

turbojet engine strike data ( $N = 5,800$ ; 1990 — 2003) from the FAA National Wildlife Strike Database found 293 instances of multi-engine bird strikes and 74 cases of multi-engine damage. There were 5 reports of all 4 engines on 4-engine aircraft being struck and 4 reports of all 3 engines on 3-engine aircraft being struck. There were 223 (17 corporate aircraft, 206 air carrier aircraft) reports of strikes involving both engines on 2-engine aircraft. Of these, 63 (12 corporate aircraft and 51 air carrier aircraft) strikes damaged both engines. These data indicate that the threat of multi-engine strikes and danger posed by flocking birds is more serious than the ARAC's recommendations would indicate. I recommend that the FAA reject the ARAC group's recommendations in favor of more stringent requirements.

**(3) A DISCUSSION OF BIRD STRIKE DESIGN ISSUES FOR ENGINES WITH OBSCURED FANS**

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In general, the design of rotating structures to withstand bird strike and the associated testing is a difficult process; not least because of the variable nature of bird internal structures and the random manner in which birds present themselves at the inlet to the engine. What increases the difficulty of this process is a case such as a single-engine military aircraft where the fan face may not be visible from the entry to the aircraft intake. In this case, the bird will have significant interaction with the internal structure of the intake during its passage from intake lip to fan. This paper explores the possible interactions that take place in such an installation prior to the bird reaching the fan and makes use of test and analytical evidence to make observations about the effect of such interactions on the bird structure. The implications of these interactions on the behaviour of the fan during the bird ingestion are then explored; again using test and analytical evidence.

**(4) APPLYING SCIENCE TO RESOLVING LAND USE ISSUES: PREDICTING THE BIRDSRIKE RISK FROM WETLANDS NEAR AIRPORTS**

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The International Civil Aviation Organization's new standard for airport bird control requires that: The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome unless an appropriate aeronautical study indicates that they are unlikely to create conditions conducive to a bird hazard problem. In the UK, there is a requirement for any new development within 8 miles of an airport to be evaluated in terms of flight safety and for the airport to be given the opportunity to object. Such objections often result in appeals, public inquiries and other legal proceedings. Both sides seek to show that the risk is either unacceptable (in the case of the airport) or negligible (in the case of the applicant). Both sides rely heavily on the opinion of expert witnesses, but there is little good scientific evidence to support the arguments of either side. Wetlands clearly constitute a bird attraction, but the numbers and species attracted, and hence the likely risk, are frequently disputed. This presentation reports on a study, funded by the UK minerals industry, designed to determine how to accurately predict the

numbers and species of birds that will be attracted to wetlands of different designs and to objectively determine how their movements might influence the birdstrike risk at nearby airports. Models have been developed that relate the physical characteristics of a wetland to the numbers and species of birds likely to be present. Measurements of the frequency, length and altitude of bird movements have been made and related to the location of other features such as feeding sites or other water bodies. Results are promising, but a greater range of factors needs to be included in the models. Work is currently on going to gather the necessary data.

**(5) FEDEX EXPRESS' APPROACH TO BIRD STRIKE PREVENTION**

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Airlines can help in the prevention of bird strikes. This presentation is an overview of FedEx Express' Bird Strike Prevention Program. FedEx has given a new meaning to bird and wildlife strike reporting by focusing on the type and amount of information Flight Safety receives from the pilots, which is transferred to the FAA's National Wildlife Strike Database. By maintaining specific records and statistics of the bird strikes and their effects on the aircraft, FedEx can share information with the USDA Wildlife Services wildlife biologist at FedEx's biggest hub in Memphis, Tennessee. This enables the biologist and air operations crews to locate nests or roosts of birds on the airfield in order to disperse the indigenous bird population. Flight Safety in turn shares the same information with the governing airports when more than two strikes occur in a month. In addition, FedEx's internal publication of the Straight in Approach communicates information with the FedEx pilots regarding all collected bird strike trends and analysis.

**(6) EUROPEAN STARLINGS AND PASSENGER-LOADING BRIDGES: AN AVIATION INDUSTRY-WIDE PROBLEM**

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The European starling population exceeds 800 million throughout the world with one-third of the population residing in North America. Between 1990 and 2002, starlings represented 1.6% of all known aircraft damaging strikes. Of the 36 species groups, starlings were ranked seventh in causing substantial aircraft damage and ranked sixth in causing minor damage. The potential damage to aircraft and economic loss resulting from bird strikes is real. There is another problem; however, associated with aircraft loading bridges which current designs do not address. Starlings, being cavity nesters, are given an endless number of opportunities for nesting sites within loading bridges. Over time, and specifically during summer months, the odor can be overwhelming for passengers unless the airline or airport makes a conscious effort to clean the loading bridges of nesting material several times a year. It has been documented that humans may be prone to serious respiratory diseases by breathing airborne fungal spores that originate in starling fecal matter - putting passengers and employees at risk. Several products, including chicken wire, porcupine wire, mylar tape and electronic control devices have been used in an attempt to address this problem, but with varying degrees of effectiveness.