BRITISH AEROSPACE

PUBLIC LIMITED COMPANY

AIRCRAFT GROUP

WEYBRIDGE/BRISTOL DIVISION

United Kingdom Ministry of Defence Preparation of a Design Manual for Aircraft Resistance to Bird Impact

A contract has been placed by the United Kingdom Ministry of Defence on British Aerospace to determine the design principles concerning aircraft resistance to bird strike and to present the information in the form of a design manual.

The development programme comprises :

(i) Collection of data from world wide sources concerning test information, technical reports, bird strike incident reports, statistics, etc.

(ii) Comparison of data and formulation of design guidance information

(iii) Recommendations for future test programmes

(iv) Recommendations for future data collection

The proposed contents of the manual are :

1. Introduction
2. Bird Strike Statistics
3. Bird Impact Loading
4. Structural Design Information
5. Further Design Considerations
6. Testing and Test Facilities
7. Recommendations for Further Testing
8. Operational Data Collection
9. Bibliography

The manual will report on the study of bird strike statistics taking account of :

- geographical location of event
- season of the year
- weight of bird
- aircraft height and speed
- position of strike on the aircraft
- damage sustained
- effect on aircraft
- effect on [illegible]
- palliative measures applied to the aircraft and on the ground

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Recommendations will be made if appropriate regarding the suitability of current bird strike resistance requirements taking account of various types of mission.

A review of available literature has revealed useful theoretical and practical investigations into the loading due to bird impact. A section of the manual will be devoted to this subject.

The structural design information section of the manual will summarise the literature survey of available information and will attempt to give design guidance on methods of determining bird impact resistance by discrete calculations and by more extensive programmes such as finite element analyses, for varying bird mass and aircraft speed.

Examples of components to be included are :

(a) Leading edges of wing, tailplane and fin. Various parameters will be investigated including leading edge radius, impact angle, rib pitch, rivet spacing, materials, etc.

(b) Engine air intake lip structure and sidewall structure.

(c) Systems fairings, e.g. external actuators for control surfaces, antennae. Parameters will include effect of shape, impact angle internal support structure, materials, etc.

(d) Front fuselage structure ahead of flight crew and essential systems including crew compartment roof for larger aircraft, also nose bulkhead following penetration of radome.

(e) Nose cones/radomes

(f) Transparencies - windscreens, canopies, quarterlights, side windows. Parameters will include impact angle, type of construction, method of edge mounting, support structure stiffness and strength, spalling of glass, residual vision, etc.

The presentation for each component will include :

(i) data sheets with worked examples where applicable

(ii) limitations on the use of this data

(iii) guide to level of confidence in data provided

Further design considerations will deal with detail features of design for bird strike resistance with regard to airworthiness, continued mission performance and cost of ownership concerning secondary effects of structural damage and consequence of impact on systems.

Attention will be drawn to the need to investigate the damage tolerance of the aircraft following a bird strike taking account of :

(a) Aerodynamic handling

(b) Residual strength and stiffness of structure

(c) Change of flutter characteristics

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Further design features concerning bird strikes on transparencies will be highlighted examples being :

(a) likelihood of failure of adjacent transparencies due to deformation.

(b) ingress of bird debris due to inadequate stiffness of openable direct vision window operating mechanism

(c) large deflection of plastic components on impact may be unacceptable for items of close proximity

(d) effect on head-up display

(e) effect of temperature variation on strength and stiffness of transparent materials

Further design features concerning systems will be emphasised including consideration of positioning and duplication of essential services, examples being :

(a) vulnerability of cables, pipes, control lines, items of equipment etc. in leading edges, at the front of landing gears or the rear wall of landing gear bays.

(b) the need to duplicate exposed avionic sensors, antennae, etc.

(c) effect of disturbed airflow on sensors etc. following impact on structure ahead.

Guidelines will be laid down for establishment of a test programme capable of demonstrating acceptable integrity following a bird strike.

A comparison will be made of U.K. and overseas test methods and facilities.

Recommendations will be made on methods of collecting and reporting bird strike data with a view to increasing safety and reducing cost of ownership in the future.

The value of the manual will depend to a very large extent on the amount of co-operation and input received from all interested organisations.

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