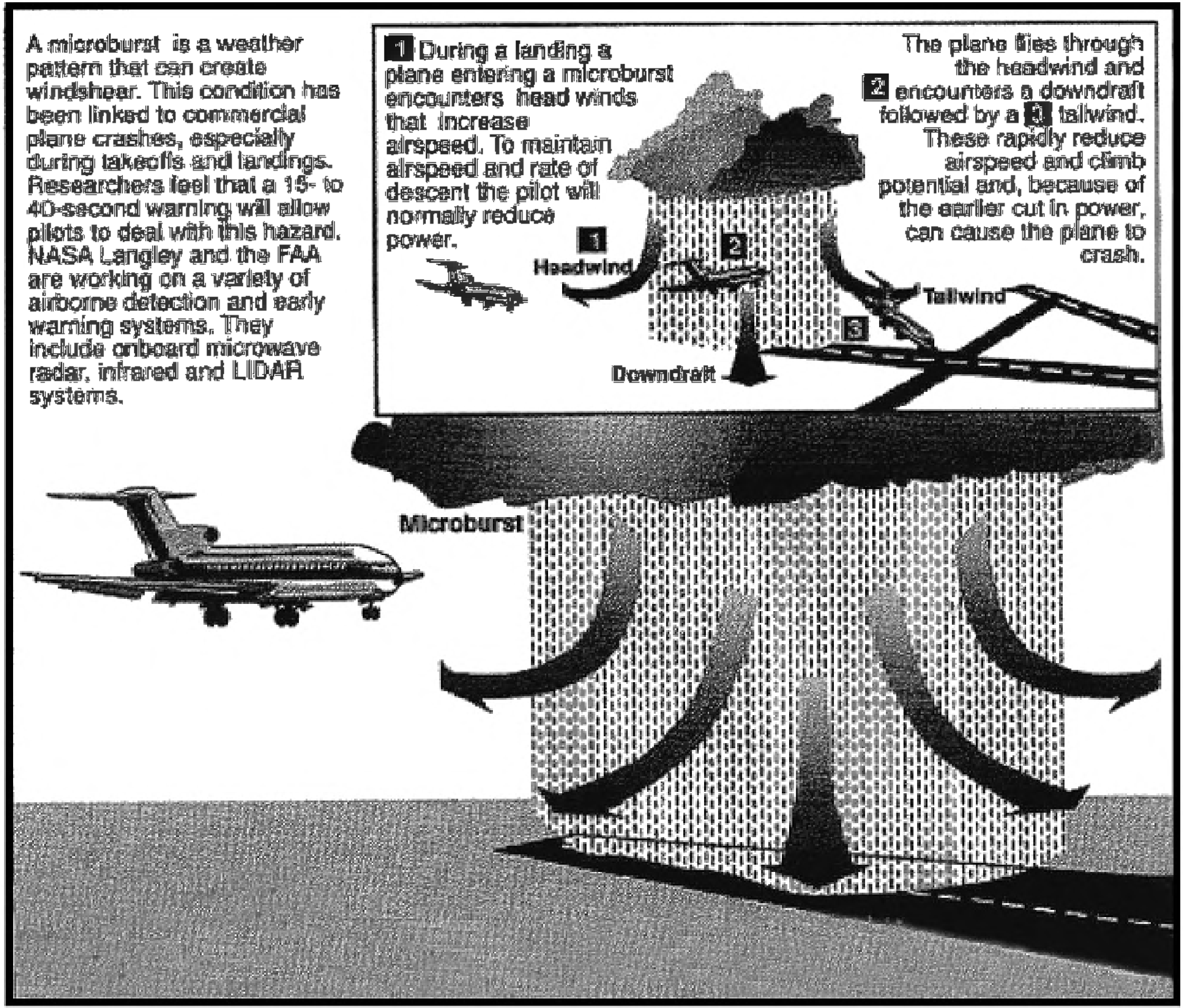


SCHEMATIC B - Demonstrative Schematic showing a DC-10 entering the peripheral Horizontal Vortex of a Microburst - [Sketch courtesy of John McCarthy]



SCHEMATIC C - Illustrative Sketch of a Microburst located over a runway ahead of an aircraft approaching the runway (Sketch courtesy of NASA)

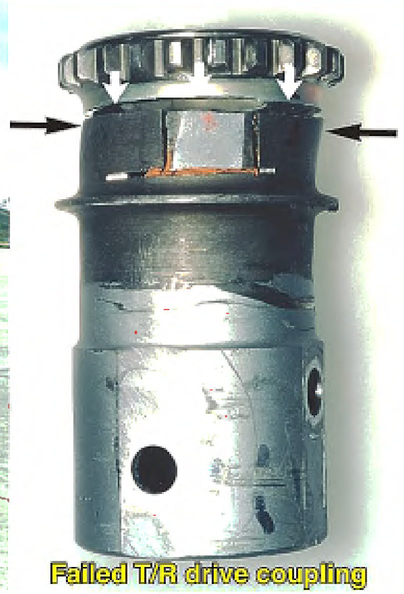
Microburst and Windshear Phenomenon



SCHEMATIC D - (Sketch courtesy of NASA)

AIR: Accident Investigation and Research Inc.

In-flight failure of tail rotor drive shaft coupling



Failed T/R drive coupling

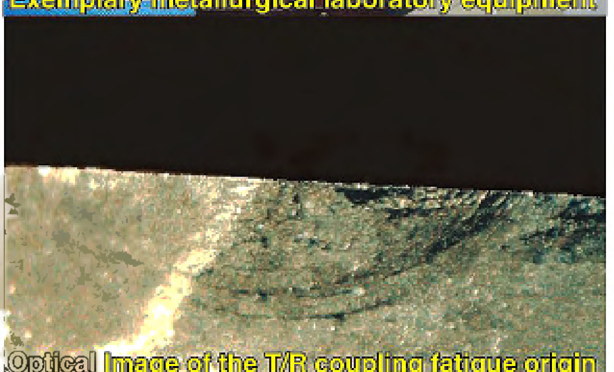
What Services does AIR Offer?

▼As noted in the Introduction, AIR offers world class integrated, multi-disciplinary accident investigation and failure analysis services as a single-source resource, enabling clients to avoid the complications of retaining a multitude of separate specialist experts. AIR's major strength is the vast collective experience of its principals and support staff; and this is backed by its in-house laboratory and computer based services, which will be described herein.

▼Typically AIR's services are not retained until long after an accident has occurred, but AIR is capable of field investigations at the active site of accidents if so requested. Usually field documentation and critical components, FDR/CVR tapes and the like are forwarded to AIR's facilities for detailed integrated analysis; causation diagnosis; and development of reports and resource materials for delivery of expert testimony as required for trial, settlement and/or safety action.

Takeoff and roll-in (reversed control cables)

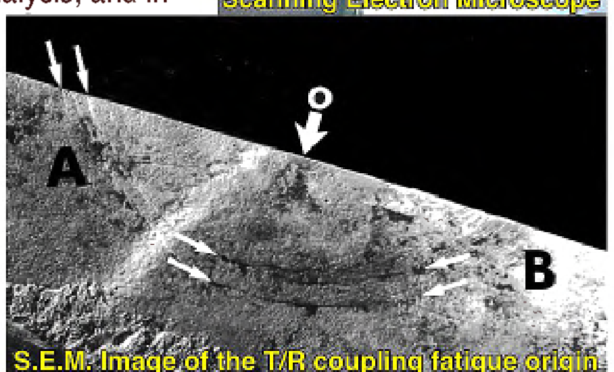
Exemplary metallurgical laboratory equipment



Optical Image of the T/R coupling fatigue origin

▼Suspect critical components would then be documented in AIR's photo facilities and subjected to material failure analysis in our metallurgical laboratory, which includes optical macro- and micro-photography labs, metallurgical analysis capabilities, scanning electron microscopy and X-ray spectrometric analysis; and in-house capabilities for preparation of detailed technical reports and/or trial /deposition exhibits (including static graphics or dynamic simulations).

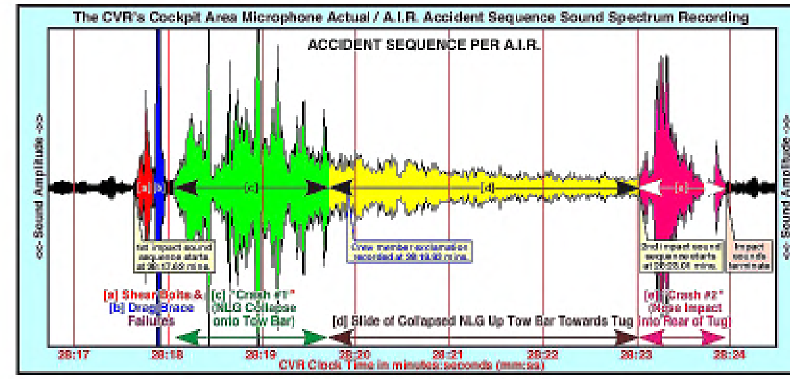
Scanning Electron Microscope

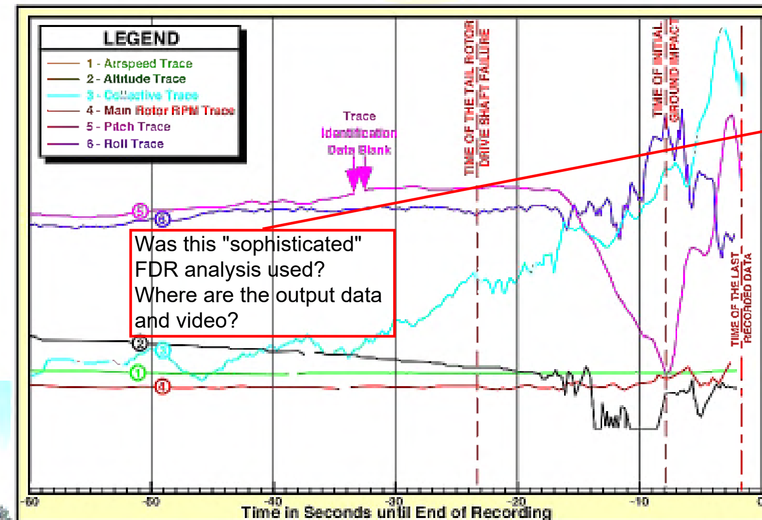


S.E.M. Image of the T/R coupling fatigue origin

What Services does AIR Offer? (continued)

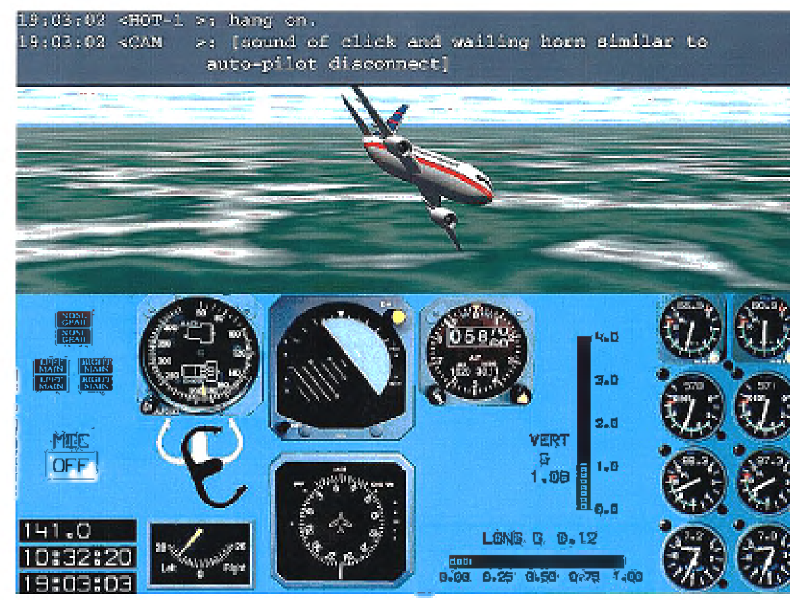
▼When AIR is retained to investigate a complex air (carrier) accident, AIR can bring its sophisticated CVR analysis resources to bear upon the accident. The image to the right illustrates a filtered sound spectrum stripped from the CVR recording of a ground tug/airliner collision; in which specific sound peaks were directly and uniquely ascribable to the accident sequence of failures and impacts, thereby establishing the accident's causation and liability.





▼Similarly, AIR can also bring its sophisticated FDR analysis resources to bear upon the accident for any source (foil, optical, tape or solid state) recording media. The image to the left is derived from the UN helicopter accident shown as the lead image in this handout; enabling AIR to integrate the time sequence of initial tail rotor drive shaft rupture (fortunately at low altitude), consequent loss of directional control capability and subsequent ground impact; thereby proving that the tail rotor drive rupture was the lead event in the accident, and not a secondary result of a ground impact due to pilot error induced control loss.

▼Finally, in the case of an extremely complex in-flight upset and subsequent crash of an airline aircraft, AIR employed its advanced capabilities to integrate CVR, FDR, ATC communications and radar data to create a sophisticated 4-D flight "animation" (from which the image at the right is an exemplar "frame") so as to provide a detailed visualization tool as part of the total accident reconstruction. By integrating this information with the parallel component material failure analyses of key suspect components, AIR was able to provide our client with expert opinions as to causation and liability. It should be noted that the sophisticated computer-based procedures and software involved in radar analysis and "animation" were developed by and under the guidance of AIR.



What Services does FAIR Offer?

▼FAIR is backed by the same laboratory technology and research resources offered by AIR (as described herein); and of course is supported by the same wide-ranging human expertise and experience provided by AIR's staff and principals. FAIR's investigatory services, however, will generally only require limited access to AIR's most sophisticated resources for its generally more simple problems, and hence is offered at more cost-effective rates.