HAZARDS OF FLIGHT IN HEAVY RAIN

Original idea from P. Warr

In the summer of 1997 there were two accidents, involving the loss of large transport aircraft, which occurred in very heavy rain. The first casualty was a Korean Airlines Boeing 747 which came down on Guam, and the second, a Vietnamese Tupolev in Cambodia. Both aircraft accidents occurred in torrential rain on approach to an airport. Although it may turn out that rain was not a factor in either of these accidents, research indicates that heavy rainfall can have a significant effect on the performance of an aircraft.

EFFECT ON WEIGHT AND SPEED

Research has shown that the mass of any water film that accumulates on the surface of an aircraft increases the weight, of a typical large transport aircraft, by no more than about 1 %; this is largely insignificant. Raindrops striking an aircraft lose momentum on impact and in a torrential downpour, of 500 mm/hr for 20 seconds, can theoretically cause a 4 kt loss of airspeed for a Boeing 747 in cruise configuration. The effect in the approach configuration is unknown but likely to be greater.

AERODYNAMIC EFFECT

In torrential rain a film of water will form on the surface of the wing. This film will become distorted and "wavy" under frictional stress in the airflow, thus increasing the "roughness" of the wing surface. The roughness will be further increased by the continuing impact of the large raindrops because these will crater the water film. One effect is to move forward the point of transition increasing drag and reducing lift, especially at high angles of attack (compare figure 1 and figure 2). At rainfall rates of 100 mm/hr the increase in drag has been estimated at 5-10%, increasing to 30-50% in 2000 mm/hr rainfall. The other penalty is a reduction of up to 30% in the maximum lift generated. The knock-on effect of increased drag and reduced lift is to increase the stalling speed of the wing. All these factors become more pronounced in a high-lift configuration.

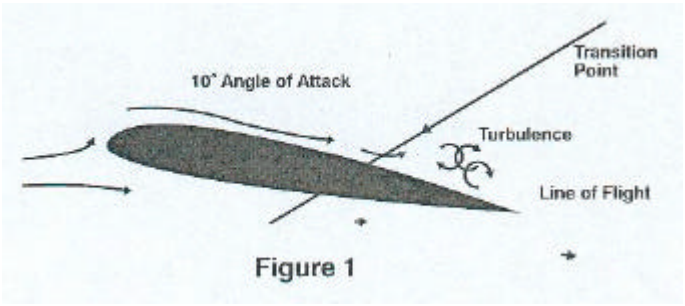

Figure 1

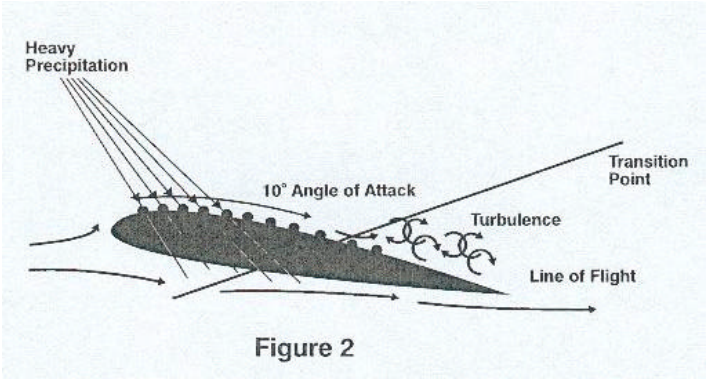

Figure 2

FREQUENCY AND DISTRIBUTION OF INTENSE RAINFALL

Significant rainfall rates are usually associated with tropical storms. However, large convective cells in Europe are also capable of violent storms with rainfall rates of nearly 1000 mm/hr and a 1860 mm/ hr rate is on record for a site in Maryland USA. Rainfall of such high intensity tends to be localized and lasting only a matter of minutes.

The probability of encountering such heavy rainfall on the approach to an airfield is small. The trouble is that the accident record does contain such encounters.

SUMMARY

The effect of heavy rain is another reason to avoid thunderstorms wherever possible. In particular the landing, take-off, missed approach or go-round phases of flight are especially vulnerable in and near thunderstorms, when the significant aerodynamic penalties imposed by intense rainfall could combine with microburst windshear to place an aircraft in a potentially unsafe situation.