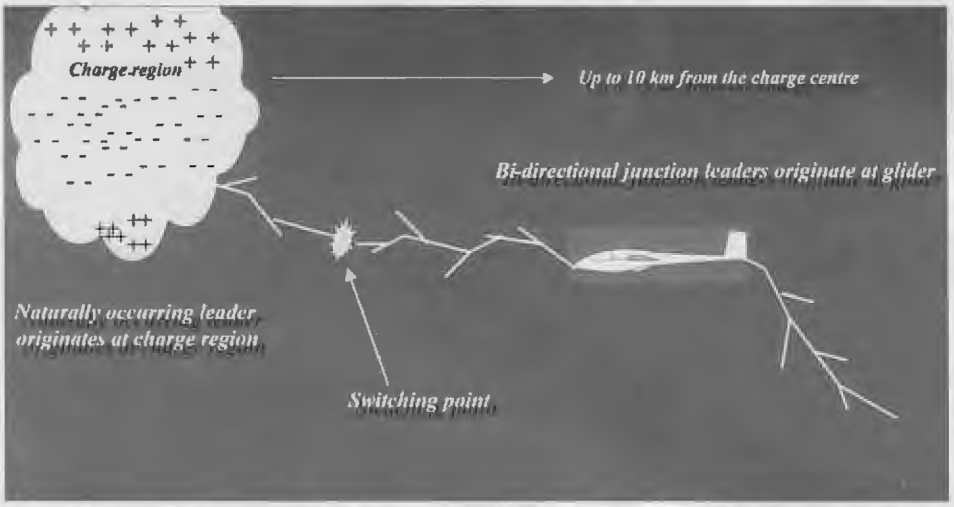
How the hit happened

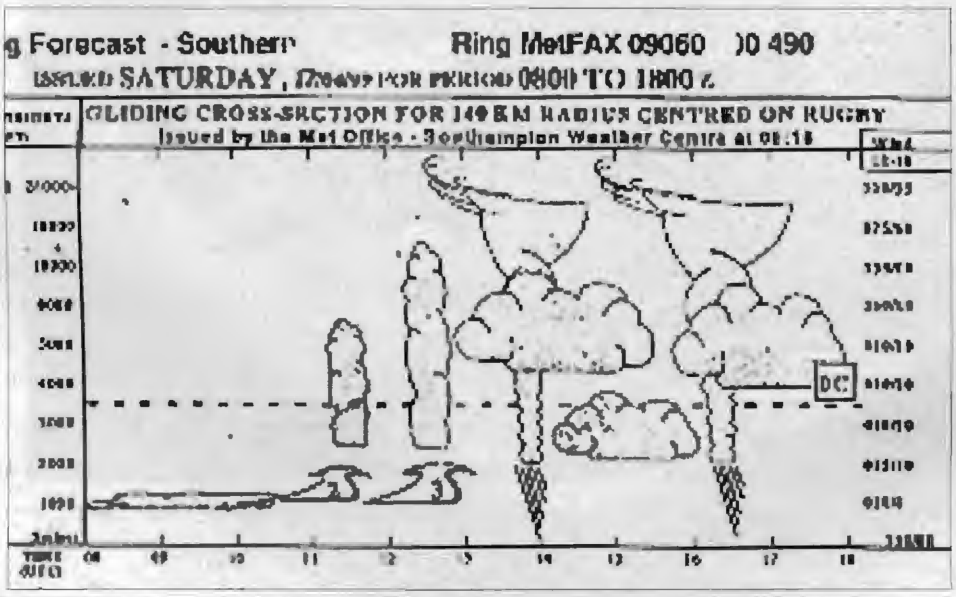


ELECTRIC charges within clouds are produced by complex processes of freezing and melting and by movements of raindrops and ice crystals. A lightning flash starts with the formation of an ionised column of air, called a leader, which travels out from a region where the electric field is strong enough to begin to break down the air.

A naturally-occurring lightning strike begins when an aircraft intercepts a lightning leader. The leader's electric field intensifies around the aircraft extremities and then new discharges (called "junction leaders") emanate from these areas. One or more junction leaders connects with the lightning leader at the "switching point", and creates the "entry point" (the initial lightning attachment point). At the same time, more junction leaders are propagated from other extremities and travel towards a region of opposite polarity (the earth or another cloud charge region), creating the "exit point(s)". Entry and exit points occur on surfaces such as nose, wing, empennage tips and tail.

An aircraft-induced strike (see above) results when the aircraft enters an electric field associated with charged cloud regions – which can extend up to 10km from the cloud – and the field intensity around its extremities is sufficient to trigger bi-directional leaders. These link regions of opposite polarity and again conduct lightning currents through the aircraft. It is not known if GBP intercepted a strike, or if it induced one, but the effects would be similar.

On take-off (1610 hr) the K-21 pilot reports that the cumulus was spaced two to three miles apart in an otherwise clear sky and was not greatly developed. The forecast (below) proved reasonably accurate, with warnings of severe turbulence, lightning and hail in the vicinity of cu-nims.



Technical view

IT IS immediately encouraging to learn that this particular strike has been classified as a very rare and abnormal event, with associated energy levels far in excess of those normally considered appropriate for aircraft designers to design to. This is entirely logical when one considers the number of gliders around the world which have for years sniffed around much more powerful cu-nims than we usually get in the UK.

It is this rarity that has stimulated the intense interest of the AAIB and of scientists whose work involves high-energy electrical discharges. Important lessons can be drawn from their observations which should be of particular interest to glider designers. The BGA Technical Committee strongly endorses the AAIB's findings.

The electrical energy passed through the wing along the aileron circuit, between the two aileron horns. The aluminium alloy tubular control rods carried the extreme energy relatively well, although they were bizarrely distorted by electro-mechanical forces associated with the high voltages.

The explosive damage to the airframe structure was in the region of the pushrods' end fittings which, being made from more electrically-resistant steel, melted in the extreme heat. The ensuing separation of the control circuit drew an arc similar to that commonly seen in arc welding operations, but massively more energetic.

The shock waves which accompanied the formation of the arcs were strong enough to destroy the local composite structure and to blow the cockpit canopies from their frames.

Had the control circuits not separated and the arcs not formed, it is likely that the glider would have escaped relatively unscathed; so the question arises as to how this might be achieved.

One simple solution might be to make the end fittings of the control rods from a more electrically-conductive material such as brass or bronze, so that the energy can be transmitted through the circuit without causing the fittings to heat up and melt. Another solution approaches the problem from the opposite viewpoint, namely making all the control circuits non conductive by using a filament wound kevlar/glass composite control rod tube.Either way, a greater degree of survivability could be achieved.

We can only hope that glider designers feel it appropriate to pay attention to such details in the future.

Mike Woollard, Chairman
BGA Technical Committee