Managing hailstorms

By: Albert URDIROZ
Flight Safety Manager

1 | Introduction

In the second issue of this magazine, dated September 2005, readers found information on turbulence encounter and avoidance in an article titled “Managing severe turbulence”. Further to this, we will here discuss about the possible consequences of hailstorm encounter and the adequate prevention means.

No civil air transport aircraft structure is designed to absorb large hailstone impacts without damage. In conditions of extreme hailstorm encounter, consequences like destruction of the radome, loss of visibility through the two front windshields, unreliable air data or engine failure may turn out to jeopardize the safety of the flight.

Safe operations therefore consist in avoiding areas of hailstorms by relying, like the avoidance of turbulences, on the efficient use of weather radar. The effectiveness of the latter has been increased by the introduction of enhanced weather radars.

In order to illustrate this discussion, we will refer to in-service events that have been experienced by a few Airbus operators. Events with similar structural and operational consequences have been reported to occur with other aircraft type.

2 | Possible damages to the structure and engines

Windshields

Most of the civil air transport aircraft share the same design of windshields, made of two inner plies that ensure the structural strength, and of one outer ply. The structural plies will withstand impacts, but the outer ply may be damaged. Even if strength is not compromised, effects may be significant in terms of visibility, as shown by this picture taken after flight into a severe hailstorm.

Radome

In most of the severe hailstorm encounters, radomes suffer body damages but still fulfill their functions of fairing and protection for the radar and antenna. However, the air transport industry has recorded a few occurrences of radomes being destroyed.

Fuselage, wings, antenna, probes etc

Leading edges and protruding components may be damaged, or may brake when overstressed.

Engines

Even if Airbus has never received such report, the air transport industry has recorded some occurrences of engine(s) flame-out due to ingestion of hail.

3 | Possible subsequent consequences

All the communication and navigation aid systems may become inoperative when antennas are damaged (VHF, VOR, ADF etc..)

In addition, destruction of the radome may imply:

- Further structural damages upon impact with radome debris
- In isolated cases, engine flame-out upon ingestion of these debris
- Loss of the radar and attached wind shear prediction function
- Loss of ILS information
- Unreliable Air Data situation from disturbed airflow along the probes located downstream of the radome (Ref. sketch, probes location on A320 family).

Unreliable Air Data situation may also result from hail impacting the probes.

A fly-by-wire aircraft experienced such a situation recently. Because pitot probes were impacted by hail, airspeed information was affected.
Systems responded as follows:

- F/CTL NAV ADR DISAGREE was triggered;
- Electrical Flight Controls Systems reverted to alternate law;
- Autopilot and auto thrust disengaged;
- Flight directors were no longer available.

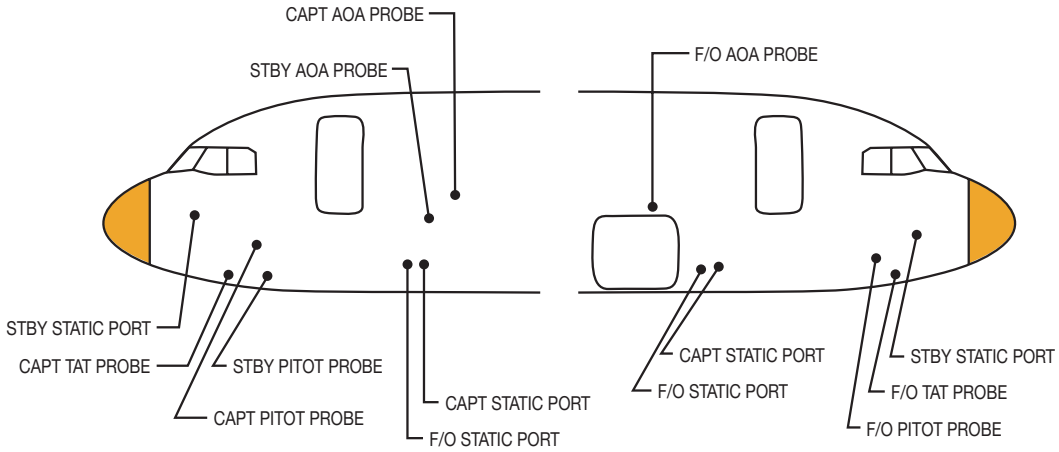
All these effects resulted from the unreliable airspeed flight conditions, which the crew had to manage as per ECAM.

During the same event, the windshield outer ply was damaged, as shown on the picture above. Autopilot, autothrust and flight directors were not recovered when the aircraft flew out of the hailstorm.

An emergency landing was performed, in the following adverse conditions:

- no autoland capability,
- no ILS guidance,
- no visibility through the front windshield.

The crew was able to land with the sole visual references obtained through the lateral cockpit windows.



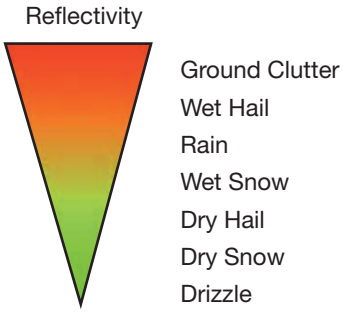
Probes location

4 Prevention means

The Flight Operation Briefing Note entitled "Optimum use of weather radar" explains how to tune weather radar in flight and to interpret the information displayed. It then considers the decisions to take in terms of adverse weather avoidance.

This document highlights that adverse weather management relies on:

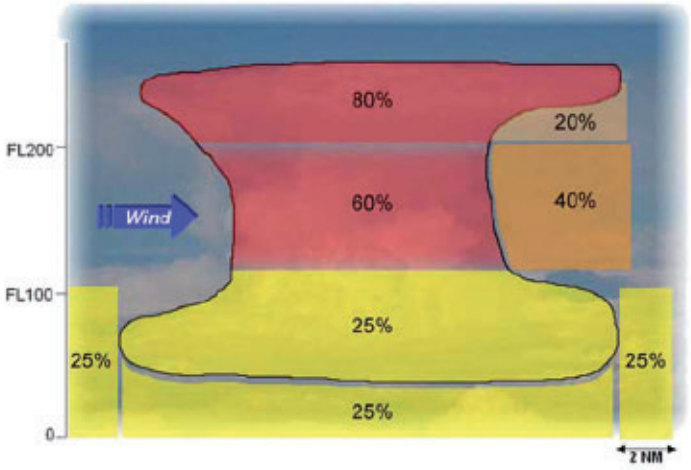
- Awareness of weather radar capabilities and limitations;
- Active and optimum use of radar, with crew tuning the range, gain and tilt;
- Flight crew's interpretation of the Navigation Display radar image;
- Relevancy of decisions taken.



Reflectivity Acording to Droplet Type

One of the radar limitations is that it indicates presence of liquid water. It does not identify the nature of returns, i.e. displays will not positively indicate presence of hail.

Consequently, avoiding hailstorm areas not only relies on the adequate use of the weather radar, but also on the good understanding of the structure of the cumulonimbus clouds that produce hailstorms.

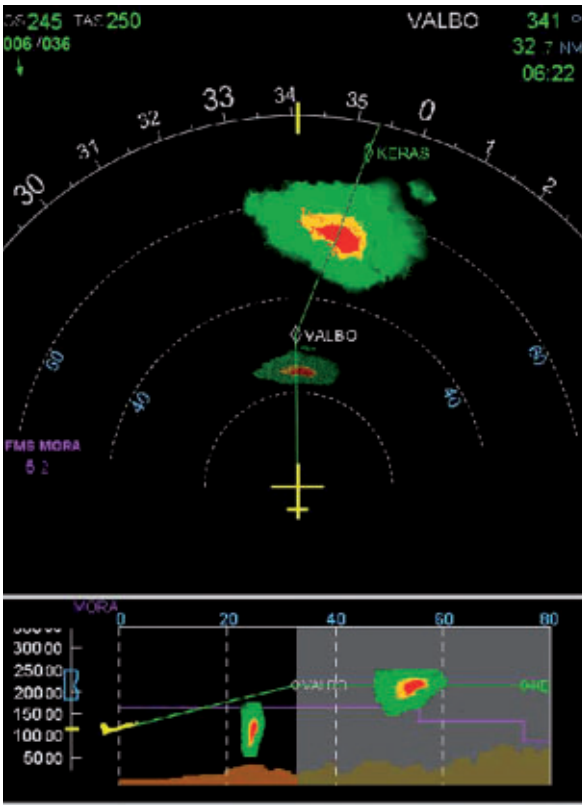


The Risk of Encountering Hail relative to Cb Cloud Position

Airbus recommends that this briefing note be used for training purposes and be made available to crews for developing and maintaining their radar usage knowledge.

5 Adverse weather radar avoidance initiatives

Airbus and the weather radar manufacturers continuously cooperate in increasing radar performance and have introduced enhanced weather radars, which:



- Are more sensitive and accurate;
- Use pulse compression technology and algorithms;
- Scan airspace ahead of the aircraft out to 320NM and up to 60,000 feet;
- Feature 3D display of aircraft route (Ref. picture);
- Feature Auto-tilt.

These enhanced weather radars are proposed at entry into service for new programmes (A380, A350). Feasibility of introduction onto other programmes is under study.

6 Conclusion

In extreme situations, hail encounter may result in:

- Severe damages to the structure,
- Engine flame-out,
- Major systems disruptions,

and thus may jeopardize the safety of the flight.

Consequently all efforts should be made to avoid hailstorms areas. In that perspective, crews should optimally use the weather radar, i.e. adapt the tuning to the flight conditions and correctly interpret the information displayed, in order to take the appropriate decisions. Useful information is provided in the dedicated Flight Operation Briefing Note titled "Optimum use of weather radar".

Enhanced weather radars features, now implemented on new programmes, may be considered for introduction on in-service aircraft as available. For more information contact your Customer Support Manager or your dedicated Upgrade Services Manager.

The briefing note dedicated to the optimum use of the weather radar can be downloaded from the Airbus Safety Library website:

http://www.airbus.com/en/corporate/ethics/safety_lib/

Safety First

The Airbus Safety Magazine
For the enhancement of safe flight through
increased knowledge and communications.

Safety First is published by the Flight Safety Department of Airbus. It is a source of specialist safety information for the restricted use of flight and ground crew members who fly and maintain Airbus aircraft. It is also distributed to other selected organisations.

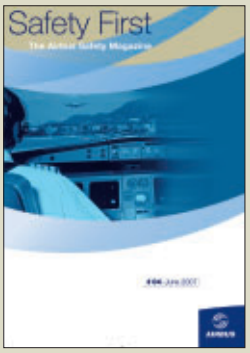
Material for publication is obtained from multiple sources and includes selected information from the Airbus Flight Safety Confidential Reporting System, incident and accident investigation reports, system tests and flight tests. Material is also obtained from sources within the airline industry, studies and reports from government agencies and other aviation sources.

All articles in Safety First are presented for information only and are not intended to replace ICAO guidelines, standards or recommended practices, operator-mandated requirements or technical orders. The contents do not supersede any requirements mandated by the State of Registry of the Operator's aircraft or supersede or amend any Airbus type-specific AFM, AMM, FCOM, MEL documentation or any other approved documentation.

Articles may be reprinted without permission, except where copyright source is indicated, but with acknowledgement to Airbus. Where Airbus is not the author, the contents of the article do not necessarily reflect the views of Airbus, neither do they indicate Company policy.

Contributions, comment and feedback are welcome. For technical reasons the editors may be required to make editorial changes to manuscripts, however every effort will be made to preserve the intended meaning of the original. Enquiries related to this publication should be addressed to:

Airbus
Product Safety department (GS)
1, rond point Maurice Bellonte
31707 Blagnac Cedex - France
Fax: +33(0)5 61 93 44 29
safetycommunication@airbus.com



Safety First
 # 04 June 2007

Safety First is published by Airbus S.A.S
1, rond point Maurice Bellonte
31707 Blagnac Cedex / France

Editors:
Yannick Malinge,
Vice President Flight Safety
Christopher Courtenay,
Director of Flight Safety

Concept Design by
HCSGM 20070592
Production by Quat'coul

Copyright: GSE

Photos copyright Airbus
Photos by ExM:
Hervé Berenger
Philippe Masclet
Hervé Goussé

Printed in France