ANSV AGENZIA NAZIONALE PER LA SICUREZZA DEL VOLO

FINAL REPORT

ACCIDENT
Boeing B767-300 registration marks N189DN,
Climbing after take-off from Malpensa International Airport,
24th of July 2023

OBJECTIVE OF THE SAFETY INVESTIGATION

The Agenzia nazionale per la sicurezza del volo (ANSV), instituted with legislative decree No 66 of 25 February 1999, is the Italian Civil Aviation Safety Investigation Authority (art. 4 of EU Regulation No 996/2010 of the European Parliament and of the Council of 20 October 2010). **It conducts, in an independent manner, safety investigations.**

Every accident or serious incident involving a civil aviation aircraft shall be subject of a safety investigation, by the combined limits foreseen by EU Regulation No 996/2010, paragraphs 1, 4 and 5 of art. 5.

The safety investigation is a process conducted by a safety investigation authority for the purpose of accident and incident prevention, which includes the gathering and an[omissis, name]sis of information, the drawing of conclusions, including the determination of cause(s) and/or contributing factors and, when appropriate, the making of safety recommendations.

The only objective of a safety investigation is the prevention of future accidents and incidents, without apportioning blame or liability (art. 1, paragraph 1, EU Regulation No 996/2010). Consequently, it is conducted in a separate and independent manner from investigations (such as those of Judicial Authority) finalized to apportion blame or liability.

Safety investigations are conducted in conformity with Annex 13 of the Convention on International Civil Aviation, also known as Chicago Convention (signed on 7 December 1944, approved and made executive in It[omissis, name] with legislative decree No 616 of 6 March 1948, ratified with law No 561 of 17 April 1956) and with EU Regulation No 996/2010.

Every safety investigation is concluded by a report written in a form appropriate to the type and seriousness of the accident or serious incident. The report shall contain, where appropriate, safety recommendations, which consist in a proposal made with the intention of preventing accident and incidents.

A safety recommendation shall in no case create a presumption of blame or liability for an accident, serious incident or incident (art. 17, paragraph 3, EU Regulation No 996/2010).

The report shall protect the anonymity of any individual involved in the accident or serious incident (art. 16, paragraph 2, EU Regulation No 996/2010).

This report has been translated and published by the ANSV for the English-speaking concerned public. The intent was not to produce a factual translation and as accurate as the translation may be, **the original text in Italian is the work of reference**.

GLOSSARY

AMC: Acceptable Means of Compliance.
AMEL: Airplane Multiengine Landing rating.
ANSV: Agenzia nazionale per la sicurezza del volo, Italian Safety Investigation Authority.
ARO: ATS Reporting Office.
ASEL: Airplane Single Engine Land license.
ATC: Air Traffic Control.
ATP: Airline Transport Pilot.
ATS: Air Traffic Services.
AWABS: Aircraft Weight and Balance System.
CAM: Cockpit Area Microphone.
CAT: Commercial Air Transport.
CBO: Central Briefing Office.
CH: Channel.
CPT: Captain.
CRM: Crew Resource Management.
CVR: Cockpit Voice Recorder.
EASA: European Union Aviation Safety Agency.
EFIS: Electronic Flight Instrumentation System.
ENAV SPA: Italian air navigation service provider.
EO: Engine Out.
FAA: Federal Aviation Administration.
FAR: Federal Aviation Regulations.
FDR: Flight Data Recorder.
FH: Flight hours.
FL: Flight Level.
FMC: Flight Management Computer.
FO: First Officer.
FT: Foot.
HSI: Horizontal Situation Indicator.
ICAO: International Civil Aviation Organization.
IR: Instrument Rating.
KT: Knot.
LCP: Line Check Pilot.
MCC: Maintenance Control Centre.
MET: Meteorological.
METAR: Aviation routine weather report.
MTOM: Maximum Take Off Mass.
NM: Nautical Miles.
NOSIG: No Significant Changes.
NTSB: National Transportation Safety Board, United States Safety Investigation Authority.
OM: Operative Manual.
OR: Organization.
PA: Passenger Announcements.

PF: Pilot Flying.
PIC: Pilot in Command.
PIREPS: Pilot Reports.
P/N: Part Number.
RMT: Rulemaking Task.
RTE: Route.
RWY: Runway.
SATCOM: Satellite Communication.
SID: Standard Instrument Departure.
SRI: Surface Rainfall Intensity.
TAF: Terminal Aerodrome Forecast.
TP: Threat Plot.
TR: Technical Requirements.
TSRA: Thunderstorm with rain.
UTC: Universal Time Coordinated.
WXR: Weather Radar.

All the times shown in this investigation report, unless otherwise specified, are expressed in **UTC** (Universal Time Coordinated), which, on the date of the event corresponded to the local time minus 2h.

FOREWORD

The accident occurred on July the 24th, 2023, at 10:58', shortly after take-off from Malpensa Airport. It involved a Boeing 767-332(ER) aircraft registered in the United States with registration marks N189DN, scheduled for a flight to New York, JFK Airport.

During the execution of SID DOGUB 6T, the aircraft encountered severe hail, causing extensive damage.

The crew then decided to divert to Rome Fiumicino International Airport (FCO) for a precautionary landing. This occurred at 11:55' without further incident.

The ANSV was informed of the event the same day. The deemed notifications were sent in accordance with the international and EU regulations (ICAO Annex 13 and Regulation EU 996/2010).

The NTSB, representing the aircraft's State of design and production, the State of operator, and the State of registry, appointed an accredited representative to the safety investigation conducted by the ANSV. The NTSB also appointed technical advisers, as allowed by the aforementioned international and EU regulations, from Delta Airlines, the operator of the aircraft involved in the event.

Based on the provisions of the Regulation EU 996/2010, the ANSV also appointed EASA as its technical adviser.

ACCIDENT
Boeing B767-300 registration marks N189DN,
Climbing after take-off from Malpensa International Airport,
24th of July 2023

Aircraft type and marks

Boeing B767-300 registration marks N189DN, flight DL185.

Date and time

24th of July 2023, 10.58'.

Location of the event

Climbing through 13000 ft after take-off from Malpensa airport, during the execution of the SID DOGUB 6T (Figure 1).

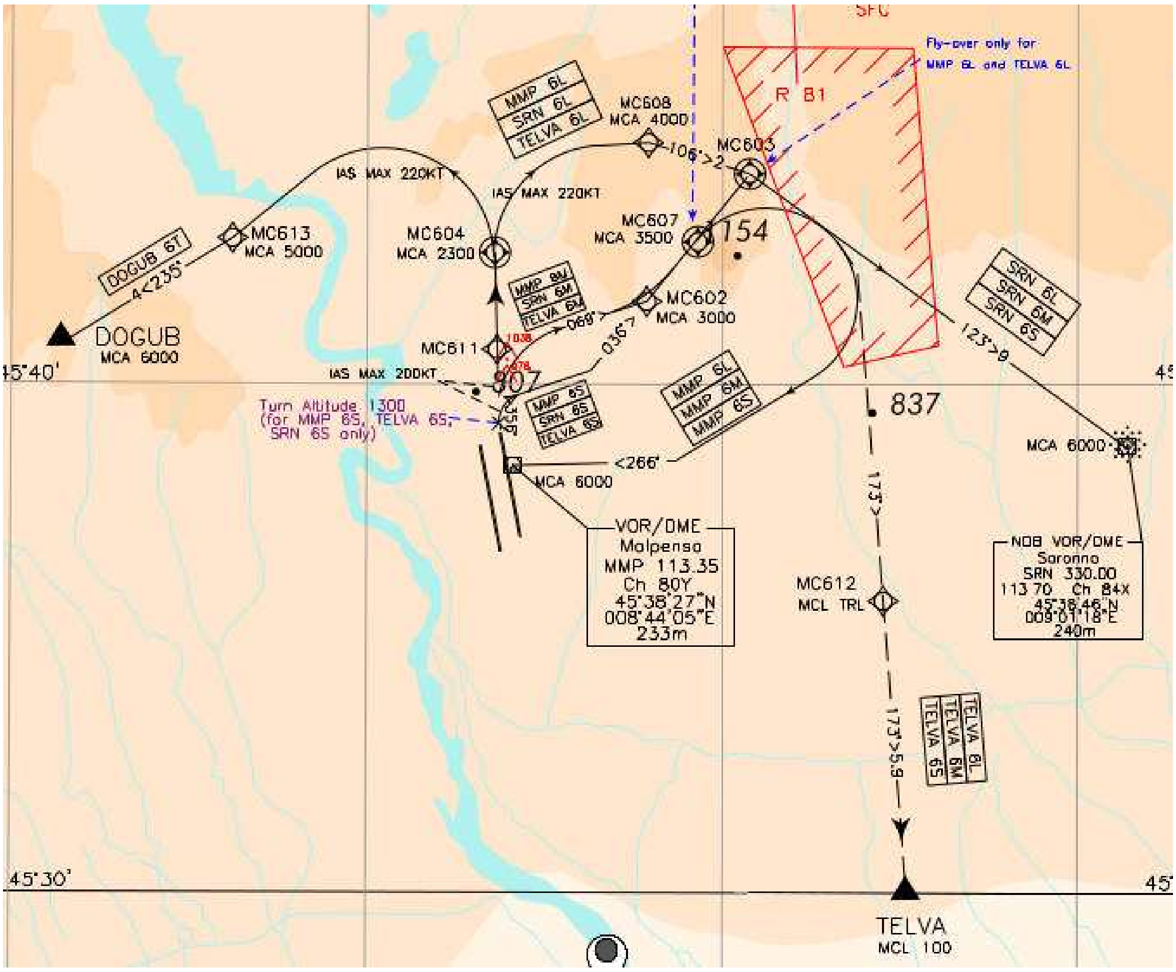


Figure 1: SID DOGUB 6T.

Narrative

The flight DL185 was planned MXP-JFK (Milan Malpensa, New York). The scheduled departure time was 10.30'. After take-off from RWY 35R at 10.52', the aircraft was performing the assigned SID, DOGUB 6T, when, passing through FL 130 at 10.58', encountered severe hail. When at FL150 the FO windshield cracked and the crew, after the initial decision of returning to MXP, decided to direct to Rome Fiumicino international airport (FCO). The aircraft landed overweight at 11.55' without further inconvenience.

Operator

Delta Air Lines.

Type of flight

Passenger Commercial Air Transportation.

Persons on board

4 flight crew members: 1) Captain; 2) LCP; 3) First officer; 4) Relief officer.
8 cabin crew members.
214 passengers.
In total, 226 persons on board.

Damage to the aircraft

The aircraft suffered a high number of dents and holes due to the hail. Following some of the main damages found:

- #1 engine spinner front segment 3.5"x 4" damage;
- #2 engine spinner front segment 12" x 14" missing;
- Right horizontal stabilizer 10 dents (several deeper than 0.125");
- Right-wing leading-edge panel 611FB 19"X25" and 21"X22" areas damaged;
- Left wing leading-edge panel 511FB 21"X25" and 20"X26" areas damage;
- Radome 27"x 30" hole;
- Weather radar antenna 20 hits from hail;
- #2 engine spinner rear segment 18 hits from hail;
- Co-pilots R1 window outer pane shattered from hail;
- Right wing landing light lens shattered;
- Upper anti-collision light lens shattered;
- Lower anti-collision light lens shattered;
- Left wing tip nav light assy. Lens shattered;
- Right wing tip nav light assy. Lens shattered;
- #2 engine nose cowl 21"x 39" delaminated and 10 dents on leading edge and 6 dents with cracked composite.

Figure 2: damage to the radome.

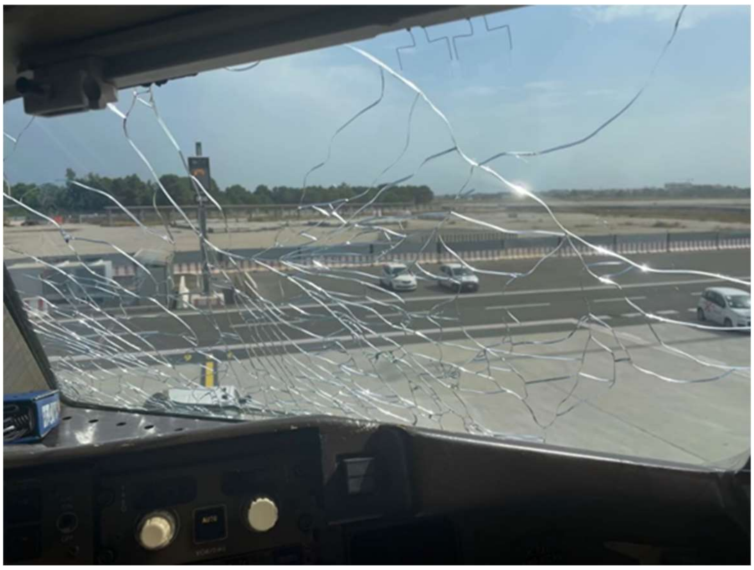


Figure 3: damage to the First officer windscreen.

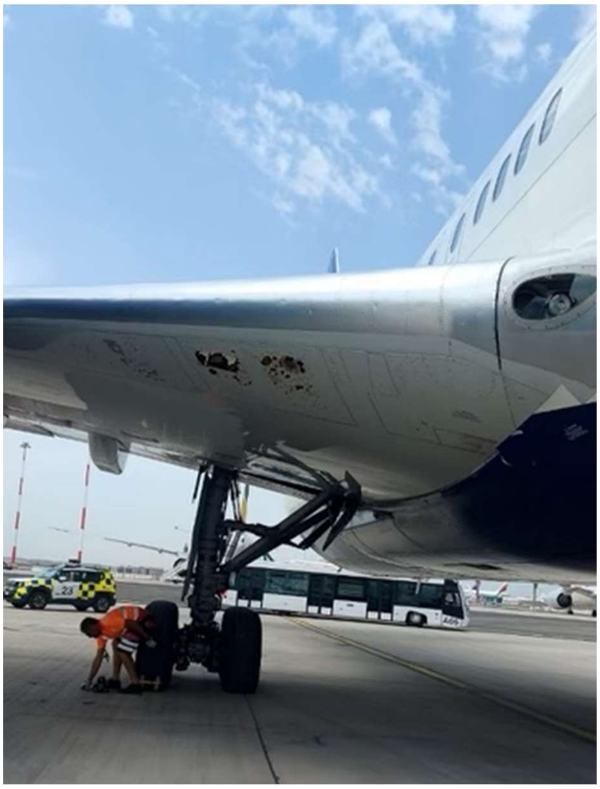


Figure 4: damage to right wing panels.

Figure 5: damage to right engine nozzle cone.

Figure 6: *weather radar damaged.*

Flight crew information

- Captain, seated in the left seat.
  - FAA Airman Certificate: 3728778
    - ATP, AMEL, ASEL, Commercial
    - Type Ratings: B757, B767, EMB145, ERJ170, ERJ190
  - Date of last First Class Medical: 12 May 2023
  - Flight hours prior the event:

Last 7 days	Last 30 days	Last 1 year
18.36	73.31	842.53

Total experience of the Captain was about 5000 FH. In the two months preceding the event flight, the Captain received two more line checks on the 3rd of May (standard line check) and on the 5th of June. In this latter case a new Line Check Pilot (LCP) was receiving an FAA observation, which happened to be on the same flight the captain was scheduled to operate. The flight of the event had previously been assigned a line check when the Captain decided to choose to join it. Therefore, in the event flight the Captain was undergoing a line check flight. This resulted in unsatisfactory after the flight of the event due to the outcome of the flight.
About the line check, the following provisions were applicable:

DELTA	FOM - FLIGHT OPS MANUAL	Revision: 17.0.0 Date: 01-Nov-2022
	20 FLIGHT TRAINING & STANDARDS 20.11 LINE CHECKS	

20.11 LINE CHECKS

20.11.1 Line Check Administration

Line Checks are observations performed by Line Check Pilots (LCP) to verify the proficiency of pilots and monitor line operations. They may be given at any time, but at a minimum, each captain will receive a Line Check every 24 months.

Line Checks are not optional. A pilot may not refuse a Line Check and remain qualified to perform his duties. Refusal will result in the pilot being returned to his CPO as unqualified to fly and will be graded as unsatisfactory.

Line Check procedures are as follows:

- Captain Line Checks are valid for 24 months (plus one month grace period)
- The proficiency of all pilots is observed during a Line Check
- On single-leg Line Checks, the captain will be the Pilot Flying (PF).

An FAA Aviation Safety Inspector observation does not satisfy this requirement.

Line Checks require that all observed crewmembers be graded. The LCP is required to complete a debriefing. Normally, the Line Check is conducted from the jump seat but may be conducted from a control seat, if required.

Successful completion of OE or SOE is certified by a Line Check given while the LCP occupies a control seat.

- For single-leg Line Checks, the pilot receiving the line check will assume PF duties regardless of the rotation sequence.
- If it is scheduled for two legs, the pilot receiving the Line Check will normally be observed once as the PF and once as the PM.
- All pilots in international categories must have a Line Check in one of their primary theaters of operation.

- LCP – onboard to administer a line check of the PIC and PF. He was seated on the jumpseat behind the Captain.
    - FAA Airman Certificate: 3353193.
        - ATP, AMEL, ASEL, Commercial.
        - Type Ratings: B757, B767, DC-9.
    - Date of last First Class Medical: 17 July 2023.
    - Flight hours prior to the event:

Last 7 days	Last 30 days	Last 1 year
16.55	63.42	714.41

The LCP before being hired from Delta had a previous military experience of about 2800 FH. In addition to that, at the time of the event he had flown in Delta 2474 FH.

- First Officer – seated in the right seat.
    - FAA Airman Certificate: 3396907.
        - ATP, AMEL, ASEL, Commercial.
        - Type Ratings: A320, B757, B767, EM145, GV.
    - Date of last First Class Medical: 15 June 2023.
    - Flight hours prior to the event:

Last 7 days	Last 30 days	Last 1 year
13.34	68.42	488.25

Total experience of the First Officer at the time of the event was 7425 FH.
Based on the provisions for Line check, also the first officer was under line check in the flight of the event. For him the result after the event flight was considered satisfactory.

- Relief pilot[1]
    - FAA Airman Certificate: 3054805.
        - ATP, AMEL, ASEL, Commercial.
        - Type Ratings: A320, B757, B767, DHC8, EMB145, ERJ170, ERJ190.
    - Date of last First Class Medical: 22 November 2022.
    - Flight hours prior to the event:

Last 7 days	Last 30 days	Last 1 year
8.49	69.47	630.36

Total experience of the Relief pilot at the time of the event was about 7500 FH.

[1] During critical phases of flight, high workload or areas of vulnerability (AOVs), the Relief Pilot(s)' primary responsibility is to monitor the aircraft's flight path (including autoflight systems, if engaged) and to immediately bring any concern to the PF's attention. The Relief Pilot is secondarily responsible for monitoring non-flight path actions (radio communications, aircraft systems, other operational activities, etc.). – Delta Flight Ops Manual.

Aircraft information

The B767-300 is a twin-engine family of airplanes designed for medium to long range flights. It is powered by advanced high bypass ratio engines. The main characteristics include:

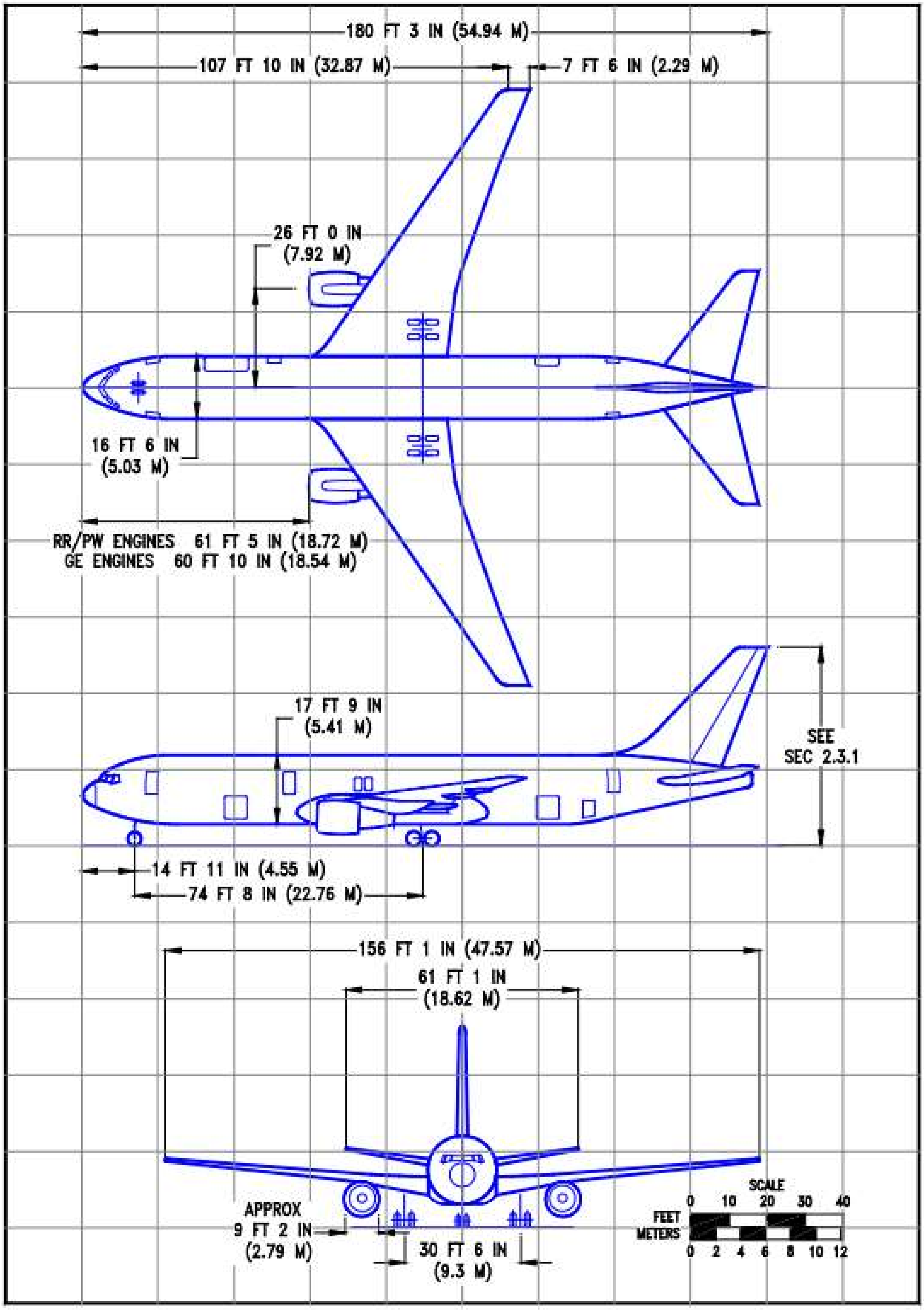
- Two-crew cockpit with digital flight deck systems.
- High bypass ratio engines.
- Twin-aisle seating.
- Extended range operations.

The following general characteristic applies (source Boeing D6-58328 REV 1 July 2021):

CHARACTERISTICS	UNITS	767-300ER (1)				
MAX DESIGN TAXI WEIGHT	POUNDS	381,000	388,000	401,000	409,000	413,000
	KILOGRAMS	172,819	175,994	181,891	185,519	187,334
MAX DESIGN TAKEOFF WEIGHT	POUNDS	380,000	387,000	400,000	407,000	412,000
	KILOGRAMS	172,365	175,540	181,437	184,612	186,880
MAX DESIGN LANDING WEIGHT	POUNDS	300,000	300,000	320,000	320,000	320,000
	KILOGRAMS	136,078	136,078	145,150	145,150	145,150
MAX DESIGN ZERO FUEL WEIGHT	POUNDS	278,000	278,000	288,000	295,000	295,000
	KILOGRAMS	126,099	126,099	130,635	133,810	133,810
SPEC OPERATING EMPTY WEIGHT (2)	POUNDS	193,840	193,940	195,040	198,440	198,440
	KILOGRAMS	87,924	87,970	88,469	90,011	90,011
MAX STRUCTURAL PAYLOAD	POUNDS	84,160	84,060	92,960	96,560	96,560
	KILOGRAMS	38,174	38,129	42,166	43,799	43,799
SEATING CAPACITY	ONE-CLASS	FAA EXIT LIMIT = 290 (3)				
	MIXED CLASS	261 - 24 FIRST + 237 ECONOMY				
MAX CARGO LOWER DECK	CUBIC FEET	4,030	4,030	4,030	4,030	4,030
	CUBIC METERS	114.1	114.1	114.1	114.1	114.1
USABLE FUEL	U.S. GALLONS	24,140	24,140	24,140	24,140	24,140
	LITERS	91,380	91,380	91,380	91,380	91,380
	POUNDS	161,740	161,740	161,740	161,740	161,740
	KILOGRAMS	73,364	73,364	73,364	73,364	73,364

NOTES:

1. SPEC WEIGHT FOR TYPICAL ENGINE/WEIGHT CONFIGURATION SHOWN SEE TABLE 1.3.1 FOR COMBINATIONS AVAILABLE. CONSULT WITH AIRLINE FOR SPECIFIC WEIGHTS AND CONFIGURATIONS.
2. TYPICAL OPERATING EMPTY WEIGHT SHOWN. ACTUAL WEIGHT WILL DEPEND ON SPECIFIC AIRLINE CONFIGURATION.
3. 299 WITH SECOND OVERWING EXIT DOOR



The B767-300 involved in the event was a 767-332(ER) with S/N 25990, registration certificate issued in 1997 with marks N189DN, equipped with two PW4060 engines.
Checklists relevant for the event are presented below.

1.10 Window Damage

Condition: A flight deck window has one or more of these:

- An electrical arc
- A crack
- Is shattered
- A delamination (separation of vinyl and glass layers)
- Is deformed (additional outward curvatures or bowing of windows)

Objective: To remove electrical power to prevent arcing, if needed. To descend to minimize forces on the window if an inner pane is shattered or cracked, if needed.

1 Choose one:

◆ Window is **arcing, shattered, or cracked**:

WINDOW HEAT switch
(affected window) . . . . Off

Do **not** accomplish the following checklist:

WINDOW (HEAT)

►► Go to step 2

◆ Window is **not** arcing, shattered, or cracked:

►► Go to step 2

▼ Continued on next page ▼

▼ 1.10 Window Damage Continued ▼

2 Choose one:

◆ Damaged window is **deformed or** an **air leak** is **observed**:

Deformed is defined as an additional outward curvature or bowing of window.

►► Go to step 3

◆ Damaged window is **not** deformed and an air leak is **not** observed:

Note: Damage to the outer pane does not affect the structural integrity of the window.

■ ■ ■ ■

3 Plan to land at the nearest suitable airport.

4 Choose one:

◆ Airplane altitude is **above** 10,000 feet:

Descend to lowest safe altitude or 10,000 feet, whichever is higher. This minimizes forces on the window.

►► Go to step 5

◆ Airplane altitude is **at or below** 10,000 feet:

►► Go to step 5

5 Sustained flight below 10,000 feet is not recommended due to greater risk of bird strike.

■ ■ ■ ■

The aircraft is equipped with weather radar[2]. This was a RDR-4B, 2D type radar. It consists of a receiver–transmitter, an antenna, and a weather radar indicator. Controls for the system are contained on the indicator.

Radar returns are displayed on the HSI (Figure 7). The weather radar switch (WXR) on the EFIS control panel selects the weather radar display. The radar display range is set by the range selected on the EFIS control panel. Weather radar returns can also be displayed on the dedicated radar indicator on the forward aisle stand (Figure 8).

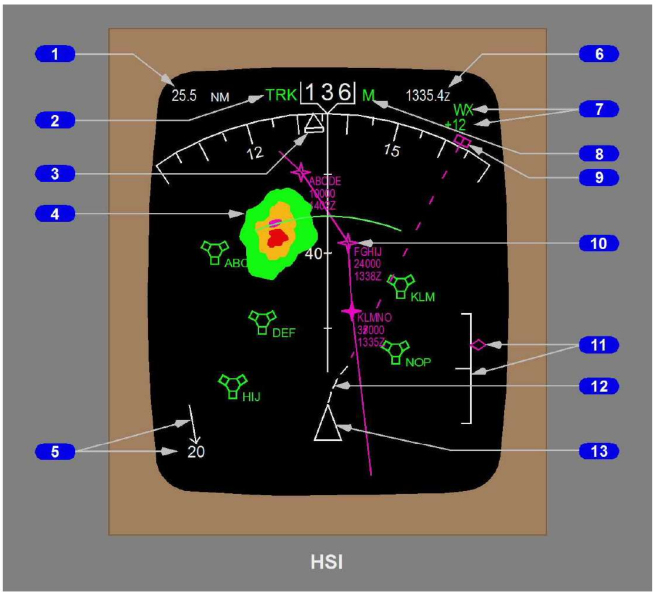


Figure 7: *weather radar* returns (4) displayed on the HSI.

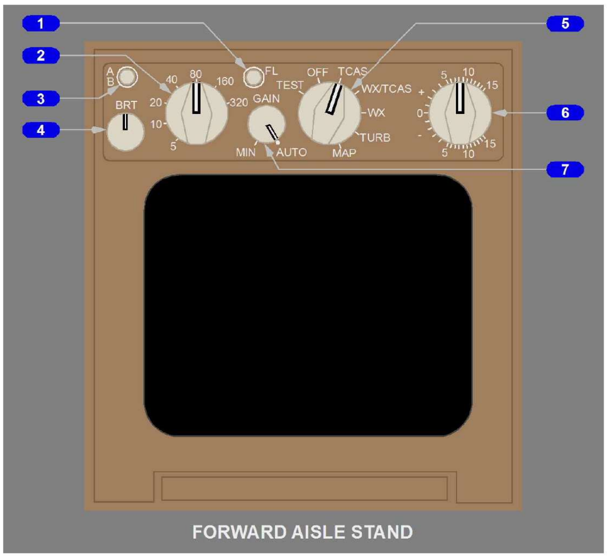


Figure 8: *weather radar* can be displayed on the forward aisle stand. The mode selector (5) when on WX/TCAS displays TCAS traffic and weather radar returns at selected gain level. (6) tilt control; (7) gain control.

[2] Document DAL/767/VOL2.

The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence can be sensed by the weather radar only when there is sufficient precipitation. Turbulence is displayed in magenta. Clear air turbulence cannot be sensed by radar. The reflectivity and, therefore, the sensing capability of the radar is explained in Figure 9.

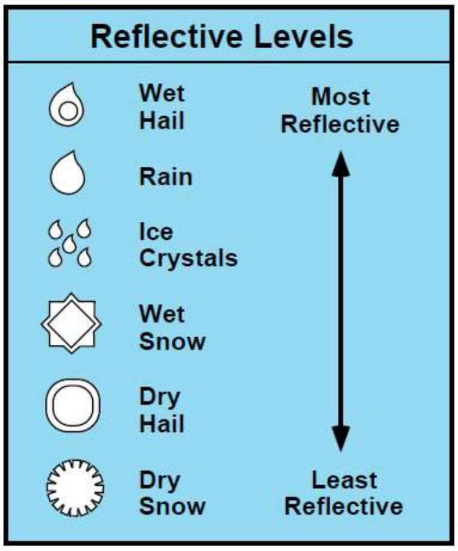


Figure 9: reflective levels.

The hail detection would be facilitated when considering the shape of storm, as illustrated in Figure 10.

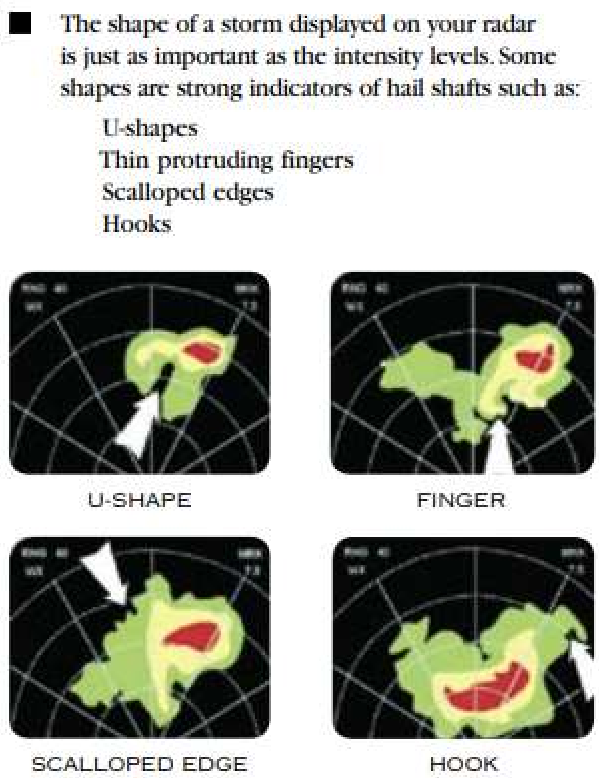


Figure 10: weather shapes indicating hail activity.

The Gain and tilt controls are on the forward aisle stand. Actual range of the weather radar depends on the settings, however being between tens and hundreds of NM.
In more detail:

TILT control
Rotate clockwise – radar antenna tilts up to selected degrees from horizon.
Rotate counterclockwise – radar antenna tilts down to selected degrees from horizon.

GAIN Control
AUTO – normal operation, detent position provides automatic gain control calibrated for optimum return.
Rotate – provides manual control of radar gain. Gain increases as control is rotated clockwise.

Organizational information

Operator's safety actions after the event
In the aftermath of the event the B767 fleet captain published a newsletter highlighting the importance of thunderstorms and hail avoidance. In addition, the operator's B757/767 fleet is receiving the RDR-4000 Weather Radar upgrade. In July 2025 approximately 31% of the fleet was upgraded. The estimated completion date is April 2027
The RDR-4000 is advanced 3D weather radar systems for air transport, it does provide higher sensitivity in addition to other improvements. In more detail, new features, among others, include a predictive hail display.

Operator dispatch responsibilities
Based on the operator's FOM:
"Captains and dispatchers have joint responsibility and must agree that the planned flight is safe and can be operated in accordance with FARs and Company policy. Either party may delay flight departure, but only Dispatch may cancel a flight. If enroute conditions change such that the flight cannot or should not continue as planned, the first party aware of these conditions must notify the other."

Hail encounter procedure
Following the information provided to the crew (FOM) relevant to the possibility of hail encounter.

DELTA	FCTM 757-767	**Revision:** 3.0.0 **Date:** 07-Jun-2021
	1 GENERAL INFORMATION **1.13 FLIGHT IN MODERATE TO HEAVY RAIN, HAIL, OR SLEET**	

1.13 FLIGHT IN MODERATE TO HEAVY RAIN, HAIL, OR SLEET

The aircraft is designed to operate satisfactorily when the maximum rates of precipitation expected in service are encountered. However, flight into moderate to heavy rain, hail, or sleet could adversely effect engine operations and should be avoided whenever possible. If moderate to heavy rain, hail, or sleet is encountered, reducing airspeed can reduce overall precipitation intake. Also, maintaining an increased minimum thrust setting can improve engine tolerance to precipitation intake, provide additional stall margin, and reduce the possibility of engine instability or thrust loss.

For more procedure information, refer to:

Fleet	Reference
757/767-300	Volume 1 757-767 5.16.8 Moderate to Heavy Rain, Hail or Sleet
767-400	Volume 1 767-400 5.16.8 Moderate to Heavy Rain, Hail or Sleet

5.16.8 Moderate to Heavy Rain, Hail or Sleet

Flight should be conducted to avoid thunderstorms, hail activity or visible moisture over storm cells. To the maximum extent possible, moderate to heavy rain, hail or sleet should also be avoided.

If moderate to heavy rain, hail or sleet is encountered:

Engine Start selectors. . . . . CONT

This selection maintains a minimum thrust setting of approach idle and provides continuous ignition.

The following information about the operator weather management from the FOM are considered relevant to the event.

14.5 WEATHER

14.5.1 Threat Plot (TP)

Avoidance measures for both planned and enroute turbulence are based primarily on Threat Plot (TP) messages and upper air depiction charts issued by Delta Meteorology.

These products are based on forecasts and actual pilot reports from comparable aircraft types.

TPs are issued specifically for Delta operations. The nature of the threat, the availability of new data, and the degree of change expected over a given period of time dictate how often they are issued.

TP messages prevail over other sources, such as SIGMETs, WidgetWx, actual turbulence data, and other forecast products. TPs may also include volcanic ash information.

14.5.2 Weather Briefings

Pilots may access weather briefing information at any time from a computer terminal or through a gate agent. A weather briefing is automatically generated when the dispatcher prints the flight plan, which provides the most reliable information available at the time of dispatch.

An Updated Weather Briefing is automatically printed when the Flight Attendant Departure Report is generated. It includes the current release number and the most current weather information subsequent to the Weather Briefing.

An Updated Weather Briefing is required. If a printed Updated Weather Briefing is not received, request it via ACARS Free Text message to Flight Control/Dispatch or call the dispatcher for a verbal briefing.

Verify the release number on the Updated Weather Briefing (printed or verbally via the dispatcher) matches the flight plan.

Pilots can access updated weather information from the dispatcher or Meteorology through Atlanta radio. When asking for Meteorology, specify either "Surface" or "Upper Air," and include your dispatcher's desk number.

The content of a weather report is established in paragraph 14.5.4.1 of the FOM,

- Time of the observation
- Wind direction/speed
- Visibility
- Ceiling
- Temperature/dew point
- Altimeter setting.

In addition, the operator clarified the pilots and dispatchers have the ability to compare satellite and radar imagery to the flight path. The operator also highlighted that this is not a requirement, due to the availability of data in the flight deck. Dispatchers utilize a flight following tool that can plot the satellite imagery along the routes of their flight. Pilots utilize a WidgetWeather app (also WidgetWx) on the flight deck, which provides satellite imagery and cloud height information. In this framework, it is worth to mention the following FOM paragraph.

16.1.16 EFB Weather Depictions

Weather overlays in EFB applications can help pilots make strategic decisions on the ground and in flight regarding route of flight and cruising altitude. These weather depictions do not replace the aircraft weather radar for real-time weather avoidance.

WidgetWeather is only available when the flight crew have connection via WIFI or cellular data service.

CVR recordings

The operator has specific procedures about how to deal with incidents and accidents. In the following tables the relevant information. In more detail, specific tasks are addressed to segregate and protect CVR recordings before leaving the flight deck.

Post-Accident Checklist	
Step	**Action**
Before leaving the flight deck	To facilitate post-evacuation events, to the extent practical, remove: • Emergency/medical equipment • EFB(s) • Aircraft logbook • Flight plan and addendum • Weather reports • Pre-pushback message if printed • WDR • Landing Performance Request (LPR), if applicable. After landing and clear of the active runway after a ground accident/incident resulting in substantial aircraft damage • Deactivate the CVR by pulling the circuit breaker. NA for the A220/A330/A350. • FARs require certificate holders to retain CVR information after a flight has had an occurrence that requires immediate notification of the NTSB • Notify the dispatcher as soon as practicable and advise that the CVR has been deactivated

Post-Incident/Irregularity Checklist	
Step	**Action**
Before Leaving the Flight Deck/Clear of Active Runway	• Deactivate the CVR by pulling the circuit breaker. NA for the A220/A330/A350 due to accessibility issues. • FARs require certificate holders to retain CVR information after a flight has had an occurrence that requires immediate notification of the NTSB • Notify the dispatcher that the CVR has been deactivated.

Before leaving the scene	The primary responsibility of the captain and crew is the welfare of the passengers.
	• Assemble a safe distance away from the aircraft.
	• Get medical attention, if required.
	• Determine the status, location, and complete an accurate head count of all crewmembers and passengers.
	Accumulate and protect flight data.
	• Collect all possible data and information as soon as possible after the accident.
	• Obtain names, addresses, telephone numbers, and an outline of available facts from any witnesses and/or passengers.
	• Document/record conditions which might deteriorate or be subject to change in the course of the recovery effort.
	• Observe and record any perishable information that might relate to the accident. This information might include, but is not limited to:
	  ◦ Indication of ice on the control surfaces
	  ◦ Diagrams of the incident site
	  ◦ Location and diagrams of significant tracks or marks on the ground or in the snow. Measurements may be required
	  ◦ Evidence of bird strikes (feathers, flesh, etc.) on the windshield, wings, stabilizer, fuselage, intakes, engines, etc.

European requirements on meteorological information

The appropriate meteorological information for CAT flights should be relevant to the planned operation, as specified in point (a) of point MET.TR.215 of Annex V (Part MET) to Regulation (EU) 2017/373.

This is reported below:

MET.TR.215 Forecast and other information

(a) Meteorological information for operators and flight crew members shall:

(1) cover the flight in respect of time, altitude and geographical extent;

(2) relate to appropriate fixed times or periods of time;

(3) extend to the aerodrome of intended landing, also covering the meteorological conditions expected between the aerodrome of intended landing and alternate aerodromes designated by the operator;

(4) be up to date.

(b) Meteorological information provided to rescue coordination centres shall include the meteorological conditions that existed in the last known position of a missing aircraft and along the intended route of that aircraft with particular reference to elements which are not being distributed routinely.

(c) Meteorological information provided to aeronautical information services units shall include:

(1) information on meteorological service intended for inclusion in the aeronautical information publication(s) concerned;

(2) information necessary for the preparation of NOTAM or ASHTAM;

(3) information necessary for the preparation of aeronautical information circulars.

(d) Meteorological information included in flight documentation shall be represented as follows:

(1) winds on charts shall be depicted by arrows with feathers and shaded pennants on a sufficiently dense grid;

(2) temperatures shall be depicted by figures on a sufficiently dense grid;

(3) wind and temperature data selected from the data sets received from a world area forecast centre shall be depicted in a sufficiently dense latitude/longitude grid;

(4) wind arrows shall take precedence over temperatures and chart background;

(5) height indications referring to *en-route* meteorological conditions shall be expressed as determined to be appropriate for the situation, for instance in flight levels, pressure, altitude or height above ground level, whilst all references referring to aerodrome meteorological conditions shall be expressed in height above the aerodrome elevation.

(e) Flight documentation shall comprise:

(1) forecasts of upper-wind and upper-air temperature;

(2) SIGWX phenomena;

(3) METAR or, when issued, SPECI for the aerodromes of departure and intended landing, and for take-off, *en-route* and destination alternate aerodromes;

(4) TAF or amended TAF for the aerodromes of departure and intended landing, and for take-off, *en-route* and destination alternate aerodromes;

(5) a SIGMET message, and, when issued, an AIRMET message and appropriate special air-reports relevant to the whole route;

(6) volcanic ash and tropical cyclone advisory information relevant to the whole route.

However, when agreed between the aerodrome meteorological office and the operators concerned, flight documentation for flights of two hours' duration or less, after a short stop or turnaround, may be limited to the information operationally needed, but in all cases the flight documentation shall at least comprise the meteorological information listed in points (3), (4), (5) and (6).

(f) Charts generated from digital forecasts shall be made available, as required by operators, for fixed areas of coverage as shown in Appendix 2.

(g) When forecasts of upper-wind and upper-air temperature listed under point MET.OR.275(a)(1) are supplied in chart form, they shall be fixed-time prognostic charts for flight levels as specified in points MET.TR.260(b), MET.TR.275(c) and MET.TR.275(d). When forecasts of SIGWX phenomena listed under point MET.OR.275(a)(2) are supplied in chart form, they shall be fixed-time prognostic charts for an atmospheric layer limited by flight levels as specified in point MET.TR.275(b)(3).

(h) The forecasts of upper-wind and upper-air temperature and of SIGWX phenomena above flight level 100 shall be supplied as soon as they become available, but not later than 3 hours before departure.

(i) Aeronautical climatological information shall be prepared in the form of aerodrome climatological tables and aerodrome climatological summaries.

In addition, MET.OR.240 states,

MET.OR.240 Information for use by operator or flight crew

(a) An aerodrome meteorological office shall provide operators and flight crew members with:

(1) forecasts, originating from the WAFS, of the elements listed in points (1) and (2) of point MET.OR.275(a);

(2) METAR or SPECI, including TREND forecasts, TAF or amended TAF for the aerodromes of departure and intended landing, and for take-off, *en-route* and destination alternate aerodromes;

(3) aerodrome forecasts for take-off;

(4) SIGMET and special air-reports relevant to the whole route;

(5) volcanic ash and tropical cyclone advisory information relevant to the whole route;

(6) area forecasts for low-level flights in chart form prepared in support of the issuance of an AIRMET message, and an AIRMET message for low-level flights relevant to the whole route;

(7) aerodrome warnings for the local aerodrome;

(8) meteorological satellite images;

(9) ground-based weather radar information.

(b) Whenever the meteorological information to be included in the flight documentation differs materially from that made available for flight planning, the aerodrome meteorological office shall:

(1) advise immediately the operator or flight crew concerned;

(2) if practicable, provide the revised meteorological information in agreement with the operator.

ATC OM on the weather information[3]

The Italian ATS provider MO-MET contain provisions that explain how the above information listed in MET.OR.240 is provided on request from the ARO-CBO to the operators and crews.

More in general and with reference to the weather information to be provided to the air crew before take-off, the OM of the Air Traffic Service provider indicates:

5.3.1.1.2 Before take-off, aircraft shall be advised:

a) of any significant change in the direction and speed of the wind at the surface, air temperature and visibility or RVR values provided in accordance with the provisions of the previous para. 5.3.1.1.1;

b) of significant meteorological conditions in the take-off and climb-out areas, except when it is known that this information has already been received by the aircraft;

c) of the change of runway in use, applying the provisions of para. 5.2.5.

Note. Significant weather conditions in this context include the existence or expected existence of cumulonimbus clouds or thunderstorms, severe or moderate turbulence, wind shear, hail, severe or moderate icing, severe squall line, freezing precipitation, severe mountain waves, sandstorm, dust storm, snowplough, funnel cloud (tornado or waterspout) in the take-off and climb-out areas.

6.4 INFORMATION FOR DEPARTING AIRCRAFT

6.4.1 Meteorological conditions

6.4.1.1 Information concerning significant changes in meteorological conditions

in the take-off or climb-out area, which comes into the possession of the unit providing approach control after a departing aircraft has established communications with that unit, shall be transmitted to the aircraft without delay, except when it is known that the aircraft has already received such information.

[3] Original text in Italian, the English translation is unofficial and for curtesy purpose.

Note. Significant changes in this context include, for aircraft not yet airborne, changes in the direction and intensity of the wind at the surface, visibility, RVR, or air temperature (for turbine-engine aircraft) as well as, for all aircraft, the presence of thunderstorms or cumulonimbus clouds, moderate or severe turbulence, wind shear, hail, moderate or severe icing, severe squall lines, freezing precipitation, severe or severe mountain waves, sandstorms, dust storms, high snowdrifts, funnel clouds (tornadoes or waterspouts).

In this framework is worth to highlight that:

- the hail encounter along after the climb-out phase. In addition, the ATS does not provide forecast, but actual weather based on the available observation;
- the crew neither the operator requested to the ARO-CBO any weather information available.

Weather information

Following the METAR and TAF relevant to LIMC airport referred to the time range in which the event occurred:

METAR LIMC 240850Z 10004KT 060V200 9999 BKN060 21/20 Q1013 NOSIG=
METAR LIMC 240920Z 02005KT 340V050 9999 BKN080 22/20 Q1013 NOSIG=
METAR LIMC 240950Z 36009KT 320V040 9999 FEW020 BKN065 22/20 Q1014 NOSIG=
METAR LIMC 241020Z 03011KT 9999 FEW025CB BKN065 24/21 Q1012 NOSIG=
METAR LIMC 241050Z 01010KT 9999 FEW025CB SCT030 BKN065 22/20 Q1012 TEMPO TSRA=
METAR LIMC 241120Z 02011KT 7000 TSRA SCT025CB OVC060 21/19 Q1010 NOSIG=
METAR LIMC 241150Z VRB04KT 4000 -TSRA FEW010CB OVC030 19/18 Q1012 RETSRA NOSIG=
METAR LIMC 241220Z 11010KT 9999 -RA BKN015 20/19 Q1012 RETS NOSIG=

240713 TAF AMD LIMC 240711Z 2407/2512 VRB05KT 9999 SCT030 TEMPO 2407/2410
TSRA TEMPO 2415/2506 3000 TSRA=
241125 TAF LIMC 241100Z 2412/2518 04008KT 9999 SCT030 TEMPO 2412/2506 3000
TSRA=

The distance between LIMC and the area of the hail encounter is about 16 NM (about 30 km).
The applicable SIGMET charts follow:

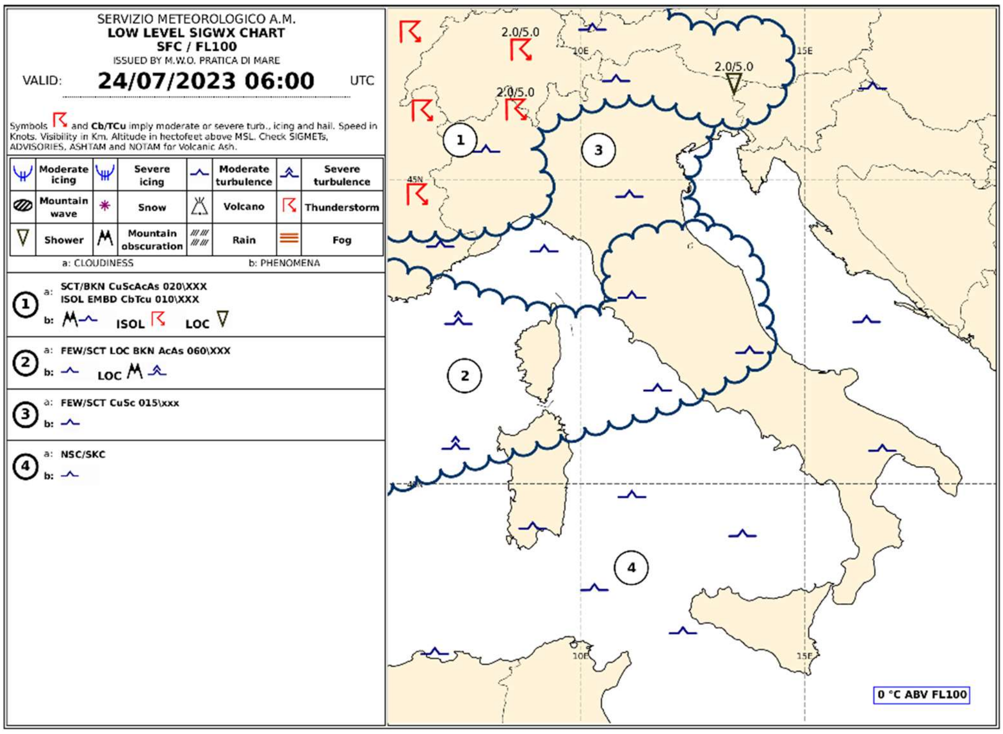


Figure 11: SIGMET chart 06.00’.

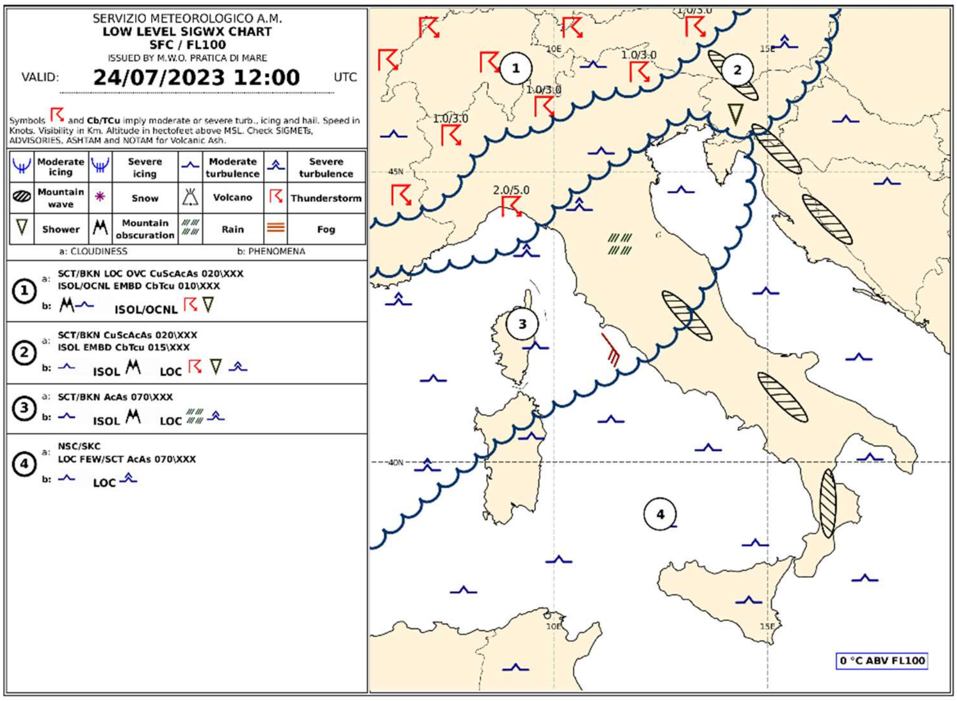


Figure 12: SIGMET chart 12.00’.

From Figure 13 to Figure 19 the satellite radar images SRI from 10.30’ to 12.00’.

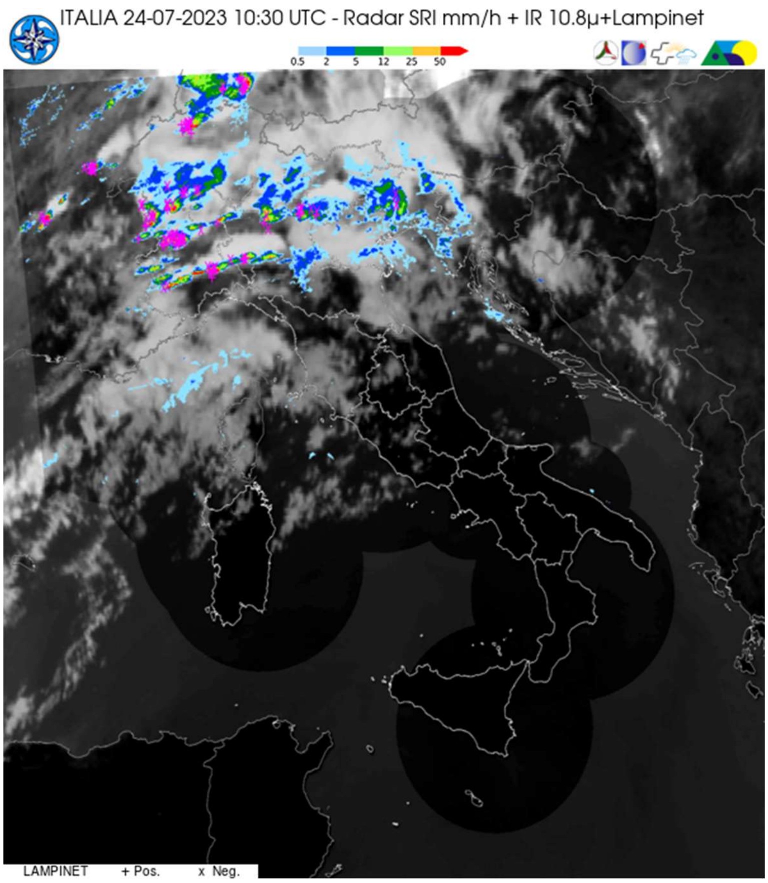


Figure 13: radar SRI 10.30’.

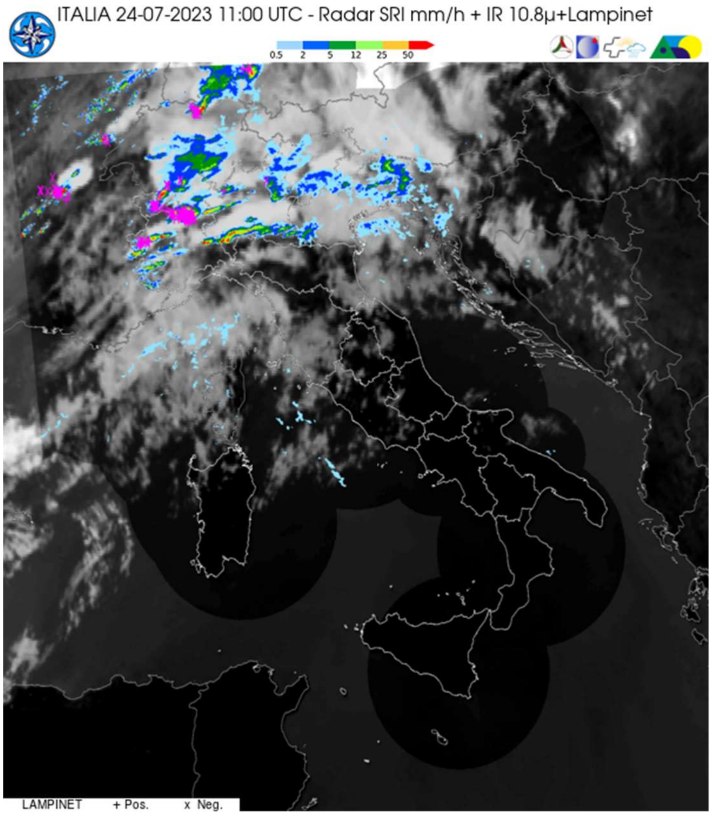


Figure 14: radar SRI 11.00'.

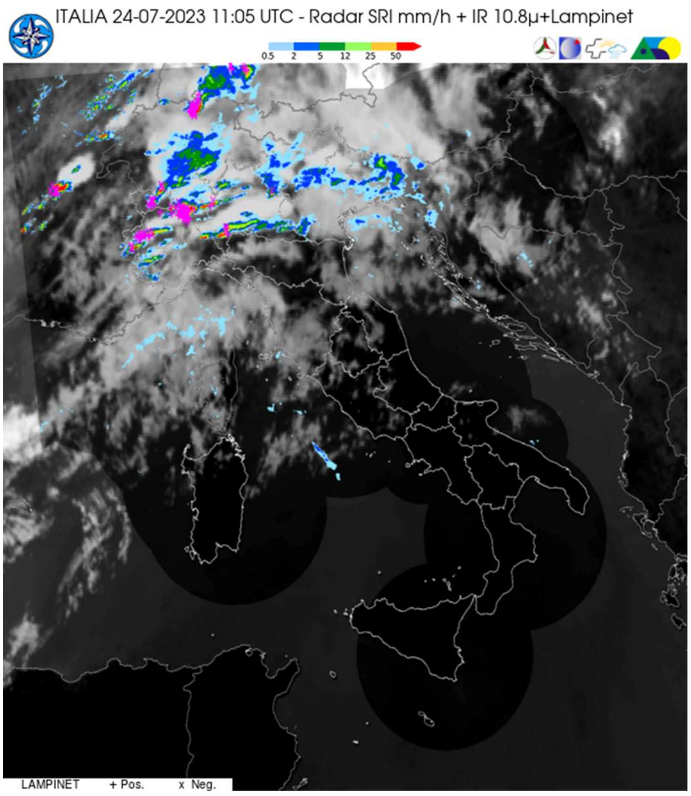


Figure 15: radar SRI 11.05'.

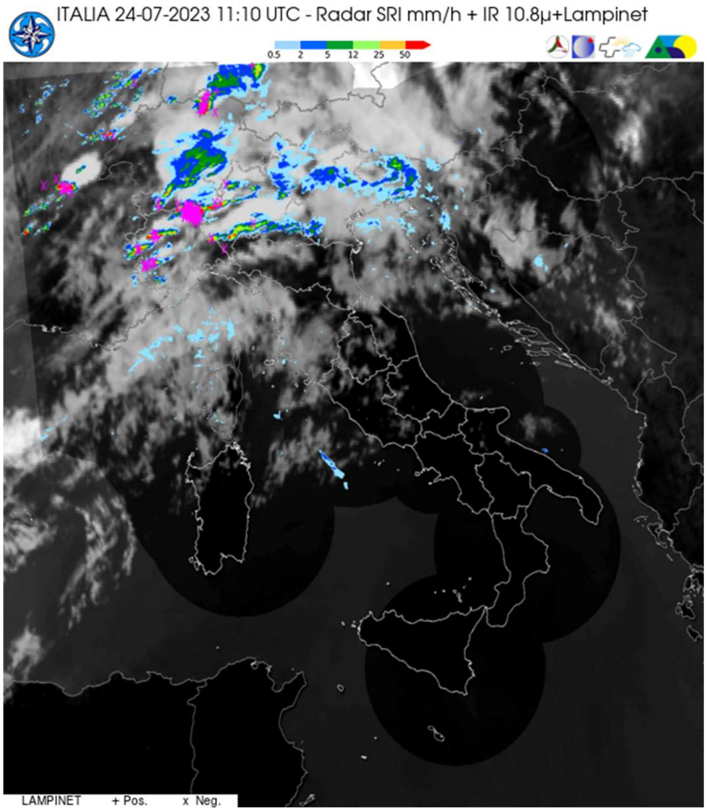


Figure 16: radar SRI 11.10’.

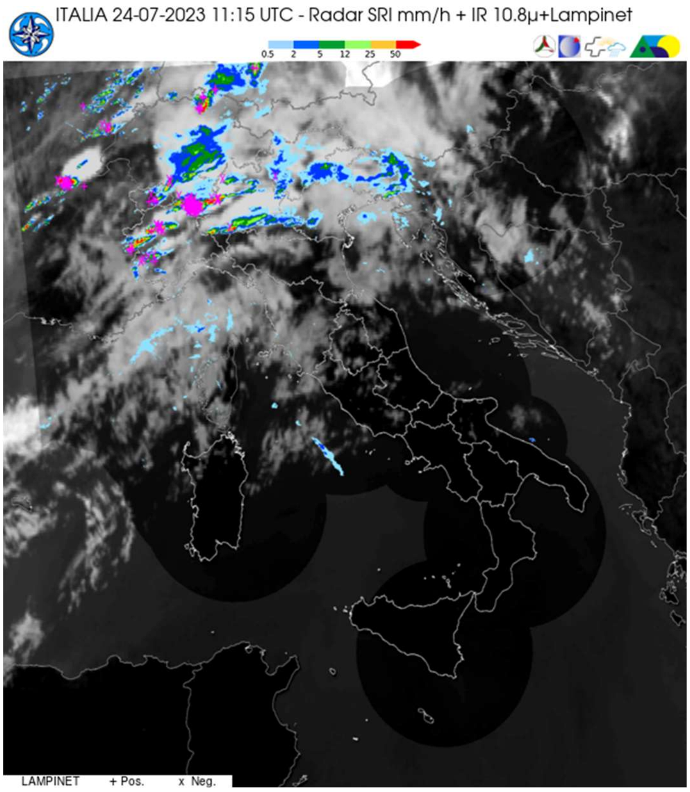


Figure 17: radar SRI 11.15’.

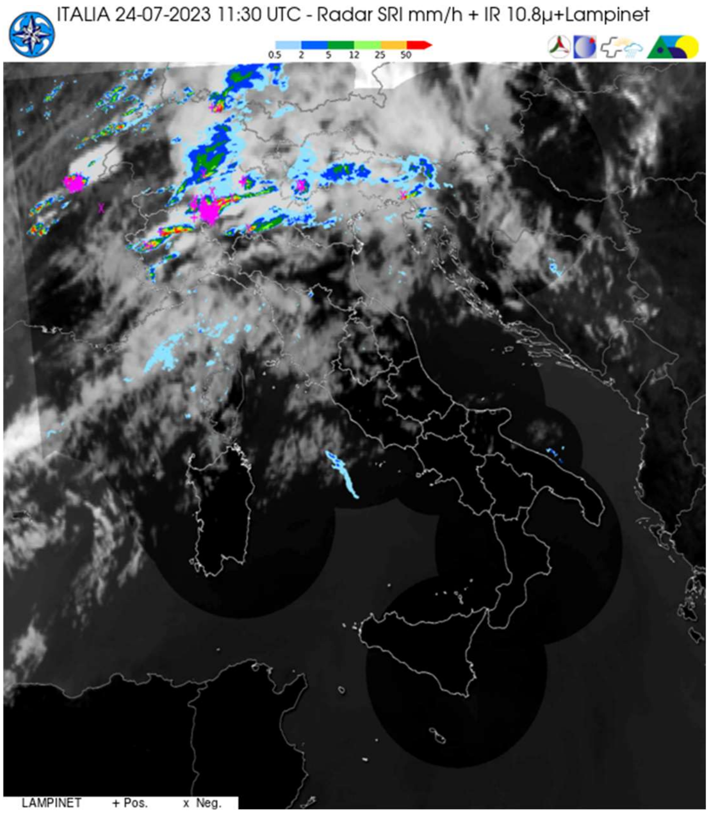


Figure 18: radar SRI 11.30’.

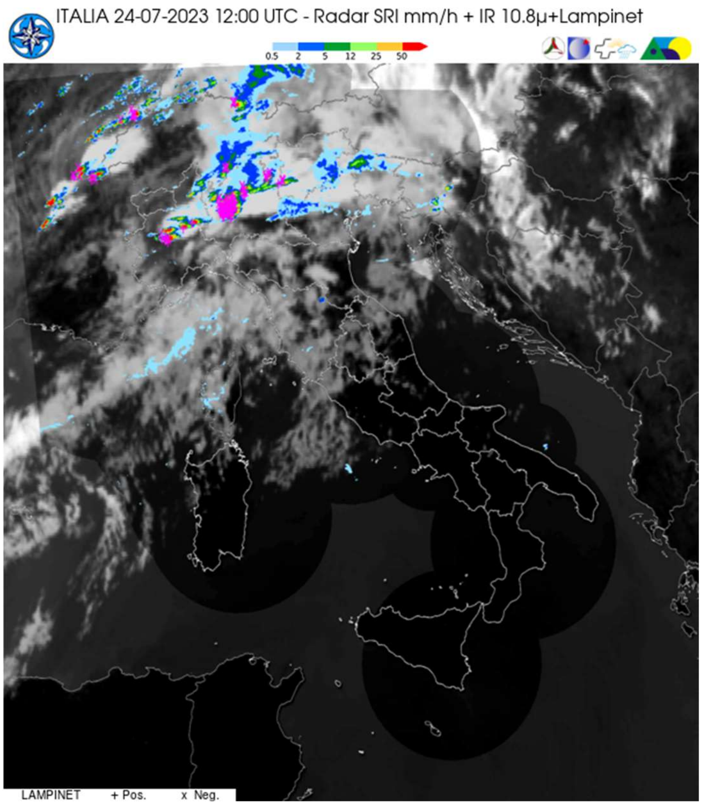


Figure 19: radar SRI 12.00’.

In reference to satellite radar imaging, it is important to mention that several different sources provide real time view and short-term forecasts. These, covering the next 30’, are usually very reliable.

As per FOM, the weather briefing to the crew from the operator mainly consists in the METAR, TAF and PIREPS along the planned route and possible alternates. For the flight of the event, the crew received a first weather briefing at 8.12’ and a subsequent at 10.14’, none of them showing weather incompatible with the flight. The operator meteorology department did actually sense the weather situation worsening at 11.00’ (TP depicted in Figure 20). However, the DL185 flight took off at 10.52’, not received the update. In any case the Alert of the operator meteorology department was relevant a very large area.

Figure 20: 11.00’ weather alert from the operator’s meteorology office (TP).

LIMC traffic between 10.45 and 11.15[4]

The aircraft that took off from LIMC in the time range of DL185 hail encounter are the following:

- 10.45 9H-FHB
- 10.46 OE-ISD
- 10.49 TS-IMO
- 10.51 9H-QEG
- **10.52 N189DN (DL185)**
- 10.55 OE-GBH
- 10.58 4X-EHF
- 11.01 OE-LQP
- 11.15 9H-WDV

[4] Source www.adsbexchange.com

The aircraft that landed in LIMC in the time range of DL185 hail encounter are the following[5]:

- 10.55 UNK
- 10.58 EC-MTV
- 11.00 T7-MRF
- 11.04 OE-LSM
- 11.07 OE-IVE
- 11.15 9H-ZAZ

All the other aircraft routes were not directed into the hail phenomenon at S-W of LIMC.

Air-Ground communications

Following the relevant AIR-GROUND communications between the DL185 and the Air Traffic Service Provider (ENAV).

10.52.32	DL185	Milano Radar Delta185 passing two thousand two hundred climbing five thousand feet.	
10.52.36	LIMM ANW	Ciao Delta185 climb level two hundred.	
10.52.40	DL185	Confirm level two hundred Delta185?	
10.52.43	LIMM ANW	Ahhh…yes Sir level two zero zero.	
10.52.45	DL185	Two zero zero Delta185.	
10.55.57	LIMM ANW	Delta185 contact one two five two seven five.	
10.56.01	DL185	One two five two seven five Delta185 ciao.	
10.56.10	DL185	Delta185 passing level nine six climbing level two zero zero.	
10.56.14	LIMM WN2	Delta185 radar contact climb flight level two four zero.	
10.56.19	DL185	Climb level two four zero Delta185.	
10.58.04	DL185	Delta185 request left immediately to avoid.	Loud noise, reasonably due to hail encounter.
10.58.08	LIMM WN2	Delta185 avoid at your convenience.	
10.58.11	DL185	(*) confirm Delta185?	Loud noise, reasonably due to hail encounter. * Unclear words.
10.58.14	LIMM WN2	Yes Sir.	
10.58.16	DL185	Ok (*) Delta185.	Surrounding noise.
11.00.02	LIMM WN2	Delta185 continue climb level three zero zero.	
11.00.07	DL185	Climb level three zero zero Delta185.	Surrounding noise.

[5] Source www.adsbexchange.com

11.00.13	DL185	Request level two two zero Delta185.	Surrounding noise.
11.00.20	LIMM WN2	Confirm level two eight zero Delta185?	
11.00.23	DL185	(*) Delta185 request level two four zero.	Surrounding noise. * Unclear words.
11.00.25	LIMM WN2	Ok climb and maintain level two four zero.	
11.00.29	DL185	Level two four zero Delta185.	
11.02.07	DL185	Milano Delta185?	
11.02.09	LIMM WN2	Go ahead!	
11.02.11	DL185	(*) severe turbulence and hail we are gonna (*) return to Milan (*)	* Unclear words.
11.02.19	LIMM WN2	Delta185 confirm you want to return to Malpensa Milan Malpensa?	
11.02.22	DL185	Stand by for now we need to (*) we have contacted the dispatch maintenance.	* Unclear words.
11.02.28	LIMM WN2	Ok Sir stop climb level two three zero and…hold…make a three six on present position	
11.02.35	DL185	Ok stop climb level two three zero and… and stand by for the ehmm… do you give us a heading for now?	
11.02.42	LIMM WN2	Ok you can maintain the heading Sir.	
11.02.45	DL185	Maintain the present heading Delta two three zero.	
11.04.58	DL185	Milano Delta185?	
11.05.00	LIMM WN2	Go ahead Sir!	
11.05.01	DL185	Request return to Milano Malpensa and request descend.	
11.05.05	LIMM WN2	OK Delta185 descend level two hundred two zero zero.	
11.05.09	DL185	Two hundred Delta185.	
11.05.22	DL185	Delta one (*) request level one zero zero dua a crack wind-shield.	* Unclear words.
11.05.26	LIMM WN2	Ok Delta185 continue descend level one six zero.	
11.05.30	DL185	One six zero Delta185.	
11.05.42	LIMM WN2	Delta185 call Milano one two five six three zero.	
11.05.46	DL185	One two five six three zero Delta185.	
11.06.02	DL185	Milano Delta185 passing level two one eight descending level one six zero.	
11.06.05	LIMM ASW	Ciao Delta185 identified able to join ASTIG-3E arrival?	
11.06.12	DL185	Ehmmm… negative… possibly… we are talking to the company on the other telephone and possibly return to a different airport, request level two hundred for now until we have the airport to divert to	

11.06.24	LIMM ASW	Ok one eight five level two hundred is approved… so you will maintain the area holding or performing orbit?	
11.06.30	DL185	* maintain… maintain present heading and like level two hundred Delta185.	* Unclear words.
11.06.35	LIMM ANW	Roger.	
11.07.33	LIMM ANW	Delta185 relay heading to Milano one three five four five five.	
11.07.37	DL185	One three five four five five Delta185 bye bye.	
11.07.48	DL185	Milano Delta185 level two hundred.	
11.07.50	LIMM WS2	Delta185 ciao radar contact, when ready report your intentions, thank you.	
11.07.57	DL185	Will report intentions when able Delta185.	
11.13.08	DL185	Milano Delta185?	
11.13.10	LIMM WS2	Delta185 Milano?	
11.13.11	DL185	Request vectors Rome Fiumicino.	
11.13.14	LIMM WS2	Copy vector to Fiumicino… hmm… fly on heading one four zero.	
11.13.18	DL185	Fly on heading one four zero Delta185.	
11.13.22	LIMM WS2	Ok… you need any special assistance?	
11.13.25	DL185	Not this time.	
11.14.28	DL185	Milano Delta185?	
11.14.30	LIMM WS2	Delta185?	
11.14.31	DL185	Declare an emergency at this time, ehmm…possibly damage to the (*) like to continue to Rome Fiumicino and… with the (*) landing and like to have fire truck standing by on the arrival.	* Unclear words.
11.14.42	LIMM WS2	Ok Delta185 copy the emergency to Fiumicino… ehmm… I'll call you.	
11.14.19	DL185	Roger… and (*) advice the runway in use in Fiumicino?	* Unclear words.
11.14.52	LIMM WS2	I'll let you know.	
11.15.17	DL185	And Delta185 would like to go direct to Rome.	
11.15.21	LIMM WS2	Ok… Malpensa is closer to Fiumicino you want anyway to go to Fiumicino?	
11.15.26	DL185	Affirmative! direct Fiumicino… confirm?	
11.15.28	LIMM WS2	Ok… for Fiumicino is ok, but Malpensa is closer then Fiumicino… you want to go to Fiumicino anyway?	
11.15.36	DL185	Affirmative!	
11.15.38	LIMM WS2	Affirmative… ok copy emergency to Fiumicino	
11.15.41	DL185	Just confirm present position direct Fiumicino?	

11.15.43	LIMM WS2	Ok… ehmm… proceed to ELKAP the runway will be one six left - one six left.	
11.15.50	DL185	One six left… and say that (*) ELKAP?	* Unclear words.
11.15.54	LIMM WS2	Affirm! Direct to ELKAP… eco lima kilo alfa papa.	
11.16.00	DL185	Direct ELKAP and (*) one six left Fiumicino Delta185.	* Unclear words.
11.16.04	LIMM WS2	Correct!	
11.19.56	LIMM WS2	Delta185 Milano?	
11.19.58	DL185	Delta185 go ahead!	
11.20.00	LIMM WS2	Ok… when able we need to know people on board and remaining fuel.	
11.20.07	DL185	Ok ehmm… stand by.	
11.20.08	LIMM WS2	Yeah… of course we have time.	
11.20.11	DL185	Delta185… two hundred twenty six souls, two two six and remaining fuel is eight hours thirty six minutes and that's one hundred and fifteen thousand pounds.	
11.20.19	LIMM WS2	Ok one more time… people two two six you said?	
11.20.22	DL185	(*) two two six and fuel one one five decimal one, that's in the pounds and eight hours thirty five minutes of fuel.	* Unclear words.
11.20.33	LIMM WS2	Thank you! copy all.	
11.21.28	LIMM WS2	Delta185 Milano?	
11.21.30	DL185	Delta185 go ahead!	
11.21.32	LIMM WS2	Ok… now we have runway only for you, will be one six right - one six right, you have to proceed direct to SUVOK sierra uniform victor oscar kilo.	
11.21.44	DL185	Ok… proceed direct sierra uniform victor oscar kilo, Delta185.	
11.21.48	LIMM WS2	Correct for one six right	
11.21.50	DL185	(*) Delta185.	* Unclear words.
11.22.40	LIMM WS2	Delta185 call Roma one tow four decimal eight good bye!	
11.22.45	DL185	(*) Delta185.	* Unclear words.

ATC Radar plot

The DL185 flight was recorded by the ATC service provider; the track is superimposed to the satellite weather radar image (time 11.00') in Figure 21.

After take-off the aircraft followed SID DOGUB 6T as expected. At 10.55' it completes the left turn to S-W. The distance between the aircraft and the magenta area indicated by the satellite radar image is about 14.5 NM. Starting from 10.58' the aircraft enters in the magenta area. At 11.00' he is still in the magenta area, coming out at 11.02'.

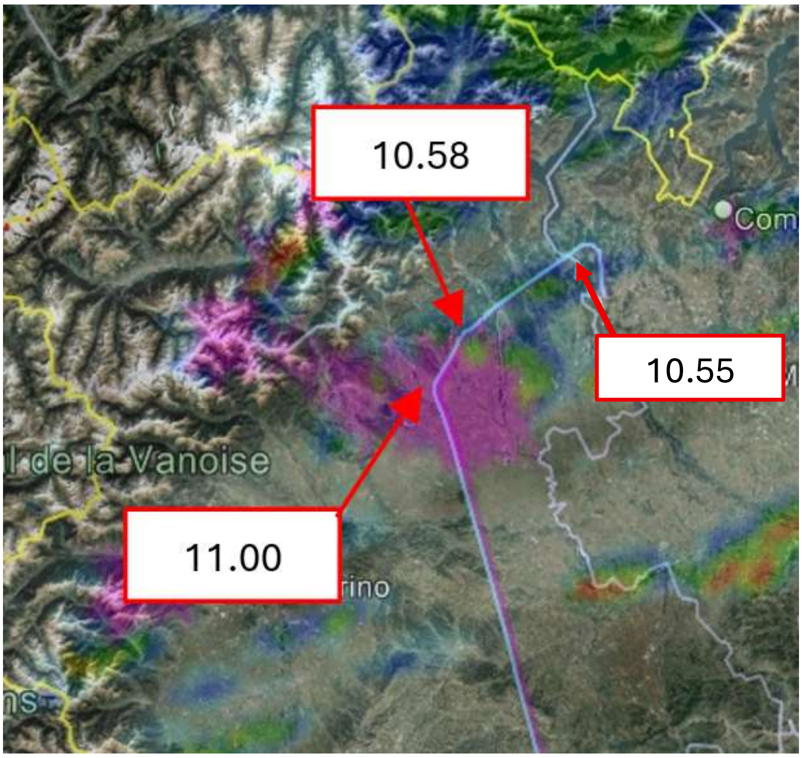


Figure 21: DL185 trajectory compared to the satellite weather radar (image taken at 11.00’).

CVR and FDR data.

The N189DN was equipped with CVR and FDR recorders.
The operator notified the event on the same day of the event.
The ANSV requested immediately details on the event, ordering to preserve the recorders in less than 24 hours.
The CVR onboard the N189DN in the occurrence flight was a L3Harris FA 2100 P/N 2100-1020-00. This records 6 audio tracks:

- CH-1, Pilot, high quality 30’ duration;
- CH-2, Co-pilot, high quality 30’ duration;
- CH-3, PA, high quality 30’ duration;
- CH-4, CAM, high quality, 30’ duration;
- CH 1+2+3 combined, standard quality, 2h duration;
- CAM, standard quality, 2h duration.

All the recordings were retrieved. After the hail encounter the aircraft flown almost one hour more. Therefore, all the 30’ audio tracks were expected to be overwritten. However, the 2h audio tracks should have realistically captured the audio evidence of the occurrence. Nonetheless, the retrieved CVR recordings (2 hours duration) were only attributable to conversations occurred during maintenance activity, held after the event. Therefore, no CVR recording was useful for the investigation, despite the operator procedures requiring to preserve CVR recordings after incidents and accidents.

On the other hand, the FDR 25 hours (Fairchild F1000 P/N S800-2000-00) data showed information on the accident flight. In more detail, take-off occurs at 10.52.00. Then, the data show that between 10:58:00 and 11:00:45 the overall acceleration level rises. This happens when the aircraft is crossing 13000 ft altitude up to levelling at 22500 ft.
At the same time some excursions in pitch, roll and drift angles are observed. After the hail encounter, the aircraft kept 20000 ft en-route altitude. The FDR data do not record any specific warning in this instance.
According to the operator, not observing pressurization issues, according to the relevant procedure, the crew elected to not descend further to minimize bird-strike risk.
Landing in FCO take place at 11:55:07 when the overall weight of the aircraft is 376640 lb (170841 kg), overweight.

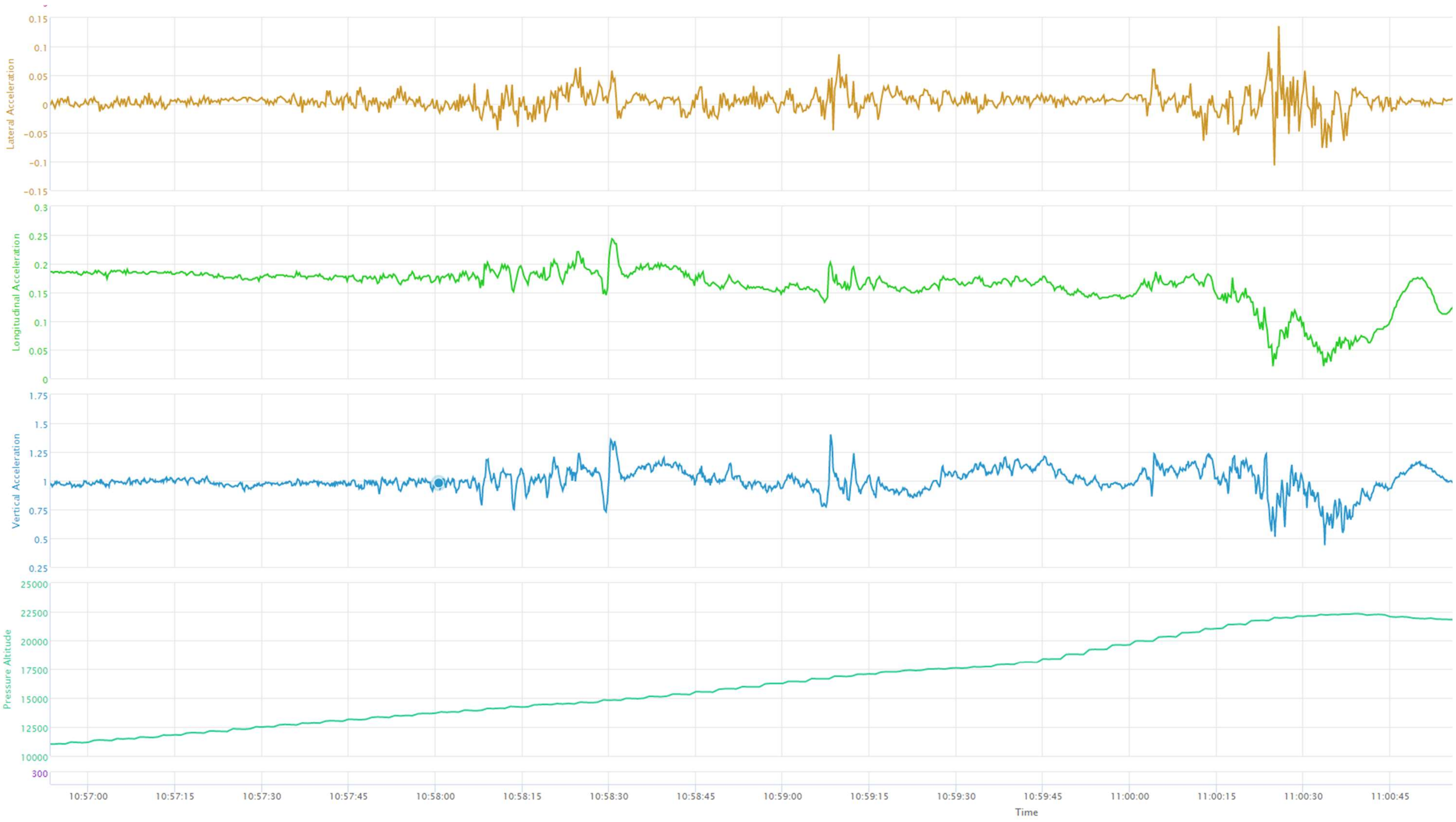


Figure 22: FDR data, accelerations in [G].

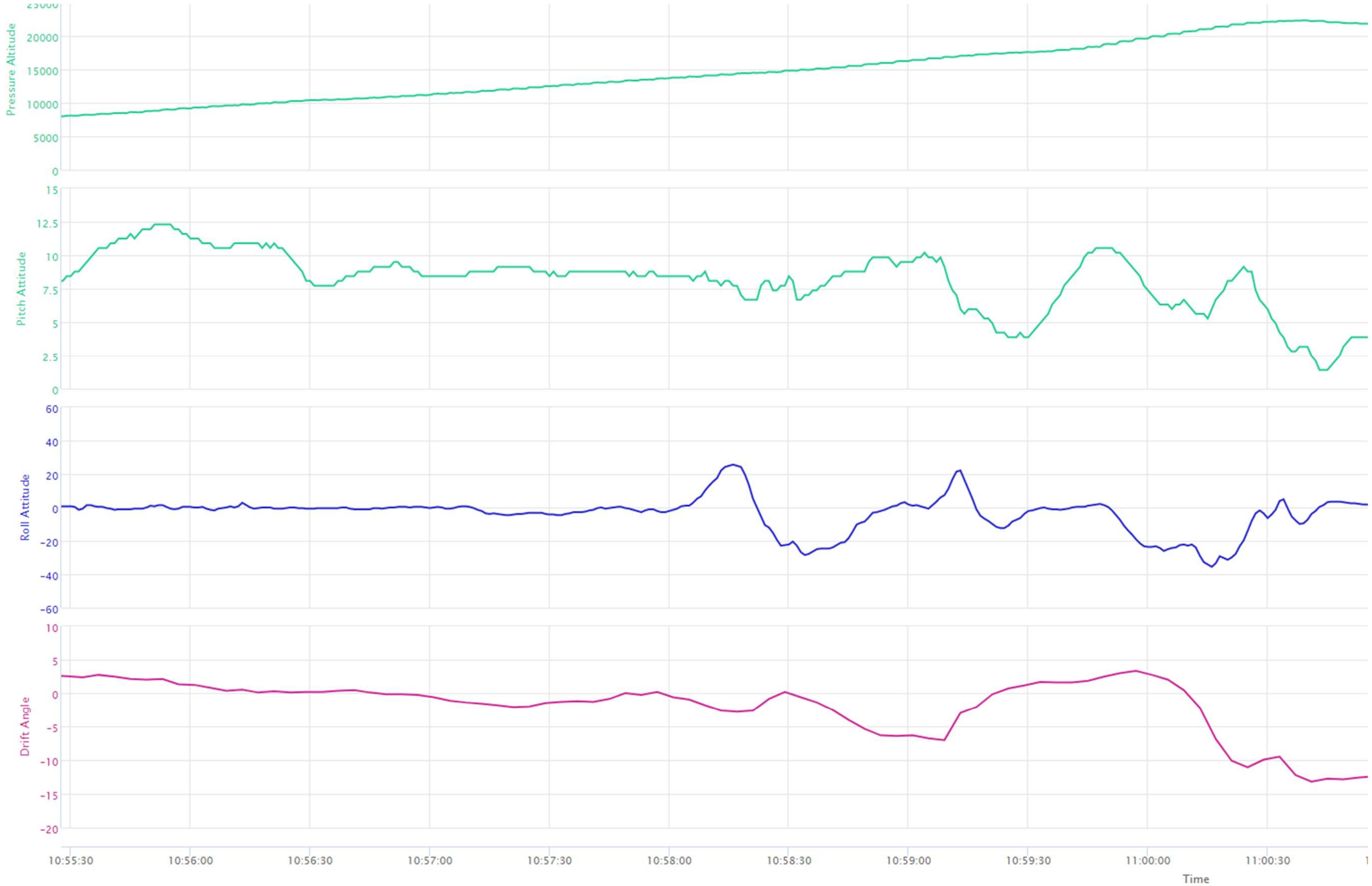


Figure 23: FDR data, attitudes in [deg].

Statements

Captain seated on the left seat.

«At the time of departure, we observed the weather north of the airport. We had already briefed it earlier and planned to deviate around it while continuing to concurrently monitor the weather and the high terrain located west of the airport. Climbing through 10000 ft, we encountered heavy rain, which was followed by hail at 13000 ft. We immediately requested a left deviation from ATC to remain clear of the terrain and get out of the weather.

The hail intensified as we were climbing, and eventually the outer pane of the front window on the First Officer's (FO) side, cracked. We requested to stop the climb, levelling at FL230 and 250 kts. I transferred aircraft control and communication to FO [omission, name], who assumed the Pilot Flying (PF) role and Relief Pilot, FO [omissis, name], used SATCOM to contact the Company to inform them about the situation.

Captain [omissis, name, LCP] and I executed the damaged window checklist, which advised to land at the nearest suitable airport, and so we declared an emergency. After coordinating with the Company, a collaborative decision was made to divert to FCO. Enroute to FCO, we ran the overweight landing consideration checklist and requested the longest suitable runway, which was identified as 16R.

We proceeded to FCO for Runway 16R, and I resumed the PF role. We ran all appropriate checklists and advised FCO to have fire trucks inspect our brakes after landing.

After being cleared by the fire chief, we continued taxi to our assigned parking location and parked without incident. All appropriate checklists were completed, and logbook entries were entered after shutdown.»

Captain administrating the line check (LCP)

«On July 24, 2023, on Delta Air Lines Flight 185 from MXP-JFK on 24JUL2023. I occupied the jumpseat behind and to the left of Captain [omissis, name] to administer a line check.

We departed MXP on the DOGUB 6T, AOSTA 5W departure. Climbing through FL100, the aircraft encountered heavy rain. As the climb continued, the rain turned to hail around FL130. From my position on the jumpseat I could not see the weather radar display, but I do not recall hearing Air Traffic Control (ATC) warning the crew of severe weather along our flight path.

The crew made the decision to deviate to the left to fly out of the hail which had become quite severe. Climbing through FL150, the First Officer's (FO) front windscreen cracked because of the hail, so the crew stopped the climb at FL230 and maintained 250 KIAS once the aircraft exited the severe weather. Because of the damaged windscreen and possible airframe damage, we decided that we needed to land earlier than scheduled. The Relief Pilot contacted Delta Flight Operations Dispatch and 767 Maintenance Control to consider divert options. We all agreed that Rome was our best option because of its proximity and clear weather. Captain [omissis, name] gave control of the aircraft to the FO who initiated the divert to Rome and declared an emergency with ATC. Meanwhile, I ran the damaged windscreen checklist and had the Relief Pilot run the overweight landing checklist. Captain [omissis, name] took back control of the airplane and made an uneventful overweight landing in Rome. Station fire department inspectors looked over the airplane and gave us the "all clear" to taxi to a remote pad to shut down and deplane the passengers. »

First Officer

«I was a First Officer of Delta Air Lines Flight 185 from MXP-JFK on 24JUL2023.

At the gate, prior to departure, the Captain (Pilot Flying (PF)) gave a thorough briefing to all pilots. We discussed the complexity of the SID which included terrain and a complex EO procedure. The plan was to depart 35R and fly the DOGUP6T followed by AOSTA5W. The Captain and I agreed to load the engine out procedure in RTE2[6]. Once we depart, the Captain would have me load the terrain boxes in RTE2 because we would be overflying the terrain to the north. Reaching the end of 35R, I asked the Captain if he wanted the weather radar turned on as it had started to drizzle while taxiing out. He agreed, and we turned it on, but at this point there was no indication of significant weather on our radar display or by looking outside. ATC also had not advised us of any adverse weather, and we did not observe any significant radar returns once airborne.

The auto pilot was engaged early as we both agreed to actively monitor the aircraft, keeping in mind the many published crossing restrictions and speed restrictions on the SID from the brief. As the aircraft rolled out on a southwesterly track, I noticed significant radar returns at our 9 through 1 o'clock position so I asked the PF wanted any deviations. He said yes, and I advised ATC that we required left deviations to avoid, which ATC approved. At this point, we began to enter what felt like moderate precipitation.

The radar showed the quickest path clear to the north, however we knew there was also rising terrain, so I advised the PF to turn left immediately as it would allow us to exit the weather faster than staying on course. As we began our left turn, I noticed a flash of light on my windscreen followed by a sudden crack. Several seconds later, we exited all precipitation and were between layers. The Relief Pilot (RP) quickly began the QRH for a cracked windshield. Upon speaking with Dispatch and Maintenance, we were advised to continue to Paris or Madrid. I quickly looked at the METAR for Paris and noticed towering cumulus (TCU) clouds over the field. Since we were pointed south, I asked if Rome was an option. Dispatch then advised that we divert to Rome.

The PF delegated aircraft control and communication to me. I declared an emergency with ATC and asked for vectors to Rome LIRF. We continued uneventfully, and the Captain resumed PF duties just prior to landing, while the RP ran the overweight landing checklist and divert considerations. After an uneventful landing on 16R, Crash, Fire and Rescue (CFR) personnel advised we shut engines while they inspected the aircraft and brakes. Upon being given a thumbs up by CFR personnel, the Tower Controller advised us to start engines and taxi to the hardstand – which we did, without incident. All abnormal checklists were run by the RP from the Jumpseat, and the PF and I completed all normal checklists.»

Relief pilot

«I was the designated Relief Officer for DL185 from Milan to New York on July 24, 2023. I was occupying the center flight deck jump seat during departure when the aircraft encountered severe adverse weather conditions. A great deal of pre-flight effort was focused on the departure runway and potential AWABS issues. The weather in the area was known and briefed, but from our perspective, the departing traffic from Milan seemed to flow smoothly and there was no delay in taking off.

During departure, I focused on backing up the Captain to ensure we were at proper speeds and altitudes to allow acceleration and flap retraction. The First Officer (FO) was the Pilot Monitoring

[6] Completion of the FMC preflight requires data entry in all minimum required data locations. Within the data entry operation there is the completion of the Route page. RTE2 is route n.2 loaded in the Route page n.2.

(PM), and his Multi-Function Display (MFD) was depicting the weather radar. He brought it to our attention that the weather was directly ahead and that we would soon penetrate it. Climbing through 13000 feet, we entered severe precipitation, which became heavier and louder as we continued climbing, to the point where it was difficult to communicate. The FO asked ATC for clearance to deviate from course to clear the weather, which they cleared us to deviate as necessary. This was the only communication we received from ATC regarding any adverse weather.
Also complicating matters was the high terrain to the right of our flight path. In response, the Captain made a left correction and the FO prompted him to turn further south. We encountered hail climbing through 15000 feet, and I subsequently motioned for the Captain to turn due south as oral communication was ineffective. We exited hail at approximately FL190, however the FO's windscreen had already cracked because of the hail. We reached out to ATL RADIO via SATCOM, where we conferred with Dispatch and MCC. We all agreed to divert to FCO, as there was no inclement weather between us and the landing field (all other options either had weather issues of their own or were simply too far away).
We completed our conversation with the Company, briefed the flight attendants as to the nature of the emergency, and ran the necessary checklists in preparation for the arrival (including the Overweight Landing checklist). PAs were made to the nature of the incident and our intent to land in Rome. We safely landed in Rome. After parking and shutdown, we ran the shutdown, diversion, and post-emergency checklists. Local agents and flight attendants deplaned the passengers. There were no injuries reported, and all passengers were taken inside. »

Extreme weather phenomena[7]

Scientific evidence shows that climate change increases the impact of severe and extreme weather phenomena, such as storms and hurricanes, drought, floodings and heatwaves, and that it may also increase frequency and severity of natural hazards that can pose a particular threat to aviation safety, such as turbulence, airborne icing and bird populations.

As an example of the potential impact on aviation safety, climate change is likely to increase the frequency and severity of clear-air turbulence in some regions where international air traffic is dense, such as the North Atlantic, South-East Asia and the North Pacific. Severe clear-air turbulence is already one of the main causes of passenger and cabin crew injuries worldwide.

Other research shows that climate change is predicted to increase the likelihood of encountering large hailstones, with a diameter of several centimetres. In the worst case, such hailstones could cause a multiple engine shutdown at low altitude, damage aircraft equipment in the aircraft's radome or destroy the windshield.

In this framework, it is worth highlighting the areas for improving meteorological information in the cockpit found from the EASA Weather Information to Pilots project[8] :*"Weather Information to Pilots Strategy Paper, An Outcome of the All Weather Operations Project" from 2018: "Pilots, who have the ultimate responsibility of the operations and the safety of the passengers and crew, sometimes consider that they are not always provided with the most relevant up-to-date weather information from the time they prepare for the flight until they land at the destination. In some instances this may be due to the limitations of the available meteorological information (observations and forecasts) at the pre-flight stage, but also of the awareness of all actors involved in the provision and/or management of meteorological information in-flight, and of course the variability of communications capability. The latter may reflect limitations in aircraft equipage and/or ground and satellite based communication systems.*

WXR, as an aircraft system, is not of itself dependent upon external sources. However, analysis of accidents and incidents has shown that in many cases pilots did not operate the radar correctly. The information was available, but improper use of the system and/or not understanding system limitations compromised the overall situational awareness.

It is also appropriate to consider ICAO's own reference to the display of Meteorological Information in the Cockpit, as outlined in Appendix 9 of ICAO Doc 8896 – Manual of Aeronautical Meteorological Practice.

In section 2.3 of Appendix 9 to Doc 8896, it is noted that apart from the standard products specified in ICAO Annex 3, the following products are useful for enhancing situational awareness in the cockpit, and could be provided subject to agreement with the operator concerned;

- *wind profile derived from automatic downlink meteorological data;*
- *weather radar images;*
- *satellite images;*
- *lightning location display;*
- *short term forecasts (nowcasts);*
- *terminal movement area weather products for "tailored approaches"; and*
- *three dimensional (3D) displays (e.g. radar and volcanic ash).*

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[7] https://www.easa.europa.eu/en/newsroom-and-events/press-releases/easa-launches-new-initiative-tackle-impact-climate-change-flight

[8] Weather Information to Pilots Strategy Paper - An Outcome of the All Weather Operations Project -19 January 2018.

Whilst it may not be feasible to provide all of the above in the near future, it does provide an overview of a range of products/services that would assist situational awareness. In any event, and as noted in ICAO Annex 3, certain data types (such as satellite imagery) do require specialist knowledge and so the provision of such information should be supported by a combination of documentation, training and appropriate 'visualisation' of the data.

It should be noted that there are, already, EFBs with applications to display meteorological information."

Analysis

Conduct of the flight

The meteorological situation available from METAR, TAF and SIGMET was showing instability but nothing that would have precluded the take-off, especially considering that several different aircraft took off and landed prior the DAL 185 and after. However, none of them flown to West or South-West after take-off; they all directed toward North, North-East. On the other hand, satellite radar images would have showed a high probability of the encounter of an intense weather phenomenon along the SID.

The Crew properly briefed the flight, also considering the mission and weather briefing coordinated by the operator's Dispatch office. This did not contain satellite radar images, although these may have been available on EFB before the boarding door was closed[9], in addition to the possibility to request such information to the ARO. The take-off occurred at 10.52' implying both the crew and the Dispatch agreed the flight was safe as planned. No ATC communication warned the DL185 of possible hail encounters. However, the aircraft had already completed the climb-out and based on the ATS provider MO, it was not requested to provide such information. The operator meteorology department did sense the weather situation and issued a warning at 11.00'. Nonetheless, they also could possibly forecast in advance the meteorologic phenomenon along the planned flight path by use of the satellite radar images. This did not occur.

The weather radar on board has some limitations in the hail detection. However, according to the FO statement, this showed significant returns when the aircraft turned South-West along the SID DOGUB 6T. At that moment, estimated at about 10.55', the aircraft was about 14.5 NM far from the hail encounter. At 10.58', the crew requested to immediately deviate from the planned route. The main effective deviation would have been toward North. However, the presence of the Alps did not make possible this manoeuvre and forced the crew to deviate further left, entering anyway in the hail area. This occurred between 10.58' and about 11.01' from 13000 ft to 22500 ft.

The windscreen cracked and the crew processed the relevant checklist. This would have required to land at the nearest airport descending to 10000 ft in order to minimize the forces on the window.

The crew, after consulting with Delta Dispatch and Maintenance by satellite communications decided to divert to Fiumicino due to the better weather along the route together with possible logistic considerations related to the subsequent maintenance and reprotection of the passengers. Being a not negligible flight time to Rome and considering no pressurization issues arose, the crew elected to stop the descent at 20000 ft in order to minimize bird-strike risk as the windshield damage checklist suggests. During the remaining part of the flight no significant inconveniences arose.

Environmental factor

The weather information for of the day of the accident was indicated some forecasted to present instabilities. The LIMC METAR from 10.50' reported TSRA but several aircraft took-off and landed in the applicable time range, meaning the meteorological phenomena on-going at the LIMC airport were not considered as limiting the operations in that area. Nonetheless, LIMC is about 30 km far from the hail encounter area: this highlights that the local situation, in some instances, for some meteorological phenomena, cannot reflect the real weather in areas even only few tens of km away. Indeed, except for satellite radar information, none of information available would have warned the

[9] WidgetWeather is only available when the flight crew have connection via WIFI or cellular data service.

crew of the possible meteorological phenomenon along the route before the take-off and shortly after. The hail encounter occurred during the execution of the SID DOGUB 6T.

Technical factor
No direct contribution to the event. All the damage was consequence of the hail encounter.

Human factor
The decision of the crew to take off was in line with the meteorological information directly provided to them in the briefing pack. However, the radar satellite images available through the ARO and EFB (WidgetWeather app) would have presented a high possibility of an encounter with a severe weather phenomenon along the SID. Meanwhile, the traffic from/to Malpensa appeared to be regular with several take off before the DL185 and this was also a considered factor. The DL185 took off at 10.52'. When in climb, executing the SID DOGUB 6T, the crew realized, at the completion of the left turn to S-W, the certainty of entering in a meteorological phenomenon. This was at about 10.55', about 14.5 NM before the hail encounter, occurred at about 10.58'. Only at that time, the crew requested to deviate immediately. However, it was too late: they were already entering in the meteorological phenomenon area. The operator MO provisions state that weather phenomena should be basically avoided.
The hail caused the FO windshield to break. The crew in coordination to the operator's Dispatch Office and Maintenance Office, contacted by satellite communication, decided to divert to Fiumicino Airport. This was in apparent contradiction of the relevant checklist that requires to land at the nearest suitable airport. Beside the windshield, from the cockpit the crew could not have a precise idea of the hail damage all over the external aircraft. However, considering the meteorological situation on-going in the North of Italy, in addition to the necessity of having available a suitable runaway for the heavyweight landing, the decision to land in Fiumicino is considered understandable. This also considering that the FDR data do not show the arising of any specific warning.
Further analysis of the human factor is limited by the unavailability of the CVR recordings.

Organizational factor
As per OM, the responsibility of the dispatch of the flight is shared between the Captain and the Dispatcher Office. While it is surely expected the tactical management of the flight being performed by the crew including relevant decisions by the Captain, the strategic planning should be allocated to the Dispatcher. The operator provisions in this respect are:
"Captains and dispatchers have joint responsibility and must agree that the planned flight is safe and can be operated in accordance with FARs and Company policy. Either party may delay flight departure, but only Dispatch may cancel a flight. If enroute conditions change such that the flight cannot or should not continue as planned, the first party aware of these conditions must notify the other."
In this view the mission and weather briefing were indeed provided by the operator's Dispatcher Office. However, the weather information consisted mainly in METAR, TAF and PIREPS along the route, also considering possible alternate airports. Therefore, the information actively made available to the crew would have not presented any situation requiring cancelling or delaying the take-off. In this framework it is important to highlight both the crew and the operator's Dispatcher could have available more detailed information by means of the WidgetWeather app that would have allowed to

forecast the encounter along the SID of significant weather phenomena. However, delayed departure was not put in place neither different flight planning: the DL185 flight took off at 10.52'. The operator meteorology department did actually sense a TP at 11.00'. In any case the Alert of the operator meteorology department was relevant such a large area that it would been of not practical use for the crew. In addition, Operators Dispatchers utilize a flight following tool that can plot the satellite imagery along the routes of their flight.
The overall scenario of the event has to be considered in comparison with weather phenomena, apparently becoming more frequent and more extreme. EASA itself is aware of the issue, several initiatives are on-going to improve safety in this area.
Nonetheless, many of the recommended safety measures were already in place within the operator, meaning that methods to forecast the flight path encountering an area of severe weather were available both to the Dispatcher and to the crew. Furthermore, the Dispatchers also may have provided a warning to the crew considering the availability a flight following tool that can plot the satellite imagery along the routes of their flight.
Based on the above the investigation considers that some form of operative pressure influenced the actions decisions of both the dispatcher and the crew during in the planning phase as well as in flight. The lack of the CVR recordings hampered the possibility to verify this hypothesis.
It is worth noting that the operator put in place safety actions in the aftermath of the event aimed to minimize the risk of future similar events: it was published a newsletter highlighting the importance of thunderstorms and hail avoidance. In addition, the operator's B757/767 fleet is receiving an advanced 3D weather radar systems that provides higher sensitivity.

Cause

The aircraft damage was caused by the hail encounter, occurred due to the delayed decision of the crew to deviate from the planned flight path. The lack of CVR recordings hampered the depth of the human factor analysis. However, the inadequate usage of all the information about the weather phenomena along the flight route, possibly available to the dispatcher and to the crew, contributed the event to occur.

Safety recommendations

Based on the gathered evidence, the ANSV does not deem necessary to issue safety recommendations.