ROYAL AERONAUTICAL SOCIETY

Prestwick

Branch Newsletter

January 2009

Chairman's Comments

I hope that you had an enjoyable festive season. As you are probably aware, I am taking a back seat from Branch matters for a few months at the moment. That means I missed the December meeting and will miss the January meeting too.

This month's newsletter sees two very welcome new contributors, Ian Adams and Hugh Lorimer and consequently has a particularly "SAL feel" to it.

Hopefully I'll be fully back with you next month.

Dave

When All Else Fails....

Ian Adams

In military fast jets if it all goes “pear shaped” the crew usually have the option of “banging out” but if a transport or multi-crew aircraft becomes uncontrollable in flight there is usually no means of escape for the occupants. However, on the plus side, transport aircraft are operated within safe limits that have been previously determined by flight-testing and, as a result, have a very good safety record. But what of the flight-test crews who are asked to deliberately fly these types of aircraft to the extreme corners of the flight envelope and limits of performance to enable the safety margins to be determined for normal flight? What can be done to reduce the risk for them when the unexpected happens and it all goes wrong?

Firstly it can be decided which of the test flights are likely to put the crew into high-risk situations. For instance, when exploring the flying qualities around the stalling speed of the aircraft, unexpected large departures from controlled flight might be encountered. Also, during checks to ensure that the aircraft is free of any disastrous “flutter” modes, an unexpected structural failure could occur at high airspeeds during the deliberate excitation of the aero-elastic characteristics of the structure. There may be other high-risk tests to be considered depending on the type of aircraft. Having assessed the possible risks, an in-flight escape system can be devised to give all of the crew the best chance of survival.

BAE SYSTEMS Prestwick was asked to consider the design of such a system for the prototype MRA 4 Nimrod.

The Vulcan and Concorde crew escape systems were tested on the ground using the blower tunnel at Boscombe Down and when we used the same facility to test the Bulldog canopy jettison system we were shown films of these tests. The blower tunnel was a magnificent piece of kit; it was like a giant hair drier with the fan powered by four Rolls-Royce Merlin engines. It made a beautiful noise at full power and could produce an air blast of about 350 knots at the working end of the nozzle. Also we already had some experience of the relatively simple escape systems that we fitted to the Jetstream family of aircraft.

The original flight test reports were available for the Vulcan and Valiant bombers showing what happened when suitably kitted dummies were dropped from the escape hatches at various speeds. Airbus gave us information on the system used on all their aircraft including the ATR turbo-props. The pragmatic Airbus approach to the problem was to simply use a shaped explosive charge to blow a large square hole in the lower fuselage and this in turn released a spring-loaded flat air dam out into the airflow. The crew jumped down through a hole in the cabin floor and a smooth walled tunnel guided them to the exit. Pyrotechnic fuses were used to trigger the explosives so the system was entirely independent of the aircraft systems. In ground tests they found that they could get three crewmembers out in less than 10 seconds. Advice was also sought from a military parachute drop tester who was at the time carrying out trials on the C17 and the C130J. Boeing was rather quiet on the subject. Maybe they did not expect their aircraft to go wrong.

By assessing all this information it appeared that it might be possible to get people out of the Nimrod at speeds up to about 250 Knots Equivalent Air Speed (KEAS) if they could be got safely from their crew stations to the escape hatch. We had expected the lead design group at Warton to supply a full engineering specification for the escape system but all we got was a brief request from the test pilots. At the forward and rear passenger doors they wanted the existing inner door handle replaced by a larger one, and asked for a knotted rope to be fixed along the length of the ceiling in the cabin.

The passenger doors in the Nimrod [originally the Comet] pressurised hull were designed to be very safe. They were true plug doors i.e. the doors were bigger than the door aperture and therefore the differential pressure load on the doors was distributed evenly onto the door surround frame via the door seal and the pressure ensured that the doors stayed closed in flight. The door handle operated the four small shoot bolts at the edges of the door. These shoot bolts did not carry any of the pressure loads and were only required to keep the door from falling inboard during un-pressurised flight and when the aircraft was on the ground. The disadvantage of using these doors for fast escape routes was that they could only be opened into the cabin when all of the cabin differential pressure had been exhausted. So it appeared that the request to fit a bigger handle to more easily retract the shoot bolts would not assist in opening the doors and the crew would have been trapped inside the aircraft until all of the cabin differential pressure was exhausted.

BAE SYSTEMS' photograph of the installation described in the article. Clearly visible are the large, central pull handle and to left, part of the air dam that is fired out of the open door. If anybody has access to a picture of the door fully deployed, we would be happy to publish in a future newsletter

However, as requested, we submitted a design scheme to Warton that complied with the pilots' request but we added some comments giving our misgivings of the proposed system. The report stirred up interest at Warton and a meeting was convened to discuss what should be done. The points-of-view of many and various specialists was considered and before we knew it the whole concept had changed entirely. We suggested the Airbus approach to the problem but Warton thought that explosives would be too dangerous. Very strange since they intended the Nimrod to be flown eventually with the weapons bay full of all kinds of nasty explosives. Warton insisted that the existing passenger doors should be used as the escape routes to avoid extensive structural changes to the aircraft and that we should design for a crew of six. We highlighted the fact that the forward door would be of limited use since it was just ahead of the engine intakes but it was decided to use it anyway. We were asked to design for safe escape at airspeeds up to 250 KEAS, vertical accelerations of -1g to +2 g and for all possible aircraft attitudes. Despite our best efforts the specification had now become very complicated.

A small team at Prestwick assisted by a sub-contract office in the Isle-of-Man, set about designing the system to meet the new specification. The original fairly tight design programme had now only a short time remaining. The existing front and rear starboard cabin doors were detached from their normal hinges and modified to have a large central pull lever that not only retracted the normal shoot bolts but, by contacting a pad above the door, gave the operator the ability to jack the door open against a residual pressure of about 1 pounds per square inch gauge (psig). Simple guide rails and counterbalance springs were added so that the door would shoot up into the ceiling of the cabin when opened. Blank metal panels replaced three of the port cabin windows and on each were mounted two electrically operated pressure dump valves. A manually operated back-up system was also fitted to open the dump valves in the event of total electrical failure.

A single guarded "abandon aircraft" switch was fitted in a central position in the flight deck. This multi-function switch shut down the normal high pressure bleed-air from the engines, opened all six dump valves, sounded loud warning horns, Illuminated the large "abandon aircraft" signs at the cabin crew positions and illuminated the large green "clear to jump" lights above the doors. A self-contained electrical supply was devised to operate the escape system to avoid reliance on the aircraft systems. At each of the forward and rear doors a retractable air dam powered by strong gas springs was designed to normally sit in the cabin but, when triggered by the opening of the door, was released to a position outside the aircraft at the forward edge of the door aperture. The air dam allowed the escapee to more easily enter the airflow and was provided with a series of round holes to allow it to baffle the airflow without creating strong vortices from the edges of the panel.

To avoid snagging clothing or equipment during exit through the door aperture, a metal panel that covered the whole height of the door was also fired by springs into position at the rear of the door frame to provide a smooth edge to the exit. A number of vertical poles were fitted on either side of the cabin aisle to allow the crew to move hand-over-hand down the cabin in both positive and negative G conditions. To allow the crew to attach their parachute static lines to the aircraft just before exiting, an anchorage cable was fitted just inside the doors. The parachutes to be used were normally activated by the static line but, in the event of a bail-out at high altitude, a barometric release delayed the actual opening until a safe height had been reached. The crew could over-ride the automatic release system by pulling a standard “D” ring ripcord. The parachute packs also included a small oxygen supply to allow the crew to reach the escape door without blacking out due to high altitude.

The design was finished on time complete with a description of the system, ground test schedules and notes for the crew and flight manuals. Later, when the build of the prototype aircraft was running late to programme, the production team asked if the system could be simplified. Another design meeting was called and it was decided that it would be much more sensible to have a maximum of three crewmembers on board during high-risk flights and that they would all be in the flight deck. This allowed all the warning signs and horns in the cabin to be deleted. Also it was decided to delete the smooth guide plates at the rear of the doors. The design and documentation was amended and re-issued. This was to set the standard of the system that was eventually fitted to the aircraft. During ground tests it was established that even with the maximum differential pressure in the cabin, the system could be activated and be ready for crew exit in about 15 seconds. This was fairly good but of course an out-of-control aircraft could lose a lot of altitude in that time.

I am glad to say that the system was never used in anger.

This was quite an interesting design package and despite the short time-scale we had a few laughs along the way. One “expert” was worried that if we depressurised the aircraft too quickly we might damage the hearing of the crew, he obviously had not considered all of the consequences. Another told us that the crew would not be able to exit the aircraft in a controlled manner since they would be forcibly sucked out of the aircraft by the high speed airflow on the outside of the fuselage. He presumably had never wondered why ejection seats were invented to punch pilots out into the airflow.

Lecture Programme 2008-9

08 September 2008
RAF Air Traffic Control in Afghanistan and Iraq
Squadron Leader Andy Butterfield, RAF Prestwick

13 October 2008
The Fairey Rotodyne
David Gibbings

20 October 2008
Partmentier of KLM and Tragedy at Tarbolton
Jim Hood

10 November 2008 (joint lecture with IMechE)
Thermal Spray Coatings used within Gas Turbine Applications
David Gill, Rolls Royce

08 December 2008
Typhoon
Group Captain Mark Knight, RAF

19 January 2009 - The McIntyre Lecture
The Barnwell Brothers
Professor Dugald Cameron

09 February 2009
HMS Gannet Search and Rescue Flight
Lieutenant Commander Martin Lanni, RN

09 March 2009
Recreating Percy Pilcher's 1895 "Bat"
Ian Adams, Quentin Wilson and Stephen Kunz

20 April 2009 - Branch AGM
Amphibious Flying from the Clyde
Hamish Mitchell

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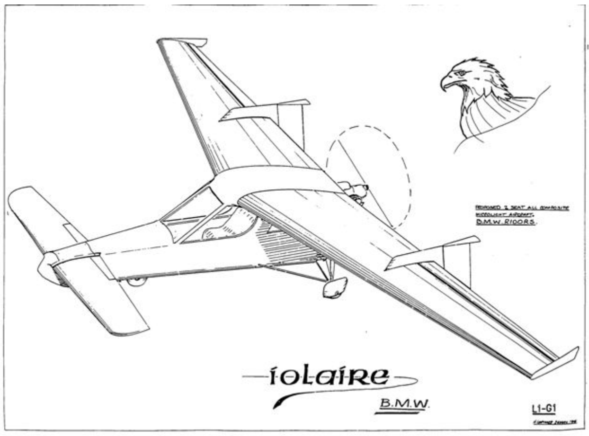
Hugh Lorimer - One Man Aircraft Factory!

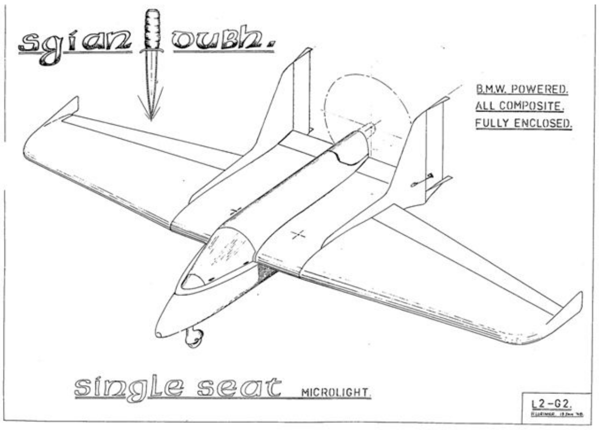
Photos Hugh Lorimer. Words Dave Lacey

Sometime apprentice with Scottish Aviation Limited and retired schoolteacher, Hugh Lorimer has long been an enthusiastic member of the Prestwick Branch. His aeronautical training clearly had an effect because Hugh is now Scotland's only serial designer and manufacturer of complete aircraft!

Hugh has heroically championed aircraft designed, built and certified in accordance with British Civil Airworthiness Requirements (BCAR) Group S.



"Iolaire" is the only one of Hugh's aircraft to actually leave the ground - it has around 20 minutes on the clock. Noteworthy (and particularly controversial) is the use of an "all-flying" canard for pitch control.



Hugh's second design is the "Sgian Dubh". Although it has yet to fly, Hugh has exhibited her at many rallies both in the UK and in Europe.

The most recent output from the "factory" is the "Quaich", a pretty single seat tail-dragger - and surprisingly conventional compared to its stablemates!

Find out more about Hugh's remarkable flying machines at www.hughlorimer.co.uk