BIRD STRIKE COMMITTEE EUROPE

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THE EFFECT OF BIRDS ON AIRCRAFT

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ABSTRACT

The presentation uses colour slides to summarise case histories of selected serious and fatal bird strike incidents to airliners, general aviation aircraft and military aircraft. Comprehensive statistics from European Airlines 1980-85 including rates are also shown. The legal aspects and a summary of remedial measures are also covered.

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by: John Thorpe,

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This paper is the work of an individual member of staff and may not reflect the final views of the Civil Aviation Authority.

SUMMARY OF MAIN POINTS OF VISUAL PRESENTATION ON BIRD HAZARDS TO AIRCRAFT

by: John Thorpe, Chairman Bird Strike Committee Europe

THE THREAT

- First fatal accident 1912, Cal Rogers first man to fly across USA killed at Long Beach in California. Gull *lodged in flying controls* of Wright Flyer. Birds were a problem right at start of aviation - and it was our current major threat, gulls.

- More recently, DC10 on take-off from Kennedy Airport 1975 ingested gulls including 2 kg (4½ lb) Great black-backed (Larus marinus) into engine 3. Uncontained failure, wing tank ruptured at V1 decision speed. Abandoned take-off on wet runway, just stopped at far end on high speed turn-off. 139 on board evacuated successfully, all were airline employees who knew procedures.

- The burnt out remains of the DC10.

- Nearer to home, B737 with 3 crew doing touch and goes at Gosselies in Belgium. Ingested a Wood pigeon (Columba palumbus, 465 gm) in one engine, such a severe loss of acceleration that it felt as though both engines had ingested birds. Take-off abandoned well beyond V1 - over-ran across main road into industrial estate, burnt out. Crew escaped. Just one bird had written off a $20 million aircraft.

- Lear 23 climbing through 4,000 ft near Cincinnati USA, hit Loon (Gavia immer), a 3.7 kg (7 lb) water fowl. Came straight through windshield killing co-pilot, pilot badly injured with facial and hand injuries. He did a brilliant job in returning to airport with...

- ...one engine failed because of ingested pieces of windshield, wind blast and communication difficulty, dead co-pilot and lost main hydraulic and brake system.

- BAe 125 which on take-off lost both engines due to ingestion of Lapwings (Vanellus vanellus 215 gm). Force landed straight ahead, unfortunately by a million to one chance it hit a car on the road past the end of the airfield, killing the lady driver and 5 children. Three of the children were families of pilots on the airfield. Traffic lights have now been installed. On the day in question the Lapwing distress call tape was broken. It is important that adequate spares are available.

- Norwegian Jet Falcon at Norwich airport after ingesting gulls. The aircraft force landed in the open fields near the airport and stopped after hitting a large dung hill, which was very effective, if smelly! All occupants escaped without injury except the cabin attendant who was standing on the flight deck on take-off. As a result the insurers of the aircraft sued the insurers of the airport for their loss and eventually the case came to the UK High Court. After a week long hearing, the judge in his summing up said that no matter what you do you will not prevent all bird strikes, however you must take reasonable precautions and these reasonable precautions are laid down in a CAA Publication now known as CAP384, 'Bird Control on Aerodromes'. The fact that the airport authority knew from the bird strike record that there was a hazard, from the tower log that there were birds on the airfield and that they had no system in place to deal with them, means that they were negligent. It had also been a factor that Air Traffic Control were unable to see the airfield clearly because the tower windows were not double glazed, there was rain on the outside and condensation on the inside. The judge said that pilots had their own job to do when taxying, such as controlling the aircraft, completing check lists etc and were not responsible for checking the runway state. As far as the CAA were concerned this was an excellent judgement because it showed very clearly where responsibilities lay.

- This was one of the problem birds at Norwich airport, the Black-headed gull (Larus ridibundus, 275 gm), which only has a black head in the breeding season, the rest of the year there is only a black spot behind the eye.

- This BAe 146 was involved in a night-time parcel flight from Genoa in Northern Italy. This aircraft, because it is very quiet, is used for these sorts of operations. At rotation the aircraft ran through a large flock of gulls, one engine over-temperatured and had to be shut down and the other 3 engines were surging and losing power. It limped to 1,000 ft to complete a circuit and return. Inspection of the aircraft revealed all 4 engines needed to be changed and 2 of the engines had core damage as well as fan damage.

- The aircraft itself suffered 54 bird impacts, in addition to the engine damage. There was extensive denting of the engine cowling.

- The whole airframe was covered with blood and guts and needed a good wash.

- The culprit here was the Mediterranean herring gull (Larus argentatus, 1.0 kg) which is very similar to the UK Herring gull excepting that the UK one has pink legs instead of yellow legs.

- The interior of the first class area of a Boeing 747, this is not where CAA staff normally travel! A lady passenger was sitting in the left-hand front seat during a night departure from Heathrow for New York and at about 4,000 ft, somewhere over the Brent Cross area of North London, there was a sudden bang and the lady found herself covered in blood. The story goes that she had a babe in arms on her lap and had hysterics because she thought the baby had blown up! In fact it was a bird strike, in this case a Lapwing at night over North London.

- It had impacted on the top right-hand corner of the cabin window, pushed against the seal between the 2 layers and broken the inner one allowing the remains to squeegee through the gap and over the unfortunate passenger. This is known to have happened at least twice previously.

- The tail plane damage on the 747 was quite severe and the engineers thought they had hit large birds but, the aircraft had been at climb speed of 240 kts and the V squared law applies. A small increase in speed results in a big increase in damage, most people are used to seeing damage in the circuit or approach where speeds would be 140 to 160 kts and the difference shows the effect of impact is quite considerable.

- Some of you will be familiar with the Lapwing which is a commonly found bird on most airfields in the UK throughout the Autumn and Winter. It can be known colloquially as the Green plover or the Peewit. It does not exist in North America.

- In 1989 at about 6 am a Jetstream commuter airliner was descending into Madison Airport, Wisconsin USA and at 4500 ft and 230 kts it struck a flock of 7 or 8 Canada geese. Both wings had an 18-20 inch holes through the main spar with top and bottom angles destroyed. The horizontal stabilisers were badly buckled and torn. The pilot reported there were no handling difficulties. The right-hand wing had to be replaced.

- In March 1993 a Freight Boeing 747 was taking off from Frankfurt when, shortly after V1 a bird was ingested in Engine 2. Take-off was abandoned and the aircraft over-ran by 450 m causing damage to engine 1 on the ILS antenna, engine 2 (CF6) was badly damaged by a bird identified as a Buzzard (Buteo buteo, 1 kg).

AIRLINER FATAL ACCIDENT

- It is surprising there has only been one fatal accident involving a jet powered airliner. There have been fatal accidents involving turbo-props and jet powered executive aircraft, but only one airliner fatal. This involved a JT8D engined Ethiopian Airlines Boeing 737 on departure from Bahar Dar airport, in Ethiopia.

- Just at rotation a large flock of pigeons (Speckled pigeons, Columba guinea, 320 gm) were struck resulting in both engines surging very badly. The pilot attempted to limp to circuit height in order to return but after 70 seconds both engines had failed and he was forced to put down in the open countryside, unfortunately containing a river bank which shredded the aircraft resulting in the death of 35 occupants.

- All that was left of the tail, amazingly 69 people survived.

- A close-up of the engine, at the bottom the charcoal-like remains of the blades and the stator stubs around the outside. It was completely burnt out. The airport is 5,000 ft above sea level and any loss of power is very significant.

STATISTICS - European Airlines 1980-1985

- The annual strike rate shows that for many years there has been a general increase with a recent flattening out of the bird strike rate at about 5 per 10,000 movements. In spite of greater awareness, increased resistance for engines and aircraft, and greater effort on the airports there has been little or no improvement

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in the strike rate. In view of the fact that some of the bird species which are a problem on airports are showing an increase in population, and that the expected rise in air transport movements will result in a doubling of movements by the year 2010, clearly there is a problem that we MUST deal with now.

- Strike rate by some European countries shows that some have an excellent standard of reporting, together with a bird strike problem whilst other countries have either a limited problem or a poor standard of reporting. In Scandinavia, for example, many of the birds leave the cold climate for warmer places such as the UK and therefore for much of the year there are very few birds around. Clearly Switzerland, Italy and Ireland have a good standard of reporting, together with a major problem.

- Strike rate at selected major European airports shows that Heathrow and Gatwick are doing a very good job in spite of the presence in the Heathrow area of up to half a million gulls in winter. This is because of 24 hour, 7 day week airfield inspection and scaring by trained staff. Manchester is an interesting case, during the period in question a high strike rate is shown because scaring was in the hands of the firemen who preferred to fight fires, train to fight fires, play snooker and darts and not chase birds around the airfield. However, Manchester bit the bullet and decided to implement a 3 man bird control unit and very quickly this unit was able to deal with the problem because, for example they were small team, air traffic were able to give them permission to operate anywhere on the movement area and only call when crossing the runway. Whereas with the fire vehicles they always had to call before crossing each individual area, thus inhibiting their movement around the airfield to deal with the bird problem. There is now a major problem at Manchester with boredom because the bird control staff have removed all the birds and there is nothing to do.

- The worst airport for European airline bird strikes is Bangkok but the birds there are all small (and dark haired!) and little damage results. But at a number of airports in particular Delhi, Karachi and Nairobi the birds are mainly large birds of prey which cause a significant percentage of damage. Birds of prey have few, if any, natural enemies and are almost impossible to deal with. The 1943 files show that on the Indian Sub-Continent bird strikes resulted in fatalities in a number of Spitfires, Hurricanes, Mosquitoes etc operating in that part of the world so it is not a new problem. The problem was identified over 50 years ago as garbage and animal slaughter houses near the airfields.

- When looking at individual aircraft types there are a number of differences that cannot readily be explained. With 4 engined aircraft the strike rates for the DC8 and Boeing 707 are quite different, with 3 engined aircraft the rates for the DC10 and Tristar are quite different on aircraft that look almost identical. Coming to the twin-engined aircraft the 1-11 and the DC9 which look similar in fact have similar rates. There may be differences possibly due to noise and indeed Concord, which makes more forward noise than anything else, does have a very low strike rate.

- However, when all this data is put together it does look sensible in that the 4-engined aircraft, which have a greater frontal area have a higher strike and damage rate that the 3-engined and 2-engined and when you come to the turbo-prop aircraft these are smaller and take-off at a lower speed, giving the birds more chance to get out of the way, and there are less strikes and damage. Helicopters are slow and noisy with a lot of forward rotor thump and there are even lower strike and damage rates. This does help to give you confidence in the data.

- Almost 40% of bird strikes are due to gulls, with the Black-headed gull and the Herring gull being the most frequently identified. In second place are the Lapwings and this percentage is increasing, followed by swifts, swallows and martins, small summer visitors which don't give much of a problem except to light aircraft and helicopters. Next comes birds of prey, mostly outside UK, followed by small perching birds such as sparrows and pigeons which are present on many airfields. The corvid family, that is crows, rooks, jackdaws, magpies and ravens are rarely struck in spite of the fact that they can be seen on many airfields. They are said to be the most intelligent bird family and indeed you can see this when driving on the highway in that a crow (corvus sp) will be feeding on the remains of something in the road ahead of you, as you get close he walks out of the way to the edge and you look in the mirror and when you've passed he's walking back again. They are very good at judging traffic. Most of the crows struck appear to be juveniles according to the reporting forms that arrive in my office.

- The weight of birds identified is of particular importance on the airworthiness side. For many years there has been a requirement that catastrophic failure must not result from striking a bird of up to 4 lb in weight. This covers 99% of bird strikes. This 4 lb requirement was excellent because it has meant that, as far as I know, no transport aeroplane windshield has ever been penetrated by a bird of any weight, at any speed.

Engines were allowed to lose all thrust. However, about 20 years ago a new requirement was implemented that meant that engines had to be able to take a number of 1½ lb birds depended on the size of the engine and only lose 25% of thrust. The CF6, JT9D, CFM56, Concorde Olympus and RB211 all met this new requirement, however, the JT8D was from an earlier era and was not tested with multiple birds. Thus, with an engine that is likely to be in service well into the next century the only remedial measures must come on the airport.

- Showing how effective the 4 lb requirement is this RB211 swallowed 3 Canada geese (Branta canadensis, 3.6 kg) and was still running, albeit with reduced power.

- The take-off and climb are similar to the approach and landing, very few birds are struck during the cruise phase.

- Fifty five percent of all bird strikes occur within the first 50 ft with 65% up to 100 ft, 88% of all strikes are below 1000 ft. However, it should be noted that 6% of strikes are above 2500 ft and in fact the highest bird strike known is at 37,000 ft off the west coast of Africa involving a Ruppell's griffon vulture (Gyps ruepellii, 7.5 kg). Why he was there we don't know, possibly migrating using a strong jet stream to help him along the same as airline pilots like to do. We also know of 2 strikes at 33,000 ft over the Sahara at night so birds do sometimes fly high.

- As the airspeed increases on take-off birds have increasingly less chance of getting out of the way of an aircraft and up to about 90 to 100 kts there are only a few percent of strikes but above that there is a rapidly increasing risk of a strike taking place. This is because birds do not have time to get out of the way.

- Parts of the aircraft most frequently struck are the windshield, nose and radome area which account in all for almost 50% of all bird strikes but the engines account for 17% of which 1.3% are multiple strikes whereby more than one engine is struck. This is the greatest risk. The tail is very rarely struck, only 1% of strikes there but as a result of an accident in America where a Viscount tail plane was removed by a 13 lb (6.0 kg) Whistling swan (Cygnus columbianus), causing the aircraft to crash, killing all 17 people on board, the Americans brought in an arbitrary requirement of 8 lb on the tail plane. This is in spite of the fact that only 1% of birds are known to be over 4 lb in weight. This requirement, in fact, adds about 50 lb of structural weight to even a small aircraft like a Short SD360.

- During this 5 year period no aircraft were lost, but in the preceding 5 year period 2 aircraft were lost, the Boeing 737 in Belgium and a Learjet in Italy. However, during this period 488 engines were damaged. This, of course, is European airlines world-wide and does give some idea of the universal scale of the problem. Note that windshield damage is only 25 cases and these were the outer panes of the double paned system, either can take the aerodynamic and pressure load. A UK Boeing 727 had the outer windshield shattered by a bird at 20,000 ft over St Abbs Head.

GENERAL AVIATION

- This black Falco was practising for an air race round the Isle of Wight, just off the south coast of England, and at about 500 ft and 140 kts over the water there was a thump at the front and the engine lost all power. The pilot managed to glide down and land successfully on the beach, stopping literally inches from the rocks.

- Investigation revealed that a bird had gone straight down the carburettor intake and when the remains were removed they were found to be a Belgian racing pigeon, off the Isle of Wight in the UK. By coincidence the black Falco had at one time been on the Belgium register, so quite clearly this was a homing pigeon!

- But seriously, a pigeon will do this sort of damage to a Cessna 152 windshield, even at circuit speed, because light aircraft windshields are not required to withstand birds, of any size.

- A Bandeirante was on a test flight in South America when it struck an American black vulture (Coragyps atratus, 1.7 kg), which is about 4 lb, they claimed this as their 4 lb windshield test, in Europe we use a test rig!

- A gull caused major damage to an AA5 wing, some General Aviation aircraft have wet wings whereby the whole wing is full of fuel, there is no separate tank. If this had been the case here there would have been major fuel leakage and risk of fire.

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- A newspaper headline appeared a couple of years ago when a Piper Navajo struck a White-backed vulture (Gyps bengalensis, 5.3 kg) in one of the Kenya game parks. It came through the windshield, killing the pilot, the aircraft crashed and burnt, killing the 9 on board.

- Just 3 weeks later a Cessna 401 in the same Kenya park, struck a bird believed to be a Marabou stork (Leptoptilos crumeniferus, 5.9 kg) which removed the wing tip and aileron. It spun down killing all the 6 on board.

- Marabou storks on the garbage dump outside Nairobi City, fortunately some distance away from the airport.

- In Nairobi and at many airports throughout Africa, the Middle East, India, Far East, Japan and Northern Australia the Black kite (Milvus migrans, 780 gm) is a major problem. A scavenging bird of prey which seems impossible to deal with.

- Birds of prey have been known to attack aircraft. A glider was attacked by an immature Golden eagle (Aquila chrysaetos, 4.2 kg) in Northern Italy. The bird hit the canopy and shattered it, the pilot was busy picking the bits of Perspex off him and brushing the dust out of his eyes when a claw fastened on his shoulder, looking round he realised that the bird had only been stunned and was lodged on the parachute pack behind him. He grabbed its leg and dropped it over the side. One Swiss ornithologist has a theory that immature birds of prey, as part of their mating ritual, show off and attack aircraft in bravado, rather like youngsters driving BMWs!

- Another problem for General Aviation, is that birds will build nests in aircraft, on this Grob 109 Motor Glider pilots saw some straw sticking out, so they removed the engine cowlings to investigate, finding a nest which they removed. Before flying next day, they again removed the cowlings and found that a new nest had been built overnight. This problem is particularly severe in parts of the country where there are few trees and all airport personnel need to be vigilant and must warn the pilots of bird activity.

- A nest, believed to be a jackdaw's, was found in the bottom of the fuselage of a Piper Cherokee amongst control wires and birds will use anything to build a nest which could include the remains of stainless steel locking wire picked up from the airfield. Not the sort of thing you want amongst control systems.

MILITARY AVIATION

- In 1993 at least 3 military aircraft were lost due to bird strikes, in each case the ejector seat worked as advertised. In the UK, the RAF experiences about 13 strikes per 10,000 flying hours, the annual cost is about £15 to 20 million. The high speed at low level means that at least 56% of strikes are off airfield.

- This is the damage that results from contact between a Hawk Advanced Trainer windscreen and a gull.

- But the effect on the pilot's face can be fatal.

REPORTING AND IDENTIFICATION

- In order to encourage reporting, the BSCE poster has been widely distributed.

- The current UK reporting form is coloured yellow to identify it and this should be sent to the CAA for all birds strikes. Note that it highlights the usefulness of remains, including a feather as an assistance in identifying the bird species. If unsure of the bird species, then send the remains to the address on the reporting form. Photographs of damage are very useful.

- These small feather fragments removed from an engine were successfully able to identify the bird as a Red-tailed hawk (Buteo jamaicensis).

- This Leaflet is part of the UK General Aviation series and is to help pilots using smaller airfields where there are no bird control measures.

- Remove all garbage dumps, these are a major attraction for birds.

- Nets can be useful, these are on a garbage dump in the west of England and there are no birds present or hanging around except for a few crows that arrive at lunch time or at work finish time in the evening and walk in through the gap used by the lorries tipping refuse. These nets appear to be very effective in keeping birds off the active site, the rest of the site is covered with soil. The nets are mounted on large rollers so that they can be moved to new sections. A nearby dump with no nets had 100+ gulls waiting for lunch.

- Ploughing the fields near the airport will bring in lots of gulls to search for invertebrates in the soil and it is up to Air Traffic to look for this sort of activity and be alert to the possible hazard.

- In wet weather, pools of fresh water on an airport will attract gulls.

- Long grass is a very useful deterrent, grown about 150-200 mm (6-8 inches) high, it will restrict the birds vision so that they do not loaf on the airfield but will go somewhere else into the fields etc. Trials on 9 UK airfields over 2 years show that use of long grass reduced bird populations up to 80%. Special grass cutters may be necessary.

- Trials with different grass seed mixtures have shown that some mixes are much better than others at staying upright and not being flattened in winter, in bad weather, or by the mowing vehicle. Information on these trials and mixes is available from a group in the UK. Don't forget, pigeons love clover, you should never have any of that in your seed mix.

- Use of distress call tapes through an amplifier and external speaker system mounted on a vehicle is a very useful means of removing birds. Each species has an individual distress call but some, such as pigeons, do not have one. The vehicle should be stationery, and ought not be used in conjunction with shell crackers. The reason for this is that birds response to a distress call is to first circle over the vehicle to have a look, then depart.

- Shell crackers - these can be very useful, the smoke trail and the crack as the cartridge explodes is a good scaring technique but they can be expensive and difficult to obtain.

- Severe damage to a JT8D engine as a result of ingesting one Black-headed gull (Larus ridibundus, 275 gm), a comparatively small bird.

- Fan blades had detached, nose cowling had fallen off, the bullet had almost fallen off and some of the debris bounced off the runway and did minor damage to the other engine on the Boeing 737 as well as breaking the outer pane of one of the cockpit side windows.

- Worst of all, 2 of the 3 engine mounting bolts had broken and the engine was only being held by one bolt and the 2 hydraulic pipes at the rear.

- All concerned must work together to avoid, hazardous flocks of birds on airfields.

- When things do go wrong it makes the newspaper headlines, a 1-11 over-ran slightly without any damage after abandoning take-off just at decision speed due to ingesting a gull. There are many airports where the over-run area can be buildings, roads or the sea and there would be loss of life.

Make sure you are not in any way responsible.

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