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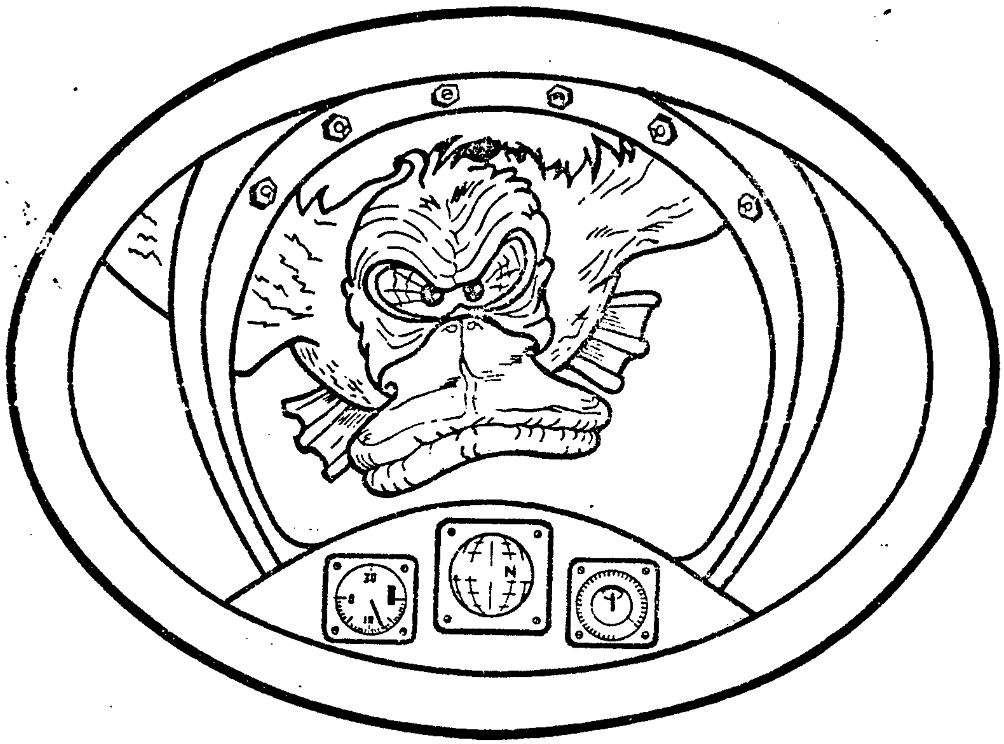
BIRD STRIKE COMMITTEE EUROPE



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The Bird Strike Committee Europe consists of civil and military participants from Europe with a common interest in the bird strike problem. Attendance is open to participants from other parts of the world. Annual Meeting Proceedings include Chairman's Report, Working Group Reports and Papers Presented:

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12th Meeting of BIRD STRIKE COMMITTEE EUROPE

Held in Paris, France

20 - 28th October 1977

Inspection Générale de l'Aviation Civile,
246 rue Lecourbe, 75732 Paris CEDEX 15,
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S U M M A R Y

The twelfth Annual Meeting of Bird Strike Committee Europe was held in Paris between the 20th and 28th October 1977. The Committee is a joint Civil-Military committee, and is currently led by the Chairman Mr. V.E. FERRY of France and Vice-Chairman Mr. L.O. TURESSON of Sweden, both of whom are elected by the BSCE members. This year's meeting in Paris was organised by the French Civil Aviation Board, and was attended by members and observers from Belgium, Canada, Czechoslavakia, Denmark, France, West Germany, Israel, Italy, Netherlands, Hungary, Poland, Spain, Switzerland, Sweden, United Kingdom, USA, USSR, Uganda, and international organisations such as ICAO, IATA, IFATCA, AACC, ECAC, WEAA.

The meeting commenced with tow days of specialist Working Group meetings, followed by a two days Plenary Meeting.

The Committee's work includes the use of radar to track bird migrations and movements in order that warning to pilots can be issued, research and trial of measures to discourage or move birds from aerodromes, collection and analysis of bird strike data, compilation of maps of European bird movements, collection of information on structural testing of civil airframes, and the establishment of communications systems for pilot warnings.

A great number of Papers were presented at the meeting.

CONTENTS

---oOo---

SECTION 1 - Recommendations

RECOMMENDATIONS ASSIGNED BY THE COMMITTEE TO THE WORKING GROUPS

------oOo------

1 - WORKING GROUP "ANALYSIS"

1.1 - As the repair cost of bird damage is an excellent guide to the seriousness of the problem, all countries are again asked to provide their costs, if possible, making it clear whether it includes parts, labour or lost revenue. (Note : The Analysis Form on Cost is being revised). A special study should be made of examples of engine and airframe damage.

1.2 - Although it appears that the use of lights during daylight may reduce bird strikes, further study should be made of the effect of lights during take-off at night. The proposed US work on the effect of lights on birds is welcomed.

1.3 - The Working Group firmly supports the Canadian photographic research of flock densities as a means of defining engine design requirements.

1.4 - It is recommended that reports about Serious bird strike incidents should continue to be sent quickly to the WG Chairman for dissemination.

1.5 - All countries are recommended to note that the Stockholm meeting in 1975 agreed that for the time being the ICAO definition of a bird strike (from ICAO State Letter AN3/32-71/150 of 28 October 1971) would be used :

"A bird encounter is considered a confirmed bird strike if it leaves, on the aircraft concerned, a trace of bird impact, or ingestion into the engine, and this either.

a) in the form of damage to the aircraft ; or

b) where no damage occurs, a blood smear or bird tissue or feathers visible somewhere on the aircraft."

(Note : The above unfortunately omits impacts felt by aircrew or seen by ground personnel, and bird carcasses with impact evidence found on aerodromes).

2 - WORKING GROUP "RADAR"

2.1 - In agreement with the last years recommendation the working Group stresses again that as long as possible raw radar date should be made available for the study of bird movements through the ATC system.

Recognicing that civilian ATC systems are increasingly relying on Secondary Surveillance Radar's which cannot detect birds, the WG considers that it is necessary to seek additional sources of raw radar information on bird movments to supplement the loss of primary radar information from civil ATC systems. Accordingly it is recommended that more use be made of military radars and weather radar for the observation of bird movements.

3 - WORKING GROUP "BIRD MOVEMENT"

3.1 - As far as this is possible, the general and special maps developped for information of pilots on bird activities should give a risk indication within concentration areas in the following categories : Heavy, Medium, Light risk.

3.2 - The above mentionned maps should show main migration routes. They should also show possible broad front migration within special periods/seasons.

3.3 - Bird protection areas which are not areas of high bird concentration should not be included.

4 - WORKING GROUP "STRUCTURAL TESTING OF AIRFRAME"

4.1 - That, in support of (i) and (iv) of the terms of reference, members should supply to the Chairman of the Working Group.

a) results of any bird impact structural testing together with geometrie details which have been completed by their organizations.

b) details of any future testing programmes by their organizations.

4.2 - That, in support of (ii) and (iii) of the terms of reference, members should supply the working group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience which have been done by their organizations.

4.3.- That the future continuation of the Working Group be judged against the reponse of the participating countries to these recommended tasks of 5.2. and 5.3.

4.4 - That the attention of the Analysis Working Group be drawn to the need for adequate information on the spatial distribution of birds within a flock for the large bird sizes to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present single bird strike requirements. (This was supported by aircrew representatives).

5 - RECOMMANDATIONS SUBMITTED DURING THE MAIN MEETING

5.1 - FOR WORKING GROUP "AERODROME" (Présented by Schiphol Airport Authority)

It is of utmost importance for those who are concerned with prevention of birdstrikes at and around airports to get published a list of all presently known possible actions and techniques to be used for minimising birdstrikes hazards ; certainly recognition should be given to the fact that airports have different organization and reponsabilities and of course different environmental conditions.

5.2 - FOR WORKING GROUPS (presented by pilot's Association)

5.2.1 - In order to obtain full efficiency with existing methods information given to pilots about birds must be improved.

1.1 - On the ground : by insuring that proper informations reach companies operations offices, where airline pilots are brieffed. Birdstams have also to appear under the aerodrome section on last issued notam panel.

1.2 - On radio communication : A. T. I. S. should be used when necessary to inform about birds risks.

5.2.2 - Pilots have a strong interest to be involved in any bird evitment experimental procedure programme, in order to avoid any contradiction with others safety rules.

THE BIRD STRIKE COMMITTEE EUROPE RECOMMENDATIONS

A. Based on the work of Bird Movement working group

1. The bird information contained in the ICAO aeronautical chart of Denmark should be an example for other countries and serve for General information of pilots.

2. Bird hazard maps for low level flying similar to Belgian and German maps should be drawn up for special information to pilots.

3. The new maps should be as simple as possible in order to avoid confusion of pilots and they should be used together with Birdtams, Forecasts etc.....

4. As far as this is possible, the above mentioned maps should give a risk indication within concentration areas in the following 3 categories: Heavy, Medium, light Risk.

5. The new maps should show main migration routes. They should also show broad front migration within special periods/seasons.

6. Bird protection areas which are not areas of high bird concentration should not be included.

7. ICAO should develope a new symbol to indicate bird concentration areas on Aeronautical charts.

B. Based on the work of Analysis working group:

.1 There is a clear need for better reporting of bird strikes, and many non-European countries do not report strikes to ICAO. In particular there is a need for data from the United States.

.2 Analysed data should be made more readily available to authorities, airports, pilots etc.

.3 As there is an international need, it is requested that ICAO be asked wheter the bird strike data can be stored and analysed using ICAO facilities.

.4 The statistics show that a disproportionately high number of bird strikes occur during darkness. This should be brought to the attention of areodrome operators.

.5 During training, both pilots and Air Traffic Controllers should be given instruction about the hazard from birds. This instruction should include reference to accidents caused by distractions to pilots resulting from bird strikes, even when those bird strikes have in themselves caused no damage.

.6 Five small turbine powered aircraft have been lost during the past three years due to ingestion of birds on take-off. In view of this obvious hazard all countries should recommend that special precautions be taken by pilots of such aircraft, and by airport authorities and ATC personnel.

C. <u>Based on the work of Radar working group:</u>

1. The need to improve the active collaboration in bird migration research in Europe is recognized. As a first step to improve this situation it is recommended that France, Germany and Switzerland co-ordinate their observations of bird concentrations along the Alpine ranges to establish the length and breadth of this migratory movement which may constitute a collision hazard.

D. <u>Based on the work of Structural testing of Airframes working group:</u>

.1 That, in view of the lack of response of participating countries, with the exception of France and the UK, in forwarding any information to the Working Group as requested at the last meeting, a member should be appointed by each participating country to be responsible for reporting to the BSCE progress in support of the recommended tasks of 2) and 3) of the Working Group terms of reference.

.2 That the attention of pilots and operators should be drawn to the deterioration in bird impact resistance of windscreen which rely on the maintenance of an optimum temperature for strength if,

- insufficient time is given for warming up the windscreen before take-off or
- the temperature is too high because the aircraft has been parked in the sun.

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BSCE 12-2
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SECTION 3 - Opening Speech

The Board of the Meeting
From the left : M. Claude ABRAHAM, Director général of the French Civil Aviation,
during his opening speech.
M. FERRY (France), chairman BSCE, M. TURESSON (Sweden) Vice Chairman BSCE,
M. F. GAUTIER, Chairman of the French Bird Strike Committee.
M. ATTIG (France), secretary.

The Board of the Meeting.

28 October 1977

Monsieur le Président, Mesdames, Messieurs,

Je voudrais tout d'abord vous dire, en vous souhaitant la bienvenue à Paris, l'agrément et la joie que sont pour moi l'ouverture de cette 3ème réunion mondiale pour la prévention des collisions entre les oiseaux et les aéronefs. Je voudrais, si vous le permettez, à cette occasion, vous faire part de quelques unes des surprises qui attendent les fonctionnaires qui, comme moi, sont chargés des problèmes d'aviation civile.

Ainsi, il y a quelques jours, certain de mes collaborateurs, me faisait relire, ce que l'on fait bien rarement, les textes de loi très anciens qui, dans ce pays, définissent le champ d'activité de l'aviation civile. Il me faisait remarquer que, si l'on interprétait ces textes de façon rigoureuse, on serait conduit à réglementer strictement et sévèrement l'usage des ballons de baudruches à partir du moment où, un enfant les laissent s'échapper, ils deviennent un aéronef.

Et voilà qu'aujourd'hui vous me procurez la deuxième surprise, en me faisant découvrir, l'existence d'un nouveau type de circulation aérienne dont la réglementation, à coup sûr, est pour le moins difficile dans la mesure où ceux qui en feraient l'objet n'ont pas l'habitude de lire les règlements et encore moins de les appliquer : il s'agit des oiseaux.

L'un des objets de votre réunion n'est-il pas de se demander comment l'homme qui, au cours des derniers soixante quinze ans, a fini par réaliser son rêve millénaire, imiter le vol des oiseaux, va pouvoir aujourd'hui échapper à certains des dangers que ces mêmes oiseaux lui font courrir.

Avouez que c'est un curieux retour des choses et un curieux tour que lui joue la nature. Certes, ce danger des oiseaux, puisqu'il faut bien l'appeler ainsi, n'est pas encore très préoccupant. Si je prends les seuls chiffres que je connaisse bien, ceux de l'aviation commerciale française, on y a dénombré au cours de l'année 1976, une collision en moyenne pour 5000 mouvements d'aéronefs, soit 80 rencontres entre un oiseau de la nature et un oiseau artificiel, 80 rencontres qui auraient coûté, dit-on, environ 3 millions de nos francs. Cela n'est pas considérable, mais ce n'est pas négligeable si l'on mesure non pas les dangers constatés, mais les dangers potentiels. En tout cas, ce type de danger semble suffisamment préoccupant pour qu'une attention soutenue y soit accordée afin de chercher à éviter des incidents plus graves ou plus fréquents, ou encore les deux à la fois.

C'est donc afin de réduire ce danger que vous organisez cette réunion et je pense que ce type d'analyse méritait d'être approfondi .

.../....

Si j'ai bien compris la nature des problèmes qui se posent, il semble qu'ils puissent être classés très grossièrement en deux catégories :

- d'une part, les risques de collisions dans une des phases critiques du vol, atterrissage ou décollage, c'est-à-dire au voisinage immédiat des plateformes aéroportuaires.

- d'autre part, les risques de collisions en altitude, pendant les vols de croisière, tout particulièrement lors des déplacements ou plus exactement lors des grandes migrations de certaines races d'oiseaux. Nous savons que la grande majorité des oiseaux sont des oiseaux migrateurs.

Les risques au voisinage des aéroports, font l'objet depuis plusieurs années de recherches approfondies, et des moyens ont été progressivement mis en place et développés pour faire face à des dangers particulièrement préoccupants sur certaines plateformes. Ainsi le visiteur qui arrive par exemple sur tel aéroport de la Côte d'Azur, se demande parfois s'il se trouve sur un aéroport ou dans un jardin zoologique. L'Administration française pour sa part a déjà mis en place un certain nombre de moyens pratiques d'effarouchement qui se sont révélés localement efficaces et elle poursuit des recherches sur la mise au point de formules plus effisaces encore, dont l'usage soit plus général et non pas spécifique à un type d'oiseau ou à une localisation. Mais il m'apparaît clairement que la difficulté même du problème, sa variation dans l'espace et dans le temps, peut-être même les facultés d'adaptation de nos amis les oiseaux sont telles qu'une coordination, qu'une confrontation, qu'un échange d'information et d' expérience à l'échelon international, s'avèrent non seulement nécessaire mais indispensable. Je suis persuadé, pour ma part, qu'une réunion comme celle-ci sera de nature à faire progresser les connaissances dans ce domaine et à enrichir votre expérience réciproque. J'espère que nous en avons tous, que vous en avez tous besoins.

De même cet échange d'expérience, cet échange de recherche et de réflexions me semble s'imposer pour la prévision et l'observation des grands mouvements migratoires dont on me dit qu'à certaines époques ils perturbent totalement l'image radar présentée à nos contrôleurs. Le nombre de pays que ces mouvements intéressent est tel qu'une coopération internationale me semble s'imposer aussi bien au niveau de la recherche qu'au niveau de l'échange d'informations. Je tiens à cet égard à rendre hommage au Comité Européen, spécialisé dans ces affaires, qui a joué un rôle essentiel à la prise de conscience et dans le premier échange d'information.

.../...

Je reste persuadé que des progrès beaucoup plus larges méritent d'être faits, et la qualité de l'assistance qui est ici ce matin me rend confiant dans l'évolution de ses recherches. Peut-être même, pouvons-nous espérer qu'un jour, l'Organisation de l'Aviation Civile qui a accepté de patronner cette réunion pourra prendre directement en charge l'examen de ce genre de problèmes car je pense que telle est bien sa vocation. J'ai parfaitement conscience que l'importance même de sa charge de travail est telle qu'il ne sera peut-être pas facile de trouver une place pour ces problèmes au sein d'ordres du jour déjà très chargés et parmi lesquels il n'est pas facile de faire des choix de priorité. Quoi qu'il en soit, je pense que les problèmes que vous allez évoquer sont certainement parmi ceux où la coopération internationale est la plus importante et la plus profitable.

Je me réjouis à cet égard que vous ayez choisi Paris pour le développement de cette coopération. Je me réjouis que vous vous réunissiez dans ces locaux qui abritent à la fois le siège européen de l'OACI et la Conférence Européenne de l'Aviation Civile. Ce sont des murs qui ont l'habitude de la Coopération internationale. J'espère et je suis sûr qu'ils vous inspireront.

Je voudrais pour terminer, vous dire mon souhait et mon espoir de vous voir aborder ce problème important des dangers réciproques présentés par les oiseaux et les avions avec, avant tout, le souci de mieux comprendre ce monde des oiseaux qui peut-être nous gêne et dont il ne faudrait en aucun cas que nous en venions à le considérer comme ennemi. Après tout, l'espace aérien était le royaume des oiseaux, avant d'être conquis par l'homme et ceci me semble de nature à nous inspirer quelque prudence et quelque respect. Nous sommes arrivés dans cet espace en intrus, il serait utile que nous nous comportions en amis et en hôtes, non en conquérants.

Je crois, par conséquent, qu'il vous appartient de trouver les moyens d'une véritable coexistence aussi pacifique que possible, qu'il vous appartient avant tout de mieux comprendre ces oiseaux, ces voyageurs de l'espace que nous risquons de rencontrer, qu'il vous appartient enfin, cherchant à protéger l'homme, de trouver les moyens de mieux protéger les oiseaux.

Si effectivement, tel était le résultat de vos travaux, alors je crois que nous pourrions tous avoir la conscience en repos, et penser que nous avons tous bien fait notre métier.

Je ne doute pas que ceci soit votre but et votre intention. En vous encourageant et en sachant d'avance que ces travaux seront fructueux, je vous remercie au nom de l'aviation et plus encore au nom des oiseaux.

That helped the committee to be so successful in its efforts. Mac Kuhring never dwelt on the problems created by bird hazards; he looked for solutions. As you know, we found solutions to many of the problems.

When he retired from his official duties at National Research Council, the committee persuaded him to continue as chairman and then convinced the National Research Council that it should pay him to do that. It was a measure of Mac's status in the scientific community in Canada that he should be hired under a contract to continue the same job that he had done before he retired.

Just before the 1969 World Conference which he had planned, he suffered a heart attack. That did not prevent him being present at the conference. It did not prevent him from having ideas about how support could be secured from the scientific arm of N.A.T.O. to encourage a number of European countries to try some of the ideas on bird hazard forecasting which the Canadian Committee had begun to use successfully in Canada. Some of you here know how important the money provided by N.A.T.O. was in getting research programs started. When those programs showed positive results, they were continued and expanded with local funds. I did much of the work in getting the money from N.A.T.O. and dividing it among the countries which began work in the bird/radar/weather complex in Europe. It was Mac Kuhring's idea to go that route and it was his letters to N.A.T.O. which gave us the more than $60,000 that we secured to aid research here.

It was my privilege to work closely with Mac Kuhring on an almost daily basis in Ottawa for more than ten years. At least once a year, I accompanied him as he travelled in Europe strengthening the bonds of friendship with many of you, dropping ideas here and there about things that should be tried and picking up ideas helpful to us in Canada. Many of you knew Mac personally. I am sure you shared our feelings out him. Mac's declining health made him realize that he should withdraw from a high level of activity and in 1973 I was asked to take over as chairman. We still made a place for him at meetings when he was able to attend and he still took an active part. One of his last acts as chairman was to support the idea of a book on Bird Hazards to Aircraft to be prepared by Hans Blockpoel of our Canadian Wildlife Service in Ottawa. Mac helped in collecting the information published.

Mac Kuhring was a heavy smoker. That may have led to the lung cancer which required the removal of a part of one lung in 1975. He was on the road to recovery from that situation when it was learned in the spring of 1976 that he was suffering from a developing brain tumor. He never lost his good humor and his creative abilities. He submitted to complex chemical and radiation treatment for the brain tumor until a few weeks before he died in the fall of 1976. Almost to the end, even though older and weaker, he was still the same active man we had all known.

Mac was active in many things besides the bird hazard problem. Much of his work was directed toward world wide programs to aid people in distress. He was an active christian. He wrote on religious topics right to the end. The minister of his church, as a part of his memorial service, read some of Mac's writings which he had discussed with the minister just a few weeks before he passed away.

In his passing, we all lost a good friend, a devoted leader, and a man whose enthusiasm led to the formation of Bird Strike Committee Europe and many other useful things in addition to his leadership of the Canadian Committee.

I wish you every success in your deliberations in this World Conference on Bird Hazards to Aircraft. I look forward to the continuing work which will result from this important meeting which now begins.

OPENING REMARKS

Victor E.F. Solman *

World Conference on Bird Hazards to Aircraft

Paris October 24, 1977

We had the sorrow this year to learn the death of one of our dear friends and we all deeply sadden. However it is a privelege for me to do homage to Malcolm Kuhring (Mac to his friends) and to his role in the Associate Committee on bird hazards to aircraft both in Canada and in Europe. It was probably because I worked at Mac's side for 12 years that your president asked me to recall to you the contributions Mac made toward solving the problems of bird hazards to aviation.

Long before the committee was formed, a number of us were much concerned about bird hazards to aircraft. I first met Mac at a meeting of the Canadian Institute of Aerospace Studies where I had lectured on bird hazards to aircraft. I was told that he would be chairman of a multi-agency to do something about bird hazards. I was very much impressed by him even at our first meeting. When the committee was formed in 1962, and I became aware of the dynamic leadership he provided, I was even more impressed. He had had a distinguished career working on large jet aircraft engines. He made many tests of their behaviour under a variety of conditions including those associated with low temperatures which occur during winter in Northern Canada. He was chosen as chairman of the committee because one of the most serious problems faced by Canadian aviation at that time was damage to jet engines by bird ingestion. With his engineering experience, Mac looked first for engineering solutions to the problem. From his knowledge of engine testing in relation to ingestion of foreign objects, he knew the limitations

* Canadian Wildlife Service, Ottawa, (Ontario), Canada

Chairman, Former Associate Committee on Bird Hazards to Aircraft.

of engineering in dealing with that problem. It was his idea that biologists and other specialists should be represented on the committee. That was a wise choice. After the first meetings, it became obvious that engineers could not design engines strong enough to resist the forces they were exposed to in bird impacts. From there on, keeping birds out of the engines was the committee's main concern. Mac quickly learned the principles of bird management and was soon almost as well informed about ecological management of airfield environment as were many of the biologists. His ability to grasp the biological principles involved and to see how they could be applied to remove bird hazards, even though his background was totally different, was one of the factors that made him an excellent chairman. He had a flexibility of mind and an active imagination and could see possible solutions where others saw only problems. The more I worked with him, the more I appreciated his ability to envisage new solutions to old problems and to convince others of the need of their support. When he had made up his mind that something needed to be done, it was impossible for him to conceive that it could not be done. He was always able to borrow or otherwise obtain whatever he needed in equipment and cooperation. The committee had limited funds, but, that was never a problem. We generally got what we wanted through cooperation, sometimes from agencies that initially had no intention to co-operate. If Mac wanted radar for study of bird migration he went to people who had radar and convinced them that it was in their best interest to make the radar available for the purposes for which the committee needed it. For years, the committee owned no radar equipment. During that time, the Committee had access to Defense and Traffic control radars right across Canada, in part of the United States and in a number of European countries. If we needed transportation, Mac arranged for it at no charge from the major airlines or military transport services. If we needed expert help in a special field, he was able always to find the experts and get them to work with the committee. We came to believe that with him as chairman nothing was impossible.

SECTION 4 - Introduction by Chairman

Report by the Chairman BSCE 1977

It is a great honour for the chairman of the BSCE to open this session with such an audience and we hope for a successful world-wide Conference. May I wish all of you who are coming from such different organisations and activities in order to see and cooperate to the work done in a Regional Committee; a very interesting week.

We hope also that the friendly atmosphere will help in persuading you that some other Regional Committee could be established in the near future.

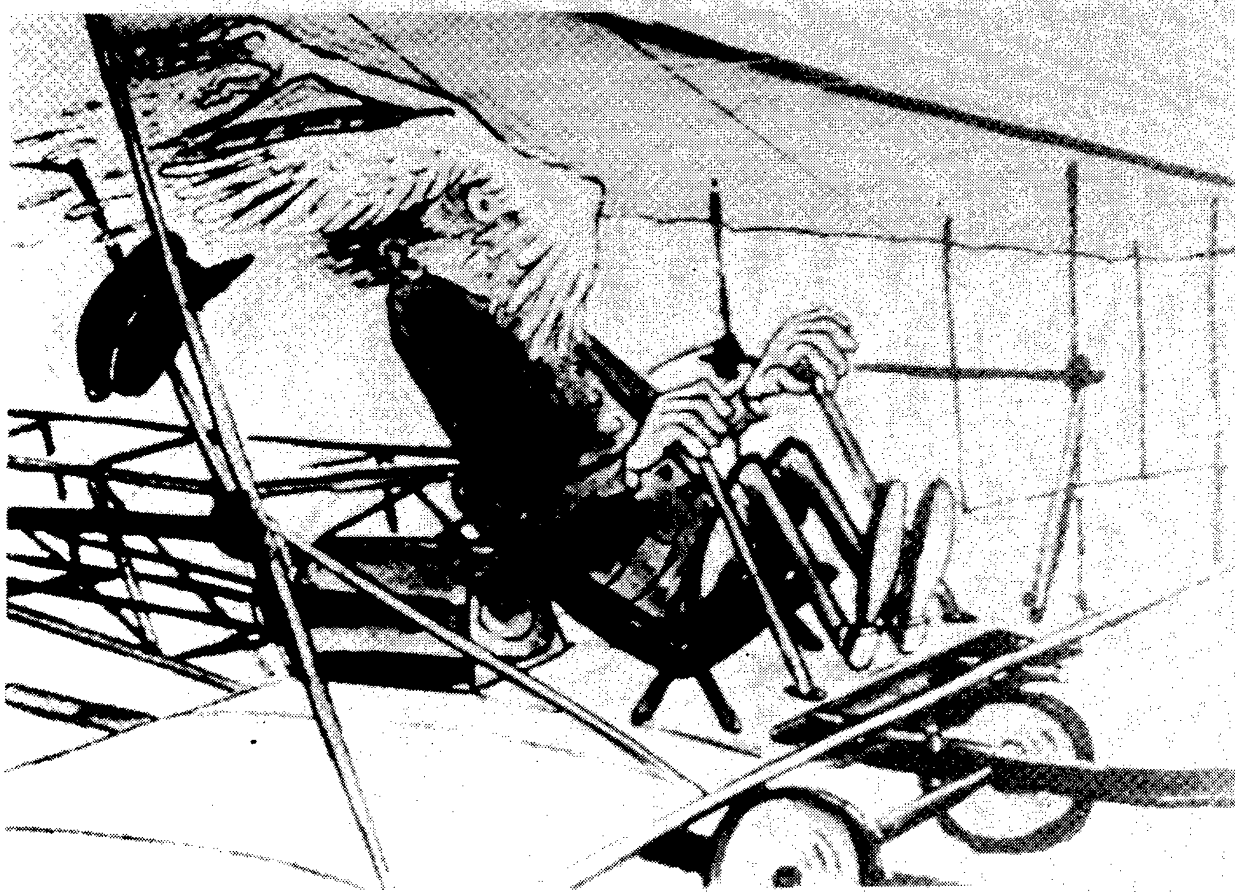
The last meeting of the BSCE was held in London 24 to 28 May 1976. The Report was slow in printing and suffered from circulation problems, but it broke a record: Its weight was over 2 pounds for the first time providing problems to those who have to pay postal rates. So, almost certainly we are bound to equal in the foreseeable future the standard 4 pds bird. But with a very different usefulness.

On the administrative side we have doubled our production of paper compared with last year and the vice chairman was also fully engaged in writing letters. We both hope that the new organisation, if not able to work miracles, has run smoothly and almost satisfactorily. If not, you still have a chance to throw the expected 4 lb book at us.

Contacts with International Organisations have been established according to the wish of the Committee and we have now participated in E.E.C. work on their Draft-Directive on Bird Conservation. You will see from the lectures that will be delivered this week that these contacts have been fruitful.

We are glad to welcome here Czechoslovakia, Hungary, Austria, Ireland and we hope to have them with us for the meetings to come.

My last words would be to thank ICAO and the Regional Office in Paris for the great help provided for this meeting and the world-wide conference which I hope will be a major contribution to the success of this meeting.



SECTION 5 Reports by Chairmen of the Working Groups of the BSCE

A - Bird Movement

B - Communications

C - Aerodrome Bird-Strike

D - Analysis

E - Radar

F - Structural Testing of Airframes

REPORTS FROM WORKING GROUPS

WORK PROGRAMMES OF WORKING GROUPS OF THE B. S. C. E.

1) **W.G. BIRD MOVMENT** (Chairman : Dr. J. HILD, vice Chairman - M. BOOMANS)

Study of bird concentrations and movements and the drawing up of special maps for the information of pilots and air traffic services

2) **W.G. COMMUNICATIONS** (Chairman : V.E. FERRY, vice chairman - M. SONNETTE)

Study of all problems relating to the transmission of information on bird movements which could present a hazard to aviation and the provision of such information to air traffic services.

3) **W.G. RADAR** (Chairman:M.BRUDERER, vice chairman - M. L. BURMAA)

Dealing with matters associated with the use of radar in the surveillance, identification, and assessment of bird movements.

The work of the group embraces :

a) scientific work on bird migration

b) technical improvements for recognition assessurent and recording of radar data on birds

c) proposals for operational use for radar data on birds.

4) **W.G. AERODROMES** (Chairman : M. K. PEDERSEN - Vice chairman - M. H. DAHL)

a) Preparation of general recommendations to reduce the bird problems an and around aerodromes.

b) Coordination of bird control research activities between States concerned.

5) **W.G. ANALYSIS** (Chairman:M.J. THORPE - Vice chairman - M.J. VAN DUSSELDROP)

Development of a standardised format for analyses based on the data contained in Bird Strike Reporting forms.

6) **W.G. STRUCTURAL TESTING** (Chairman:M.P.F. RICHARDS)

(i) To exchange information on the results obtained from :

a) Bird impact research testing of materials, structural specimens, windscreens etc.

b) Tests to meet compliance with Civil Airworthiness requirements

(ii) To discuss and evaluate the information in order to provide design guidance material forsatisfactory methods of producing bird impact resistant structures, windscreens etc.

(iii) To exchange information on analytical work.

(i v) To establish liason on future research programs in order to avoid duplication.

ACTIVITIES OF THE WORKING GROUP

1. Title : Bird Movement

2. Terms of reference : Study of bird concentrations and movements and drawing up of special bird hazard maps for information of Aircrew and aviation services.

3. Progress report :

   a) The existing maps, published in 1973/1974, have been revised regarding the biomass of birds in the various areas of the countries.

   b) Revised maps are available for Denmark, Netherlands, Belgium, France, Germany. Other countries will follow by January 1 st, 1978.

   c) All countries published bird hazard maps in the AIP.

   d) the working group elected Mr. BOOMANS météorologist /Belgium in 1975 as Vice Chairman.

4. Future Program

   a) Further revision of existing maps

   b) Drawing up of more specified airport surrounding Maps where it is wanted and seems useful.

   c) Organisation of informal meeting with pilots in Traben-Trarbach/ Germany with the aim to get their opinion.

5. Recommandations

   a) The bird information contained in the ICAO aeronautical Chart (Denmark) should be an example for other countries and serve for General information of pilots.

   b) ICAO bird concentration an migration maps should be combined into a consolidated presentation for low level flight planning, eg similar to Belgium and german maps.

   c) The new map should be as simple as possible in order to avoid confusion of pilots and it should be used together with Birdtam, Forecasts etc.

   d) So far as this is possible, the above mentionned maps should give a risk indication within concentration areas in the following categories : Heavy, Medium, Light Risk.

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e) The new maps should show main migration routes. They should also show possible broad front migration within special periods/saisons.

f) Bird protection areas which are not areas of high bird concentration should not be included.

g) ICAO should developp a new symbol to show bird concentration area on aeronautical chart.

Activities of the Working Group

1. Title: Communications

2. Recommendation from the 11th meeting - London - May 1976

As the group was officially suspended for a time, no recommendation was proposed to the Committee. However, the group accepted to carry out the following tasks required by the Committee (see 11th meeting report page 11-8)

i) prepare and circulate the complete list of addressees for Notam circulation

ii) test of the circulation of NOTAM dealing with bird movement during spring migration 1977 under the procedure already used during 1974 and 1975

iii) prepare a compilation of the already agreed practice (format of the message, code used, prefixes) to be published in the 11th Meeting Report with the final aim of becoming a part of Documentation published by ICAO

iv) study the need to collect "Flight Procedures" already used for bird avoidance.

3. Progress report:

3.1 No survey could be arranged as early migrations started before organisation for the test could be finalised. However, it has been noted that radar, based in Denmark, was sending a routine daily message without giving complete information (heading, altitude) on bird activities. The matter would be investigated.

3.2 The updated list of addressees for circulation of BIRDTAM is as follows:

EDDYZQ, EDAAYO, EDEEYO, EDDZZO, EDDZYN, EGGNYN, EGVCYC, EGZMMKK, EHMCYO, LFZZNH, LFYXYRSM, LIIAYN, LIJJYA, LIZZNA, EHZZNH, LXGBYN, EDANYO, EBWMYM, LEZZNE, EPWAYG, EHMRYX, EDZXYT, LTAAYN, ESDAYM, ESMMZP, ESGBZP, UUZZNK EDNVYO, ESSAZP, EKMCYO, EBMIYO.

Representatives from countries agreed to provide their list and propose amendments to the comprehensive summary that would be made available in the near future.

It was suggested that BIRDTAMs be forwarded to Airline Operations rooms as pilots seldom visit Flight Information Offices at airports. This matter will be explored by the chairman.

Furthermore, one observer stressed that where poor communication systems existed an alternative way to provide proper information to airlines was required pending a final solution of the problem.

3.3 No further action was taken in order to improve the phraseology; the experimental period was consequently extended by one year. It was noted that the Controller would be greatly assisted if at least a tentative phraseology could be agreed upon internationally.

3.4 Regarding the "Flight Procedures" it was said that for Military Forces some well proven procedures already exist. When the bird activity is above a given level, flights are stopped and aircraft already in flight are required to fly at a safe level. In some countries Air Traffic Control directs pilots to circum navigate or overfly the dangerous areas.

For Commercial traffic procedures in use include switching landing lights on under 10000 ft and the noise abatment procedure on take-off. However, their original purpose was not aimed at avoiding birds and evidence of their efficiency is not firmly established. It should be noted that the use of landing lights has the merit of providing proof that birds are flying at night.

As routes in the vicinity of airfields are difficult to change and because air navigation constraints exist it is impracticable to impose special flight procedures for bird avoidance. The Working Group concluded that there is a need for internationally agreed flight procedures to recognise birds as obstructions and for them to be treated as such.

It was also stated that these procedures should be developped inside ICAO.

4. <u>Chairman's Report</u>

4.1 The chairman sees no reason to alter the conclusion already reached during the 11th meeting, namely:

"A special effort has to be made from the communication point of view in order to convince people of the urgent need for the information carried by birdtam or bird warning forecast".

28 October 1977

"COMMUNICATIONS W.G."

- List of participants -

Maj D. BRUSSOW	G.A.F.	Director Flying safety Federal Armed Forces GERMANY 5 KOLN 90
J.C. SONNETTE	S.N.P.L. and I.F.A.L.P.A.	S.N.P.L. -COMETEC B.P. 213 94396 ORLY-AEROGARE
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FERRY	Chairman of the Group	Direction Générale de l'Avia- tion Civile - DGAC/D 93, Bld du Montparnasse PARIS 6e

ACTIVITIES OF THE WORKING GROUP

1. <u>Title:</u> Aerodrome

2. <u>Recommendations from the 11th meeting - London - May 1976</u>

2.1 The Working Group is to prepare a summary document to be used by airport manager. The information provided by Working Paper No. 24 is to be transferred into a check list by the Working Group.

2.2 Each State shall provide details about

a) successful bird dispersal devices

b) devices judged to be unsuccessful

in order that the Chairman of the Working Group can distribute a consolidated report for the next meeting.

2.3 Each State shall provide local and national regulations applying to Garbage Dumps and to controllable bird movements (eg racing pigeons).
(See Stockholm recommendation No. C.2).

2.4 In order to avoid duplication, members are requested to provide information they may have through their national organisations about the activity of the International Organisation on matters relating to the Group activity.

2.5 Chairman of the Aerodrome Working Group will collect observations made by States on ICAO Document 9137-AN898 Part 3 "Bird Control and Reduction", and send the agreed amendments by an ad hoc group of those received before 1 January 1977.

3. <u>Progress Report</u>

3.1 After presentation of w.p. 27 by L.S. Buurma, Holland, on the subject "Installation of bird control units at 6 airforce bases" an exchange of views took place regarding both the passive and the active methods to discourage birds from aerodromes.

3.2 After introduction by Mr. Graffin from the environmental section of E.E.C. on a E.E.C. Directive dealing with bird conservation it was agreed that B.S.C.E. should demand that the interest of aviation safety be secured. Some working group members felt that the working group should demand an exemption from the Directive, others felt that the working group should state clearly that aerodrome managers etc. were entitled to kill and harass birds on aerodromes and elsewhere in the interest of aviation safety according to the national regulations. It was finally agreed to accept the below recommendation.

3.2.1 The Working Group notes that the proposal of a Directive from the E.E.C. dealing with bird conservation provides for derogations to protect economic activities from damage caused by birds but reaffirms its demand that aviation safety shall be mentioned in the list of reasons for which Member States may derogate from the measures of protection of birds foreseen in the Directive.

3.2.2 The Working Group recognizes the necessity of a wise and controlled utilization of this possibility but asks the Council of Ministers to adopt such provisions dealing with this point as the responsible authorities of the Member States would be allowed to take measures within a sufficient range of action to prevent the damages to aviation safety.

3.2.3 The Working Group asks that when the Commission examines the measures taken by the Member States in implementation of the provisions for derogation, it will be advised by competent experts in reduction of bird hazards to aircraft such as National Bird Strike Committees.

3.2.4 The Working Group notes with interest that the Directive provides for the development of research in order to allow a satisfactory implementation of the Directive in particular dealing with behaviour and migratory movement of birds. In this context the Group asks that aviation safety will be mentioned in the list of themes of research.

3.3 The Working Group agreed to carry forward recommendation 1 from B.S.C.E. 11 it being understood that the summary document including the check list should be based both on the replies to working paper 24 to the 11th B.S.C.E. and the answers mentioned in E.C.A.C. letter of April 28, 1976.

3.4 The working group recommends that the chairman shall send out a questionnaire to all states represented at the meeting at least covering the items mentioned in rec. 2 and 3 from BSCE/11 Aerodrome Group and the addressees will make sure that the questionnaire will be answered within 2 months. Upon arrival of the answers the working group chairman will make a list in order that the items mentioned in the questionnaire can be discussed in more details at the next working group meeting.

3.5 Although the recommendation 4 from BSCE/11 was still valid it was felt unnecessary to repeat it.

3.6 The working group noted that the vice chairman of BSCE had taken over the collection of observations made on ICAO document 9137-AN.898 Part 3 and that consequently it was no longer the duty of the chairman of the working group.

3.7 The working group agreed that it should elect a vice chairman to the group.

3.8 The working group elected Mr. Kurt Pedersen, Copenhagen Airport Authority and Mr. Hans Dahl, Directorate of Civil Aviation, Denmark to chairman respectively vice chairman.

BSCE/I2 - 5-4
28 October I977

ACTIVITIES OF THE WORKING GROUP

I. Title : Analysis

2. Recommendations from the IIth Meeting - London - May I976

a) The Committee recommends that all countries should be asked to review their reporting system on non-damaging as well as damaging strikes.

b) The Committee recommends that all countries should establish a system for the proper identification of bird remains, noting that identification is possible from remains as small as one feather, or from a colour photograph of a carcass.

c) That the Chairman asks ICAO to request each State that :

(i) on receipt of a bird strike report involving an aircraft of that State but occuring at an airport in another State, to send a copy of such report to the State in which the strike occurred and

(ii) that the State in which the strike occurred should in turn forward it to the aerodrome concerned.

d) That all countries should institute the measures of para 3(a) and 3(b) by sending the report to the appropriate name on the list to be supplied by the Working Group Chairman.

e) That the Chairman of the Working Group should send the appropriate members of the Working Group modified sets of Analysis Forms, in order to make the changes agreed at the Working Group Meeting.

f) That the Chairman of the Working Group shall circulate proposals for a Computer based data storage and analysis system.

g) That it is recommended that for Design Requirement and Test purposes the specific bird weight should be quoted and words should not be used :

i.e.	IIO	g	(I/4 Ib)
	675	g	(I I/2 Ib)
	908	g	(2 Ib)
	I.8I	Kg	(4 Ib)
	3.63	Kg	(8 Ib)

However, for statistical and descriptive purposes etc the following should be used :

"very small	below IIO g (I/4 Ib)
small	between III g and 68I (I I/2 Ib)
medium	68I g to I.8I Kg (4 Ib)
large	I.82 to 3.63 Kg (8 Ib)
very large	over 3.64 Kg"

ICAO is to be approached by the Chairman of the Committee to adopt this proposal.

h) That the Association of European Airlines be approached with the information contained in Bird Strikes to European Registered Civil Aircraft.

i) That information on Serious Civil Accidents due to bird strikes be sent to the WG Chairman in order that Quarterly Bulletins may be circulated.

3. <u>Progress Report</u>

2.I Notes of the major points from the Analysis WG Meeting in London were sent to those who attended the Meeting, in addition to the Chairman of the other WG's.

2.2. The following countries have sent Analysis in BSCE form since the last Meeting :

CIVIL			MILITARY	
Belgium	I975	-	Belgium	I975
France	I975	-	Canadian Forces	
Denmark	I975	I976	Europe	I975
Finland	I975	-	Denmark	I975
Netherlands	I975	-	France	I975
Norway	I975	-	Norway	I975
Switzerland	I975	I976	Sweden (too late for inclusion)	I975 I976
UK	I975	-	UK	I975 I976
Sweden	-	I976	US Air Force Europe	I975

Other countries will be sending theirs soon.

2.3 The following papers have been prepared from the information supplied to the Working Group.

"Bird strikes during I975 to European Registered Civil Aircraft"

"European Military Aircraft Bird Strikes I975"

strikes
"Analysis of Bird/Reported by European Airlines I972 to I975"

"Bird Strikes to Transport Aircraft Jet Engines"

2.4 ICAO State Letter NA 3/32 - 76/III of I4 July I976 requested that when a bird strike occurs outside the country of register, that country and appropriate aerodrome authority should be informed. Further efforts will be made to implement the State Letter.

2.5 Some progress has been made in obtaining the costs due to bird strike damage.

2.6 Modified sets of Civil Analysis forms, deleting some items and adding "Weather" and "Use of Lights" were sent to appropriate members. The only change proposed this year is to modify the form on Costs.

2.7 A draft Specification of a Computer Data Base has been circulated for comment to the appropriate people in the working group. Comments have been received from most members and these have been discussed and agreement reached on any changes. The WG Chairman has been asked by the CAA to make the following statement :

The UK CAA Computer Services Branch have made a cost and feasibility study of the draft specification which was circulated to you. This study shows for the UK bird strike data the cost is not justified and we would not proceed. However, if the data base were to include European participants, with the extra cost being shared by the European participants, then we would proceed.

The costs are as follows:

(i) programming and setting up cost of £ 6,000 to be shared by Uk and European participants (the US Air Force are prepared to consider £ I,000 of this).

(ii) annual cost of £ I,000 to be shared by European participants. All countries have different numbers of bird strikes, however, since everyone would have equal access to the data it is suggested that all countries should contribute equally. Each country would be expected to provide the data already coded on the forms (or cards) which would be provided.

However, there are possibilities of using other computer facilities, and this is reflected in the Recommendations.

The BSCE Chairman agreed to send a letter to each country involved requesting an answer by Ist Jan 1978 .

2.8 The amount of information available for the Serious Civil Incidents Bulletin has only justified sending out one issue, NO. 2 being sent to Chairman of Bird Committees and person responsible for civil analysis in each country on 26 July I976. Another will be issued shortly, and information is being collected.

2.9 At the request of the BSCE Chairman the WG Chairman has compiled the Analysis Working Group Code of Practice for submission to the European Civil Aircraft Commission.

2.I0 The Chairman reported that as he had a number of tasks that required a higher priority, he had been told by his Director to request that other members of the WG must be asked to take on a much greater share of the work. The setting up of the Computer system could resolve some of this. At the Working Group meeting Mr. J. van Dusseldrop from the Netherlands Ministry of Transport Civil Aviation Department agreed to undertake some of this work, and to act as Vice-Chairman of the Analysis Working Group. This must first be agreed by his director.

Activities of the Working Groups

1. Title: Radar Working Group

2. Recommendations from the 11th meeting - London - May 1976

   The Radar Working Group reminds all BSCE members that future radars currently being developed may incorporate digital or computer-aided data processing, which will exclude unwanted targets - such as birds.
   In the case of radars with electronically-scanned aerials, data processing may be used at the input of the radar, and in other cases data processing may be performed at the radar which may be sited a long distance from the airfield.
   The Committee then recommends that these types of radar be fitted with a raw radar display which could be used for bird observations.

3. Progress report

   3.1 The WG agreed:
   - Because of the increased use of digitalized and secondary radars, it was desirable to amend the recommendation of the 11th meeting (see para 5).
   - That the terms of reference should be amended to draw attention to the different areas of work covered (see para 5).

   3.2 The countries represented at the present meeting reported as follows:
   - Belgium is continuing to use their computer-aided echo counting system.
   - Denmark is testing the "Faust" electronic counting system on different radars and takes 16 mm films. Threshold adjustments are made to exclude wave and cloud echoes.
   - France has no new projects; some radar films are usually taken during migration periods and multivariate statistical analyses had been applied to data from the Paris area.
   - The Netherlands have investigated the bird movements in the vicinity of power lines using a tracking radar; bird conservationists claim heavy mortality near these lines. Echo signatures have been recorded and computer analysis of the digitalized data is planned. They are adapting the danish "Faust" system to a multi-beam radar; it will be ready for use in spring 1978.
   - Sweden makes daily forecasts during the migrational season. Polaroid photos are taken at three military/weather radar stations. Statistical analysis of weather and bird migration data has been carried on.
   - Switzerland has carried out no new observations. Evaluation of accumulated data covers the following topics: evaluation of digitalized echo signatures, multivariate analysis of weather data and measurements on height and density of migration, horizontal and vertical concentration of birds along leading-lines.
   - In Uganda some radar studies on bird migration have been done at Makerere University.
   - **In Federal Republic of Germany, studies are under progress and reports will be available for the next meeting.**
   - In the USA different research groups are involved in radar studies on birds. Most of them are concerned with the mechanics of bird migration. With respect to the bird strike problem significant work has been done to elucidate the relationship between bird echoes and the actual number birds moving, and between weather and migration.

3.3 A small sub-group discussed technical details of the two most important methods currently in development:

a) electronic counting

- Current capability:
One system (Denmark) can give counts of bird echoes detected by the radar and expressed as a percentage of occupied to available counting area. This system can be related to a density scale and uses unprocessed video. The gates for counting can be adjusted in size and azimut, but are used at fixed distances.
One system (Belgium) can give counts of bird echoes in areas chosen by the controller on the radar screen. This system uses processed video and automatically gives a printout on an electronic display device of the echo density and the speed and direction of selected bird echoes.
- Desired capability:
To count the number of echoes and to measure the amount of energy received from these echoes, and to relate these data to the amount of bird biomass in the atmosphere per unit area.
It will then be possible to calculate a bird strike probability scale.
If possible altitude information should be included in these data.
- Some practical points to be considered:
One needs pulsed radar with access to raw video and with a high dinamic range.
One needs to locate areas where bird echoes are aesily detected and areas free of permanent echoes.
When using radars with special circuits (e.g. MTI, STC) or settings (e.g. linear or circular polarization), care should be taken in selecting sampling sectors and in calibrating the effects of the circuits or settings.

b) multivariate statistics on weather and bird migration data

- Some points to be considered:
With respect to the dependent variable we have clearly to distinguish between migration traffic rate (depending on wind) and the density (or volume) of migration (birds per unit area or unit volume). For the calculation of bird strike risks the density has to be used.
It seems that with current methods only about 50% of the variation in the activity of migration can be explained. Improvements seem to be possible when analyses are confined to single species; further improvement by accounting for the number of grounded migrants available and their migratory readiness is difficult to attain.
It has to be checked for dependent and independent variables, if they are normally distributed; appropriate transformations have to be used.

4. <u>Proposals for future work</u>

a) migration research
- statistical analysis of improved data (see above)
- comparison of densities and height distribution over land and over sea
- analyses of the movements of different species or groups of birds
- analyses of bird movements along leading-lines.
- weather dependence of density, height and direction of migration.

b) improvement of methods
- electronic counting
- calibration of different types of radar with respect to bird numbers and types of birds
- bird recognition by signature analysis
- means of quantification in terms of height.

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c) application
- application of forecasts (longtime, day-to-day)
- actual information to pilots
- application of echo signatures for the recognition of behavioural differences (e.g. different flight levels for birds of different size).
- training of flight controllers in bird recognition

Radar WG

List of participants

20 October 1977
ICAO office PARIS

Bruderer Bruno — Schweiz - Vogelwarte, CH- 6204 Sempach — Switzerland

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ACTIVITIES OF THE WORKING GROUP

1. Title : Structural Testing of Airframes

2. Introduction

The Working Group was reminded of the terms of reference agreed at the formation of the Group in Stockholm, June 1975 and that these were the basis for the recommendations in respect of work to be done, arising from the First Meeting of the Group in London, May 1976 : namely.

Terms of reference

(i) To exchange information on the results obtained from :

(a) Bird impact research testing of materials, structural specimens, windscreens, etc.

(b) Tests to show compliance with Civil Airworthiness requirements.

(ii) To discuss and evaluate the information in order to provide design guidance material for satisfactory methods of producing bird impact structures, windscreens, etc.

(iii) To exchange information on analytical work.

(iv) To establish liason on future research programmes in order to avoid duplication.

3. Recommandations from First Meeting (BSCE IIth - London , May 1976).

3.1. That, in support of (i) and (iv) of the terms of reference, Members should supply to the Chairman of the Working Group

(a) results of any bird impact testing together with geometric details which have been completed by their organizations.

(b) details of any future testing programmes by their organizations.

3.2. That, in support of (ii) and (iii) of the terms of reference. Members should supply the Working Group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience which have been done by their organizations.

3.3. In order that the Chairman can commence the work of drafting the initial manual material in time for the next meeting, reports should be sent as early as possible but, preferably not later than the end of October 1976.

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4. Progress Report

This present meeting spent its time reviewing progress made against these recommandations. Briefly, despite Recommandations (3), nothing was produced until this meeting and then only by France and the U.K.

Structura
These report are attached and are outlined as follows :

4.1. Summary of Bird Impact Research Test Programme made by Centre d'Essais Aeronautique de Toulouse, January 1977.

A comprehensive programme of testing of windscreen transparency designs and materials involving around 200 bird shots and of leading edge structures has been accomplished. This report summarises the first part of testing and the analysis of results. Formulae for required thickness of windscreens is given in terms of forward speed, impact angle and bird mass for different forms of construction and materials. The results of the leading edge structural testing has been compared with the formulae given in RAE TR 72056 and preliminary findings indicate an acceptable degree of accuracy of these formulae for initial design work. Independent analysis of the test results tends to confirm that the energy generated can be correlated with the area of the section destroyed (i. e. perimeter of hole times thickness of material) and that the tickness of the adjacent parts are additive (such as e leading edge slat skin plus the leading edge skin of the fixed surface).

4.2. Falcon 10 - Summary of Bird Impact Tests, January 1977.

This reports on the 4lb bird strike tests made on the windscreen and empennage and also on the 8lb bird strikes made on the latter. The conclusion is reached that the extent of damage produced by the 5lb and 8lb bird strikes on the empennage differs little for the same forward speed conditions since the bigger bird tends to be split and deflected.

4.3. Impact Resistance of Typical Empennage Structure to 8 lb Bird - CAA

This report is on tests made by Shorts on empennage structure during the development of the SD3-30. The results have been compared with the formula in RAE TR 72056 and show an acceptable accuracy for the latter.

4.4. Bird Impact Resistance of Aircraft Windscreens - CAA

This is a preliminary report on the findings of a comprehensive test programme made by RAE on a wide range of windscreen designs and materials. Formulae for the design of bird impact resistant windscreens are given. The disadvantages of the heated thick PVB interlayer type design are revealed.

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4.5. **Effect of Temperature on the Resistance of Glass-laminated Windscreens to Bird Impact - CAA**

This Note will form the basis of a U.K. Aeronautical Information Circular to be issued by the CAA. It draws the attention of pilots and operators to operational problems which may arise in respect of the type of windscreen presently in widespread use which relies on the heating of the thick PVB interlayer for bird impact resistance. The problem concerns on the one hand, the possibility of too low a temperature if insufficient time is given to warming up the windscreen a take-off and, on the other hand, too high a temperature of the windscreen which can result if the aircraft is allowed to stand in the rain.

The following are the more important points made during the meeting.

(1) Whilst recognizing the valuable pioneering test and analytical work accomplished in developing the formulae given in RAE TR 72056 there is a need to confirm these formulae for bird weights particularly beyond 4 lbs, and also for further test and analytical work to extend the formulae to cover a wider range of forward facing structures likely to be met in design. Guidance on design for energy absorption capability, such as the use of foam, or on the use of splitters would also be welcomed.

(2) It is highly desirable that derived formulae should give some guidance also on possible gross distortion effects, since penetration is not the only criterion. Distortion could lead to possibl safety hazards such as the jamming of controls, disruption of systems or the leaking of fuel. The french testing programme is endeavouring to give some guidance on this and also on the possibl change of trajectory of the bird remains following penetration.

(3) It is unlikely, however, that formulae can be developed to the exactitude that all safety implications can be covered and this emphasizes the importance of appreciating that the formulae are primary for initial design guidance and that final proof of acceptability rests on testing of the actual structure in the mo vulnerable areas.

(4) Arrangements will be made for a meeting betwen the RAE and CEAT to discuss the results of their separate test programmes and correlation of methods of analysis.

(5) The packing of a bird into the breech of an airgun has the result of compressing the bird into a denser mass and it was agreed that this was unavoidable in testing and is likely to lead to conservatism in the test results at the higher bird weights.

(6) The likelihoud of multiple strikes occuring was considered, but it was agreed that from the statistical evidence available the spatial distribution of birds within a flok is likely to be such for large birds that the spacing between strikes is great

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Structural Testing of Airframes

enough for the strikes to be considered to be independent of om another. There is a need, nevertheless, for more statistical evidence on spatial distributions of birds within flocks to confirm this view.

(7) In recognizing forward speed as the most critical parameter influencing bird strike damage, it was agreed, nevertheless, that it would be difficult to formulate practical operational advise to pilots on slow-down, except perhaps for larger birds whose movements were possibly more predictable. Nontheless it was noted that the imposed ATC restriction of forward speed to 250 knots below 10,000 ft in the US produced a pratical benefit in providing additional bird impact protection on existing aircraft designs when operating in the US.

(8) It was agreed that the attention of pilots and operators should be drawn to the conclusion of the UK study of the influence of operational conditions on the actual temperature of the type of windscreen which relies on the maintenance of the temperature of its thick PVB inter-layer at an optimum level for adequate bird impact resistance.

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Structural Testing of Airframes

5. <u>Recommandations</u> : The following have been approuved by the Committee as W.G. Recommaadations.

5.1. That, in support of (i) and (iv) of the terms of reference, members should supply to the Chairman of the Working Group.

a) results of any bird impact structural testing together with geometrie details which have been completed by their organizations.

b) details of any future testing programmes by their organisations.

5.2. That, in support of (ii) and (iii) of the terms of reference, members should supply the Working Group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience which have been done by their organizations.

5.3. That the future continuation of the Working Group be judged against the response of the participating countries to these recommended tasks of 5.2. and 5.3.

5.4. That the attention of the Analysis Working Group be drawn to the need for adequate information on the spatial distribution of birds within a flock for the large bird sizes to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present single bird strike requirements.
(This was supported by aircrew representatives).

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Structural Testing of Airframes

5. <u>Recommandations</u> : The following have been approuved by the Committee as Committee Recommandations

5.1. That, in view of the lack of reponse of participating countries, with the exception of France and the UK, in forwarding any information to the Working Group as requested at the last meeting, a member should be appointed by each participating country to be responsible for reporting to the BSCE progress in support of the recommended tasks of 2) and 3) as follows of the Working Group.

5.2. That the attention of pilots and operators should be drawn to the deteriotation in bird impact resistance of windscreens which rely on the maintenance of an optimum temperature for strength if.

- insufficient time is given for warming up the windscreen before take-off or
- the temperature is too high because the aircraft has been parked in the sun.

CIVIL AVIATION AUTHORITY

Bird Strike Committee Europe - Meeting in Paris
20/21 October 1977

Structures Working Group

Impact Resistance of Typical Empennage Structure to 8lb Bird

1. Introduction

This report is presented by kind permission of Short Bros. & Harland and is a summary by CAA of tests completed by Hawker Siddeley Aviation on behalf of Shorts.

The Short SD3-30 based on the earlier SC7 Skyvan was required to meet the 8lb bird impact resistance required by the US Civil Airworthiness Regulation given in FAR 25.631, an extract of which reads:

"The empennage structure must be designed to assure capability of continued safe flight and landing of the airplane after impact with an 8lb bird when the velocity of the airplane (relative to the bird along the aircraft's flight path) is equal to Design Cruising Speed V_C at sea level."

The following testing was done on a SC7 empennage in design development of the SD3-30. All tests were done with an 8lb bird fired from a compressed air gun to give a speed on impact of 240 mph.

2. Test Procedure and Results

The type of leading edge structure for the fin and tailplane was determined by bird strike tests on local specimens (see Figs 1, 2 & 3). Strike No. 1 penetrated the nosing, causing also internal damage. The nosing was modified according to Figure 2 and subjected to Strike No. 2. This specimen was not penetrated although there was considerable local buckling of the nose section.

The SC7 empennage unit (fin, tailplane and rudder) which is of similar design to the SC3-30 was then tested according to Figure 4. Reinforcements of the leading edges of the fin and tailplane were made as in Figure 2 and also of the tailplane to fuselage drag attachments. Strikes Nos. 1 and 2 were then made with the following results:

Strike No. 1 - The birds did not penetrate the specimen but produced local buckling of the nosing and nose rib as before. The lower surface skin of the tailplane aft of the front spar was slightly buckled in a shear buckling pattern.

Contd..

Strike No. 2 - The bird did not penetrate the specimen but again produced local buckling of the nosing and nose rib. The fin end rib was distorted causing local fouling of the tip of the rudder horn. This was overcome by applying light hand pressure to the rudder. The upper surface skin of the tailplane was buckling aft of the front spar in a shear buckling pattern. There was no apparent damage to the lugs attaching the tail unit to the fuselage side.

3. Conclusions

The reinforced empennage structure of the SC7 described has been shown to withstand successfully in two critical positions the impact of an 8lb bird at 240 mph. Although there was some permanent buckling of the fin and tailplane covering skins the remainder of the primary structure was undamaged. The stainless steel leading edge would appear to have acted effectively as a bird splitter in preventing penetration.

The SD3-30 empennage has been further improved by extending the stainless steel leading edge to give a better attachment to the top fin, and the end rib has also been reinforced. The tailplane skins between the front and rear spars have also been increased in thickness from .018" to 0.35". This latter change not only improves buckling capability but is to offset the 7" increased fin length of the SD3-30.

The above test results have been compared by CAA with the empirical formula given in RAE Technical Report TR72056.

For the unmodified leading edge penetration occurred at 240 mph, whereas calculations would suggest at least 256 mph.

For the modified leading edge no penetration occurred at 240 mph; calculations would suggest that this could occur at around 287 mph.

Since the test work behind the establishment of the formulae in TR72056 was not taken beyond a bird size in excess of 4lb, it is considered that the comparison given above tends to confirm that the formulae are of the right form and sufficiently accurate for initial design involving bird weights above 4lb. It is urged, however, that a further check be done of these formulae from bird impact test results involving bird weights above 4lb.

Research [illegible]

Subject Bird Strikes on Fin & [illegible]

Compiled C Simpson Approved [illegible]

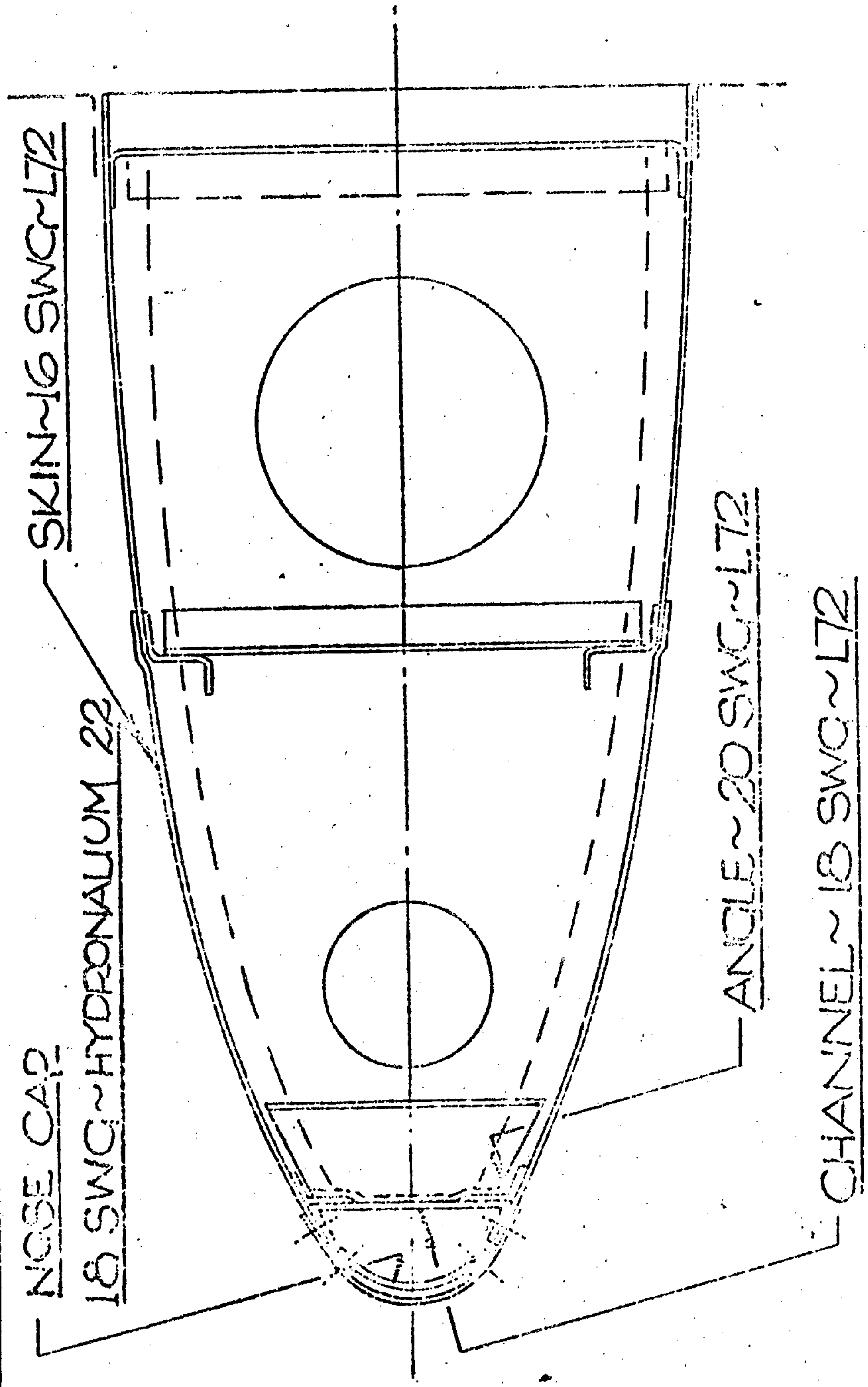

FIG. 1

SECTION THRU' FIRST FIN SPECIMEN

Subject ...

Compiled ...pson Approved ...

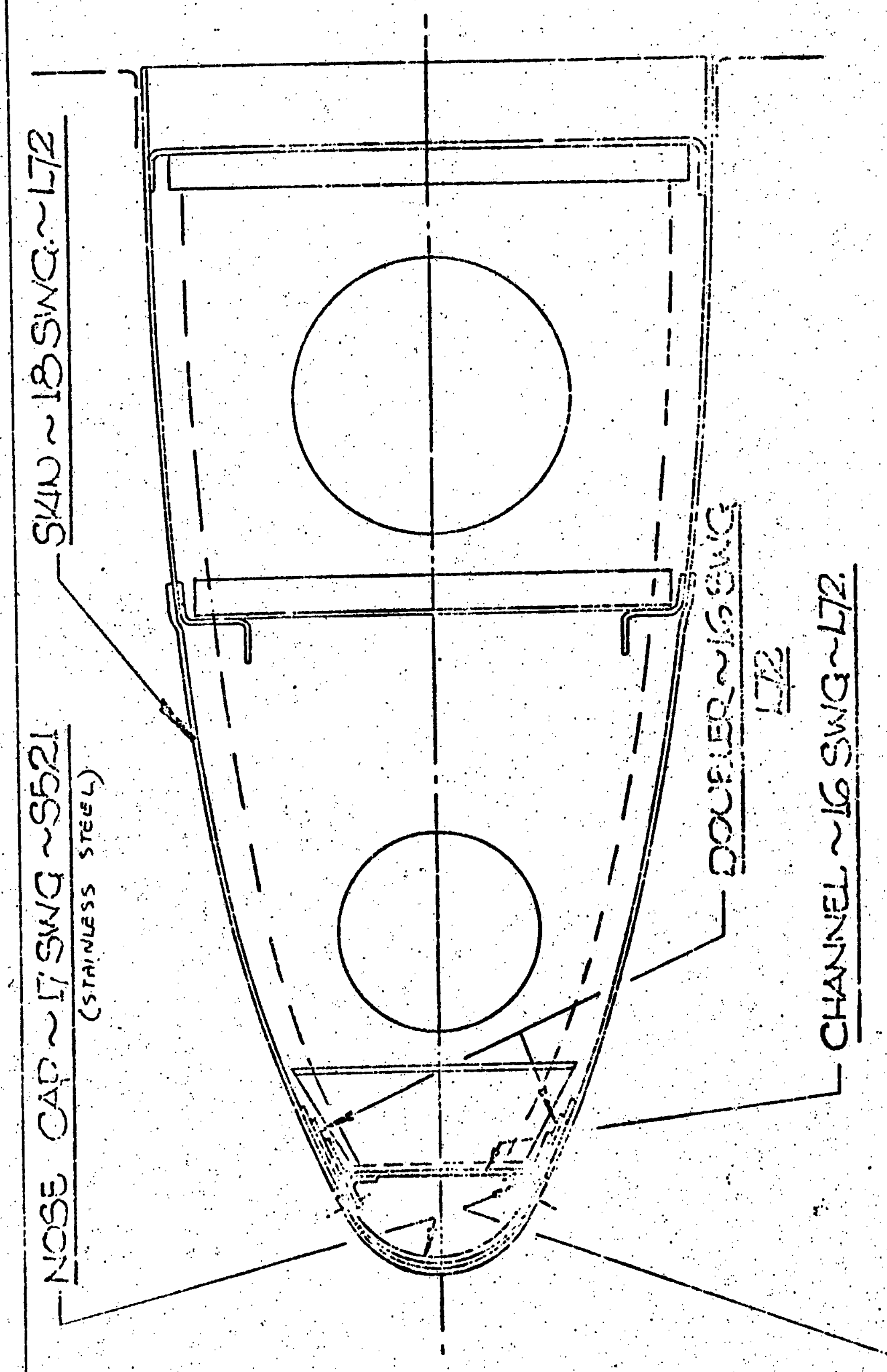

FIG. 2
SECTION THRO' MODIFIED FIN SPECIMEN

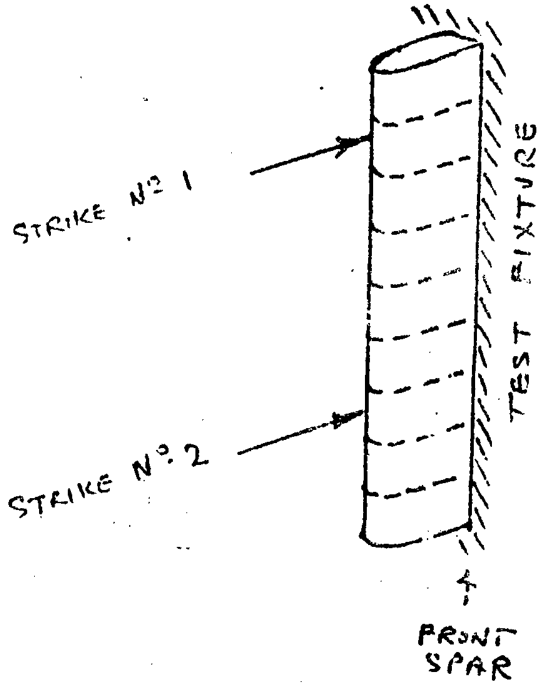

FIGURE 3

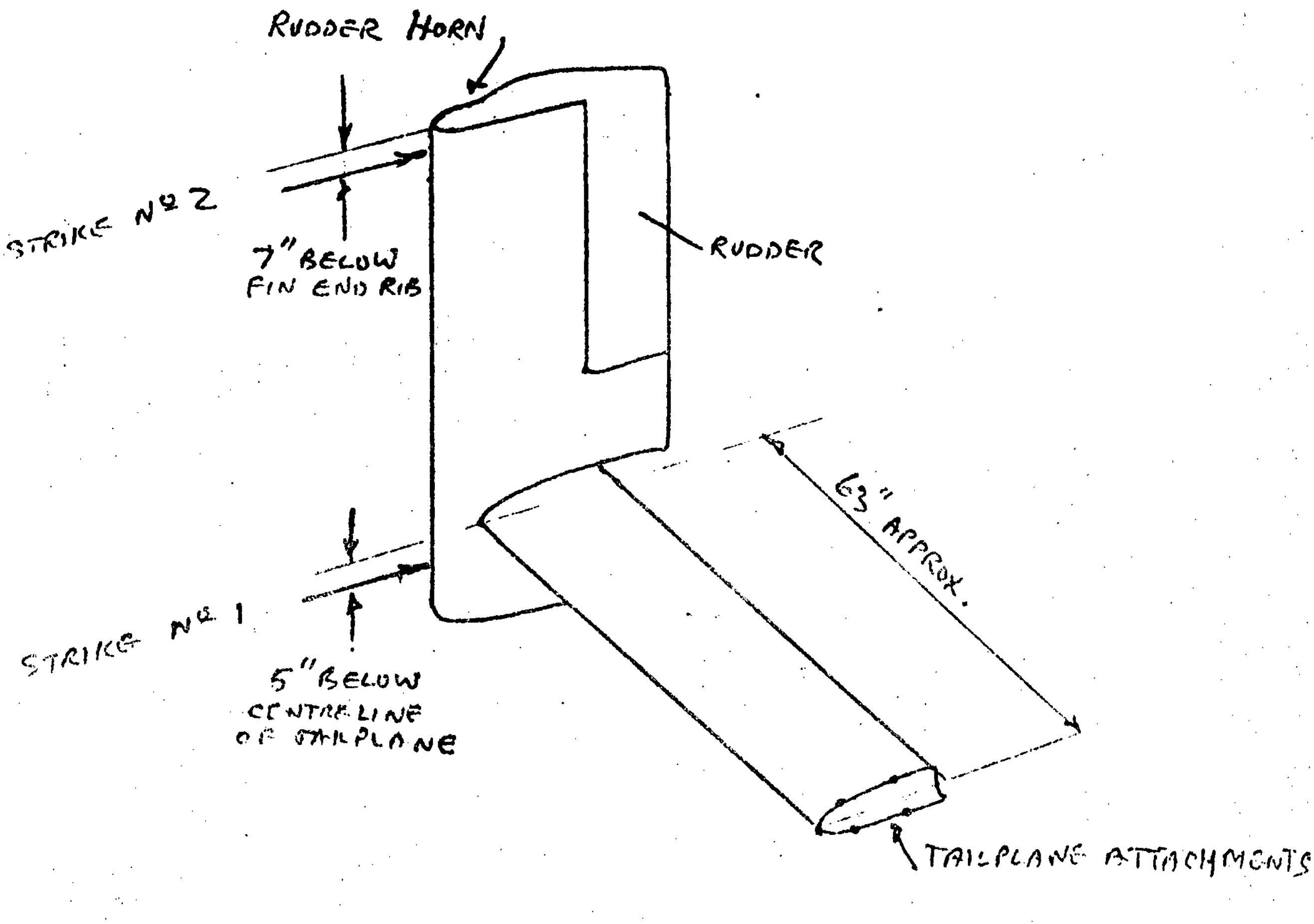

FIGURE 4

BSCE 12-5-6
28 October 1977

CIVIL AVIATION AUTHORITY

Bird Strike Committee Europe - Meeting in Paris
20/21 October 1977

Structures Working Group

Bird Impact Resistance of Aircraft Windscreens

1. Introduction

For a number of years now it has been UK practice to make preliminary design estimates of bird impact strength of windscreens using RAE T.N. 106. The formulae in this report were based largely on US data generated in the late 1940's.

More recent testing of windscreens consisting of thick polyvinyl butyral (PVB) and load bearing glass layers showed that the resistance of the two materials were not additive. Much more importantly, tests of gold film heated windscreens in a controlled environment, giving cold clamped edges to the screen, resulted in shear failure of the thick PVB layer around the panel edge at impact speeds well below that for the same design of screen but with the edges heated.

At the same time, comparative tests of multi-laminated thermally toughened glass panels, assembled using thin PVB interlayers, showed that these had at least the same impact resistance of that of the thick PVB layer type in which the edges were heated. Since these multi-laminate designs are not dependent upon heating for bird impact resistance (which is a major cause of unreliability), these results are considered to have ended any good reason for the use of the heated thick PVC layer as the energy absorption medium for the basis of design of bird impact resistant windscreens.

This present preliminary report gives the latest results of UK testing of various types of windscreen design in comparison with the thick PVB layer type.

2. Results and Conclusions

Tests have been made (in the 1960's) of monolithic and laminated specimens of thermally toughened glass, chemically toughened glass, as-cast acrylic and stretched acrylic. A total of 185 specimens were tested and 347 bird impacts made.

Specimens were 635 x 475 mm with rounded corners.

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With laminated thermally toughened glass (TTG) the effect of encastration depth was examined. Tests were made with 10, 15 and 21 mm encastration. Little difference between 15 and 21 mm but results at 10 mm much lower.

Minimum encastration of 15 mm is recommended and all subsequent tests were made at this encastration.

Effect of temperature on TTG panels. Tests at -40°C, +50°C and normal temperature range 16-26°C showed a 10% reduction in penetration speed at the temperature extremes.

Effect of panel thickness was examined with monolithic and laminated panels over the thickness range 16.5 mm to 47.6 mm.

Impact angle over the range 45°, 53°, 60° and bird weight 0.46, 1.14 and 1.82 kg were investigated.

Effect of strike near panel edge was also investigated and showed upper top corners to be more vulnerable than centre or lower edge strikes.

Derived formulae taking all factors into account and defining resistance as non-penetration in the case of monolithic panels and at least one main ply undamaged in the case of laminated panels:

(1) Thermally toughened glass

(For monolithics within present production thickness capability and laminates.)

$$t = (0.0925 \; V \; \cos\alpha \; \sqrt[3]{W})^{1.15}$$

for $t \leq 25$ mm

and, $$t = 0.1475 \; V \; \cos\alpha \; \sqrt[3]{W}$$

for $t > 25$ mm

where, in these and the following formulae,

V = speed (knots)

t = total thickness (mm)

α = impact angle (degrees), between a line drawn normal to the windscreen and the line of flight

W = weight of bird (kg)

(2) As-cast and stretched acrylic

Monolithic $$t = (0.0466 \; V \; \cos\alpha \; \sqrt[3]{W})^{1.5}$$

Laminated (any number of plies) $$t = (0.0393 \; V \; \cos\alpha \; \sqrt[3]{W})^{1.5}$$

The types of windscreens covered by (1) and (2) above are not dependent upon heating for their bird impact resistance.

For comparison, the existing formula for thick PVC laminated with thermally toughened glass is as follows:

(3) <u>Thick PVC laminated with thermally toughened glass.</u>

$$t = 1.27 \, \text{antilog}_{10} \, V \cdot \frac{\cos\alpha}{260}$$

This assumes that the PVC layer is fully heated, including the edges.

It should be noted that the above formulae are for the impact resistance of the windscreen itself, including any clamped edge effect of the mounting, and do not cover the capability of the surrounding canopy structure. Thus, the formulae should be treated as being of particular value for preliminary design and for full confidence should be followed by tests on the windscreens mounted in the canopy structure.

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28 October 1977

CIVIL AVIATION AUTHORITY

Bird Strike Committee Europe - Meeting in Paris
20/21 October 1977

Structures Working Group

Effect of Temperature on the Resistance of Glass Laminated Windscreens to Bird Impact

1. Aircraft windscreens designed to be resistant to bird impact, generally include a layer of electrically heated poly-vinyl-butyral as the main "bird resistant" member. Tests carried out at the Royal Aircraft Establishment demonstrated that a significant deterioration in bird impact resistance results if the temperature of the vinyl layer is not maintained at the optimum temperature. A problem can thus arise if the windscreen is operating at too low or too high a temperature in relation to the optimum value.

2. It is the purpose of this Note to draw the attention of pilots and operators to this possibility, particularly under take-off conditions, on this type of windscreen. On the one hand, too low a temperature can result if insufficient time is given to warming up the windscreen and, on the other hand, too high a temperature of the windscreen can result if the aircraft is allowed to stand in the sun.

3. In the case of the former, as an indication of the "warming up" time which should be allowed, the windscreen used by RAE in the tests referred to, took at least 15 minutes (with an outside air temperature of 10°C.) after the electrical heating system was switched on, for the vinyl layer to reach the optimum temperature. In lower air temperatures, the required time, of course, would be longer. The degree of heat selected at the windscreen heater control switch has little effect on the time taken for the heat to penetrate the thick vinyl ply.

4. It is therefore important to switch on windscreen heaters at a sufficiently early stage, before take-off, to ensure that windscreens are properly resistant to bird strikes. Windscreen heating should be switched on for not less than the period stated in the aircraft Flight Manual. If the manual provides no time guidance the windscreen heater should be switched on at least 15 minutes before take-off.

5. A similar deterioration in bird impact resistance can arise as a result of overheating from solar radiation, due to the aircraft standing in the sun, and cases of overheat warning due to this have occurred in practice.* Since the level of overheat under such conditions will not be known, pilots are warned that a take-off should only be proceeded with when the overheat warning is extinguished or when they are aware by other means that the windscreen temperature is within acceptable limits.

6. Reliance should not be placed on protection from solar heating being provided by canopy covers and, in the event that the aircraft cannot be placed in the shade, operators are advised to park the aircraft with the nose pointing away from the sun.

* Tests show that a rise in temperature of the windscreen above the outside ambient temperature of around 30°C can arise, in which case, in an ISA +35°C ambient temperature condition the total temperature on the windscreen could be of the order of 80°C. Assuming a typical overheat sensor setting of 60°C, this would mean that the windscreen could be 20°C in excess of this.

Analysis indicates that the cooling effect on a windscreen due to forward speed of an aircraft during take-off and initial climb amounts to between 1 and 2°C per minute. Thus it could take between 10 and 20 minutes after take-off for a windscreen to cool to the windscreen's sensor temperature limit. The aircraft's windscreen would be exposed to a reduced bird impact capability during this period if it employs a thick PVB interlayer on the main bird resistance member.

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ETUDES GENERALES

1 - RESISTANCE DES GLACES

2 - RESISTANCE DES BORDS D'ATTAQUES

3 - ETUDES EN COURS DE DEFINITION

- Extension de l'étude sur BA à l'ensemble de la structure de l'avion
- Etude des matériaux amortisseurs

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1 - ETUDE DE LA RESISTANCE DES GLACES

BUT DES ESSAIS

Etudier la résistance des glaces aux impacts d'oiseaux. Les glaces sont de compositions diverses : feuilleté verre, plexiglass, polycarbonates et composites.

BILAN

8 campagnes d'essais entre 1968 et 1974.

Plus de deux cents tirs sur glaces de formes et compositions diverses.

REFERENCES

1968	Commande	A 7 7311	P.V. 13/H1
1969 - 1970	Commande	4769	P.V. 36/H1 partiels 1 à 4
1969	Commande	5330	P.V. 45/H1
1971 - 1972	Commande	4280	P.V. 61/H1
1974	Commande	4094	P.V. 83/H1

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Cette étude a pour but de donner une estimation de la résistance des glaces aux impacts d'oiseaux en fonction de divers paramètres :

- Masse et vitesse de l'oiseau
- Composition et forme de la glace
- Angle de la glace avec la trajectoire de l'oiseau

L'exploitation de l'ensemble des résultats d'essais a permis d'établir des formules empiriques qui relient les principaux paramètres entre eux.

La formule établie par le C.E.A.T. pour le verre feuilleté fait intervenir la notion de contrainte équivalente σ' de la glace.

$$e^3 = 2,5\, V^2 \sqrt[3]{M^2}\, \sin\alpha\, \frac{S}{\log \sigma'}$$

avec e : épaisseur de verre

α : angle de la glace sur la trajectoire

S : surface de la glace

MM. POULLAIN et CLAMINGIRARD (A.M.D.-B.A.) exploitant les résultats de façon différente proposent, pour le verre et le plexi étiré, les formules suivantes (*) :

$$e^{\gamma} \times C = V^2\, M^{2/3} \sin\alpha . \lambda$$

e : épaisseur de verre

C : coefficient de résistance du matériaux au choc à l'oiseau

λ : coefficient de forme de la glace $[\, 0,9 < \lambda < 1,1 \,]$

$\gamma = 3/2$ pour le verre

$\gamma = 2$ pour le plexi étiré

Pour le verre : $107 < C < 300$

Pour le plexi : C voisin de 30

(*) Mémoire présenté à l' "Optical Transparency Symposium" en 1971 à LONDRES

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Lors des derniers essais sur glaces en polycarbonate le C.E.A.T., exploitant les résultats de façon similaire, propose la formule :

$$V^2 . M^{0,7} . \sin\alpha = A' e^{1,74} \quad (A' = 240)$$

(mêmes notations)

Ces relations permettent d'obtenir un bon dimensionnement de la glace avant essais sur la structure complète (Influence des conditions aux limites) et d'ajuster, après les résultats obtenus lors d'un premier essai, ce dimensionnement.

Elles font apparaître une loi assez générale, vérifiée depuis pour d'autres essais et exprimée par la relation :

$$MV^a = C^{Te} \qquad a \simeq 3$$

Si l'on veut comparer aux essais sur structure métallique (Bords d'attaque) on peut faire apparaître l'angle de la normale à la glace avec la trajectoire (Flèche $\varphi = \pi/2 - \alpha$) et l'on obtient une relation du type :

$$V = \frac{K}{\sqrt[3]{M} \, (\cos\varphi)^{\frac{1}{2}}}$$

qui est très voisine de la formule RAE pour les bords d'attaque :

$$V = \frac{K}{\sqrt[3]{M} \, (\cos\varphi)^{\frac{2}{3}}}$$

Ceci tend d'ailleurs à confirmer la conclusion avancée dans le rapport 61/H1 selon laquelle l'influence de α était sous estimée.

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En 1972, après que des tirs sur éléments de bord d'attaque CORVETTE aient été effectués, deux réunions avec le S.T.Aé d'une part, avec la S.N.I.A.S. d'autre part ont permis de définir le but des essais et la composition des maquettes à essayer.

1 - BUT DES ESSAIS

Il s'agit d'une étude à caractère général sur les différents paramètres susceptibles d'avoir une influence sur la vitesse de pénétration (vitesse critique) à savoir :

- épaisseur et nature du revêtement
- rayon de courbure du BA
- flèche et incidence
- masse du projectile

Le critère à retenir peut être, soit le déchirement du revêtement, soit la protection de certains équipements ou organes de commandes situés au voisinage du BA (bielle de gauchissement, réservoirs carburant ...)

2 - DEFINITION DES MAQUETTES

A la suite des essais réalisés en 1971 sur des éléments de bord d'attaque CORVETTE il est apparu nécessaire de définir des maquettes représentatives de la réalité par leur élasticité globale :

- envergure (2100 mm)
- pas de nervures
- profondeur du caisson (200 mm)

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2 - ETUDE DE LA RESISTANCE DES BORDS D'ATTAQUE

BUT DES ESSAIS

Il s'agit d'une étude à caractère général sur les différents paramètres susceptibles d'avoir une influence sur la vitesse de pénétration (vitesse critique) à savoir :

- épaisseur et nature du revêtement
- rayon de courbure du BA
- flèche et incidence
- masse du projectile

BILAN (fin 1976)

Trois campagnes entre 1971 et 1976

Trente tirs effectués sur maquettes de bords d'attaque

REFERENCES

Etude sur éléments de BA du CORVETTE - 1971 - 64/H1

Etude sur bords d'attaques cylindriques - 1973 - 84/H1

La première partie de l'étude étant directement axée sur la recherche d'un bord d'attaque du type CORVETTE les seuls paramètres variables sont :

- l'épaisseur du revêtement en AU4G
- la structure du BA (renforcé ou non par un fendoir)

les autres paramètres (figés) sont directement représentatifs du BA CORVETTE :

- rayon de courbure R = 48 mm
- flèche = 22,5°
- pas des nervures = 300 mm
- la masse de l'oiseau est de 1,8 kg

Le but fixé à cette première partie de l'étude a donc conduit à réaliser deux types de maquettes :

a) Bord d'attaque cylindrique : 4 maquettes (planche 1)

b) Bord d'attaque renforcé par fendoir : 3 maquettes (planche 2)

a) Bords d'attaque cylindriques:

Des essais semblables ont été conduits en Angleterre et ont permis de conclure à la proportionnalité entre la vitesse de pénétration et l'épaisseur du revêtement. La planche 3 montre que les résultats obtenus confirment assez bien cette loi jusqu'à e = 2,5 mm.

- -

b) Bords d'attaque renforcés

Dans le cas type du CORVETTE le critère principal est le bon fonctionnement de la biellette de gauchissement, et les bords d'attaque du type (a) ne permettent pas (avec des épaisseurs réalistes) de satisfaire à ce critère, d'où l'idée de protéger la biellette par un fendoir (planche 2).

Dans les conditions suivantes :

{ épaisseur revêtement : 0,8 mm
{ épaisseur feudoir : 1,6 mm

la biellette de gauchissement reste libre pour une vitesse de 140 m/s.

A titre de comparaison pour obtenir un résultat semblable avec un bord d'attaque cylindrique il faut une épaisseur de 3 mm et à performance égale le gain de masse est supérieur à 15 % (P.V. 84/H1).

La deuxième partie de l'étude, en cours actuellement, consiste à vérifier l'influence des autres paramètres sur la vitesse de pénétration (rayon de courbure, flèche, incidence) la masse étant toujours de 1,8 kg.

D'autre part l'étude sur bord d'attaque renforcé sera poursuivie. Pour cela 14 maquettes sont réalisées en 1976 complétées par 4 qui seront achevées début 1977.

Pour l'étude de la vitesse de pénétration sur bords d'attaque cylindriques le critère retenu est la limite de déchirure du revêtement afin de pouvoir comparer avec les résultats anglais (RAE TR n° 72 056). Ces résultats sont d'ailleurs utilisés pour limiter le nombre d'essais nécessaires pour encadrer la vitesse critique (deux tirs par maquette et pour une valeur d'un paramètre donné).

Dans le but aussi de tirer le maximum d'informations de chaque tir un moyen de mesure des efforts et contraintes lors de l'impact a été mis au point. La mesure de l'effort d'impact est effectuée au moyen d'une balance de choc. Des essais préliminaires sur plaque plane inclinée ont permis de vérifier la reproductibilité des efforts lors de l'impact ainsi que la cohérence des résultats obtenus (comparaison avec l'estimation théorique et avec des essais anglais).

Actuellement l'étude de l'influence de la flèche est presque terminée (Résultats planche 4) et la campagne d'essais actuellement en cours doit permettre de terminer l'étude fin mars 1977.

Cette étude aura permis de chiffrer l'influence des divers paramètres affectant la vitesse de pénétration des bords d'attaque cylindriques en AU4G.

Les résultats obtenus jusqu'à présent (qui confirment les résultats anglais) montrent bien que ce type de bord d'attaque n'est pas capable de résister à des vitesses élevées ($V \geq 180$ m/s) dès lors que le rayon de bord d'attaque (Influence exponentielle) devient supérieur à 20 ou 30 mm avec des épaisseurs de revêtement réalistes.

La poursuite de l'étude doit donc s'orienter en 1977 vers la définition de bords d'attaque renforcés capables de tenir à des vitesses élevées lors de l'impact d'un oiseau de 4 livres.

La première solution envisagée a consisté à introduire un fendoir (problème particulier de la biellette de gauchissement) mais d'autres solutions peuvent être essayées : revêtement Titane, matériaux amortiseurs ...

Cette nouvelle orientation nécessite une concertation entre constructeurs afin de définir les solutions envisageables sur les bords d'attaques les plus représentatifs.

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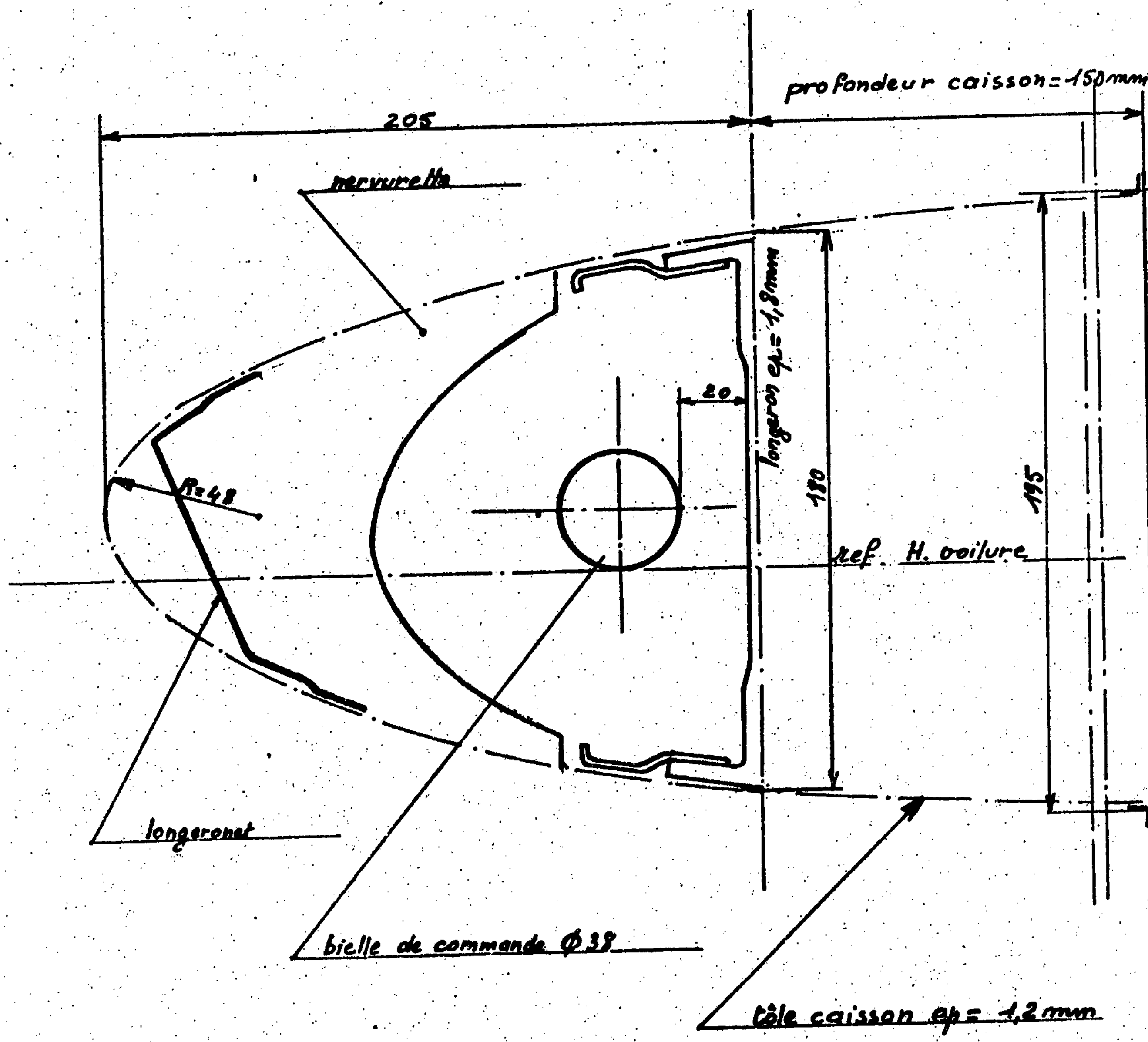
BORD D'ATTAQUE TYPE "CYLINDRIQUE"



échelle 1/2

PLANCHE N° 1

CENTRE D ESSAIS AERONAUTIQUE DE TOULOUSE

BSCE 12-5-6
28 October 1977

BORD D'ATTAQUE TYPE "FENDOIR"

3 - ETUDES EN COURS DE DEFINITION

Dans le cadre des études générales de résistance des structures métalliques aux impacts d'oiseaux deux études sont en cours de définition :

- Extension de l'étude sur bords d'attaque à l'ensemble de l'avion
- Etude des matériaux amortisseurs

1 - EXTENSION DE L'ETUDE SUR BORDS D'ATTAQUE A L'ENSEMBLE DE L'AVION

Cette extension pourrait s'appuyer sur l'exploitation d'essais déjà effectués et de prolonger par des tirs sur maquettes, de façon à déterminer des lois empiriques ou semi-empiriques du choc à l'oiseau sur les différentes parties de l'avion.

Ainsi, de la même manière que pour les glaces, une approche du dimensionnement et du choix des matériaux pourrait être faite a priori, dont la validité serait contrôlée a postériori sur une maquette représentative.

Empennage FALCON 10 :

Les essais à 8 livres ont permis de mesurer l'angle de déviation de l'oiseau (environ 7°) et d'obtenir l'énergie captée par le BA ainsi que la force mise en jeu lors de l'impact.

La mesure de l'effort d'impact au cours du 2ème tir a permis d'obtenir un bon recoupement avec la valeur calculée.

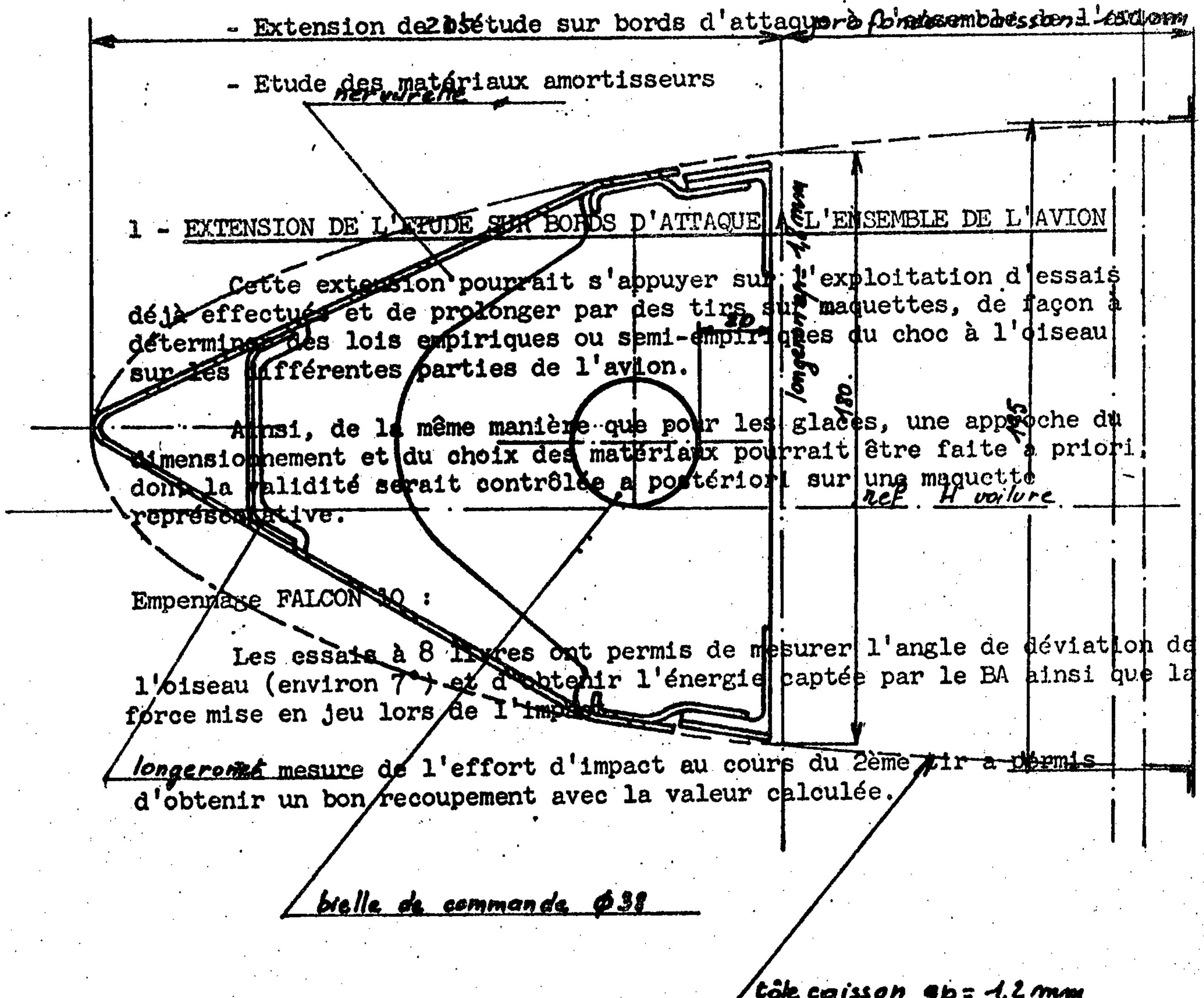


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PLANCHE N° 2

CENTRE D'ESSAIS AERONAUTIQUE DE TOULOUSE

PROCES-VERBAL DE L'ESSAI N°

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28 October 1977

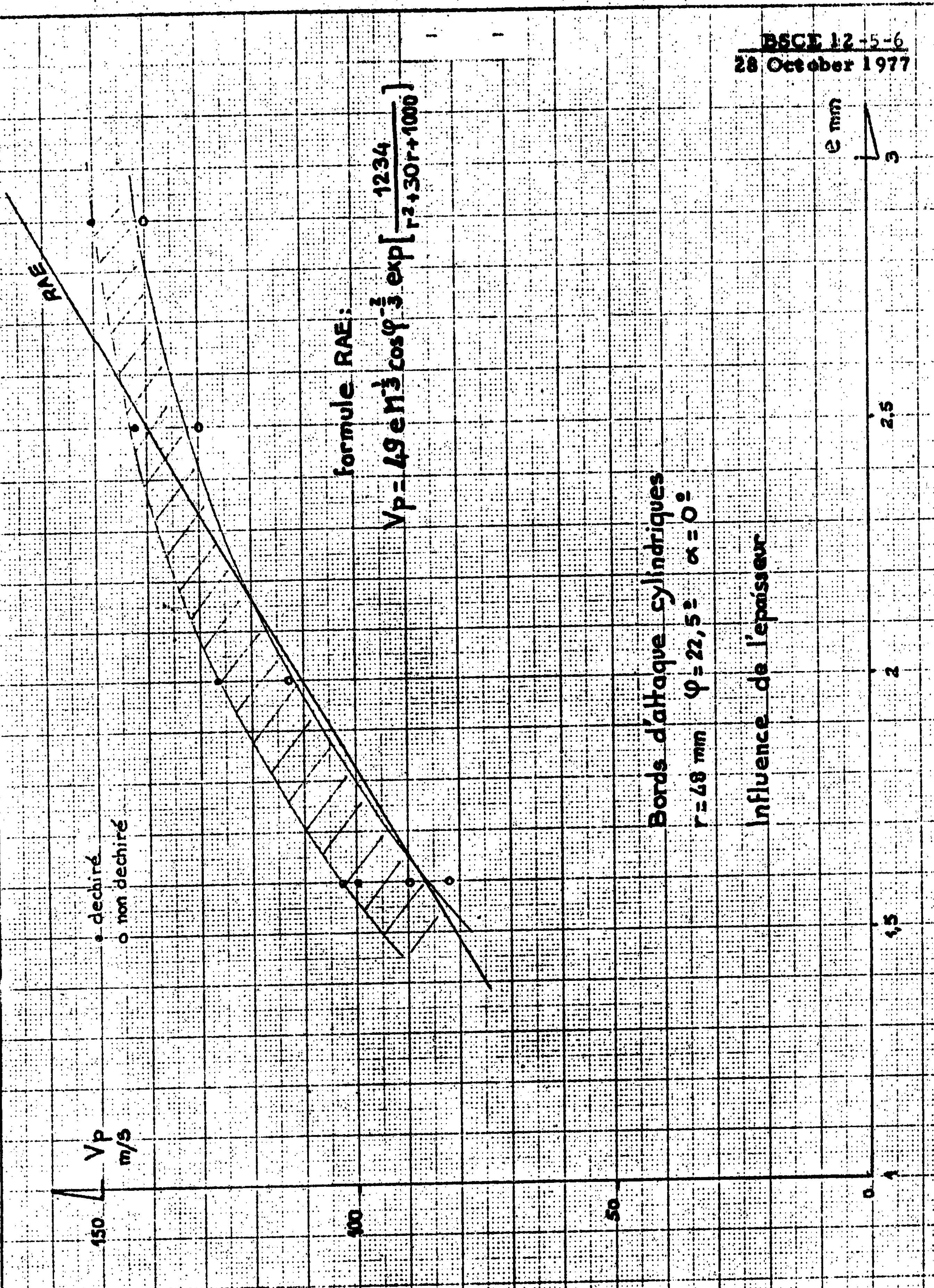

PLANCHE N° 3

D8

3 - ETUDES EN COURS DE DEFINITION

Dans le cadre des études générales de résistance des structures métalliques aux impacts d'oiseaux deux études sont en cours de définition :

- Extension de l'étude sur bords d'attaque à l'ensemble de l'avion
- Etude des matériaux amortisseurs

1 - EXTENSION DE L'ETUDE SUR BORDS D'ATTAQUE A L'ENSEMBLE DE L'AVION

Cette extension pourrait s'appuyer sur l'exploitation d'essais déjà effectués et de prolonger par des tirs sur maquettes, de façon à déterminer des lois empiriques ou semi-empiriques du choc à l'oiseau sur les différentes parties de l'avion.

Ainsi, de la même manière que pour les glaces, une approche du dimensionnement et du choix des matériaux pourrait être faite a priori, dont la validité serait contrôlée a postériori sur une maquette représentative.

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Les essais à 8 livres ont permis de mesurer l'angle de déviation de l'oiseau (environ 7°) et d'obtenir l'énergie captée par le BA ainsi que la force mise en jeu lors de l'impact.

La mesure de l'effort d'impact au cours du 2ème tir a permis d'obtenir un bon recoupement avec la valeur calculée.

PROCES-VERBAL DE L'ESSAI N°

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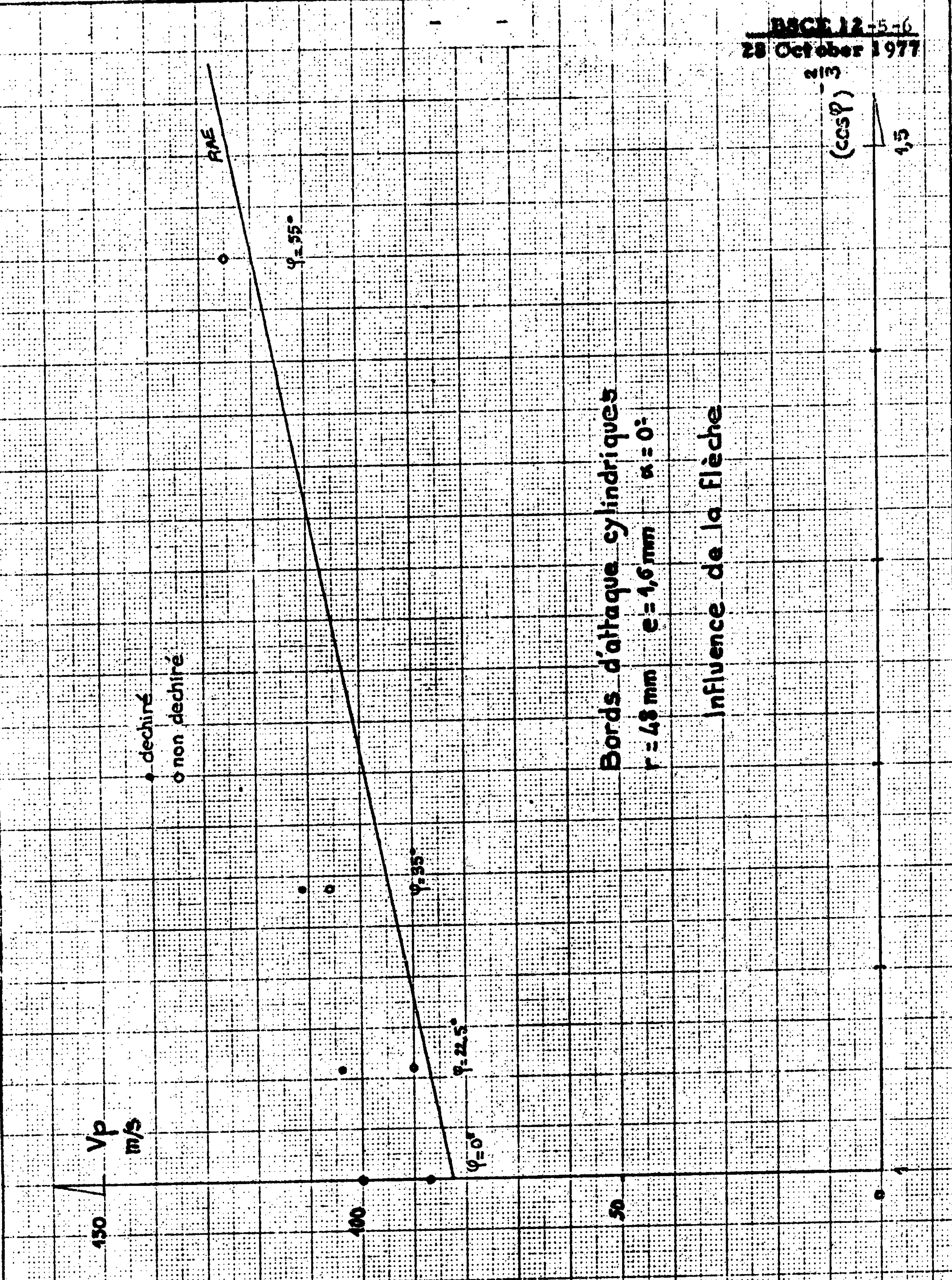

PLANCHE N° 4

Casquette MYSTERE 20 :

L'exploitation des essais sur maquette cylindrique et sur casquette réelle MERCURE a permis d'établir la courbe énergie normale en fonction de l'épaisseur du revêtement.

L'essai effectué sur casquette du MYSTERE 20 donne les résultats suivants :

W_N = 2800 J pour e = 0,88 m et une flèche de 50 mm

ce qui est conforme à la courbe MERCURE.

2 - ETUDE DES MATERIAUX AMORTISSEURS

Cette étude est en cours de définition, le programme d'essais devra être arrêté après concertation avec les constructeurs.

Des essais partiels avaient déjà été réalisés lors des essais sur le radôme et cadre 1 MERCURE.

Il s'agit d'établir le comportement dynamique de matériaux du type Nida à l'impact d'oiseau (Effort d'écrasement, hauteur écrasée, énergie admissible...)

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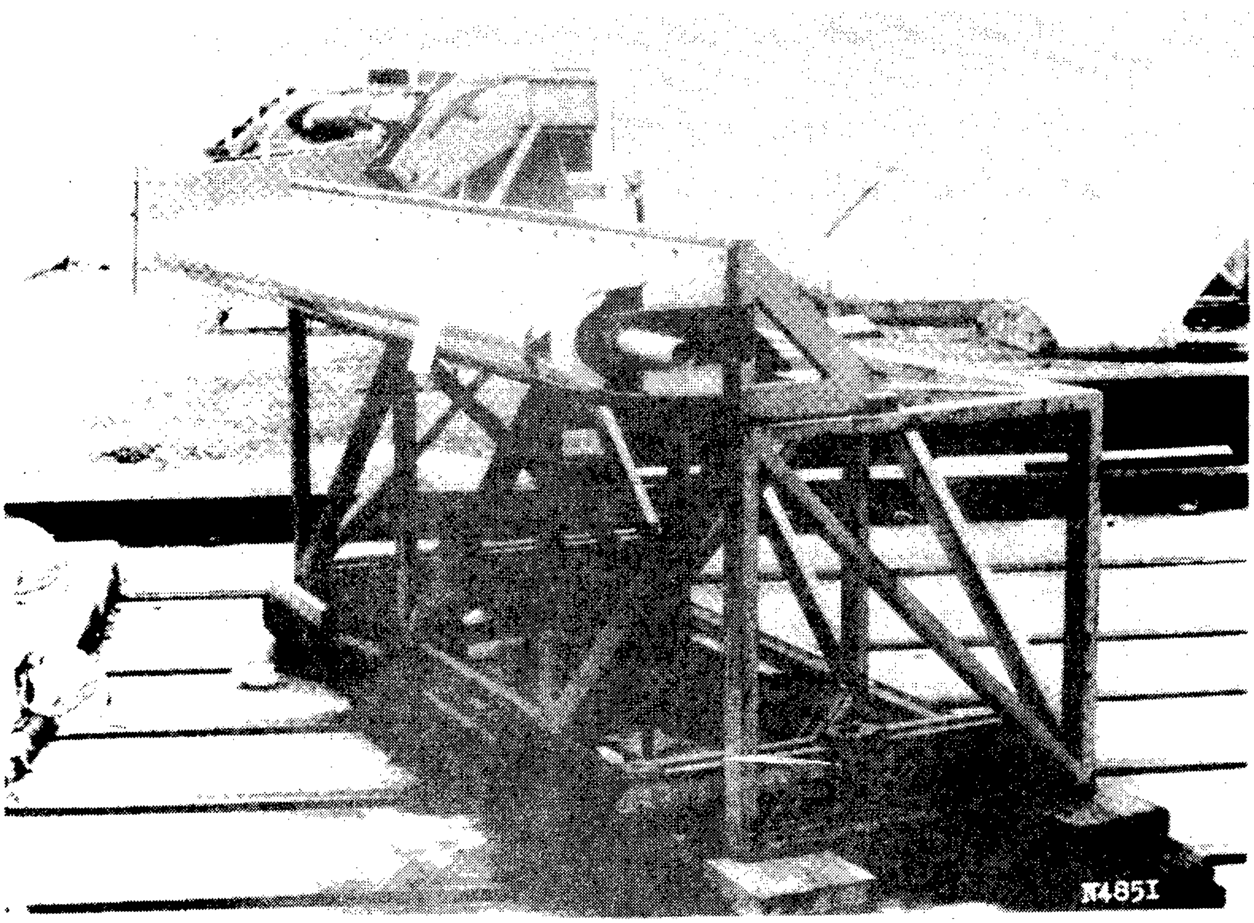
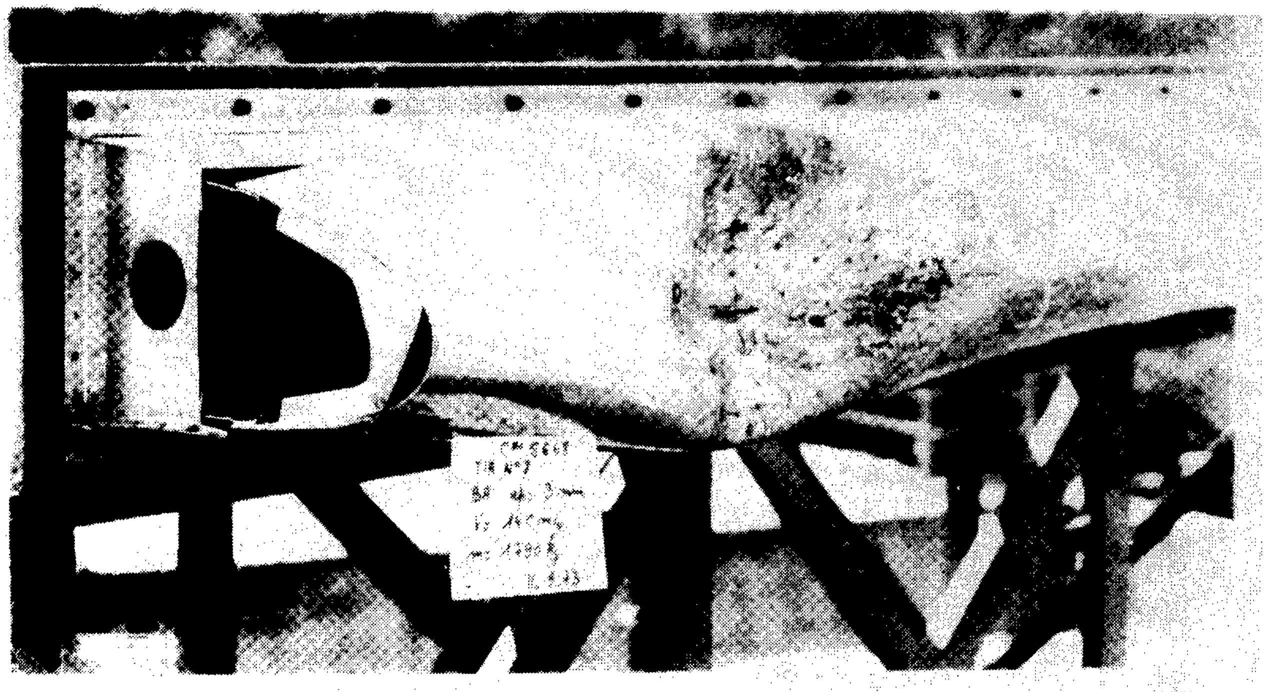


Montage d'essai



Influence de l'epaisseur du revetement.

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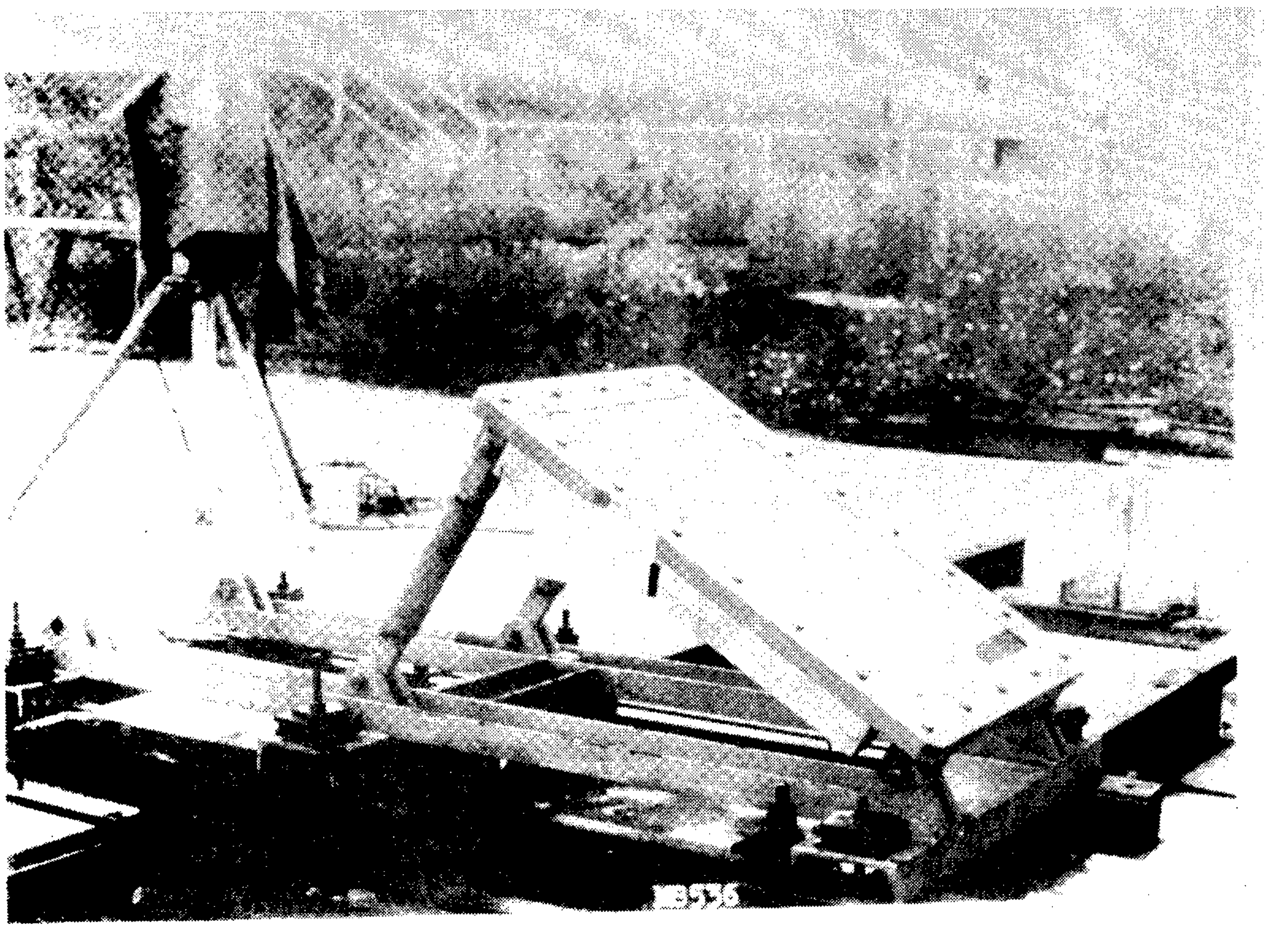

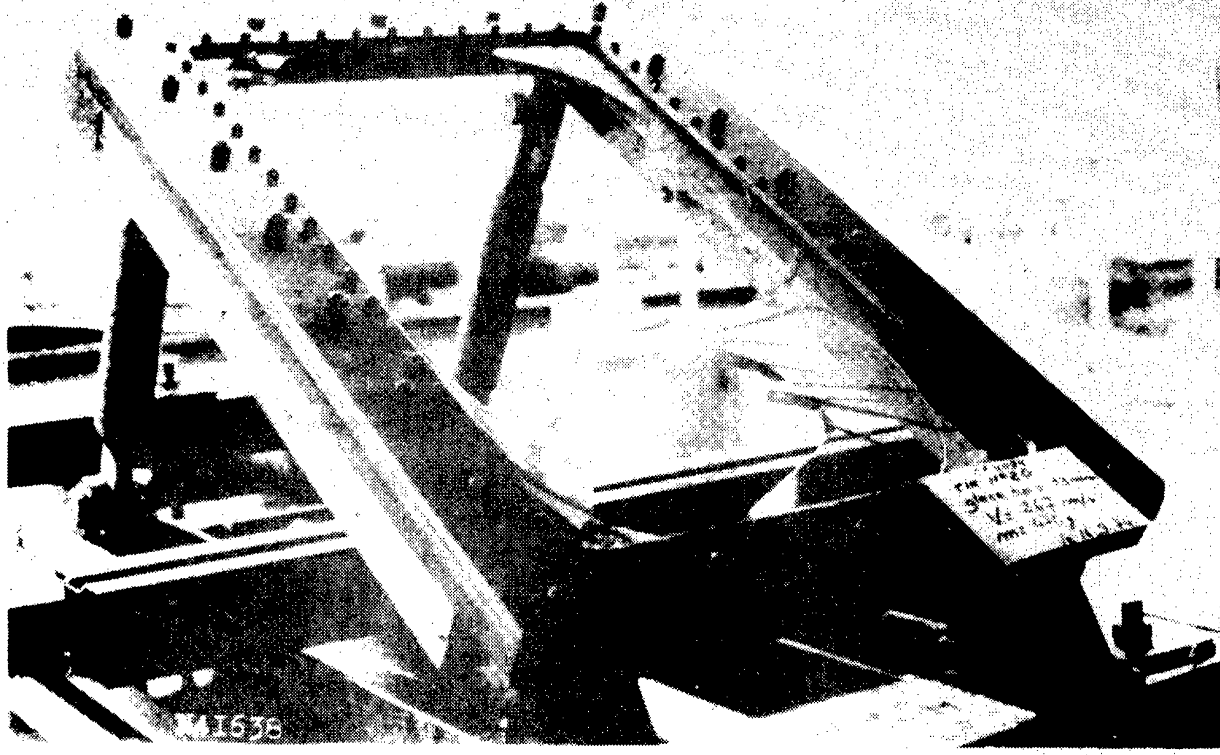

Polycarbonates.

Plexi. étiré

BSCE 12-5-6
28 October 1977

FALCON 10

ESSAIS DEMANDES

1 - Pointe avant

Tenue des parties frontales de l'avion à l'impact d'un oiseau de 4 livres à la vitesse de 180 m/s.

2 - Empennage

Résistance de l'empennage après l'impact d'un oiseau de 4 livres à la vitesse de 180 m/s.

En complément : résistance à l'impact d'un oiseau de 8 livres.

BILAN DES ESSAIS

Sept campagnes situées entre 1970 et 1976.

15 tirs effectués sur les structures réelles de la pointe avant et de l'empennage.

BSCE 12-5-6
28 October 1977

1 - POINTE AVANT

Conditions	Impact	Résultats	Observations	Réf.P.V.
V = 180 m/s M = 1,8 kg	Glaces frontales bombées verre semi-trempé TRIPLEX	Rupture de toutes les dalles pas de perforation quelques débris de verre	Tenue limite à 180 m/s	1970 54/H1 2 tirs
V = 180 m/s puis190 m/s M = 1,8 kg	Glace frontale bombée verre renforcé chimique TRIPLEX	Aucun dégât puis Dalles brisées et éclats	La limite de la glace, située entre 180 et 190 m/s est satisfaisante	1971 62/H1
V = 178 m/s et 176 m/s M = 1,8 kg	Glaces latérales ouvrantes	Glaces brisées	Mauvaise tenue Renforcements à étudier avec essais complémentaires	4 tirs
V = 180 m/s M = 1,8 kg	Glaces latérales ouvrantes	Glace intacte bon verrouillage	La tenue des glaces ouvrantes et de leur verrouillage est satisfaisante jusqu'à la vitesse de 190 m/s	1971 69/H1 3 tirs
V = 190 m/s M = 1,8 kg		bonne tenue de la glace et du verrouillage		

Modifications apportées à la suite des essais

1 - Allègement des glaces frontales (4 dalles au lieu de 5 et verre trempé chimique)

2 - Modification des glaces latérales ouvrantes

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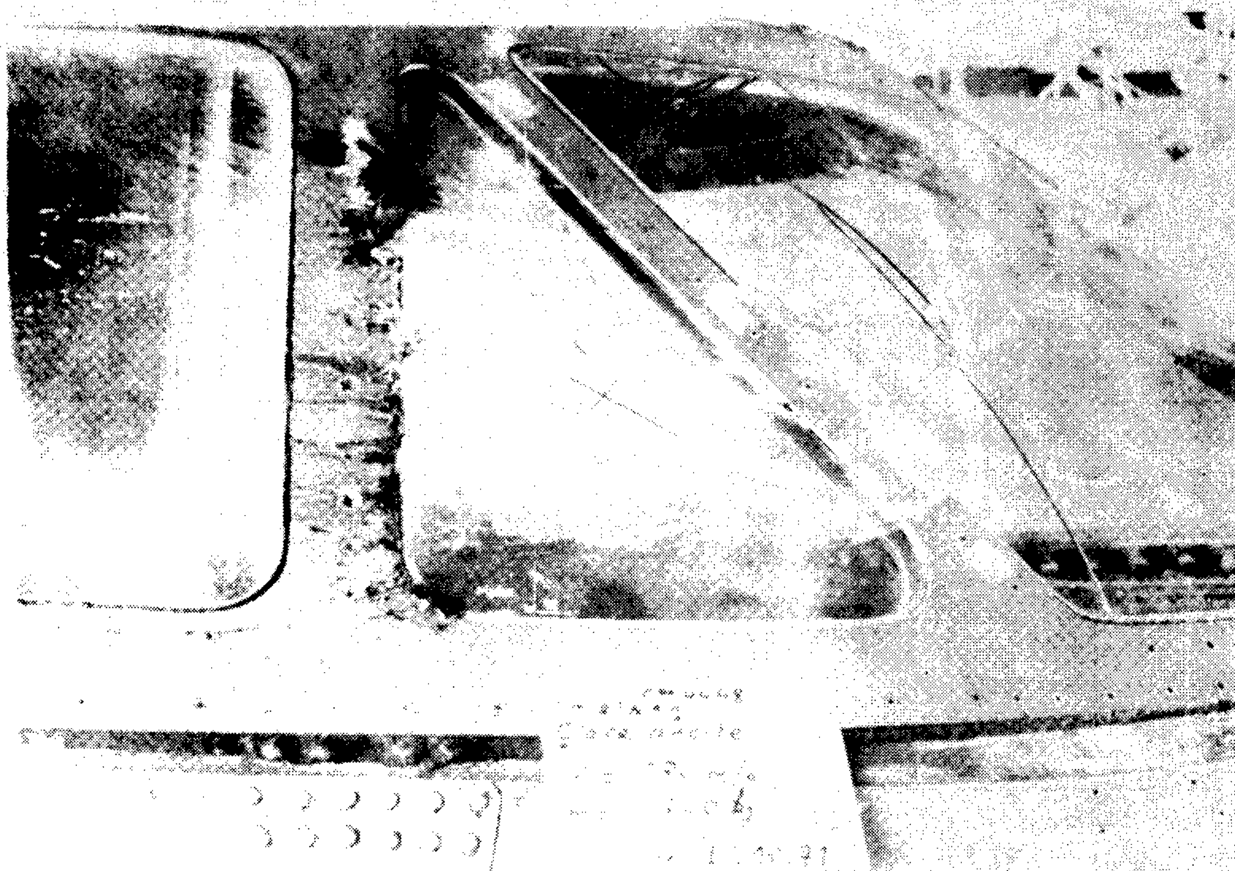
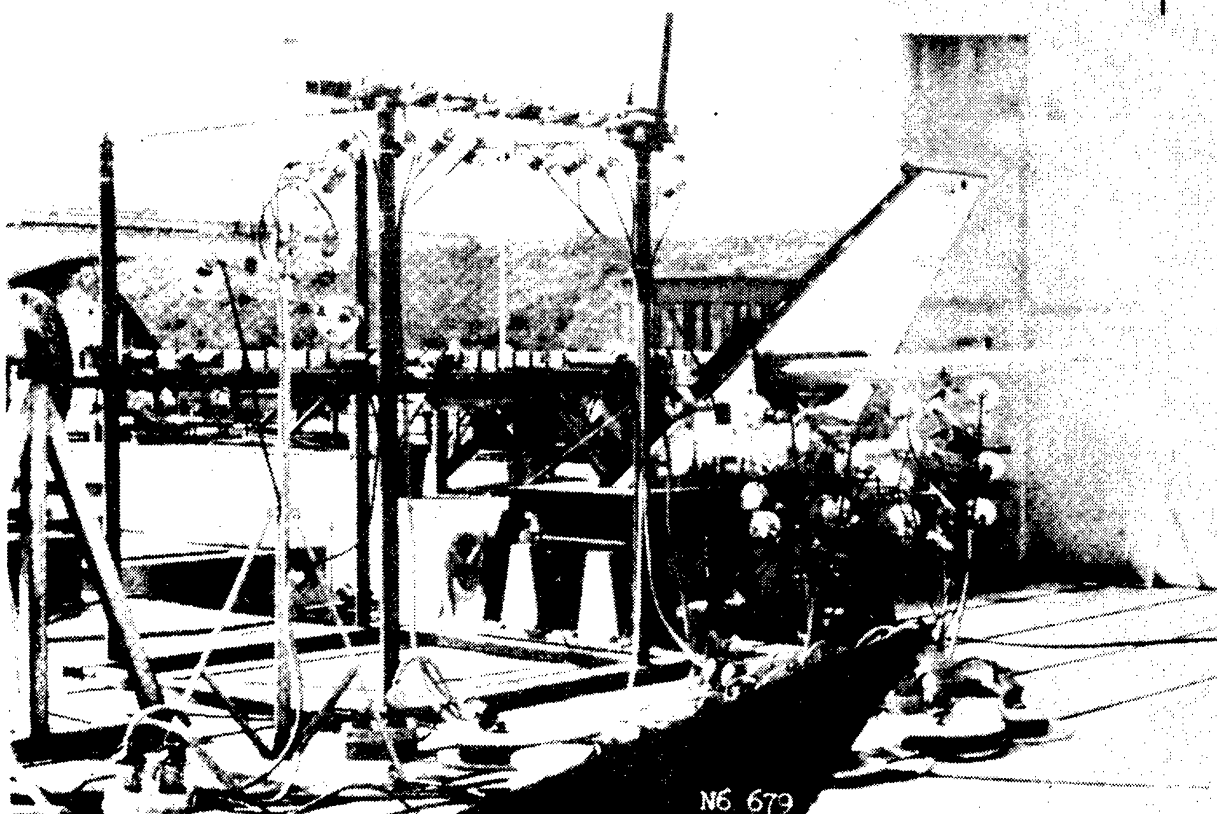
28 October 1977

2 - EMPENNAGE

Conditions	Impact	Résultats	Observations	Réf.P.V.
M = 1,8 kg V = 178 m/s	Croix des empennages	Pénétration sans perforation du longeron dérive		1974-76
M = 1,8 kg V = 178 m/s	Empennage H 180 mm axe avion	Déformation BA nervure à ressort		en cours d'édition
M = 1,8 kg V = 177 m/s	Empennage H extrémité	Destruction de la structure BA et longeronnets	Attaches non affectées par le tir	
M = 1,8 kg V = 189 m/s	Empennage H 2000mm axe avion	BA détruit Pénétration jusqu'au longeron AR intact	Essai demandé par S.T.Aé	
M = 3,6 kg V = 176 m/s	Empennage H 300 mm axe avion	Pénétration jusqu'au longeron central déformé		6 tirs
M = 3,1 kg V = 195 m/s	Empennage H 700 mm axe avion	Pénétration jusqu'au longeron central découpé en partie		

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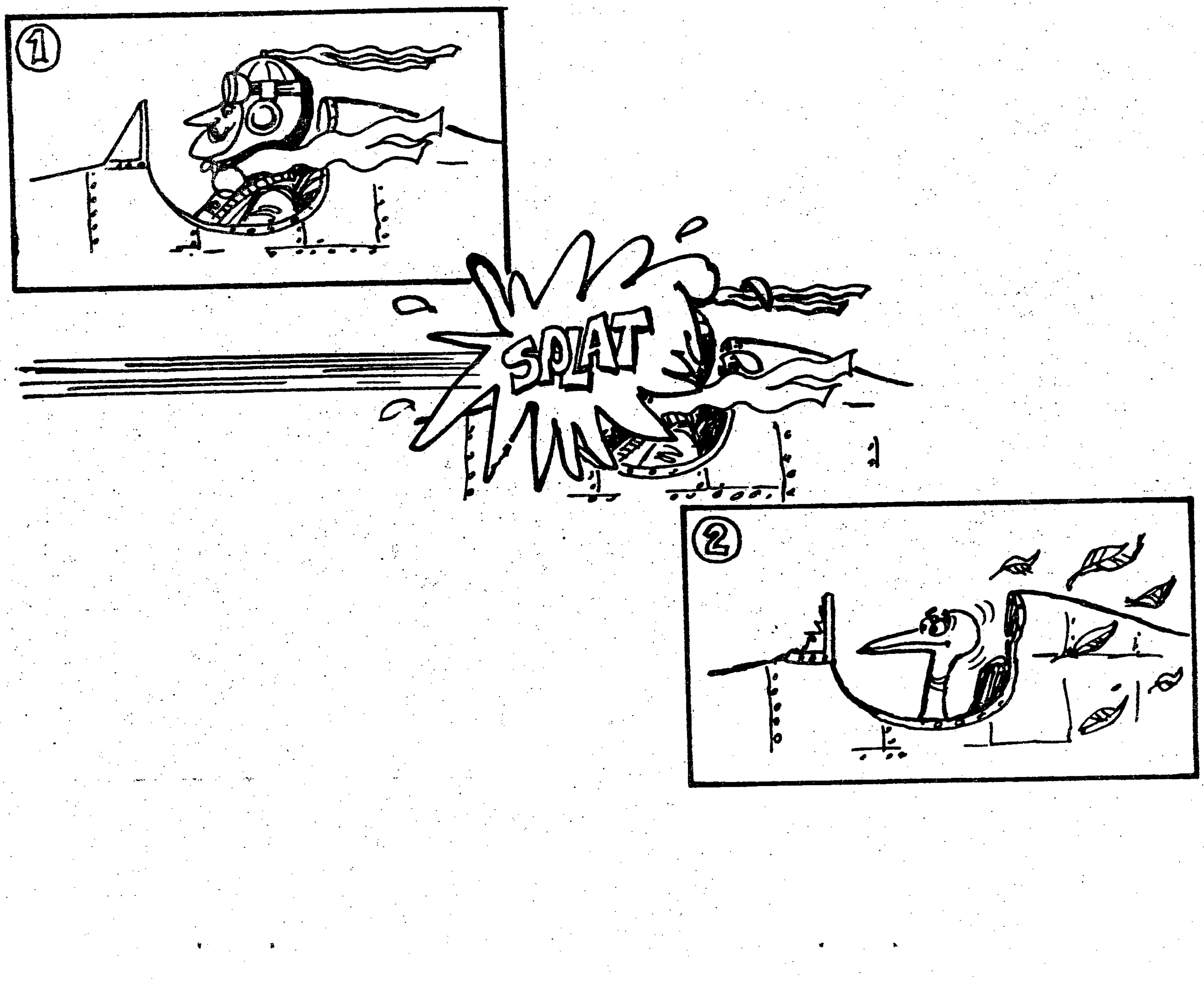
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SPLAT
2

SECTION 6 - Papers Presented

NB : Most of these papers are as provided by the presenters.

WORKING PAPERS PRESENTED AT THE MAIN MEETING BSCE 12

WP/1 Birdstrike-Risk-Forecast by regierungsdirektor
Dr. J. Hild - R.F.A.

WP/2 Bird strikes during 1975 to european registered civil aircraft
by J. Thorpe - U.K.

WP/3 Establishment of Bird control units at 6 Dutch air bases
by L.S. Buurma - Royal Netherlands Air Force

WP/4 Birds killed by aircraft in the United Kingdom 1966-76
by J.B.A. Rochard and N. Horton - U.K.

WP/5 Some Statistic Data on Birds'Strike to Aircraft and Helicopters over the Territory of the Soviet Union
by A.I. Rogachev, D-r O.K. Trunov - U.S.S.R.

WP/6 Bird strikes in German Air Force 1968-1976
by Dr J. Hild - R.F.A.

WP/7 Attempts to control the breeding population of the Herring Gull (Larus argentatus) near Copenhagen airport
by H. Lind - Denmark

WP/8 Development of the theoretical construct of synergised aluminium ammonium sulphate for the control of birds at airports
by R.J. Stone

WP/9 Treatment for repelling birds at Ben Gurion (LOD) international airport - ISRAEL

WP/10 The influence of weather variables on the density of nocturnal migration in spring
by Sidney A. Gauthreaux - South Carolina - U.S.A.

WP/11 Weather-dependence of Height, Density and Direction of Migration in Switzerland -
by B. Bruderer - Switzerland

WP/12 Autum radar study of the coastal migration in Western Holland
by L.S. Buurma - Royal Netherlands Air Force.

WP/13 Surveys of bird concentration areas as a tool in aviation safety work with an example from Sweden.
by J. Karlsson - Sweden

WP/14 Bird strike problems at Ben-Gurion international airport (LOD)
by Sh. Suaretz - Israel

WP/15 Plane as a deterrent an attractant
by V.E. Jacoby - U.S.S.R.

BSCE 12
28 Octobre 1977

AD F616151

Birdstrike - Risk - Forecast

by

Regierungsdirektor Dr.J.Hild, German Military Geophysical Office, Mont Royal, 5580 Traben-Trarbach/Germany.

In German Air Force there exist three types of warning or information about bird movements, and that:

1. NOTAM/BIRDTAM : on the base of actual bird movement observations a birdtam is published by German Military Geophysical Office. This warning is obligatory for pilots at more than intensity 3: it can be prolonged,beguiled, cancelled or the text can be changed in case bird movement situation changes.

   Birdtam-Form:

   Bird movement - intensity 6 - over hotel hotel,hotel lima up to 2000 ft(GND) - or : between 2000 and 3000 ft (GND); valid from 12.00 until 16.00 (Z).

2. Bird Movement FORECAST: It is published every 14 days or 4 weeks on the base of the momentary tendency of bird movement, the bird movement situation during the last weeks, the bird movement situation during the same periods of the last years plotted by computer, the momentary weather situation, the weather situation expected for the next period, the vegetational state in the various districts of Germany, reported by a new program of biophenological observation. This type of warnung is only informative.

   Forecast-Form:

   a) Increasing bird movement from..... into ...
   b) Bird species expected from..... into ... up to.... ft
   c) Strongest intensities between ......(Z) and .... (Z)
   d) Airfield areas
   e) LL-flights of helicopters f.i. .... biophenological state.

f) Bird movement will be favoured by following weather or meteorological parameters:

....

g) Actual birdtam are published by.....

3. Birdstrike - RISK - FORECAST: It is a newer form of forecast corresponding to birdtam. GAF publishes those forecasts every day in the late afternoon with validity of 12 or 24 hours. This forecast has the same background as the long-term forecast but it is more correct because weather forecast is better.
It serves for information of weather offices and AIS on the airfields in case birdtam are not available f.i.because of lacking radar-information at weather situations and in seasonal periods during which bird movements may happen. This forecast indicates larger areas of Germany.

<u>Forecast-Form</u>:

Heavy, moderate or light birdstrike risk in areas A 1,A 2 and A 3; in A 1 up to 2000 ft(GND), in A 2 and A 3 between 2000 and 3000 ft(GND). Valid: 230374 00.00 until 240374 24.00(Z)

German Air Force intends to combine warning form 1(birdtam) and warning form 3(risk-forecast) as soon as more data are available for the computer.

BSCE 12
28 Octobre 1977
ADF616152

BIRD STRIKE COMMITTEE EUROPE

PARIS, October 1977
BSCE/12-WP/

BIRD STRIKES DURING 1975 TO EUROPEAN REGISTERED CIVIL AIRCRAFT

J Thorpe - UK

SUMMARY

The paper contains a consolidation of the Tabulated Data from 12 European countries of bird strikes reported throughout the World during 1975, to aircraft of over 5,700 kg (12,500 lb).

BIRD STRIKE ANALYSIS

EUROPEAN OPERATORS 1975

CIVIL AIRCRAFT OVER 5700 KG (12,500 LB) MAXIMUM WEIGHT

Notes: 0.1 The following are NOT included in this Analysis:
(a) aircraft of maximum weight 5700 kg (12,500 lb) and under,
(b) all military type and operated aircraft.

0.2 All Tables are for strikes reported World-Wide.

0.3 The TOTAL columns of many of the Tables are different, as some countries have not been able to provide full information for every Table.

TABLE 1 COUNTRY -1975

Country	Number of Incidents (Aeroplanes)	Number of Movements (Aeroplanes only)	Rate per 10,000 Movements
Austria	2	44,500*	0.5
Belgium	53	127,172	4.2
Denmark	64	168,590	3.8
Eire	16	70,120*	2.3
Finland	0	73,720	0
France	80	566,370	1.4
Italy+	12	108,790*	1.1
Netherlands	202	197,370	10.2
Norway	26	202,670	1.3
Sweden	54	193,520*	2.8
Switzerland	72	181,316	4.0
UK	357	1,003,604	3.6
TOTAL	938	2,940,000	3.2

Notes: 1.1 There are two movements per flight.

*1.2 Movement data for Austria, Eire, Italy and Sweden is approximate (based on ICAO sources).

+1.3 Data from Italy is for second half of year.

1.4 Data from Switzerland is for Swissair only.

1.5 Data from France and Norway does not include piston-engined aircraft.

1.6 Helicopters are excluded from this table.

1.7 Very limited data from Germany is used in Table 6.

TABLE 2 AIRCRAFT TYPE - 1975

Type	Aircraft	No of Countries Reporting	No of Strikes	No of Movements	Strikes per 10,000 Movements
JET 4 engined	Douglas DC8	9	92	145,360	6.3
	Boeing 747	10	36	76,880	4.7
	Boeing 707/720	6	63	199,790	3.1
	BAC VC10	1	7	29,420	2.4
	HS Comet 4	1	2	14,020	1.4
3 engined	Lockheed 1011 Tristar	1	11	7,800*	14.1
	HS Trident	1	91	144,340	6.3
	Douglas DC10	10	29	58,320	5.0
	Boeing 727	5	9	101,650	0.9
2 engined	VFW 614	1	1	1,480*	6.7
	Boeing 737	5	73	149,840	4.9
	DA01 Mercure	1	13	30,870	4.2
	Douglas DC9	8	213	580,190	3.7
	A300B Airbus	2	4	14,320	2.8
	Fokker F28 Fellowship	1	6	22,100	2.7
	BAC 1-11	2	47	209,460	2.2
	SE210 Caravelle	6	40	231,950	1.7
	SN601 Corvette	1	1	10,000	1.0
	Cessna Citation	1	0	980	0
	HS 125	2	10	60,000	1.7
	Lear	3	2	-	-
	Falcon 20	4	2	-	-
TURBOPROP	HS Argosy	1	1	1,530*	6.5
	Canadair CL44	2	4	9,360	4.3
	BAC Viscount	1	74	288,660	2.6
	BAC Vanguard/Merchantman	1	5	20,010	2.5
	HP Herald	1	14	56,040	2.5
	Fokker F27	6	34	140,080	2.4
	HS 748	1	4	25,520	1.6
	Beech 99	1	2	26,000	0.8
	Nord 262	2	4	57,040	0.7
	DHC6 Twin Otter	4	3	114,800	0.3
PISTON	Douglas DC6	2	1	2,360*	4.2
	Convair 440	4	21	104,874	2.0
	Douglas DC3 Dakota	3	1	12,750	0.8
	ATL 98 Carvair	1	0	10,506	0
	DH114 Heron	1	0	3,620	0
UNKNOWN		17	-	-	-
HELICOPTER	S61	3	4	176,980	0.2
	Others	4	1	27,560	0.4
TOTAL			943		

TABLE 2A SUMMARY OF AEROPLANE TYPE

Jet			752	2,065,160	3.6
Turboprop			145	752,970	1.9
Piston			23	130,490	1.8
TOTAL			920	2,940,000	3.1

Notes: - 2.1 There are two movements per flight.

*2.2 Rates for aircraft types with less than 10,000 movements are included in the Table, but are subject to greater error.

2.3 Rates for types where ICAO data has been used are only approximate (ICAO data on Charter Operators is not comprehensive).

TABLE 3 AERODROME - EUROPEAN REPORTERS 1975

Aerodrome	National Registered Aircraft			Incidents to other European Aircraft	TOTAL INCIDENTS
	Incidents	Movements	Rate per 10,000		
Austria					
Vienna	3	-	-	-	3
Belgium					
Brussels	8	52,662	1.5	3	11
Antwerp	1	5,924	1.7*	-	1
Denmark					
Copenhagen-Kastrup	16	66,785	2.4	12	28
Odense	3	2,900	10.3*	-	3
Sonderborg	2	3,540	5.6*	-	2
Alborg	3	2,140	14.0*	-	3
Eire					
Dublin	5	-	-	-	5
Finland					
Helsinki	-	-	-	1	1
France					
Paris, Orly	10	150,077	0.7	9	19
Paris, Le Bourget	2	84,256	0.2	10	12
Paris Roissy CDG	2	85,797	0.2	2	4
Nice	6	56,888	1.0	3	9
Lyons, Bron	3	67,205	0.4	-	3
Marseilles	3	83,790	0.4	-	3
Toulouse	5	56,751	0.9	-	5
St Etienne	4	30,189	1.3	-	4
Bastia	2	25,115	0.8	-	2
Ajaccio	4	48,887	0.4	-	4
Pau	2	40,535	0.5	-	2
Beauvais	2	40,537	0.5	-	2
Metz	2	29,455	0.7	-	2
Bordeaux	-	-	-	2	2
Italy					
Rome, Fuimicino	1	-	-	3	4
Milan	1	-	-	3	4
Venice	8	-	-	5	13
Pisa	1	-	-	1	2
Netherlands					
Amsterdam	44	75,543	5.8	2	46
Rotterdam	4	-	-	1	5
Norway					
Oslo, Fornebu	3	51,263	0.6	6	9
Trondheim	-	-	-	5	5
Stavanger	1	18,843	0.5	1	2

continued .... /

TABLE 3 AERODROME - EUROPEAN REPORTERS 1975 (contd)

Aerodrome	National Registered Aircraft			Incidents to other European Aircraft	TOTAL INCIDENTS
	Incidents	Movements	Rate per 10,000		
Sweden					
Stockholm, Arlanda	6	-	-	1	7
Stockholm, Bromma	2	-	-	-	2
Halmstad	4	-	-	-	4
Borlange	2	-	-	-	2
Visby	4	-	-	-	4
Sundsvall	2	-	-	-	2
Norrkoping	1	-	-	2	3
Malmo	4	-	-	2	6
Goteborg	5	-	-	4	9
Switzerland					
Zurich	23	52,891	4.3	6	29
Basle	7	9,802	7.1	3	10
Geneva	4	32,394	1.2	3	7
United Kingdom					
Belfast (Aldergrove)	27	20,460	13.2	1	28
Glasgow	31	30,160	10.3	2	33
Tees-side	5	6,590	7.6*	-	5
Wick	2	2,670	7.5*	-	2
Blackpool	5	6,750	7.4*	-	5
Luton	12	18,260	6.6	-	12
Ronaldsway I of M	8	12,830	6.2	-	8
Birmingham	11	19,290	5.7	-	11
Prestwick	17	29,700	5.7	-	17
Stansted	9	16,530	5.4	-	9
Leeds/Bradford	5	9,260	5.4	-	5
Liverpool	6	11,860	5.1	-	6
Glamorgan/Rhoose	4	7,880	5.1*	1	5
Edinburgh	8	16,960	4.7	1	9
East Midlands	7	15,280	4.6	-	7
London Heathrow	45	131,790	3.4	9	54
Newcastle	4	12,530	3.2	-	4
Aberdeen	11	35,160	3.1	-	11
Manchester	9	36,330	2.5	-	9
London Gatwick	9	69,320	1.3	-	9
Belfast Harbour	4	-	-	-	4
Alphabetic list of other aerodromes where more than one strike has been reported by European operators					
Algiers (Algeria)					3
Bahrain (Bahrain)					2
Bamako (Mali)					2
Bangkok (Thailand)					2
Bangui (C African Rep)					2
Bermuda (Bermuda)					3
Dar-es-Salaam (Tanzania)					3
Djibouti (Somalia)					2
Dusseldorf (Germany)					6

continued ....

TABLE 3 (contd)

Alphabetic list of other aerodromes where more than one strike has been reported by European operators (contd)

Aerodrome	TOTAL INCIDENTS
Entebbe (Uganda)	3
Freetown/Lungi (Sierra Leone)	3
Guernsey (Channel Islands)	3
Hamburg (Germany)	8
Jersey (Channel Islands)	3
Johannesburg (S Africa)	3
Kano (Nigeria)	2
Monastir (Tunisia)	4
Nairobi (Kenya)	2
New York JFK (US)	7
Palma (Spain)	3
Prague (Czechoslovakia)	2
Rangoon (India)	2
Singapore (Malaysia)	2
Santiago (Chile)	2
Other Aerodromes with single incidents	111
En-route	18
Unknown	173
TOTAL	934

Note: Rates for aerodromes with less than 10,000 movements are included but are subject to greater error.

TABLE 4 BIRD SPECIES - 1975

ENGLISH NAME	SCIENTIFIC NAME	APPROX WEIGHT	CATEGORY	NUMBER OF STRIKES	% BASED ON 476 ....
Black backed gull	Larus sp	-	B	2	0.4
Herring gull	Larus argentatus	1.1 Kg	B	10	2.1
Black-headed gull	Larus ridibundus	300g	B	26	5.5
Common gull	Larus canus		B	1	-
"Gull"	Larus sp.	-	B	198	-
TOTAL GULLS	-			237	51.6
Lapwing	Vanellus vanellus	200g	B	75	15.7
Pigeon	Columba sp.	450g	B	26	5.5
Swallow	Hirundo rustica	15g	A	23	4.8
Swift	Apus apus	30g	A	17	3.6
"Sparrow"	-	18-40g	A	17	3.6
Rook/Crow	Corvus spp.	400-550g	B	10	2.1
Common buzzard	Buteo buteo	800g-2Kg	B	9	1.9
Birds of Prey	-	-	B	9	1.9
Starling	Sturnus vulgaris	85g	A	7	1.5
Partridge	Perdix perdix	300-400g	B	6	1.3
Pheasant	Phasianus colchicus	1.2 Kg	B	6	1.3
Skylark	Alarda arvensis	40g	A	5	1.0
Kestrel	Falco tinnunculus	200-800g	B	5	1.0
Duck	Anas sp.	-	B	4	0.8
Owl	O.strigiformes	170-380g	B	3	0.6
Heron	Ardea sp.	-	B	3	0.8
Hooded crow	Corvus corone	550g	B	3	0.6
Blackbird	Turdus merula	100g	A	3	0.6
Curlew	Numenius arquata	800g	B	3	0.6
Crane	Grus sp.	-	C	2	0.4
Mallard	Anas platyrhynchos	900g	B	2	0.4
Martin	Hirundinisae	20-25g	A	2	0.4
Golden Plover	Pluvialis apricaria	200g	B	2	0.4
Kite	Milvus sp.	1 Kg	B	2	0.4
Redwing	Turdus iliacus	85g	A	1	-
Artic skua	Stercorarius parasiticus	450g	B	1	-
Long-eared owl	Asio otus	260g	B	1	-
Jackdaw	Coleus monedular	230g	B	1	-
Canary	Serinus canaria	12g	A	1	-
Common Heron	Ardea cinerea	1.5-2Kg	B	1	-
Unknown	-	-	-	467	-
TOTAL		-	-	943	-

Notes:-

4.1 Bird weights and scientific names are based on information supplied by Pest Infestation Control Laboratory, MAFF, Worplesdon, and the average weight has been assumed.

4.2 The bird Categories based on current Civil Airworthiness requirements are:-
CAT A - below 110g (¼ lb)
CAT B - 110g to 1.81 Kg (¼ lb to 4 lb)
CAT C - 1.82 Kg to 3.63 Kg (4 lb to 8 lb)
CAT D - over 3.63 Kg (8 lb)

4.3 Those birds not positively identified are tabled as Unknown.

4.4 Percentages are based on incidents where birds are identified.

TABLE 5 PART OF AIRCRAFT STRUCK [illegible]

PART	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 842
Fuselage	58	20	50	-	128	15.2
Nose (excluding radome and windscreen)	84	36	82	-	202	24.0
Radome	13	6	19	1	39	4.6
Windscreen	59	19	29	-	107	12.6
Engine:-						
1 engine struck	85	6	80	1	172	20.4
2 out of 3 struck	2	0	2	-	4	0.5
2 or more of 4 struck	-	-	-	-	-	
all engines struck	-	-	2	-	2	0.2
Wing/Rotor	45	4	85	-	134	15.9
Landing Gear	10	2	36	1	49	5.8
Empennage	-	0	5	-	5	0.6
Part unknown	64	12	84	1	161	-
TOTAL	420	105	474	4	1003	

TABLE 6 EFFECT OF STRIKE

EFFECT	WEIGHT UNKNOWN	CAT A	CAT B	CAT C	CAT D	TOTAL	% BASED ON 829
Loss of life/aircraft	-	-	1	-	-	1	0.1
Flight Crew Injured	-	-	1	-	-	1	0.1
Engine damage requiring repair on:-							
2 engined aircraft	12 (7)	0	17 (4)	-	-	29 (11)	3.5
Others	14 (6)	1	10 (3)	-	-	25 (9)	3.0
Windscreen cracked or broken	2	-	-	-	-	2	0.2
Radome changed	1	-	3	-	-	4	0.5
Deformed structure	6	1	8	1	-	16	1.9
Skin torn/light glass broken	6 (3)	-	8	-	-	14 (3)	1.7
Skin dented	16 (12)	1	25	-	-	42 (12)	5.1
Propeller/Rotor/ transmission damaged	-	-	2	-	-	2	0.2
Aircraft system lost	- (1)	-	7	-	-	7 (1)	0.8
Nil damage	313	88	281	4	-	686	82.7
Unknown						N/A	N/A
TOTAL	370 (29)	91	363 (7)	5	0	829 (36)	

5.1 The totals in Table 5 are higher than others, as one bird can strike several par[illegible]

5.2 The percentages are based on incidents where the part struck is known.

5.3 Where both landing gear, or both wings are struck, two incidents are recorded.

6.1 If, for example, skin is torn in two places, or both windscreens are broken, two incidents are recorded.

6.2 The figures in brackets are from Germany

TABLE 7 EFFECT - AIRSPEED - WEIGHT OF BIRD

EFFECT	AIRSPEED	0-80		81-100		101-150		151-200		201-250		over 250	
	WEIGHT	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D
Loss of Life/Aircraft						1							
Flight Crew Injured						1							
Engine Prematurely Changed				3		15		4		1			
Windscreen Cracked/Broken													
Radome Changed				1				1					
Deformed Structure		1		1		3	1						
Skin Torn/light glass broken				1		5							
Skin Dented		1		3		16		3					
Propeller/Rotor Damaged						1		1		1			
Aircraft System Lost						3		2					
TOTAL		2		9		45	1	11		2			

Note:

The TOTALS of Table 7 are very low as it includes only damaging strikes where bird weight and airspeed are known.

TABLE 8 COST - 1975 Belgium, Denmark, France, Netherlands Switzerland and U.K. only.

Type	Aircraft Movements	Damaging Strikes	Cost
Where cost is known	1,291,468	95	$107,1380
Where cost is unknown	1,646,274	-	
LIKELY TOTAL COST	2,937,742		$2.44 million

Notes: 8.1 The cost from those countries able to supply cost information has been factored by the TOTAL of aircraft movements for all the countries covered by this Analysis.

TABLE 9 **WEATHER** - STRIKES ON OR NEAR AERODROME

Weather Condition / Time of Day	Dawn		Day		Dusk		Night	
Precipitation	4		29		4		7	
Mist/Fog*	0		7		0		2	
Cloud:†	< ½	> ½	< ½	> ½	< ½	> ½	< ½	> ½
base below 1000 ft			6	4	1		1	1
base 1000-5000 ft		2		1	1			2
above 5000 ft			1	1				2
cloudy/below cloud/ overcast	7		133		13		12	
Clear	8		166		9		37	
TOTAL in each time band	21		348		28		64	
% in each time band	4.5		75.5		6.0		13.9	

Notes: 9.1* Visibility less than 1000 metres
9.2† Cloud cover less than half i.e. 1 to 4 octas
9.3† Cloud cover more than half i.e. 5 to 8 octas
9.4 Clear includes CAVOK

TABLE 10 AIRCRAFT OPERATOR REPORTING STRIKES

Operator	Number of Strikes	Number of Movements	Strikes per 10,000 Movements
Austria			
Austrian Airlines	2	44,500	0.5
Belgium			
Sabena	50	96,094	5.2
Sobelair	0	8,570	0
Trans European Airways	1	7,152	1.4
Delta Air Transport	2	12,048	1.7
Bias	0	2,956	0
Young Cargo	0	352	0
Denmark			
Maersk Air	8	19,540	4.1
SAS	34	86,414	3.9
Sterling Airways	13	42,010	3.1
Conair	5	7,010	7.1
Cimber Air	4	13,482	3.0
Others	1	23,802	0.4
Eire			
Aer Lingus	16	70,120	2.3
Finland			
Finnair	0	70,431	0
Kar-air	0	2,285	0
Others	0	1,273	0
France			
UTA	13	28,072	4.6
Air Inter	36	131,698	2.7
Euralair	1	9,000	1.1
Air Afrique	1	6,772	1.5
Air France	19	323,032	0.6
Air Alpes	3	60,000	0.5
Uni Air	1	12,852	0.8
Others	7	-	-
Italy			
Alitalia	11	108,790	1.0
VIP Air	1	-	-
Norway			
SAS	21	87,354	2.4
Braathen Safe	4	65,826	0.6
Wideroe	1	89,618	0.1
Sweden			
SAS	28	83,520	3.3
Transair	4	10,000	4.0
Linjeflug	20	100,100	2.0
Syd Aero AB	1	-	-
Swedair	1	-	-
Switzerland			
Swissair	72	181,316	4.0
UK			
British Airways (except Overseas)	188	371,540	5.1
British Airways Overseas	43	83,790	5.1
British Caledonian	20	68,900	2.9
Britannia Airways	19	38,800	4.9
British Midland	16	39,410	4.1

continued ....

TABLE 10 AIRCRAFT OPERATOR REPORTING STRIKES (contd)

Operator	Number of Strikes	Number of Movements	Strikes per 10,000 Movements
UK (contd)			
British Island Airways	13	48,260	2.7
Dan Air	6	73,040	0.8
British Airtours	5	12,310	4.1
Short Bros	5	-	-
Laker	4	18,000	2.2
Air Anglia	4	19,020	2.1
Transmeridian	3	5,390	5.6*
Monarch	2	13,800	1.5
Invicta	2	6,170	3.2*
British Airways Helicopters	2	10,620 hrs	1.8
Alidair	2	7,310	2.7*
Tradewinds	1	3,760	2.6*
McAlpine	1	7,330	1.4*
Air Bridge Carriers	1	4,710	2.1*
Others	4	-	-

Notes:

10.1 The movements of Operators who did not report any strikes are not included.

10.2 Leased aircraft are included against the operator.

SERIOUS BIRD STRIKE INCIDENTS WORLD WIDE 1975

(Executive jets and aircraft over 5700 kg)

28.1.75 Private US Lear 23

Believed struck starlings (passenger report) at 1,500 ft on take-off. At 21,000 ft right engine suffered complete compressor stall and was shutdown. Continued on one engine, on descent to destination, at 17,000 ft the left engine also stalled. Left engine re-started at 7,500 ft on base leg to airfield, right engine started on finals. Found IGVs and several first stage blades severely bent.
(Source - Flight Safety Foundation)

14.6.75 Private NA265-80 Sabreliner N67KM at Watertown, S Dakota, USA

Whilst taking off from 7,000 ft long runway aircraft struck gulls during rotation. Both engines immediately "banged" and lost power, and aircraft was crash landed in a field beyond the end of the runway. The wings were torn off and caught fire and the fuselage came to rest approx 750 ft beyond the end of the runway. Both pilots, and one of the 4 passengers sustained serious injuries (the pilots were not using their shoulder harnesses). A total of 13 dead small inland type gulls (Franklin's full - Larus pipixcan) were found on the runway, they were estimated to weigh somewhat less than 450g (1 lb), and to have a wingspan of 2 to 2½ ft. There was light rain, cloudbase 1,000 ft, visibility 1¼ miles. The two CF700 2D-2 engines were inspected, No 1 core had severe damage and compressor was not rotatable, several variable IGV's and stator vanes were torn from inner and outer bands. The fan was undamaged. Bird feathers were found in a number of locations and charred remains were found in combustion and turbine area. No 2 engine had suffered damage, probably as a result of the crash landing, however bird debris was found in the combustion area. The airport is surrounded by lakes, but gulls are rare on the airport except in spring and autumn.
(Source ICAO Subsequent Notification)

19.6.75 Private UK Grumman Gulfstream 1

Struck "plover" whilst at 3,500 ft on approach to Cologne/Bonn airport whilst flying above cloud. Hole 7in x 5in just above front centre of radome.
(Source - UK Bird Strike Reporting Scheme)

1.7.75 Air Malawi BAC 1-11 7Q-YKG at Nairobi

Struck Marabu Stork (Leptoptilos crumeniferus) on approach to Nairobi. A 10 inch square hole was made in port side of fuselage foreward of front passenger door. Skin was damaged for approx 6 feet. Manufacturer's assistance required for repair.
(Source - CAA Reporting Scheme)

17.10.75 Boeing 747

Aborted take-off on cargo flight due to hitting 30 or 40 birds at 155 kts (aircraft weight 772,000 lbs and V1 of 161 kts). Birds rose from runway directly in front of aircraft (flight was first to use runway 13R). No 2 engine was shutdown because of over-temp condition and failure to go into reverse. No 1 was shutdown after taxying off runway. No severe vibration was felt. No 1 engine had severe fan blade damage, one blade tip appox 8 in long had separated and exited through inlet cowl at 4 o'clock position making 2 holes in outboard flap canoe fairing. No 2 engine also had severe fan blade damage, one blade tip approx 8 in long separated from fan, but was recovered, no tips exited through cowl. Airport Manager stated birds would not be scared away due to rain and low ceiling.
(Source Flight Safety Facts and Reports October 1975)

12.11.75 Overseas National DC10-30 N1032F at Kennedy Airport, New York

The aircraft was taking off from a different runway from that in use by other aircraft when, shortly after passing 100 knots the captain saw a flock of approx 100 birds rise off the runway ahead of the aircraft. The captain alerted the crew to "watch the EGT's". The aircraft struck the flock of birds, and No 3 engine disintegrated, scattering parts around a wide area, and setting fire to a nearby vehicle maintenance store. The flight data recorder ceased to record soon after the aircraft attained an indicated airspeed of 168 knots (V, was 178 knots). The take-off was abandoned, but was affected by the loss of No 2 brake system and braking torque reduced to 50%, No 3 thrust reversers were inoperative, at least three tyres disintegrated, No 3 spoiler panels on each wing could not deploy and the runway surface was wet. The wing was on fire due to rupture of the No 3 engine fuel supply line, and the aircraft finally came to rest on the grass beyond the last taxyway at the end of the runway. The landing gear collapsed and ultimately most of the aircraft was consumed by fire. All 139 persons on board who were employees of Overseas National successfully escaped from the aircraft.

Approximately 20 dead gulls were found on the runway, identified as Herring gulls (Larus argentatus), Ring-billed gulls (Larus delawarensis) and Great-black-backed gulls (Larus marinus). The largest bird weighed 5 lbs and the average weight of the other birds was between 3 and 4 lbs. There was evidence of at least six significant bird strikes on the lip assembly of No 3 engine inlet cowl. The ingestion caused massive fan blade damage to the GE CF6-50 engine and, ultimately, fan rotor imbalance. When the fan rotor assembly became unbalanced the epoxy abradable rub shroud around the inside of the cowling began to pulverize and entered the HP compressor. It then exploded, the overpressure within the compressor section caused the compressor cases to separate and structural integrity of the engine to be lost.

A number of recommendations were made concerning bird control measures and engine modifications. All CF6-6 and -50 engines have now been modified in that the epoxy rub shroud has been replaced by alloy honeycomb material.
(Source NTSB Aircraft Accident Report NTSB-AAR-76-19)

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20.11.75 Private U.K. HS125 G-BCUX at Dunsfold, Surrey

The aircraft took off with two pilots and seven passengers on board, becoming airborne shortly before the half way point. At a height of between 50 and 100 feet and after the undercarriage had been retracted, at a speed of approx 150 kts the aircraft encountered a flock of lapwings (Vanellus vanellus). Both engines ingested birds and although there were no instrument indications the aircraft commander sensed an immediate loss of power on both engines. Ground witnesses saw balls of flame of varying length behind each of the engines. The aircraft was force landed straight ahead with undercarriage and flaps lowered, touching down with only 180 metres of runway remaining at a speed of approx 120 kts. It overran the end of the runway and continued across grass fields and through three hedges before crossing a main road at a speed of approx 85 kts. In so doing it struck and demolished a passing car killing the driver and five children. The undercarriage was torn off and the aircraft continued for a further 150 metres before coming to rest. Fire broke out, but all nine occupants safely evacuated the aircraft before it was largely destroyed by the fire.

A total of 11 dead lapwings were found on the aerodrome, the largest of which weighed 303 grams and had a wingspan of 610 mm. The accident took place 5 minutes after sunset and the aircraft's landing and high intensity supplemental strobe lights were in use. Approximately 40% of the aerodrome had "long grass", but there were many birds uniformly abundant in the short grass areas. Equipment for playing bird distress calls was available, however the lapwing tape had been taken to a laboratory for examination the day before the accident, as it was believed to be faulty. Subsequently examination showed that both engines had ingested birds, causing a surge condition, however the damage was such that both engines were capable of being test run.
(Source Accidents Investigation Branch Aircraft Accident Report 1/77)

20.12.75 Israeli Boeing 707 Freighter 4X-ATX at Tel Aviv Airport

During a daylight landing on runway 12, with landing lights ON, struck a flock of black headed gulls (Larus ridibundus) average weight 300 gms. Two engines and both wings were damaged.
(Source = Lloyds List and BSCE Member)

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BSCE 12
28 Octobre 1977

Establishment of Bird Control Units at 6 Dutch air bases

L. S. Buurma

Royal Netherlands Air Force

introduction

Birdstrike prevention activities in the RNLAF, but probably also elsewhere in aviation, seems to be a cyclic phenomenon. Two years ago I showed you figures and expressed some thoughts about succes and malaise as regards fighting the bird problems in Holland. Nowadays the Airstaff reconsiders all possibilities as much as possible.
After some general remarks about statistics this paper gives a short description of the establishment of Bird Control Units (BCU's), groups of personnel and equipment responsible for birdstrike prevention at air bases. Although the same denomination is used here as in the UK there are probably differences in the organisation structure, which can be of importance to our discussions.

statistical arguments

The main reason for the increasing urge to tackle the problems is the reinterpretation of statistics. Analysis of birdstrike data is highly important to raise funds but frequently leads to misunderstanding. Recruting of special personnel is expensive; so it seems important to pay some attention to the arguments.
A graph giving the annual totals of birdstrikes causing damage clearly shows the general trend, apart from annual fluctuations that are difficult to explain. It appeared to be essential to consider these statistics on a rather long-term basis. Careful analysis is necessary because of several "snacks". Especially the following points are very important:

a) the quality of reporting: their is a distinct relationship between general interest in the problem and the number of non-damage birdstrikes, which should be separated from the ones causing damage. Introduction of a BCU at an airfield will result in an astonishing increase of (non-damage) birdstrikes!

b) local ("airfield-") birdstrikes have to be separated from the "en route" ones. At airfields there is more chance of finding birdremains not only on the airplane but also on the runways. Apart from the increase in detection chances, there are also greater possibilities of identification of the species involved. This means a strong bias towards "airfield-bird-species". En route strikes seldom yield more than some feathers or minced meat. In case of no damage even the cause "bird" is not always evident. Non damage cases en route are distinctly less frequently reported and vary according to size and type of aircraft and instructions and attention of the crew. The quality of the reported data is also relatively inferior compared to those of local birdstrikes.

Our general conclusions regarding a period of 20 years, respectively without, with, without and again with keen attention to what has happened are:

1. don't draw any rash conclusions about the benefits of investments. One needs many data and it takes several years to discover the general trend.

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2. Local and "en route" birdstrikes are fundamentally different in character and to explain them different approaches are needed. Because of lower speeds of aircraft above and near airfields there is not much chance of damage, but if something happens, especially in take-off, the risk of fatal accidents is relatively great. On the other hand "en route" strikes very frequently result in damage but in dangerous cases often there will be enough time for bail-outs. The high damage ratio is partly due to detection bias but apart from this there is a relation between size of damage and flightspeed resulting in a high "en route" strike ratio for low flying military jet aircraft. The "en route" category is of no importance to civil aircraft perhaps with the exception of helicopters flying with high speeds.

3. In the RNLAF local strikes constitute roughly 40 % of the total number of damage strikes. In 1976 one jet aircraft was totally lost and the pilot fatally injured. In 1977 a similar situation went well thanks to the professional skill of the pilot and the lessons learnt from the first case.

4. The total prevention success depends on a general program with a broad scope. It cannot be simply correlated with a single element of all prevention activities. Complete incorporation of the birdprogramme in the daily operations is a must.
   As long as pilots are not convinced of the possibilities, and do not see a practical approach, birdstrike prevention will become ineffective. An operationresearch-approach to the problems within BSCE would probably do much good.

selection, training and status of personnel

After having reinforced the staffpotential by the recruitment of a full-time ornithologist, and with the help of academically trained conscripts, the air staff decided to decentralise: each jet-base is to have one specially trained birdman on a full-time basis as an extra employee of the airbase safety office which as a rule consists of 4 persons. He should take much interest in birdlife but also possess much experience in airfield operations. He should at least be able to make contacts with many people and to work independently. So the RNLAF decided to appoint non-commissioned officers who, like other flight safety specialists, keep their normal career possibilities.
This seems to differ a little bit with the UK system, where on average a team of 3 people has been contracted. In general the english BCU-members have no promotion possibilities on a longer term and therefore stay for a limited period of time while their wages are lower.
We feel that there is a need for an experienced specialist who will do the work as long as possible. Apart from joining the scaring and patrolwork he coördinates the activities of personnel already present at the airbase: especially firemen are highly suitable because of their full-time presence during operations and because as a rule their workload is not very heavy. Besides these people are often eager to join some extra activity.
We are afraid that presence of too many anti-bird specialists will lead to a decrease in the general belief in cost-effectiveness if there are no birds to scare for a prolonged period of time which in fact is our main purpose! In addition the specialists themselves will lose their belief in their own indispensability. In contrast one single senior "birdspecialist" who does the monitoring work and coördinates and trains assistents provides a better chance of long term survival of the BCU.

Besides this the person is expected to become gradually the expert on all sorts of airfield environmental problems and who knows all difficulties and the persons to contact. Difficulties arising out of our strong bird-protection law will also be reduced to an acceptable minimum.
Apart from attending the UK-course on bird-control our "Birdmen" and staff personnel exchange information every three months at a one-day meeting, held at one of the problem airfields. This proves to be very beneficial especially as regards motivation and discussions about psychological problems: within the base the job is unique and still now not every one understands the type of work.

daily programme

Routine activity is the early morning count followed by a scaring patrol to be concluded at least fifteen minutes before the first wave of fighters takes off. During the flight programme scaring is only performed: a) after having received a call from ATC or b)by way of irregular patrols in case great birdproblems already occur during the first early morning patrol. As soon as there is a pause in the aircraft activities extra care is compulsory. During operations aircraft scare away most birds but a pause in flying means that there is relative quietness in the runway area as compared with surrounding fields.
In many cases it appeared that the birds could have better be left undisturbed instead of scaring them away. Flying in the air they sometimes present a greater risk. Knowledge of the behaviour of the birds under different circumstances is of great value.

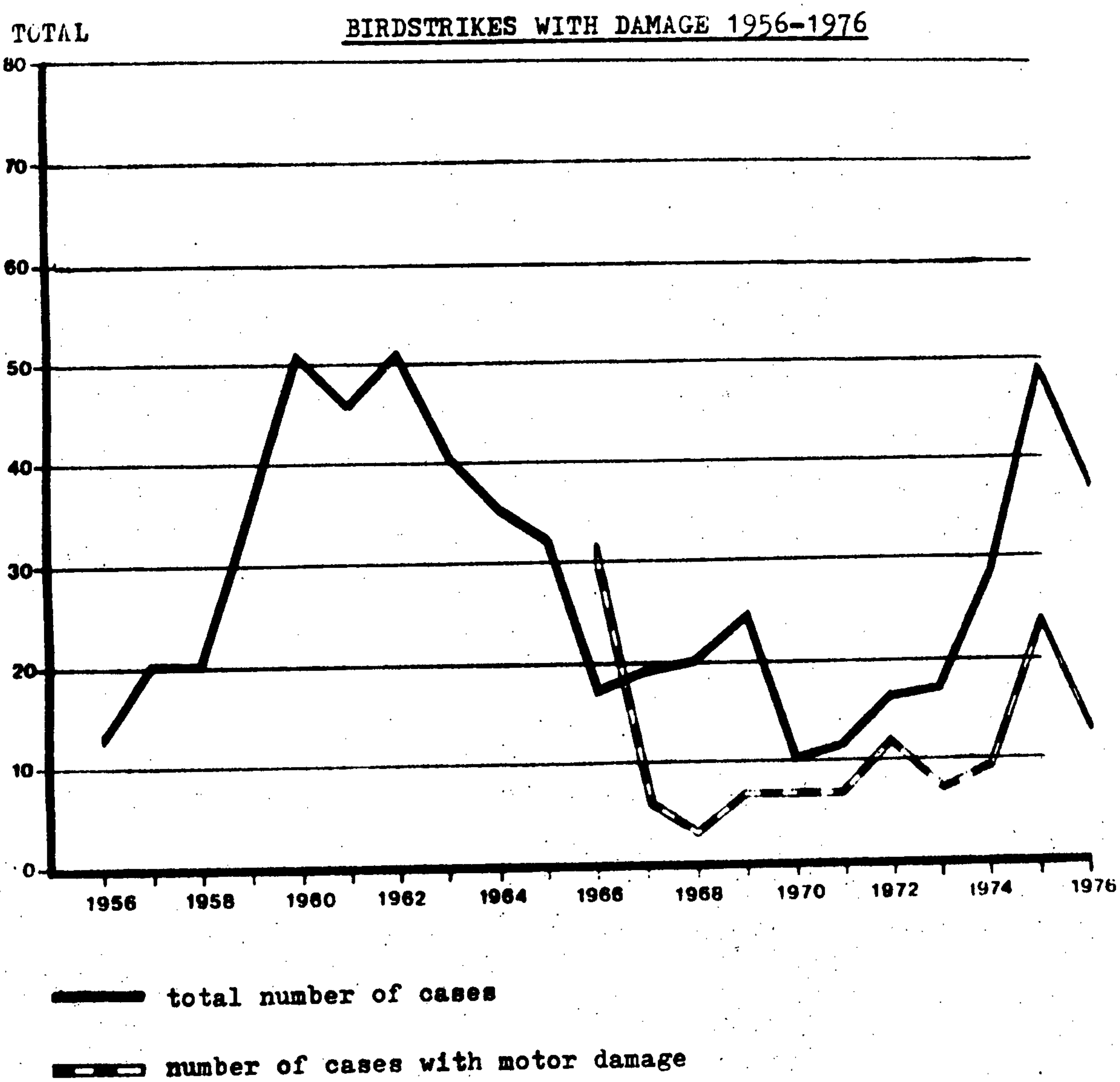
Simple mapping of the most dangerous species is considered extremely important a) as regards monitoring the situation in relation to the seasons and agricultural activities, and b) as regards keeping the birdman attentive and preventing him from having uncontrolled prejudices. We consider the last point to be of great value because in general we experienced that too many airfield people believe they know the problems and the solutions but in fact this knowledge rarely leads to any actual results; and even impedes the really effective handling of the matter. Consequently hard figures will always be required.

Scientific research requires controlled circumstances and an proper statistical approach. But environmental processes are so complicated that application of short-term results has not always been satisfactory.
Simple mapping of some birdspecies at several airfields and during all seasons far over one year, combined with information concerning agricultural activity, will therefor contribute any understanding of relationship between birdlife and the airfield environment. Moreover it will provide a general local picture of situations to be expected.
Permanent monitoring will always be necessary to encouter short-term effects of mowing, ploughing, seeding and fertilizing as far as these activities are not prohibited.

equipment

A full equipped vehicle, able to drive across all over the airfield during operations, is of course absolutely essential. We use a Volkswagenbus with mobilofoon, orange fl sh light, white spotlight to direct in all directions by the driver. distress call equipment. shell crackers, and enough space for gascanons, gull dummies, or even the radiocontrolled peregrine falcon. We believe that results can best be achieved by alternating as much as possible the application of the scaring technics. Bird scaring apparatus should never be left long at same spots.

Local birds or long-term visitors that cannot be driven away and who attract other migrants are elim-inated. It is considered a last resort not because we believe that the numbers can be reduced by this way, but because birds shot down can add to the strength of the effect of our scaring technics.
Simple shooting down as many birds as possible is not the right solution!



BIRDS KILLED BY AIRCRAFT IN THE UNITED KINGDOM 1966-76

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ABSTRACT

Bird remains from 1541 birdstrike incidents have been identified at least to ordinal level and the results analysed. This paper presents and discusses the data obtained. Small gulls and lapwings, which habitually feed on short grassland, predominated and most strikes involved species weighing 0.5 Kg or less. Numbers of birdstrikes are shown to vary with the seasonal distribution and abundance of birds; the most important factor being the influx on to airfields after breeding and the arrival of winter visitors.

Paper prepared for presentation at the World Conference on Bird Hazards to Aircraft. Paris, October 1977.

INTRODUCTION

Birdstrikes

In the United Kingdom a birdstrike occurs once in about every 1500 flights by civil aircraft (Civil Aviation Authority[1]). An executive jet crashed in 1973 following a collision with gulls at Norwich Airport and in 1975 six occupants of a passing car were killed and a crew member injured when a similar type of aircraft, on take-off from Dunsfold, crashed after encountering a flock of lapwings* (Department of Trade[2]). World-wide, several fatal accidents, two involving large airliners, have resulted from birdstrikes.

It is usually only on landing or take-off that civil aircraft fly at the lower altitudes where birds are numerous; consequently over 90% of birdstrikes to such aircraft occur on or very close to airfields (CAA[1]). In the Royal Air Force, on the other hand, about 300 strikes are recorded annually (Directorate of Flight Safety [RAF][3]) and, as a result of high speed, low flying commitments, about 40% of these strikes occur "en route" (Directorate of Flight Safety [RAF][4]), where higher collision speeds can cause greater damage. Jet engines are particularly vulnerable to damage by bird ingestion. Military training and combat aircraft generally have fewer engines than transport aircraft and recently several sophisticated military aircraft have been destroyed as a result of birdstrikes, fortunately without loss of life. In the United Kingdom, therefore, most birdstrikes occur in the vicinity of airfields and various bird control techniques exploiting the behaviour and ecological requirements of the important species are in use or under development (Brough[5], Wright[6]).

Need for Identification

Identification of the species posing the greatest hazards is necessary before effective counter-measures can be devised and introduced. Also quantitative data on the relative frequencies with which birds of different weights are struck are required by aeronautical engineers when designing aircraft structures better able to withstand typical birdstrikes.

Before 1966 no systematic identification of bird remains from birdstrikes was attempted and reports available before that date are unreliable, being based largely on identifications made by laymen who have used ambiguous terms such as "seagull", "kite-hawk", "finch-type" or even "roc". Since 1966 remains of birds from a variety of sources have been examined by ornithologists at Pest Infestation Control Laboratory and this paper records the findings.

METHODS AND LIMITATIONS

Sources of specimens

Bird remains were received from the Royal Air Force, Army, Royal Naval Air Service, Ministry of Defence (Procurement Executive), United States Air Force, commercial airlines, civil airfields, engine manufacturers and servicing companies. Military sources provided more samples than civil, probably on account of more unified communications channels, but London (Heathrow) Airport contributed a disproportionately large number of incidents compared with other airfields. Heathrow Airport has been treated separately because of several unique attributes. It virtually forms an oasis of short mown grassland in an area of urban development close to a reserv0ir complex used as a roost site by a quarter of a million gulls (Sage,[7]).

*Scientific names of species mentioned in the text are given in Table I

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Because air traffic movements were the highest and reporting standards of the best, it submitted remains from 20% of the total incidents. The number of specimens received from the different sources cannot be taken to reflect the relative frequency of birdstrikes, because within each group only a proportion of establishments submitted remains.

Birds found dead or dying on airfields in circumstances which suggested they had been struck by an aircraft or injured by its slipstream, even though no strike had been reported, have been included in the analysis as they give further indications of the potentially hazardous species on airfields. Twenty per cent of the incidents submitted were of this nature.

Bias in samples submitted

Motivation to submit remains varies between individuals. Large birds, which cause spectacular damage to aircraft, motivate people more strongly than small birds which often cause negligible damage and leave insignificant remains. There has, therefore, been a bias against the submission of small birds, though to a decreasing extent as a wider interest has been taken in the problem. For example, incidents involving species weighing 150g or less increased from 9% in 1968 to 30% in 1976. The probability of receiving remains from "en route" birdstrikes was low because frequently no remains, or none which the finder believed capable of identification, adhered to the aircraft to be recovered. Bird remains from strikes on airfields, however, stood a good chance of being found by runway inspection teams, whether or not pilots were aware that strikes had occurred.

One or more individuals may be killed when an aircraft passes through a flock. As many as 107 black-headed gulls were killed in one strike. Occasionally several species may be involved, eg. lapwing, dunlin and black-headed gull on one occasion. At least 2850 birds were killed in the 1541 incidents from which remains were received. Frequently, however, only a sample of the casualties was sent for identification and it is likely that many more individuals were involved in some strikes than the data suggest.

Identification procedures

Samples submitted for identification ranged from whole birds to one or two feathers or the macerated, tobacco-like, material recovered from jet engines dismantled for repair following bird ingestion. Whole birds were readily identified, but fragmented samples often required comparison with skins or reference to published literature. Single feathers or macerated remnants were problematical, but microscopic examination, using techniques based on the feather classification described by Chandler[8] and adapted by Day[9], usually enabled identification to at least ordinal level. An order is a major taxonomic group, eg. Order Columbiformes comprises the pigeons and doves; Order Anseriformes, geese, ducks and swans. Circumstantial evidence, such as date and location, often narrowed the possibilities to a few or even a single species and allowed weight ranges to be suggested. For example, sparse fragments of white feathers recovered from a strike in August with a bird described by the pilot as being "white and gull-like" proved to belong to the Order Pelecaniformes. As the gannet is the only white representative of this order commonly found in Britain, and as the strike occurred close to the large gannetry at Bass Rock, there is no reasonable doubt that the bird was of this species.

RESULTS AND DISCUSSION

Presentation of results

The birds identified, the mean weights of species and the numbers of incidents in which each species was involved are shown in Table I. The relative frequency of incidents with the more important species in different locations is given in Table II and seasonal variations are shown in Table III. Species that are important because of their frequent involvement, large size or flocking habit are discussed.

Greater significance has been read into numbers of incidents than total numbers of birds as it is believed that the former provide truer comparisons of relative risk at different times and places. A single strike involving a large number of birds could otherwise be misleading.

Gulls

Gulls were involved in 43% of all incidents (Table I) and because of multiple strikes, accounted for 51% of the birds identified.

Black-headed gulls were involved in more incidents (18%) than any other species; next came common gulls, which made up 10% of the incidents. Most of the strikes with these species occurred on airfields and very few involved aircraft "en route" (ie. away from the airfield as shown and defined in Tables II, IIIa and b). These small gulls frequent short-cropped grassland and often congregate on airfields to feed and rest. They also feed at refuse tips, particularly when food on agricultural land is in short supply in winter.

Incidents involving black-headed gulls generally reached a peak in September and declined towards the end of the year. It is known that black-headed and common gulls are most abundant in Southern Britain from December to February, but peak numbers of strikes with black-headed gulls were in autumn. This may have been connected with seasonal variation in food availability on airfields. Earthworms, Lumbricidae, and craneflies, Tipulidae, are commonly taken by both species (Vernon[10]). Earthworms are active in the upper layers of the soil and abundant through the autumn, but activity and numbers decrease with low temperatures or dry surface soil (Edwards and Lofty[11]). Adult craneflies mostly emerge during August and September (Vernon[12]). In 1972 and 1973, when they were extremely numerous, they were seen to be eaten by flocks of black-headed gulls at Heathrow (pers. obs.). The examination of gut contents and pellets obtained at that time showed that the gulls had been feeding exclusively on craneflies.

Strikes involving common gulls on Scottish and coastal airfields were more numerous than those with black-headed gulls. In Southern Britain common gull strikes were generally scarce, except at Heathrow where there was a peak in November. In the London area common gulls are known to arrive later than black-headed gulls and occur in smaller numbers (Meadows[13], Smith[14]). As the winter progresses and soil invertebrates become scarcer, it may be that black-headed gulls forsake airfields in favour of refuse tips earlier than common gulls, which persevere longer with grassland feeding and resort to tips only in severe weather (Vernon[15]).

Herring gulls were involved in 5.3% of the incidents and lesser and great black-backed gulls together totalled 2.9%. At coastal sites these large gulls usually feed on the shore or at fish docks, but inland in Southern Britain they subsist almost exclusively on refuse. They do not appear to feed on inland airfields to any extent and use them primarily as loafing areas. Herring gull strikes "en route" exceeded those on airfields, probably because much military low flying occurs in northern and coastal areas, where this species is more numerous, than inland in the South where most airfields are located.

Few gull strikes occurred on airfields in Southern Britain during the breeding season, but strikes with black-headed, common and herring gulls increased on Scottish airfields where they are known to breed (Tables II and IIIa, b and c.). From July onwards, strikes increased in all locations as birds dispersed from their colonies and the first Continental immigrants arrived. During the summer, many gulls moult and spend a relatively large amount of time resting on open areas, such as airfields. At this time they appear to be lethargic and are reluctant to move, either for aircraft or in response to dispersal attempts (pers. obs.) and missing flight feathers may impair their ability to evade aircraft. In general, strikes with all species peaked in the autumn and decreased as the winter progressed as gulls made little use of airfields at this time, as stated above. In March and April, gulls from the Continent which have wintered in the UK depart and British birds return to their colonies so that numbers on airfields greatly diminish.

Lapwings

The lapwing was the second most frequently struck species and occurred in 14% of all incidents. Lapwings often feed, roost and breed on airfields and are perhaps more frequently present on airfields than any other species except the skylark. Nearly all incidents, for which locations were known, occurred on airfields (Table II). Lapwings were involved in over 20% of the airfield strikes inland and in Southern Britain, but were less important at Heathrow and coastal airfields, with very few strikes in Scotland. The overall seasonal pattern of strikes (Table IIId.) showed a build-up from May to a maximum in October, with a progressive fall-off through the winter. Unlike gulls, lapwings do not feed on refuse tips, but mostly frequent farmland and damp areas. Flocks begin to form in early June after breeding. Migrants passing through the UK and winter visitors arrive from late May onwards, but chiefly September to mid-November (Spencer[16]). The reduction in strikes after November possibly reflected the departure of birds on passage or a move away from airfields, following a reduction in food supply similar to that postulated for gulls. Spencer commented that lapwings, when moulting, gathered in quiet places remote from disturbance and spent much of their time feeding and preening. Birds struck in June, July and August may, therefore, like gulls, have been frequenting airfields because they provided ideal moulting grounds. Strikes in May, ie. before flocks should have formed, could have been due to parent birds being struck when following chicks which had wandered into aircraft movement areas. Lapwing chicks leave the nest shortly after hatching, long before they are able to fly, and show a marked tendency to freeze at the approach of danger. Agitated parents have been observed flying constantly over chicks in the path of landing aircraft (A J Backx pers. comm.) and could not be scared away.

Other waders

The golden plover (1% of incidents) has similar habits to the lapwing, but in the UK breeding is mainly restricted to upland areas where there are few airfields. In winter the population is more generally distributed and greatly increased by immigration. They then occur on airfields and this is reflected by strikes occurring in autumn and winter (Tables II and IIIe.). Among the rest of the wader species which, in contrast to lapwings and golden plover, are mostly shorebirds, oystercatchers were involved in over a quarter of the incidents. This species has a mainly coastal distribution and feeds on coastal airfields. Eleven out of fifteen airfield strikes with oystercatchers were in Scotland (Tables II and IIIf.) and none was known to have occurred "en route". Little seasonal variation, other than a suggestion of spring and autumn peaks, was evident. In contrast, of 22 incidents with other wader species, where the location was known, ten involved aircraft "en route" and most occurred in spring and autumn (Table II and IIIg.).

Woodpigeons

Strikes involving woodpigeons occurred mainly on airfields in Southern Britain (Table II). Clover Trifolium spp. and other weeds in airfield grass swards apparently attract woodpigeons, but no seasonal strike pattern was evident.

Domestic and feral pigeons

Homing pigeons could only be positively distinguished from feral birds when rings were included in the remains. Nearly all the incidents occurred on airfields and the majority of the ringed birds were struck at Heathrow (Table II). Strikes involving homing pigeons were, with one exception, confined to the period March to August (Table IIIh.). According to the Royal Pigeon Racing Association (pers. comm.), training of birds commences in March and ends in September, with most competition flying between May and August. Feral birds showed no seasonal distribution, being often resident around airfield buildings.

Other species

A few other species, each accounting for only a small proportion of the total incidents, were of some significance locally or at specific times.

Five of the six incidents involving dabbling ducks (mainly freshwater, surface-feeding ducks) were at Heathrow. This airport is in an area of wet gravel pits and reservoirs which provide suitable wildfowl habitat. Other Anseriformes struck were sea ducks at coastal airfields in Scotland.

Of twenty-seven kestrel incidents, seventeen were at Heathrow, where the banks of nearby sewage lagoons form attractive hunting grounds; none was known to have occurred "en route". In contrast, buzzards were struck mainly by low flying aircraft in mountain and moorland areas. The buzzard is largely confined to hill and moorland areas in Western England, Wales and Scotland where it spends long periods soaring in thermals to considerable heights to locate prey and carrion over a wide area (Tubbs[17]).

Strikes with common and Arctic terns (offshore birds which breed mainly on sand and shingle coasts), included a number of juvenile birds and occurred between May and July at one airfield in NE Scotland where both species bred.

Swifts, which occur in Britain only in the summer, were struck mainly in the four-month period of May to August, but none was in Scotland (Tables II and IIIh.).

Among passerines (perching birds) the skylark, which frequents open grassland and cultivated ground, was struck most frequently, closely followed by the starling. Skylark incidents occurred mainly on inland airfields in Southern Britain and showed a summer peak following breeding and another in autumn at a time when immigration of Continental birds occurs (Table IIIh.). Starlings showed little seasonal variation (Tables II and IIIh.), which is perhaps surprising because of the large autumn influx of Continental birds. Some airfields, however, have large breeding populations (pers. obs.), which may have tended to equalise the summer and winter strike rates. Almost half of the incidents involving thrushes, which include many winter visitors to the UK, where the location was known, occurred away from airfields. Incidents peaked in October (Table IIIh.), suggesting thrushes may be particularly involved in birdstrikes when on autumn passage.

Strikes with corvids (members of the crow family) occurred throughout the UK, (Table II) both on airfields and "en route". More carrion crows were struck than the more numerous and gregarious rooks. Most airfields have a resident population of several pairs of crows throughout the year, but rook numbers vary from airfield to airfield according to season (Bridgman[18]). Both species scavenge, but crows are attracted to runways to feed on dead insects around the lights and the carcases of birds killed by aircraft. Incidents peaked in June and July, (Table IIIh.) reflecting an influx of corvids on to airfields after breeding.

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Seasonal variations in birdstrikes

Many factors influence the frequency of birdstrikes but two of the most important are the number of birds in the country as a whole, but especially on airfields, and the density of air traffic. Many of our resident birds and winter visitors are relatively large, flocking species like gulls and lapwings which prefer open habitats and are, therefore, attracted to airfields outside the breeding season, where they hazard aircraft. Summer visitors, by contrast, are mostly small, less social species, few of which find airfields a suitable habitat. Military flying is at a fairly constant rate throughout the year, but civil flights are more frequent during the summer holiday season. A number of factors, therefore, interact to produce the overall seasonal variations in incidents summarized in Table IIIj.

Weights of birds struck

Table IV shows the frequency distribution of incidents according to bird weight. Mean weights for each species have been estimated from published and other data, but it must be stressed that individual variations and those due to age, sex, season, condition and geographical origin may, especially for the smaller birds, affect average values by plus or minus 50%.

Because of the large number of waders, small gulls, pigeons, swifts and passerines, 86% of the incidents involved species with an average weight not exceeding 0.5 Kg. Birds weighing up to 1 Kg. accounted for a further 12% with only 2% heavier still. Gannets (mean wt. 3.5 Kg.) were the heaviest birds identified.

Some species are commonly involved in multiple strikes and ten or more birds were known to have been killed in each of twenty-nine strikes. Often only a small sample of the birds killed was submitted for identification. For example, approximately 350 gulls were said to have been picked up from an airport after several strikes on one day when only one common and three black-headed gulls were received for identification. The greatest mass of birds positively identified from one strike was 107 black-headed gulls, representing a live weight of about 32 Kg.

CONCLUSION

The majority of birds killed by aircraft in the UK were of species which find suitable habitat for feeding, loafing or in some cases, roosting or breeding on airfields. These mainly included gulls, especially black-headed and common gulls, lapwings, pigeons, corvids, skylarks and starlings. The preponderance of these species resulted in most of the strikes involving birds weighing 0.5 Kg or less. However, frequent multiple strikes made this more serious than it might at first seem.

Strikes to aircraft "en route" included a greater variety of less frequently struck, larger species, and as higher aircraft speeds are involved than in the airfield environment there is a greater potential for damage.

Total numbers of birds and the density of air traffic influence the frequency of strikes at different times of year. However, strikes remained high after the peak air traffic density suggesting that the most important factor was the influx of British and Continental birds on to airfields after breeding and through the autumn. As, even during this period, the majority of strikes occurred on airfields rather than to aircraft "en route", it appears that birds on migratory flights, with the possible exceptions of some waders and thrushes, were relatively unimportant in strikes, although migrants obviously influenced numbers present on airfields.

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TABLE I BIRDS IDENTIFIED FROM STRIKES WITH AIRCRAFT 1966-1976

	Mean weight (g)	Incidents		Birds	
		No.	%	No.	%
dentified only as "Bird"		1	-	1	-
lanx shearwater Puffinus puffinus	400	1	-	1	-
iannet Sula bassana	3500	3	-	3	-
dentified only as Ciconiformes		1	-	1	-
irey heron Ardea cinerea	1400	3	-	3	-
dentified only as Anseriformes		3	-	3	-
lallard Anas platyrhynchos	1100	4	-	5	-
'eal A. crecca	350	1	-	1	-
ligeon A. penelope	700	1	-	1	-
helduck Tadorna tadorna	1200	1	-	1	-
ider Somateria mollissima	2000	1	-	1	-
uzzard Buteo buteo	800	12	0.8	12	-
parrowhawk Accipiter nisus	200	2	-	2	-
estrel Falco tinnunculus	200	27	1.8	27	-
ed-legged partridge Alectoris rufa	420	4	-	4	-
artridge Perdix perdix	400	14	0.9	24	-
heasant Phasianus colchicus	1000	3	-	3	-
Identified only as Rallidae		1	-	1	-
Water rail Rallus aquaticus	130	1	-	1	-
Identified only as Charadriiformes		9	-	9	-
Identified only as "wader"		7	-	7	-
Oystercatcher Haematopus ostralegus	550	16	1.0	51	1.8
Lapwing Vanellus vanellus	200	215	14.0	428	15.0
Ringed plover Charadrius hiaticula	60	5	-	5	-
Golden plover Pluvialis apricaria	200	21	1.4	39	1.4
Snipe Gallinago gallinago	115	5	-	5	-
Jack snipe Lymnocryptes minimus	65	1	-	1	-
Woodcock Scolopax rusticola	300	2	-	2	-
Curlew Numenius arquata	800	8	-	8	-
Dunlin Calidris alpina	60	7	-	22	-
Great skua Stercorarius skua	1400	1	-	1	-
Identified only as "gull"		81	5.3	81	2.8
Great black-backed gull Larus marinus	1600	15	1.0	17	-
Lesser black-backed gull L. fuscus	850	29	1.9	41	1.4
Herring gull L. argentatus	1000	81	5.3	91	3.2
Common gull L. canus	420	159	10.3	285	10.0
Little gull L. minutus	120	1	-	1	-
Black-headed gull L. ridibundus	300	284	18.4	936	32.8
Kittiwake Rissa tridactyla	400	1	-	1	-
Identified only as "tern"		1	-	1	-
Common tern Sterna hirundo	120	14	0.9	19	-
Arctic tern S. paradisea	100	4	-	6	-

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TABLE I BIRDS IDENTIFIED FROM STRIKES WITH AIRCRAFT 1966-1976 (Contd)

	Mean weight (g)	Incidents		Birds	
		No.	%	No.	%
Sandwich tern S. sandvicensis	210	1	-	1	-
Identified only as Columbiformes		16	1.0	16	-
Stock dove Columba oenas	270	5	-	6	-
Feral and homing pigeon C.livia var	400	64	4.2	87	3.1
Woodpigeon C. palumbus	500	82	5.3	117	4.1
Collared dove Streptopelia decaocto	220	1	-	1	-
Budgerigar Melopsittacus undulatus	40	1	-	1	-
Senegal parrot Poicephalus senegalus	150	1	-	1	-
Barn owl Tyto alba	350	7	-	7	-
Little owl Athene noctua	170	2	-	2	-
Long-eared owl Asio otus	260	3	-	3	-
Short-eared owl A. flammeus	380	1	-	1	-
Swift Apus apus	40	86	5.6	102	3.6
Identified only as Passeriformes		32	2.1	32	1.1
Skylark Alauda arvensis	40	60	3.9	71	2.5
Swallow Hirundo rustica	18	16	1.0	20	-
House martin Delichon urbica	18	8	-	8	-
Sand martin Riparia riparia	14	2	-	6	-
Identified only as Corvidae		7	-	7	-
Carrion crow Corvus corone	550	17	1.1	17	-
Rook C. frugilegus	400	13	0.8	13	-
Jackdaw C. monedula	210	3	-	3	-
Jay Garrulus glandarius	150	1	-	1	-
Great tit Parus major	18	1	-	1	-
Identified only as "thrush"		17	1.1	17	-
Mistle thrush Turdus viscivorus	120	8	-	8	-
Fieldfare T. pilaris	100	5	-	5	-
Song thrush T. philomelos	80	3	-	3	-
Redwing T. iliacus	60	11	0.7	11	-
Blackbird T. merula	95	4	-	4	-
Wheatear Oenanthe oenanthe	25	1	-	1	-
Meadow pipit Anthus pratensis	18	7	-	7	-
Pied wagtail Motacilla alba	22	1	-	1	-
Starling Sturnus vulgaris	85	57	3.7	86	3.0
Greenfinch Carduelis chloris	30	4	-	6	-
Linnet Acanthis cannabina	18	11	0.7	12	-
Chaffinch Fringilla coelebs	22	6	-	6	-
Yellowhammer Emberiza citrinella	30	3	-	3	-
House sparrow Passer domesticus	30	5	-	5	-
TOTAL:	1541			2850	

TABLE II. Percentage occurrence of various birds according to location of incident

	Location - number of incidents in brackets						
	1 Airfield (1065)	2 En route (179)	3 Inland (579)	4 Coastal (194)	5 Scotland (149)	6 S. Britain (634)	7 Heathrow (309)
ystercatcher	1.4	-	0.3	6.7	7.9	0.6	-
apwing	16.5	3.4	22.8	9.8	4.3	22.9	8.7
olden plover	1.3	1.7	1.4	2.6	0.7	1.9	0.3
ther waders	1.2	6.7	0.9	3.6	2.9	1.3	0.3
erring gull	3.8	11.7	3.1	6.7	9.4	2.8	3.2
ommon gull	12.6	6.7	7.1	18.0	29.5	5.5	18.4
lack-headed gull	22.7	4.5	19.2	11.3	15.8	17.5	35.3
eral pigeon	1.7	1.1	1.7	0.5	1.4	1.4	2.3
oming pigeon	3.2	0.6	1.6	1.0	-	1.7	7.4
oodpigeon	4.4	3.4	5.7	6.2	-	7.1	1.0
wift	4.1	7.3	3.8	1.5	-	3.9	6.5
orvids	2.4	2.2	3.6	2.6	1.4	3.8	-
tarlings	2.3	8.4	2.8	2.6	2.9	2.7	1.3
ther passerines	9.9	12.3	15.0	8.2	1.4	17.5	1.6
ther species	12.8	29.6	11.1	18.6	22.3	10.9	13.6

Locations are defined as follows:-

1. Airfield. Strikes which occurred within the airfield boundary ie. within the perimeter fence, but excluding aircraft on approach, climb-out and in the airfield circuit. This category enables typical species on airfields to be compared with species struck elsewhere (ie. by aircraft en route).

2. En route. Strikes which occurred away from an airfield (q.v.) and its immediate vicinity ie. excludes aircraft on approach, climb-out and in the airfield circuit. Nearly all involved low flying military aircraft.

3. Inland. Strikes on airfields more than one statute mile from the coast cf. coastal. But excluding Heathrow (q.v.).

4. Coastal. Strikes on airfields at least partly within one statute mile of the coast. Coastal roosting gulls may penetrate many miles inland daily, but this category is intended to include only airfields so close to the coast that the movements of seabirds and waders have a direct and immediate effect on the birdstrike hazard.

5. Scotland. Strikes on airfields in Scotland.

6. Southern Britain. Strikes on airfields in the UK excluding Scotland and Heathrow.

7. Heathrow. Strikes at London (Heathrow) Airport.

The definition of airfield in numbers 3-7 has been widened in comparison with 1 and 2 to include strikes in the immediate vicinity of airfields as it enables a comparison of typical birdstrike species in each of these categories. Most Scottish airfields are also coastal and the percentages for species in these two locations are boradly similar.

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TABLE III. Monthly variations in numbers of incidents

For definitions of locations see Table II.

a. Black-headed gulls

LOCATION \ MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL	17	11	21	8	3	7	22	22	66	42	34	27
AIRFIELD	16	11	16	7	2	3	18	17	58	38	31	25
EN ROUTE	-	-	2	1	1	-	-	2	1	1	-	-
INLAND	9	3	7	6	-	-	12	6	22	26	12	8
COASTAL	-	-	-	1	1	3	1	6	6	1	2	1
SCOTLAND	2	-	-	-	-	3	4	4	5	1	2	1
S.BRITAIN	7	3	7	7	1	-	9	8	23	26	12	8
HEATHROW	7	8	9	-	1	-	5	5	30	11	17	16

b. Common gull

LOCATION \ MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL	18	9	12	4	6	5	13	12	18	21	22	16
AIRFIELD	17	9	10	3	6	3	8	11	16	17	20	14
EN ROUTE	1	-	2	-	-	1	1	-	1	4	2	-
INLAND	11	2	4	2	1	-	2	3	4	7	2	3
COASTAL	1	1	-	1	5	3	3	5	9	5	2	-
SCOTLAND	1	1	1	2	5	3	3	7	9	6	3	-
S.BRITAIN	11	2	3	1	1	-	2	1	4	6	1	3
HEATHROW	5	6	6	-	-	-	3	3	3	4	16	11

c. Herring gull

LOCATION \ MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL	8	3	3	5	4	11	11	9	10	4	7	4
AIRFIELD	7	1	-	2	1	4	6	3	6	3	5	2
EN ROUTE	1	-	2	2	3	4	2	2	1	-	2	1
INLAND	4	-	-	1	-	3	2	2	2	1	3	-
COASTAL	-	-	-	1	1	1	4	1	3	1	1	-
SCOTLAND	3	-	-	1	-	2	1	2	2	2	-	-
S.BRITAIN	1	-	-	1	1	2	5	1	3	-	4	-
HEATHROW	3	1	-	-	-	-	-	-	1	1	1	2

TABLE III. Monthly variations in numbers of incidents

d. Lapwing

LOCATION \ MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL	19	8	8	1	8	11	25	15	27	42	34	16
AIRFIELD	14	8	3	-	7	8	21	12	23	40	28	12
EN ROUTE	-	-	2	-	-	1	1	-	1	-	1	-
INLAND	13	7	4	-	3	5	17	10	20	28	18	7
COASTAL	1	-	-	-	2	-	1	1	2	7	4	1
SCOTLAND	-	-	-	-	2	-	-	-	1	2	-	1
S.BRITAIN	14	7	4	-	3	5	18	11	21	33	22	7
HEATHROW	-	1	-	-	2	3	3	1	2	5	6	4

e. Golden plover

LOCATION \ MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL	6	1	-	-	-	-	2	2	6	1	-	3
AIRFIELD	4	1	-	-	-	-	1	2	3	1	-	2
EN ROUTE	1	-	-	-	-	-	1	-	2	-	-	-
INLAND	3	-	-	-	-	-	1	1	1	1	-	1
COASTAL	1	1	-	-	-	-	-	1	2	-	-	-
SCOTLAND	-	-	-	-	-	-	-	-	1	-	-	-
S.BRITAIN	4	1	-	-	-	-	1	2	2	1	-	1
HEATHROW	-	-	-	-	-	-	-	-	-	-	-	1

f. Oystercatcher

LOCATION \ MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL	-	1	3	1	1	1	1	3	-	2	1	1
AIRFIELD	-	1	3	1	1	1	1	3	-	2	1	1
EN ROUTE	-	-	-	-	-	-	-	-	-	-	-	-
INLAND	-	-	1	-	1	-	-	-	-	-	-	-
COASTAL	-	1	2	1	-	1	1	3	-	2	1	1
SCOTLAND	-	1	3	1	1	1	1	-	-	1	1	1
S.BRITAIN	-	-	-	-	-	-	-	3	-	1	-	-
HEATHROW	-	-	-	-	-	-	-	-	-	-	-	-

TABLE III. Monthly variations in numbers of incidents

g. Remaining waders

MONTH / LOCATION	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL	-	1	5	3	2	-	2	2	5	2	5	2
AIRFIELD	-	1	-	-	-	-	2	1	5	1	2	-
EN ROUTE	-	-	3	2	1	-	-	1	-	-	2	1
INLAND	-	-	-	-	-	-	-	-	4	1	-	-
COASTAL	-	1	-	-	-	-	2	1	-	-	2	-
SCOTLAND	-	1	-	-	-	-	2	-	-	-	1	-
S.BRITAIN	-	-	-	-	-	-	-	1	4	1	-	-
HEATHROW	-	-	-	-	-	-	-	-	1	-	-	-

h. Other species

MONTH / SPECIES	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Feral pigeon	2	1	1	2	4	1	3	4	2	1	1	3
Homing pigeon	-	-	2	3	3	6	7	14	-	-	1	-
Swift	-	-	-	-	11	36	29	6	1	-	-	-
Skylark	1	3	4	3	4	5	8	2	3	17	9	-
Starling	9	2	9	2	2	9	2	6	1	8	6	1
Thrushes	1	4	3	3	5	3	4	1	-	16	6	2
Corvids	1	1	-	2	2	13	7	2	3	-	6	-

j. Total incidents

JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	NO DATE
100	74	95	73	77	160	187	150	194	185	177	104	48

TABLE IV. Weights of birds involved in strikes

Bird Weight (g)	Incidents	
	Number	Percentage
Up to 100	309	21.3
101 - 200	298	20.6
201 - 300	299	20.6
301 - 400	102	7.0
401 - 500	245	16.9
501 - 600	33	2.3
601 - 700	1	-
701 - 800	20	1.4
801 - 900	29	2.0
901 - 1000	84	5.8
1001 - 1100	4	-
1101 - 1200	1	-
1201 - 1300	-	-
1301 - 1400	4	-
1401 - 1500	-	-
1501 - 1600	15	1.0
1901 - 2000	1	-
3401 - 3500	3	-

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Some Statistic Data on Birds' Strike to Aircraft and Helicopters over the Territory of the Soviet Union

Introduction

The problem of birds' strike to aircraft is a part of the general problem of aircraft protection against adverse environmental effects.

At present besides such dangerous atmospheric phenomena for aviation as electric discharges, icing, wind shear, turbulence etc. the "ornithologic factor" is gaining the greatest importance and as far as its effect on flight safety is concerned it also plays one of the important roles.

Due to the construction of gas-turbine engined aircraft, their speed and acceleration increase, danger created by birds is steadily increasing. ICAO was forced to pay attention to that problem which has become some serious danger for flight safety.

If we may regard birds as belonging to the category of the so-called adverse environmental effects, we should approach this problem the same way as we did in respect of other phenomena of this category. Such common approach consists of three main interrelated aspects:

A. The determination of normalized adverse environmemtal effects (parameters of the given type).

B. The evaluation of the influence of the chosen adverse en-

environmental effects' parameters on a certain type of aircraft.

C. The development of operation methods and (or) tachnical means providing aircraft protection from the given adverse environmental effects.

Each aspect contains a whole set of problems. For example, while considering the first aspect it is necessary to determine which birds, in what amount, under what conditions and with what probability can cause catastrophic consequences at their strike to aircraft. If the probability of such catastrophic consequences exceeds the established level of flight safety, Airworthiness Standards for Aircraft (Helicopters) must provide requirements on aircraft protection from such effects. As it is known, glasses in the cockpit as well as engines must be designed to stand one bird's strike or several birds' strike, possessing certain kinetic energy.

Even if there are no catastrophic consequences birds' strike to aircraft is the cause of disastrous danger to aviation and may lead to aircraft accidents in the presence of some additional adverse factors.

Peculiarities of the Ornithologic Situation in the USSR

The Soviet Union is situated in many geographic zones and has immense territory. Because of this fact, the ornitologic situation within its territory is characterized by a great dissimilarity and inconstancy.

The attached chart-scheme shows the biggest places of concentration of birds as well as the main migration routes during spring and automn. One can see that most birds congestions are situated or Black Sea and Baltic coasts, on some northern and far eastern sea coasts as well as on some internal water bodies (Caspian Sea, Azov Sea, Aralsk Sea, Baikal Lake etc.). The most important migration routes pass as a rule along littorals, riverbeds (Volga, Ural, Yenisey) and foothills.

The most numerous birds constituting hazards to aircraft operations are gulls and ducks in Baltic Region; starlings and rooks in Central Region of Russia; gulls in Caucasus; starlings, hawks and eagles in Central Asia, ducks, crows and rooks in Siberia, gull in Far East.

The most intensive migrations take place in spring (March - April) and in automn (September - October). During these seasons birds fly at considerable heights in day-time as well as at night. In Baltic Region intensive birds migrations have been registered at altitudes up to 2-3 km, in Ukraine - up to 1-2 km, in Central Regio up to 1 km.

Cases of Collision of Civil Aircraft
with Birds during 1975-76

The USSR Civil Aviation registered in 1975 212 cases of bird strikes, in 1976 - 181 case.

The most frequent birds strikes took place at the following airports:

1975 - Domodedovo (5), Kazan, Koltsovo, Krasnoyarsk, Tashkent (4), Beguishevo, Borispol, Min.Vody, Rovno (3).

1976 - Domodedovo (6), Krasnodar (5), Borispol, Vnukovo (4), Buhara, Yerevan, Koltsovo, Minsk, Rostov (3).

The table 1 specifies the said collisions according to the types of aircraft. We can see that such aircraft as AN-24, IL-18. Yak-40 encountered birds more frequently than other types.

In general, more than half of all cases pertains to turbine-engined aircraft (57% in 1975 and 51% in 1976), the share of turbine-jet aircraft exceeds a quarter (28% in 1975, 29% in 1976), piston-engined aircraft hold 1/10 of the total number of collisions (12% in 1975, 14% in 1976), and helicopters - 3% in 1975, 6% in 1976.

The same table 1 also shows that most damaged engines belonged to AN-24, IL-18 and Yak-40. There were cases where a bird collision caused damage of 2 engines at once (IL-18 - 4 cases, AN-24 - 3 cases Yak-40 and TU-134 - one case for each type). The most frequent collissions of birds with the windshield which resulted in its break-down were registered with aircraft AN-2, because this type of aircraft is mostly used for air-chemical works and it flies at the same altitudes as birds during their intense migration.

In 1975-76 the average figures showing numbers of bird collisions at different altitudes are: 0-100 m - 38% of the total number of collisions; 101-400 m - 33%; 401-1000 m - 14%, 1001-2000 m - 10% over 2000 m - 5%.

The table II shows that at altitudes up to 100 m aircraft encountered mainly small and medium birds, at altitudes from 101 m up to 400 m - medium and large birds, at altitudes 401-1000 m - medium birds, and at altitudes more than 1000 m - small and large birds.

It is of certain interest that at altitudes from 401 to 1000 m aircraft encountered mainly pigeons, predatory birds, crows and waterfowl, and at altitudes over 1000 m - only hawks, eagles and swifts.

The distribution of the above mentioned cases according to speed of aircraft is as follows:

up to 100 km/h - 2%

from 101 to 300 km/h - 58%

from 301 to 500 km/h - 36%

more than 500 km/h - 4%.

The distribution of bird collisions by flight phases is as follows:

run/roll out - 3%

take-off (to 15 m) - 11%

climb-out - 21%

cruising flight - 11%

descent (to 15 m) - 39%

landing - 15%.

More frequent bird strikes during aircraft descent, as compared with climb-out, can be explained, to our mind, by the fact that during descent (approach to land) aircraft for a longer time fly at low altitudes where the possibility of bird collision is higher.

It should be pointed out that most bird strikes at cruising levels occur to piston-engined aircraft and helicopters which fly at comparatively low altitude at cruise speeds.

The size of birds encountered by aircraft was determined in 168 cases in 1975-76 and their species was determined in 135 cases.

Small birds (up to 110 g) hold 23% of the total number of collisions, medium birds (110-1810 g) - 63%, large birds (over 1810 g) - 14%. In reality, aircraft encounter small birds more frequently, but because of their small size and weight such cases are very difficult to be established.

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The following birds struck aircraft most frequently: pigeons (Columba) - 28%; gulls (Larus) - 16%; ducks and geese (Anatidae) - 12%; predatory birds (Falcones) - 16%; starlings (Sturnidae), sparrows (Passer), swallows (Hirundinidae) - 13%; crows (Corvus) and swifts (Apodidae) - 5%.

Pigeons struck aircraft rather frequently all year round, gulls - mainly in summer and early automn, ducks - in spring and automn.

The figure 2 shows that the biggest part of collisions of aircraft with birds was registered in the second half of summer (during after-nesting movements) and in early automn (during mass birds migration to wintering places). During spring, bird collisions with aircraft were registered more rarely. The fewest number of bird strikes was registered in winter.

The distribution of the total number of collisions by different day hours is as follows: morning - 7%, daylight hours - 62%, evening 5%, night - 26%. By "morning" we mean the period of 2 hours beginning from the moment of dawn coming, "evening" is the period of 2 hours before darkness.

If we take into consideration that the intensity (frequency) of civil aircraft flight in daylight time is much higher than at night, we can conclude that the probability of bird strike in daylight time and at night is approximately the same.

The table III helps us to conclude that the most frequent birds collisions were registered in April, August, September and October, in other words during mass night migratory flights.

From the table IV we see that birds collisions with aicraft in the night and evening time were registered mainly at heights of

100-400 m, and those in daylight time and the morning - at heights up to 100 m. It is of importance that most of collisions that occurred in the darkness relate to waterfowl and to swifts.

According to the reports of pilots in 1975-76 the percentage of cases of collisions of aircraft with a single bird comes to 37% of the total number, and collisions with birds flock constitutes 63%. But we should not take these figures for granted because many cases of collisions with bird flocks are registered as collisions with a single bird.

All data stated in our paper relate only to the period of 2 years. Nevertheless all these data are sufficient for us to make a conclusion of great importance of the problem and the necessity of its being solved as soon as possible.

Table I

Bird strike distribution by aircraft types

(1975-76)

Aircraft type	Number of bird strikes	Number of engines removed and damaged	Number of windscreen damage cases
Turbo-jet			
Yak-40	46	24	
TU-134	19	8	
TU-124	14	7	
TU-154	12	2	1
TU-104	9	9	
IL-62	11	5	
Total	111	55	1
Turbo-prop			
AN-24	130	46	1
AN-12	12	5	
IL-18	67	44	
TU-114	3	3	
Total	212	98	1
Piston-engined			
AN-2	41	8	11
AN-26	2		1
IL-14	10	3	2
Total	53	11	14
Helicopters	17	9	6
TOTAL	393	173	22

Table II

Bird strike distribution by flight altitudes and bird sizes (1975-76).

Flight alt., m / Bird size	up to 101	101-400	401-1000	1001-2000	over 2000
Small birds	10	7	1	2	1
Medium birds	47	25	13	-	-
Large birds	3	9	2	2	2

Table III

Bird strike distribution by day periods and seasons

Day period / Month	Morning	Daylight time	Evening	Night
I	-	3	-	2
II	2	4	-	1
III	2	12	1	2
IV	-	13	-	10
V	2	23	5	9
VI	2	24	-	4
VII	-	18	2	2
VIII	3	29	1	15
IX	5	29	2	13
X	3	21	1	15
XI	1	11	2	6 5
XII	2	7	2	4

Table IV

Bird strike distribution by flight altitudes and day periods

Flight alt., m / Day period	up to 101	101-400	401-1000	1001-2000	over 2000
Morning	12	2	1	1	1
Daylight time	59	46	19	12	5
Evening	3	6	1	3	1
Night	6	19	9	3	3

Bird strike distribution by months
(I975 + I976)

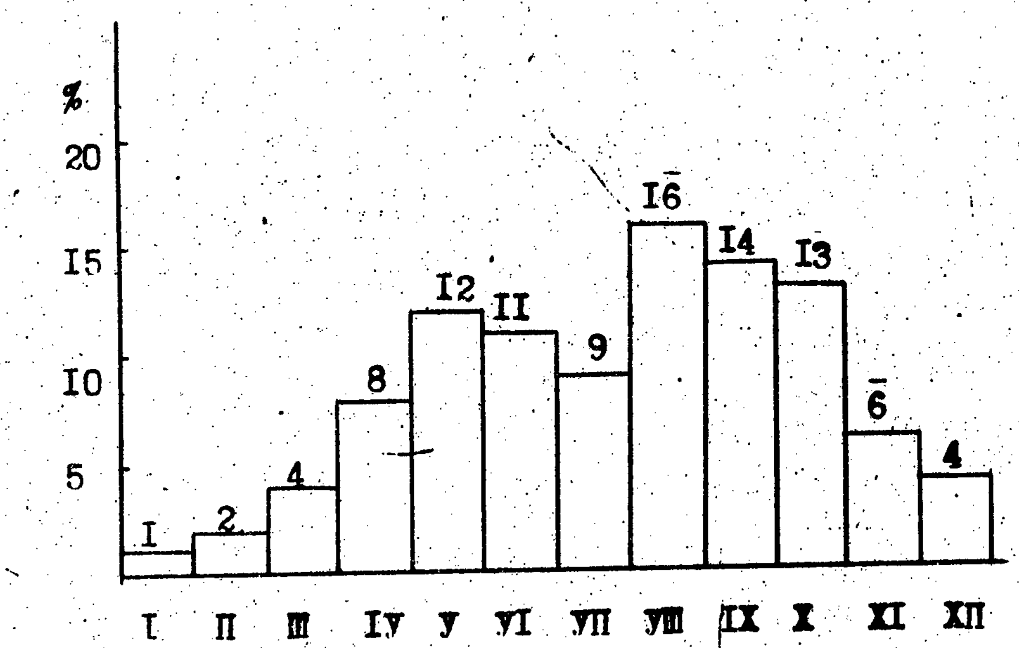

Fig.2

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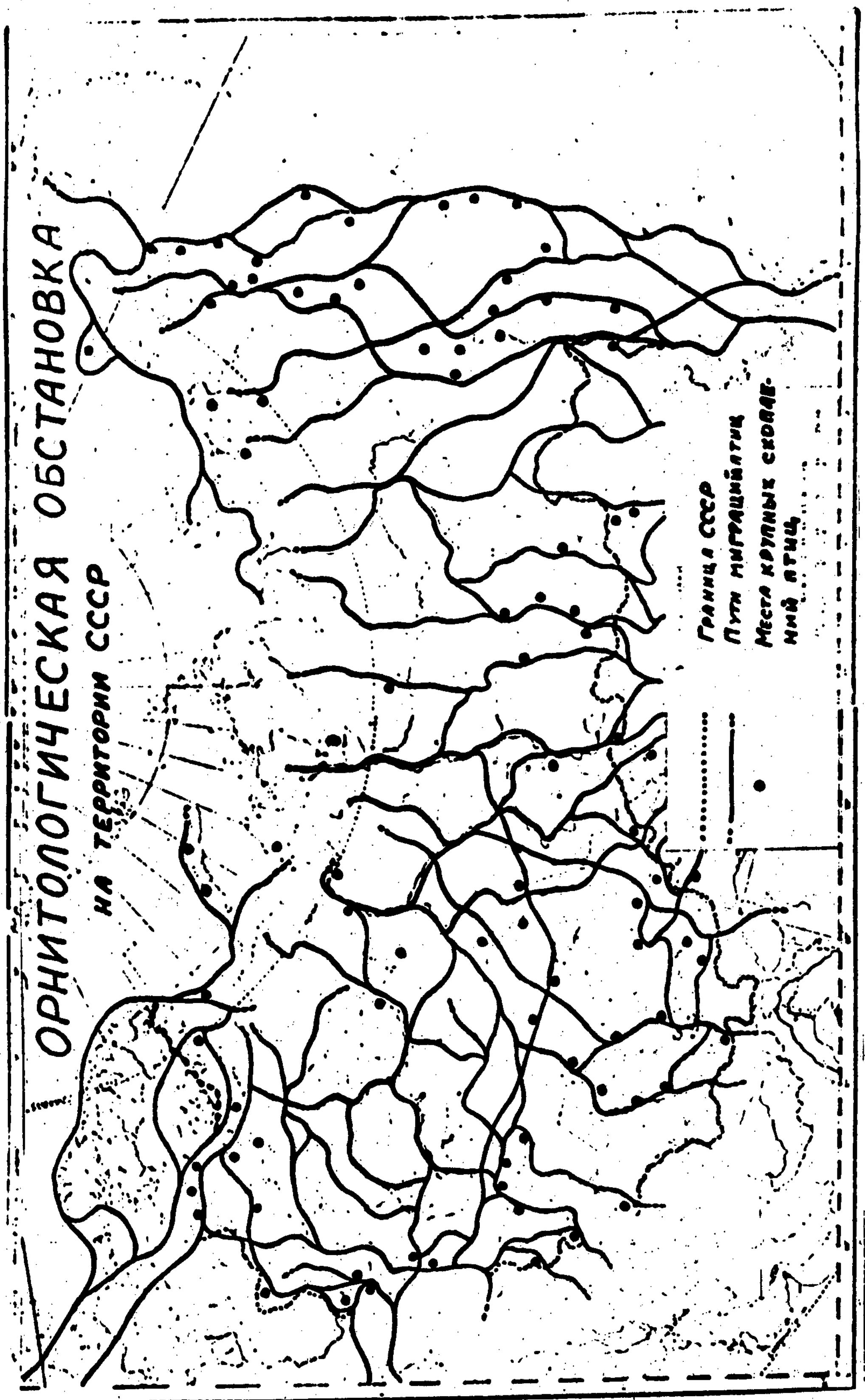
ОРНИТОЛОГИЧЕСКАЯ ОБСТАНОВКА
НА ТЕРРИТОРИИ СССР
Граница СССР
Пути миграций птиц
Места крупных скоплений птиц

Фиг. I.

BSCE 12 ADF616156
28 Octobre 1977

Birdstrikes in German Air Force 1968 - 1976

by

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During the period 1968 - 1976 GAF had a decreasing number of birdstrikes until 1971 but a highly increasing number 1976 and moreover 1977.

At take-off and landing there was to analyse a clear decreasing but a small increasing in 1974/1975. The reason for that is to see in the fact that all provisions for scaring birds from airfields coming in routine work are bad ; people involved with this negotiations should use all biological and technical possibilities; the most important point should be to regard the ecological background of the airfield.

At round airfield procedures the number of birdstrikes increased up to 62 (1976) mostly caused by the fact that there are no laws which allow to forbid garbadge dumps or new lakes in the near surrounding of the airfields. German Air Traffic Authorities are looking for corresponding laws which are in work now.

The most birdstrikes happened in low level between 400 and 1300 ft(GND), a very high number also between 1100 and 5000 ft(GND) - nearly 300 -.

Subdivided by months most birdstrikes happened in march/april (spring migration), july/august(inter-migration) and october (fall-migration). In wintertime birdstrikes were induced by winter-flight-movements from N and E depending on weather.

In spring and fall it seems possible to reduce birdstrikes by publishing birdtam and forecasts but only on condition that good radar-observation is available and possible. In summertime a reduction of birdstrikes seems difficult because birds are flying so low that radar observation is impossible. Only by using airfield radar with small range and high power it could be possible to observe birds and to warn pilots; but there does not exist a method using such radar for bird observation.

As to the geographical areas : more than 60 % of birdstrikes happened in the northern regions of Germany. Flight- and low level planning of routes may be helpful to reduce strikes in sea- and coastal districts.

As to the bird species most strikes happened with gulls,small birds, buzzards,crows and lapwings. Subdivided into categories:

up to 100 g weight	= 31 %
101 - 250 g	= 10 %
251 - 500 g	= 35 %
501 - 1000 g	= 13 %
1001 - 1500 g	= 10 %
more than 1500 g	= 1 %

The number of damages decreased during the evaluation period.

As to the consequences : GAF gives the following recommendations for prevention of birdstrikes:

1. In Case pilot observes birds or flocks of birds in LL it is recommended to pull left or right in order to overfly swarms but it is to regard that swarms of birds may be confused by noise,radar or compressed air and show special reactions.
2. Coastal areas should be flown over vertical to coastal lines because of bird concentrations.
3. Using of visor to avoid injuries of face.
4. Switch on windscreen defroster to increase flexibility and resistance of cockpit against birdstrikes.
5. Reduce speed if possible in order to reduce dimension of damage in case of birdstrike.
6. Land on the next airfield in case of an observed birdstrike.
7. Cross lakes,rivers and larger water areas in heights above 2000 ft(GND).
8. Cross river valleys vertical; regard that strongest concentrations of migratory birds may be expected on slopes of mountains.
9. Regard birdtam which should be published in more detailled form.
10. Work up ecological reports about every airfield and propose special provisions according to these reports.

11. Control yearly sometimes the control areas of airfields in order to get informations about f.i.garbadge dumps and gravel lakes.

12. Induce a better radar and visual control of small distance bird movements in the approaches of airfield and develop procedures for pilots and ATC.

13. Check for flight planning whether it will be possible to fly missions in mountain areas during special periods of year.

14. Try to get informations about bird intensities in range areas by the Range Officer.

15. Regard that a small birdstrike risk exists in all flight heights during december, january and february, a medium risk in flight heights above 1000 ft(GND) between may and august and a heavy risk in flight heights between 1000 and 3000 ft(GND) in march as well as during september/october.

16. Regard that most bird species belong to weight category until 100 g; these birds will increase during migration periods and reach flight heights up to 8000 ft(GND),

    - that buzzards,falcons,crows,pigeons,lapwings und gulls (weight category until 1000 g) dominate in agricultural and grassland areas and reach at small-distance flights heights up to 2000 ft(GND) depending on weather.
    - that waterfowl(weight-category until 2000 g) dominate in coastal areas between october and march and may reach, during migration period, heights up to 10000 ft(GND).

28 Octobre 1977

ADF616157

Attempts to control the breeding population of the Herring Gull (*Larus argentatus*) near Copenhagen airport.

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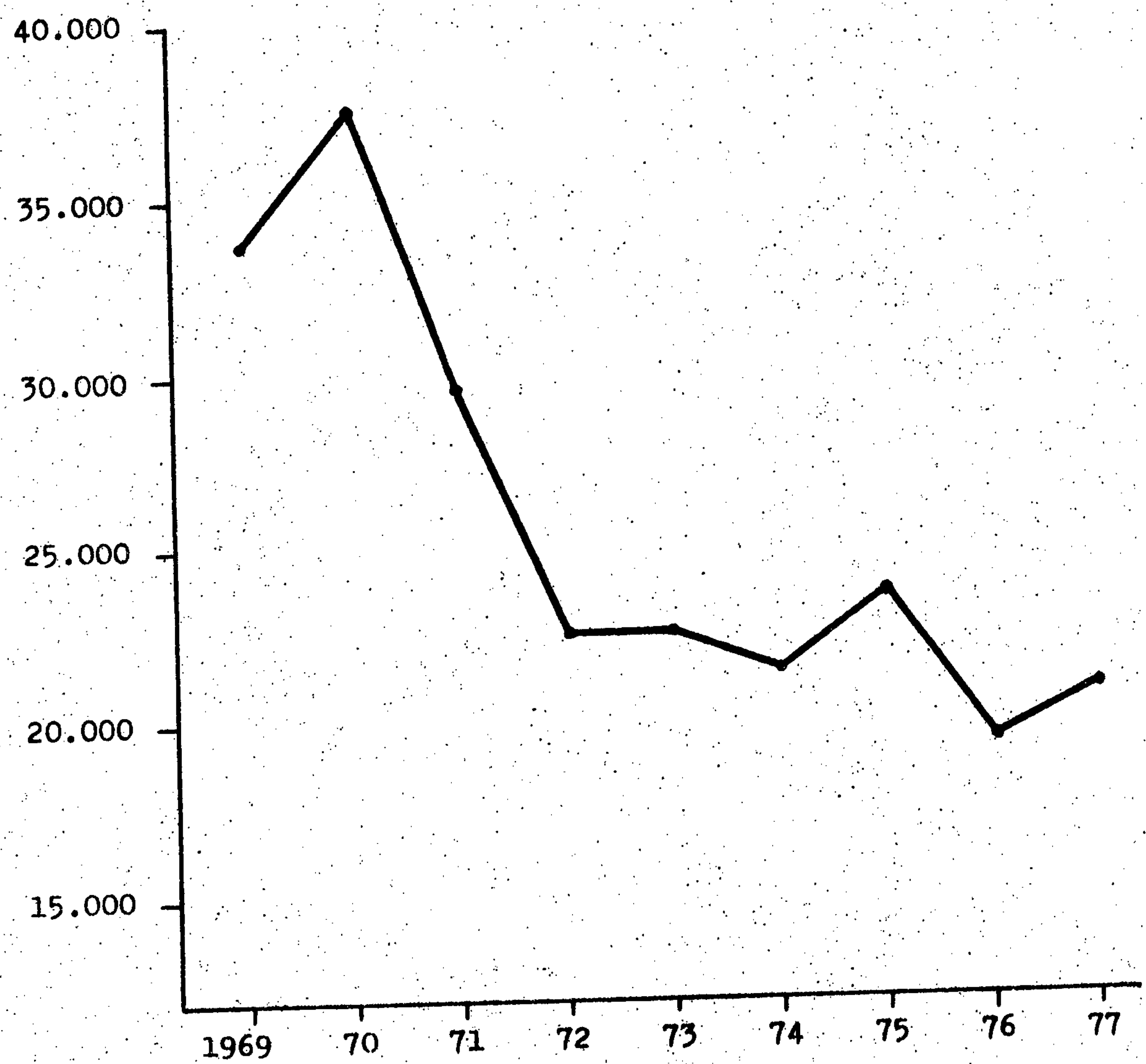
&

A. M. Glennung, Copenhagen Airport.

Gulls are the major problem in many airports. They usually breed in colonies, and if a colony is located near an airport, it may be necessary to reduce this local population. This is the case at the Copenhagen airport. The Herring Gulls breed in a large colony all over the island of Saltholm (1500 hectares) at a distance of only 5 km from the airport. In 1970 there were 38.000 pairs, and the number had been increasing for many years. The bird strike risk was above all due to the Herring Gulls, and it still is. During the period 1974 - Sept. 1977 a total of 333 birds (17 species) were recorded as killed in collisions with aircraft in the Copenhagen airport, 127 (38%) of which were Herring Gulls. By far the largest number of Herring Gulls are present in the airport during the breeding season, and observations on colour-marked birds indicate that all of them are breeding birds from Saltholm. Ring marking data indicate that even outside the breeding season most of the Herring Gulls are local birds.

In order to reduce the breeding population of the Herring Gull on Saltholm and to reduce the number of young birds leaving the colony, a control program was started in 1969 and it has continued since then. The eggs of the gulls are sprayed with a non-toxic difencryl oil emulgated in water, to which is added a blue dye. The method is, with some modifications, the same as used previously in USA (W.H. Drury & I.C.T. Nisbet: "Strategy of Management of a Natural Population: the Herring Gull in New England", World Conference on Bird Hazards to Aircraft, Kingston, 1969). The oil seals the pores of the eggs and the embryos die, but otherwise the eggs remain intact for about three weeks, and the birds continue brooding them. This is usually sufficient to prevent the production of a new clutch. An oil concentration of about 65% gives the best results, causing nearly 100% of the sprayed eggs to be killed. The nests of the colony must be treated twice during the breeding season. Other breeding birds may benefit from the reduced number of adult and young gulls, but they may also suffer by the disturbances on the breeding grounds. It was attempted to minimize the disturbing effects. The number of Eiderduck nests was counted 1974-77. It was found that the Eiderduck population increased during this period from 3500 to 5500 pairs, and so there seems to be no harmful effect of the gull control program to this species.

The effect on the Herring Gull population on Saltholm: The spraying method has been very efficient in reducing the reproduction in the colony. Very few young become fledged, only a few hundreds each year. The development of the breeding population is shown in the diagram. There has been a 45% reduction of the population, but



Herring gull, **Larus argentatus**.
Number of breeding pairs on Saltholm 1969-77.

it seems difficult to reduce it further. It seems partly to be due to a high rate of immigration and partly to the size of the colony and the island, and the optimal feeding conditions in the area. In order to accelerate the reduction of the population, killing of adults by using alfa-chloralosis started on a small scale and as an experiment in 1975. In this way 600, 1800, 3600 adult gulls have been removed from the colony during the last three years. Most gull colonies are smaller and more compact than is the case on Saltholm, and it may be easier to obtain good results of a control program in such places.

The effect on the bird strike rate: There are indications that the number of strikes with Herring Gulls have been reduced, but it is uncertain whether it is due to the reduced gull population or other measures taken against the gulls in the airport. The upper figures in the table show that during late summer strikes with young gulls of all species are much more frequent than strikes with adults, in spite of the fact that the population contains more adults than young birds. Thus, the inexperienced young birds seem to be more dangerous than adults. We should expect the same as to the Herring Gulls in Copenhagen airport, but as shown by the lower figures of the table, strikes with young Herring Gulls are relatively rare in this airport during the same period. This is a strong indication that the reduced reproduction in the colony on Saltholm has in fact reduced the number of bird strikes in the airport.

The number of gull strikes in Danish civil airports during the period 1/7 - 15/9, 1974-77.

	Adults (older than one year)	Juveniles
All species of gulls (except L. argentatus in Copenhagen airport)	19	37
Larus argentatus in Copenhagen airport	38	10

Our conclusion is that a local breeding population of gulls can be reduced to some extent (how much, apparently depends on a number of factors), and the relatively dangerous young birds of the population can be eliminated. But the needs and the reasons for actions against breeding colonies of birds in the vicinity of airports should be carefully considered before such actions are started. We think that at least 4 conditions should be made:

1) Actions against breeding birds outside the airport should be the last way out. In general, various ecological and ethological methods which can be used in the airport area should be preferred.

2) The species in question has to present a major bird strike problem to the airport.

3) It must be proved that it actually is the local population of the species which causes the problems.

4) The method which is chosen to control the population must be selective and should cause a minimum of disturbance to the breeding of other bird species. For this and other reasons the cooperation with ornithologists is important.

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WORLD / BIRD STRIKE COMMITTEE EUROPE

CONFERENCE PARIS, OCTOBER, 1977

DEVELOPMENT OF THE THEORETICAL CONSTRUCT OF SYNERGISED ALUMINIUM AMMONIUM SULPHATE+ FOR THE CONTROL OF BIRDS AT AIRPORTS

From the various papers at this and previous similar conferences it can be seen that it is the behaviour of birds at airfields which is the major cause of concern. Therefore, it is the behaviour of birds with which we are concerned and with which I shall deal. We have nothing against the birds themselves: we seek neither to destroy nor to eliminate them; but only to control the type of behaviour which is causing concern. This applies equally to the indiscriminate depletion of food stocks over the world and to the safety of travel by air.

Many species of birds frequent airfields, possibly because large open spaces relatively free from man provide safe resting places affording full visibility against surprise attacks from predators, moreover, permanent pasture areas between runways and pasture, and cereals and vegetables which are often found around the perimeters provide ample feeding grounds and, as in the case of the J.F.Kennedy Airport, New York, further food is found in the small rodents. The location is often near ecologically good food provision, occasionally with municipal refuse dumps nearby. Structure and location of the airports is, therefore, conducive to large accumulations of birds, and any long-term solution to the bird-strike problem may well have to take these ecological factors into consideration and this may involve re-structuring and, possibly, re-siting - a costly proceedure which could not take place within the forseeable future.

For the present, therefore, we have the problem of controlling the numbers of birds which frequent airfields.

Many means of bird-scaring have been used over the years, but they are time-consuming, costly, and have never yet been found to give continuous, overall, control. The ideal answer would seem to lie in the use of an effective deterrent which would control the behaviour of birds, that is, to eliminate the habit of alighting and remaining on and around airfields, providing that such method of control would be economically and ecologically viable and able to give continuous, overall, protection.

This has already been achieved at one airport - the Ben Gurion International Airport, Israel, where, after a history of bird strikes there has been a period of three years without them and, indeed, a reasonable freedom from all birds.

This freedom followed a planned spraying of all feeding areas on and around the airfield (including the municipal refuse tips on the perimeter) with the safe, harmless, chemical S.A.A.S.

Initially, clearance of birds was assisted by the transmission of taped bird distress calls and an exceedingly loud fog-emitter (Pulse-Fog), but, previously, both of these methods had only very temporary effect. (v. Ref.9)

The success of S.A.A.S. in controlling bird behaviour is only just being understood through the results of research into the electrical and chemical control of behaviour in both avian and mammalian species. Identical behaviour has been observed in the domestic hen under chemical stimulation of the brain (Fisher, 1969) during laboratory research, and, recently, in the field in sparrows when chemically stimulated with S.A.A.S. In each case, the behaviour elicited was identical: the birds stopped feeding, shook the head from side to side, then wiped the beak on the ground. The S.A.A.S., a chemical substance taken in from the environment, elicits identical behaviour to the chemical stimulation applied directly to the hypothalamus in the brain of the bird.

This paper provides the theoretical construct of how this is achieved.

THE CONTROL OF BEHAVIOUR

Behaviour, whether of feeding, resting, mating, nest-building or the establishment of social hierarchies is largely under chemical control. Electrical and chemical stimulation of areas within the hypothalamus in the brain have found separate areas primarily concerned with one of the following types of behaviour: fear, anger, feeding, satiety or the inhibition of feeding and many other activities and functions. It is believed that there is a specific "trigger" chemical for the control of specific behaviour. This chemical is within the hypothalamus and it triggers off the needed responses from the endocrine system. Our knowledge of the chemistry of the avian hypothalamic and pituitary hormones is recent and incomplete, whereas, in mammalian species, research has moved apace since the pioneering studies of Walter Rudolph HESS, who obtained the Nobel Prize in 1949 for it. Olds demonstrated the pleasure and pain centre in the hypothalamus in 1956, and Fisher, in 1964, demonstrated the ability to elicit disgust of normal food from the chemical stimulation of a particular area there.- identical behaviour to that obtained from S.A.A.S.

The chemical control of behaviour is affected by the neuro-secretory systems: one centrally situated in the hypothalamusaand one peripherally situated in the endocrine glands which are scattered throughout the animal body. Information reaches the hypothalamus via sensory perceptors and the cranial nerves - the olfactory nerve, one branch of the trigeminal nerve, the nervi terminales and the optic nerve endings in the eyes which are responsive to chemicals, and, possibly, others.

In the first of the systems, hormones are produced which when released act as trigger mechanisms to the peripheral system causing a particular gland to produce its specific chemical and release it into the body, thereby affecting and controlling behaviour (CHEDD 1971)

For example, it has long been known that Quelea quelea birds prefer privacy, each bird maintaining an individual distance within which approach by a companion is not tolerated (Hediger, 1950), and it has now been established by laboratory experiments that this behaviour is controlled by the production of luteinising hormone from the pituitary gland (Butterfield & Crook, 1968), and the trigger release mechanism in the hypothalamus for the luteinising hormone (LFH) structurally identified in 1971 (Guillemin & Burgess, 1972).

The role of chemicals in the control of animal behaviour is only now being recognised: and while there is a great deal yet to learn, the following can be stated with some degree of confidence:

External and internal changes, such as, for example, the external presence of food and the internal need of hunger, stimulate the receptors of animals. This information in the form of nerve impulses may be transferred ultimately to the neuro-secretory cells of the hypothalamus. These, in turn, communicate the information through the chemical system by means of hormone-releasing factors causing the bird to eat (Kobayashi & Wada, 1973). Animals also communicate with each other through chemical means, particularly over time and distance when visual or auditory means could not operate effectively.

This chemical information left by others is perceived by the sensory perceptors of the olfactory system, for example, and communicated to the neuro-secretory cells in the same way. This information may modify or alter the animal's behaviour, as, for example, a bird about to alight and feed may, on picking up a danger signal, fly off without alighting, leaving in its turn a chemical communication of fear. These external chemical communications in animals are termed 'pheromones' by many workers, but possibly a more useful term is 'exocrinology'. This was used by Parkes and Bruce, (1961), following their research on visual and olfactory stimulation in birds and mammals, to denote the expanded view of chemical regulators of behaviour to include, not only the internal chemical information system of endocrinology, but, also, external or exogonous chemical information which also modifies behaviour. The fact that the systems are interlinked helps to explain, in part the self-regulatory nature of population controls and the abnormal behaviour which follows overcrowding (Hall, 1969).

It is only since 1967 that reliable scientific evidence has been accumulating of the importance of the olfactory perceptual sense in avian species, although the anatomical evidence has been known for years. "Anatomical evidence, especially impressive in the case of olfaction, has existed for some time, and convincing electro-physiological and behavioural observations have been more recent contributions"(Wenzel, 1973).

CHEMORECEPTION

Our knowledge at present indicates that the perception of chemical stimuli occurs through the neural routes:

1. the olfactory nerve with receptor endings in the posterodorsal reaches of the nasal cavity,
2. taste fibres in the facial and glossopharyngeal nerves with sense cells on the tongue and buccal lining, and
3. free nerve endings distributed widely over the body surface in the neural network that respond to the several qualities of cutaneous sensation - the common chemical sense, which has had little study.

"Some writers have argued that apparent olfactory or gustatory sensitivity in the bird may actually be due to common chemical sensitivity. This argument need no longer be taken seriously because the modalities of taste and smell do exist, but cutaneous chemo-reception may also contribute". (Wenzel, 1973).

The structure of the olfactory epithelium is consistent for all vertebrates, including the two avian species Black Vulture (Coragyps atratus) and the domestic duck (Anas platyrhynchos) which were studied in detail (Brown & Beidler, 1966, and Graziadei & Bannister, 1967). The only non-mammalian chacteristic is an increase in microvilli on the terminal dendrite knob.

The size of the olfactory bulb, the terminal part of the cerebral hemisphere of vertebrates, from which springs the olfactory nerve (first cranial nerve) running to the organs of smell, varies widely among birds, but "the absence of gross differences between the avian and mammalian olfactory bulbs makes it reasonable to apply descriptions of mammalian bulb ultrastructure to birds, for no direct knowledge is available". (Beidler, 1971)

OLFACTORY PATHWAYS IN THE BRAIN

In 1971, new research techniques used by Lennart Heimer showed for the first time a central pathway for smell in the brain, and although this technique has not yet, as far as I know, been used in bird study, at least one recent study on the pigeon (Rieke & Wenzel, 1973), using electrical stimulation, confirms earlier reports that smell evokes responses in the central areas of the brain of the bird. This would seem to bear out all evidence so far obtained that there is little difference between the olfactory systems of all vertebrates.

SIMILARITY OF SMELL IN BIRDS AND MAMMALS

There is ample research to demonstrate that the sense of smell in at least fourteen different varieties of birds is indistinguishable from that of amphibians, reptiles and mammals. The methods used to demonstrate this are electro-olfactograms (electrical recordings of the olfactory nerve - Tucker, 1965), and extracellular recordings (Shibuya & Tonosaki, 1972). Furthermore, electrical recordings from the olfactory bulb itself have been obtained for fifteen different avian species (v. App. 'A'). Of the latter it was stated that "The wave bursts are very typical of recordings from any vertebrate olfactory system." (Sieck, 1967; Sieck & Wenzel, 1969; Wenzel & Sieck '72

An interesting point is the variation in responses to smell which occurs with different concentrations of the same compound and with different compounds and the variation from one bird to another of the same species (Sieck and Wenzel 1967 - 1972). The fact that the recordings were genuine reflections of the responses to smell was established by showing that the activity disappeared following the cutting of the olfactory nerve.

BEHAVIOURAL EVIDENCE OF SMELL

Even before the above evidence was known, some studies were showing that behaviour was dependent upon taste and smell, and the potential for the use of these senses is now well established.

Several instances of the use of olfaction in normal behaviour have been documented and others have been suggested (Stager, 1967). After extensive studies, Stager concluded that the Turkey Vulture and, possibly the King Vulture, locate general areas of carrion by odour cues, after which, the exact location is pinpointed by vision. (The method for this study was to hide a generator of ethyl mercaptan at the base of a canyon and to release the fumes into the still, morning air. The vultures could not see the generator, but they congregated and circled around the area of the generator repeatedly.)

Stager,1967, also proposed that the African Honeyguides which feed on beeswax, locate hives by the odour of the wax. He found that the birds were even attracted by a lighted candle, while Archer and Glen, 1969, found that Honeyguides "can be netted repeatedly in the immediate vicinity of beehives even ten to twelve days after their abandonment by the bees and when visual and auditory clues would no longer be available." They concluded, "They were able to pinpoint the location of the hives by a distance cue such as odour."

Papi et al (1971-2) reporting that homing pigeons rely on olfaction, stated, "Birds with bilateral olfactory nerve section, with both nostrils plugged with cotton tampons, and with one nerve bisected and the other nostril plugged, were all profoundly disorientated as shown by the very low incidence of returns to the home loft. The few that returned arrived later than the sham operated control birds." They had observed behaviour on six days before the operation and for seven days after, as the result of which they suggest, "pigeons in the loft learn to recognise odours from surrounding areas and to associate them with wind directions."

Johnstone et al (1970), stated, "It (avian reliance on olfaction) may even contribute to the normal operation of physiological systems in ways that are only beginning to be understood for other vertebrates."

Wenzel (1968-72), found that kiwis were completely successful at night in locating which of three feeding stations contained their food.

Grubb (1971/2) produced a variety of evidence to show that Leach's Storm Petrels and Wilson's Storm Petrels, the Greater Shearwater and, possibly, Sooty Shearwater birds accomplish at least some navigation by reliance upon olfactory cues."

Egrets found an island in the Bay of Fundy at night by flying up-wind (Grubb, 1972). Their nesting material served as an effective lure in the darkness. The birds landed through dense trees a short distance down wind from their burrows and they chose an arm of a 'Y' maze which contained the odour of their own nest material rather than the other which had similar control material taken from the ground. Finally, the birds with plugs in their nostrils or with sectioned olfactory nerves, had not returned to their burrows after one week, and Grubb concluded that the evidence supported the hypothesis that Leach's Storm Petrel depends upon olfaction for many aspects of burrow location.

"Not only does olfactory input influence many aspects of reproduction in other (than avian) forms, but it has even been shown to affect certain aspects of general behaviour in both rats and birds." (Avian Biol., 1973) which cites Douglas & Isaacson (1969); Heimer &Larsson (1967); Papi et al (1969) and Hutton & Wenzel (1971).The article continues, "Perhaps its most significant contribution to many avian forms lies in this sphere of influence rather than in the transmission of specific information about odours."

VARIATIONS IN BEHAVIOURAL RESPONSES

The variations in responses of birds and mammals has posed the greatest problems to the commercial development of an acceptable and ecologically viable chemical repellent. The complexity of behaviour is due, partly to the complexity of perceptual response in the individual, and partly, for want of a better term, 'bloodymindedness', or determination to carry out some destructive act.

The degree of variation in responses, both inter and infra species, is, at present, unaccounted for in research studies. Explanations given for it usually include past experience coupled with present nutritional and metabolic need, e.g., past water deprivation may mean that present thirst will overcome the aversion to a particular taste, (Wenzel, 1973) In such cases, a repellent, to be successful, would need the spectrum of repellency necessary for the particular species, together with such potency as to be able to overcome the tolerance limit of any individual. But, although this argument has some cogency, it has yet to be resolved.

RESPONSES TO S.A.A.S.

Evidence of the variations in responses to S.A.A.S. which would appear to have been caused by high incidence of hunger and/or thirst was first demonstrated in the Israeli Government trials by de Wolf and the Volcani Institute (1971-5). Migratory birds of varying species flying South over various farms from Hedera (32°12" N) to Gilat (31°20" N) did no damage to crops sprayed with S.A.A.S., whereas, after a further flight of some 150 miles across mainly barren desert to Neviot (29°00" N) some damage was found on the crops at the agricultural station there. (1)

Individual dislikes and preferences can be comprehended, but the apparent determination to carry out an act despite disagreeable consequences is believed to be unusual. This was first demonstrated by two dogs which shared a kennel and badly damaged it by gnawing, whereupon it was heavily painted with S.A.A.S. in an adhesive. The dogs stopped chewing for two days, but on the third day they tore the kennel to pieces, were violently sick and thereafter refused absolutely to go near any kennel.(2)

In similar vein, the buds and flowers of a row of syringa bushes in a garden were being taken by tits and sparrows and so sprayed with S.A.A.S. There was no damage for three days, but on the fourth and fifth days every bud and flower was found on the ground - not one remained on the bushes - but none of the other plants in that garden, which normally suffered heavy damage, were touched during the remainder of that season. (3)

Similar instances have been noted, but at the moment no work is known to have been carried out in this field to explain them.

SIMILARITY OF SMELL IN BIRDS AND MAMMALS

There is ample research to demonstrate that the sense of smell in at least fourteen different varieties of birds is indistinguishable from that of amphibians, reptiles and mammals. The methods used to demonstrate this are electro-olfactograms (electrical recordings of the olfactory nerve - Tucker, 1965), and extracellular recordings (Shibuya & Tonosaki, 1972). Furthermore, electrical recordings from the olfactory bulb itself have been obtained for fifteen different avian species (v. App. 'A'). Of the latter it was stated that "The wave bursts are very typical of recordings from any vertebrate olfactory system." (Sieck, 1967; Sieck & Wenzel, 1969; Wenzel & Sieck '72

An interesting point is the variation in responses to smell which occurs with different concentrations of the same compound and with different compounds and the variation from one bird to another of the same species (Sieck and Wenzel 1967 - 1972). The fact that the recordings were genuine reflections of the responses to smell was established by showing that the activity disappeared following the cutting of the olfactory nerve.

BEHAVIOURAL EVIDENCE OF SMELL

Even before the above evidence was known, some studies were showing that behaviour was dependent upon taste and smell, and the potential for the use of these senses is now well established.

Several instances of the use of olfaction in normal behaviour have been documented and others have been suggested (Stager, 1967). After extensive studies, Stager concluded that the Turkey Vulture and, possibly the King Vulture, locate general areas of carrion by odour cues, after which, the exact location is pinpointed by vision. (The method for this study was to hide a generator of ethyl mercaptan at the base of a canyon and to release the fumes into the still, morning air. The vultures could not see the generator, but they congregated and circled around the area of the generator repeatedly.)

Stager,1967, also proposed that the African Honeyguides which feed on beeswax, locate hives by the odour of the wax. He found that the birds were even attracted by a lighted candle, while Archer and Glen, 1969, found that Honeyguides "can be netted repeatedly in the immediate vicinity of beehives even ten to twelve days after their abandonment by the bees and when visual and auditory clues would no longer be available." They concluded, "They were able to pinpoint the location of the hives by a distance cue such as odour."

Papi et al (1971-2) reporting that homing pigeons rely on olfaction, stated, "Birds with bilateral olfactory nerve section, with both nostrils plugged with cotton tampons, and with one nerve bisected and the other nostril plugged, were all profoundly disorientated as shown by the very low incidence of returns to the home loft. The few that returned arrived later than the sham operated control birds." They had observed behaviour on six days before the operation and for seven days after, as the result of which they suggest, "pigeons in the loft learn to recognise odours from surrounding areas and to associate them with wind directions."

Johnstone et al (1970), stated, "It (avian reliance on olfaction) may even contribute to the normal operation of physiological systems in ways that are only beginning to be understood for other vertebrates."

Wenzel (1968-72), found that kiwis were completely successful at night in locating which of three feeding stations contained their food.

Grubb (1971/2) produced a variety of evidence to show that Leach's Storm Petrels and Wilson's Storm Petrels, the Greater Shearwater and, possibly, Sooty Shearwater birds accomplish at least some navigation by reliance upon olfactory cues."

The memory factor, together with the information given by the release of pheromones, or exogonous chemical factors giving warning messages would appear to be the only possible explanation for the action of birds and mammals in avoiding a treated area for periods of up to several months. This could be due to memory alone if only the creatures experiencing the original treatment were concerned, but newcomers to treated areas have been repelled in a similar manner after the lapse of several weeks and months and even after heavy rain would have washed away most if not all of the repellent material, as, for example, at Ben Gurion International Airport (9) where there are movements of migratory birds, and seagulls were found to arrive daily with the possible object of reconoitering the repellent effect of the S.A.A.S. At Sydney, Australia, (10) no dogs would walk on areas of parks seven weeks after treatment with S.A.A.S., during which time there had been 4-inches (102mm) rainfall and the government drugs laboratory could find no evidence of the chemical remaining on the treated areas. Similarly, rats (11-12) desert rodents (13) and rabbits (14) among the mammalian species to react to the repellent, have been totally repelled for long periods of time from the treated areas.

Response attributable solely to the gustatory effect of S.A.A.S. has been demonstrated empirically in a manner similar to that by Fisher with the hen (v. above) on only one occasion. Twelve sparrows (Passer domesticus) were found happily shredding the petals of crocus flowers with their beaks. The birds left while the petals were sprayed with a mild solution of S.A.A.S. in water but they returned after a few minutes, whereupon one of their number hopped to a flower and commenced to shred a petal as before, when it suddenly stopped, dropped the petal, shook its head several times from side to side and hopped back to its fellows. Shortly after, two others from the twelve then carried out precisely the same actions with identical results. Then, all twelve birds flew off. But, during the remainder of the season, no further damage was done in that garden to any plant by any bird although much damage was done to plants in the adjoining gardens. (15

<u>To sum up</u>, research into the control of behaviour by neuro-physiological means has now reached a stage whereby several control mechanisms are known, both electrical and chemical.

It is suggested that we use our knowledge of the normal avian chemical control of behaviour in order to control behaviour undesirable to man by the development of an ecologically viable chemical repellent.

Such a repellent has been developed and the results of the field trials at Ben Gurion International Airport (now free from most birds for three years) would seem to suggest that it is effectively controlling bird behaviour at present.

I, therefore, submit to this conference that I have demonstrated that S.A.A.S. can have behavioural control over the birds and mammals that, directly and indirectly, can cause damage to aircraft in the course of landing and taking-off at airfields, and that I have correlated the scientific research work showing that this is achieved by neuro-chemical action within the brain.

There is, of course, much laboratory and field research still to be carried out, but, meanwhile, it is suggested that the correct grade of S.A.A.S. correctly applied on areas in and surrounding airports may do much to reduce the incidence of bird-strikes to aircraft in many parts of the world.

A questionnaire is attached to each copy of this paper for the use of any authority wishing to obtain advice as to grade and quantity of S.A.A.S. to use and the method of application.

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APPENDIX "A"

The avian species shown below were used in electrophysiological experiments in olfaction by the methods and the researchers shown

NERVE RECORDING - Tucker D. 1965 in 'Electrophysiological Evidence for Olfactory Function in Birds: Nature: 207. 34-36.

Chicken (White Leghorn)
Common crow (Corvus brachyrhynchos)
Muscovy Duck (Cairina moschata)
Domestic Goose (Embden)
Ring-billed Gull (Larus delawarensis)
American Sparrow-hawk (Falco sparverius)
Blue Jay (Cyanocitta cristata)
Common Night-hawk (Chordeiles minor)
Domestic Pigeon (Columba palumbus)
Bobwhite Quail (Colinus virginianus)
House Sparrow (Passer domesticus)
Black Vulture (Coragyps atratus)
Turkey Vulture (Cathartes aura)
Common Yellowthroat (Geothypis triches)

BULB RECORDING - Sieck, 1967; Sieck & Wenzel, 1969; Wenzel & Sieck, 1972)

Black-footed Albatros (Diomedea nigripes)
Chicken (White Leghorn)
Mallard Duck (Anas platyrhynchos)
Domestic Pigeon
Manx Sheerwater (Puffinus puffinus opisthomelas)

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VETERINARY PRODUCTS

אסיא מעברות בע"מ

תוצרים וטרינריים

ADF616157 BSCE 12

28 Octobre 1977

TREATMENT FOR REPELLING BIRDS AT BEN GURION (LOD) INTERNATIONAL AIRPORT, ISRAEL

The series of anti-bird treatments by Reta Bird Repellent during 1976/77, was based on results of two previous winter trial campaigns carried out at Ben Gurion Airport in 1974/75 and 1975/76.

The programme consisted of:

a) Spraying the landstrips bordering the main runways, in order to repel birds constituting a potential hazard to planes during takeoff or landing. This was carried out during both winter and summer.

b) experimental treatments of spraying a section of the runway to prevent gulls and lapwings from settling there.

As mentioned in previous reports, the principal species of birds who constitute the greatest hazards during takeoff and landing in Ben Gurion Airport, are gulls, partridges and lapwings during the winter months, and partridges and turtledoves during the summer.

1. TREATMENTS

a) Winter Treatment: December to February

Four standard treatments were carried out on the landstrips bordering either side of the 3 main runways. The width of each of these landstrips is 50/60 metres.

The area bordering the 4000 metre runway (08-26) was treated three times at monthly intervals, as were the areas bordering the 3500 metre runway (12-30). However, the 1700 metre north/south runway (21-03) was treated only once, in December, and on the west side only. All these treatments were carried out in the rainy season in winter, although the actual days chosen were sunny, dry and windless.

8, BAVLI STREET, P.O.B. 21141, TEL-AVIV 62 331, ISRAEL, TELEPHONE 484111 טלפון .62331 תל אביב ,21141 .ת"ד ,8 רחוב בבלי

The first treatment in December was started using a tractor and ground sprayer, but after a break of a couple of days, it was completed by a Bell 47 helicopter. For air security considerations and because of the greater competence of the helicopter crew, we decided it would be preferable to complete the summer and winter treatments by helicopter.

We used 30 kilos of Reta Bird Repellent per hectare. This was mixed in 550 litres of water for the ground treatment, and in 180 litres for the aerial treatment.

b) Summer Treatment

On July 11, the landstrips bordering runway 30-26 were treated in exactly the same manner as during the winter.

c) Treatment of a Section of the Runway

On certain days in the winter, large quantities of seagulls, ranging from a few hundred up to 3000/4000, land on the runways transforming them into 'meeting places' (Prof. A Zahavi). It appears that the seagulls favour special sections of the runway, namely the east and west extremities of the long runway 26-08. In addition, there are always a number of lapwings - up to 200 - on the western extremity. They come to rest on the runways after having finished their morning feeding activities.

The western extremity of this runway was treated on February 14th over a length of 700 metres and a width of 75 metres, with a higher rate of Reta (200 kilos per hectare).

2. OBSERVATIONS

a) Winter Treatment

Behaviour of Partridges: From December 11 to the end of March, these almost entirely disappeared from the treated area. In addition, none were observed crossing the runway.

However, on runway 03-21, which was treated only once at the beginning of December, partridges were observed crossing the runway from the middle of January. This usually happened before 8.30 in the morning.

Behaviour of Lapwings: The number of lapwings in the treated area was reduced drastically. Apparently, their sensitivity to noise was also increased. We had already observed this phenomenon during our trials on seagulls the previous year. During take-off of jet aircraft, they rise much earlier and so have sufficient time to assess in which direction the danger lies. They then leave the runway area immediately.

Before treatment, they would take flight at the last possible moment and fly out in all directions in a haphazard manner. Some would actually cross the runway in front of the very plane that was disturbing them.

During the whole period of the winter treatment (December to the first half of March) there was only one bird strike, and this was during the landing of a Viscount which came down before the actual beginning of runway 30, between two lateral entrances. This was an untreated place almost opposite to the terminal.

b) Summer Treatment

Behaviour of Partridges: Their behaviour after treatment in summer was identical to the winter pattern.

Behaviour of Turtledoves: After treatment, up to the middle of August, their behaviour during take-off of planes followed the same pattern as the lapwings, their reactions being even sharper.

During this five week period, from 11th July to 16th August, there was not one single bird strike. After that date we observed the following.

On the 16th August, there was a sudden increase in the number of turtledoves on the treated areas, along with changes in their behaviour. They reverted back to previous behaviour patterns established before treatment, and when the planes took off they flew about in a haphazard manner in all directions.

On August 18th, partridges again appeared on the treated areas.

On the 18th August there was a strike of 5 turtledoves with a 707 aircraft immediately after take-off. On 19th August there was a strike between 1 turtledove and a 707, and on 25th August, there were two strikes between 707's and single turtledoves. On September 12th, there was a strike between 12 partridges and a plane. Apparently the birds collided with the main landing gear.

c) Treatment on the runway itself

After treatment, not one bird remained on the section - neither gull nor lapwing - and the area remained quite clear until the end of March/beginning of April, when they migrated north.

A more detailed subsequent survey showed that the treatment appeared to be efficacious against lapwings, as although they did not return to the treated areas, they remained on the untreated section.

The gulls too did not return to the treated areas. However they were also not to be found on the untreated areas either. As the behaviour of the gulls was inconstant before treatment, we cannot after only one test, draw definite conclusions from their subsequent absence.

a) The effect of rain

Experience has shown that rain in itself, does not usually have an adverse effect upon the stickiness of the material used for treatment. However there is one exception to this rule, and that is when there is an unusually severe and concentrated downfall. This was evidenced to us on the 24th January, 13 days after treatment, when there was a 5 day rainy period with an average 55 mm. downfall. However, an examination of the meteriological records for that period, shows that of this 55 mm. rainfall, 44.5 mm fell during 5 different periods totalling 1½ hours. It was the strength of this concentrated downpour that in all probability watered down the material.

3. PROGRAMME FOR THE 1977/78 CAMPAIGN

It is planned to continue the repellent treatment against birds throughout the year. It will be important to determine the birds' sensitivity to noise in the areas treated by Reta. We plan to examine the combined effects of bird repellent with - for example - gas cannons and distress calls.

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September 1977

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THE INFLUENCE OF WEATHER VARIABLES ON THE DENSITY OF NOCTURNAL MIGRATION IN SPRING

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INTRODUCTION

Until the availability of radars that could detect birds migrating aloft at night, studies emphasizing the influence of meteorological variables on the density of nocturnal bird migration suffered because the techniques of study were either indirect (e.g., counting grounded migrants) or limited by certain weather variables (e.g., obscuring clouds in the case of moon-watching). Lack (1960a) reviewed more than 100 papers published between 1880 and 1958 that discussed the influence of weather variables on passerine migration, and he criticized all previous conclusions because most authors had used subjective judgment or univariate statistics to study a multivariate problem. Lack also concluded that radar provided the most adequate measurements of the density of migration. At least 12 papers emphasizing the influences of weather variables on bird migration have been published since Lack's review in 1960, and each is based on radar data and employs multivariate statistics. Four of these studies concern only spring migration (Lack 1960b; Nisbet and Drury 1968; Richardson 1971, 1974a); four concern only fall migration (Lack 1963a, Gruys-Casimir 1965, Able 1973, Richardson 1976); and four studies concern both spring and fall migration (Lack 1963b, Geil et al. 1974, Richardson 1974b, Alerstam 1976).

In this paper I analyze the influence of weather variables on the nocturnal migration of passerine birds in spring using multivariate statistics and review the conclusions of similar studies. The implications of the findings are discussed in terms of the relative contributions of exogenous and endogenous factors to the migratory behavior of birds.

METHODS

I used the WSR-57 radar at the National Weather Service station at Athens, Georgia, during the spring of 1969 to gather data on the density of nocturnal passerine migration. Pertinent details of this radar are thoroughly reviewed in Gauthreaux (1970). The peak amount of migration on each of 54 nights sampled from 15 March to 19 May was determined by a technique similar to that used by radar meteorologists to measure the intensity of rainfall (see Gauthreaux 1970, 1975). This method yields density measurements of bird migration detected by the radar that are highly correlated with those obtained by moon-watching (Lowery 1951), and the amount of migration can be expressed as the number of birds crossing a mile of front per hour, the migration traffic rate.

In the multivariate statistical analyses that follow the maximum density of nocturnal migration on a given night (TR) is the dependent variable. The independent variables are photoperiod (PP), surface wind direction (SWIND), surface wind velocity (SVEL), aloft wind direction at 305 m (1,000 ft) (AWIND), aloft wind velocity (AVEL), precipitation during previous daylight hours (PPT), percentage cloud cover (CLDS), cloud height (CLHT), dry bulb temperature (DTEMP), wet bulb temperature (WTEMP), relative humidity (RH), 24-hour change in dry bulb temperature (DLDTMP), 24-hour change in wet bulb temperature (DLWTMP), 24-hour change in relative humidity (DLRH), barometric pressure (BP), 24-hour change in

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barometric pressure (DLBP), general synoptic weather over station (GENW), precipitation during sample evening (NPPT), and magnetic storm activity (K). In all, 19 independent variables are included in the analysis. Unless noted, the weather variables are those recorded at the beginning of the sample evening (19:00 EST) at the Athens, Georgia, weather station. Any variable reflecting 24-hour change is the difference between the value of the variable at the 19:00 hour on the sample evening and the value at the 19:00 hour on the previous evening. The value assigned to the general synoptic weather pattern over the station was based on the comparison between the national weather map for the 19:00 hour and Figure 1. Wind direction is a circular variable and was linearized before analysis by assigning the value of zero to north winds and the value of 180 to south winds. For winds from the intermediate directions either westerly or easterly the values ranged from one to 179 (e.g., northeast and northwest winds had a value of 45, east and west winds had a value of 90, and so forth). The dependent variable (TR) originally showed a right-skewed and leptokurtotic (clumped) distribution without transformation, but a $\sqrt{TR+1}$ transformation normalized the distribution. Other details of this analysis follow the recommendations of Richardson (1974b).

The multivariate statistical analyses of the data included a multiple correlation procedure (CORR) using the Barr and Goodnight (1972) Statistical Analysis System (SAS) package, the stepwise regression (STEPWISE), and the maximum R procedures (MAXR) using the Barr and Goodnight (1972) SAS package, and the stepwise multiple discriminant analysis procedure using the BMD07M program (Dixon 1973). Stepwise multiple discriminant analyses were performed with the dependent variable (TR) divided first into two categories, zero migration and migration, and then into three categories, zero, medium, and heavy migration.

RESULTS AND DISCUSSION

The multiple correlation analysis showed that the night-to-night change in the density of migration was correlated positively with dry bulb temperature ($p<.0001$), general synoptic weather ($p<.0003$), surface wind direction ($p< .0004$), 24-hour change in dry bulb temperature ($p<.0006$), aloft wind direction ($p<.0007$), wet bulb temperature ($p<.0009$), 24-hour change in wet bulb temperature ($p<.0036$), and correlated negatively with aloft wind velocity ($p<.0060$) and surface wind velocity ($p<.0067$). The remaining variables were not significant at the 0.05 significance level.

Stepwise regression analysis generated the best predictive model with only four variables--dry bulb temperature, general synoptic weather, precipitation during the sample night, and velocity of aloft wind at 305 meters--explaining 54 percent of the night-to-night variance in migration density (Table 1). The model shows the following relationship between peak nightly migration density (TR) and the four weather variables:

$$TR = [-66.29 + 1.49(DTEMP) + 9.13(GENW) - 28.70(NPPT) - 0.95(AVEL)]^2 - 1$$

The included weather variables are significant at the 0.05 significance level. One variable alone, dry bulb temperature, explains nearly 40 percent of the variance in TR.

In an effort to examine the makeup of the variable general synoptic weather, a maximum R procedure was performed with GENW as the dependent variable and with migration density (TR) eliminated. With all the weather variables included, only 73 percent of the variability in synoptic weather was explained. It thus appears that general synoptic weather includes additional weather parameters not specified by the array of weather variables I have chosen for my analysis. In addition, a stepwise regression analysis was performed to examine the most significant weather variables that contributed to the dependent variable, general synoptic weather. The resulting model contained only three variables: the direction of aloft wind, the velocity of aloft wind, and the 24-hour change in wet bulb temperature. The three variables accounted for 48 percent of the variance in synoptic weather, and the aloft wind direction alone accounted for 41 percent of the variance. When synoptic weather (GENW) was eliminated as an independent variable, the best regression model contained only two weather variables, surface wind direction and dry bulb temperature, and explained 44 per cent of the variation in nightly migration traffic rate.

In the first stepwise discriminant function analysis, I attempted to find the weather variables that were most important in discriminating between occasions with no migration and occasions with migration. Based on this analysis, the following variables contributed significantly ($p<.05$) to the discriminant model: dry bulb temperature, velocity of aloft winds, precipitation during the sample night, and general synoptic weather. Based on the discriminant model with these four variables, only two of the 17 cases of no migration were incorrectly classified (88% accuracy), and of the 37 cases of migration only four were misclassified (89% accuracy). When all 19 weather variables were included the misclassification in the migration category was reduced by only one case (92% accuracy). Thus four weather variables had almost the same predictor accuracy as all 19 weather variables.

When each case of no migration and migration is plotted using the first and second canonical variables, the separation of the two categories of migration traffic rate is clearly evident (Figure 2). The canonical variables incorporate the most important weather variables that allow maximum discrimination between the two categories of migration. The canonical correlation coefficient (Rc) is 0.80, and the proportion of the variance in the discriminant function accounted for by the two groups is 64 per cent.

In the second stepwise discriminant function analysis I divided the dependent variable TR into three categories: zero migration, medium migration (traffic rates between 1 and 4500), and heavy migration (traffic rates above 4500). Only three variables were significant ($p<.05$): dry bulb temperature, general synoptic weather, and relative humidity. On the basis of this discriminant model with these three variables, three of the 17 cases of no migration were misclassified (82% accuracy), 13 of the 28 cases with medium migration densities were misclassified (54% accuracy), and two of the nine cases with heavy migration were misclassified (78% accuracy). When all 19 weather variables were included, only one case was misclassified in the zero migration category (94% accuracy), eight of the 28 cases in the medium migration category were misclassified (72% accuracy), and none were misclassified in the heavy migration category (100% accuracy). Figure 3 shows the plot of the cases in the three categories along the axes of the first and second canonical variables. As expected, the medium migration cases were the most poorly classified, probably because the limits of the category were somewhat arbitrarily defined. The canonical correlation coefficient (Rc) is 0.82 for the first canonical variable and 0.54 for the second canonical variable, and the proportion of the variance in the discriminant function accounted for by the three groups is 67 per cent.

In all the multivariate studies of weather influence on bird migration two patterns emerge. First, of the weather variables that have been shown to have a significant influence on the night-to-night variation in the amount of migration, two variables, temperature and wind, have rather consistently appeared. Aspects of the weather variable wind have been shown significant in every study. In my study both wind direction and dry bulb temperature were significantly cross-correlated (partial correlation coefficient 0.43, $p<.0016$ for direction of surface wind; partial correlation coefficient 0.59, $p<.0001$ for direction of aloft wind). When one considers the flight energetics of bird migration the importance of both temperature and wind is self-evident. The other pattern evident from multivariate studies of weather and bird migration concerns the percentage of night-to-night variability in the amount of migration explained by the array of weather variables. In spring (Table 2) the average percentage of explained variability is 52 per cent with a range from 40 per cent to 62 percent. In the fall (Table 3) the average explained variability is 47 per cent with a range from 26 per cent to 61 per cent. Thus weather conditions appear to be able to account for only about half of the variation in the amount of nightly migration. The remaining variability is probably dependent on the number of grounded migrants in the general area and on the internal conditions of these migrants relative to their readiness to migrate.

SUMMARY

Fifty-four nights of radar data were gathered and processed according to the methods of Gauthreaux (1970, 1975) yielding accurate estimates of migration traffic rates. The highest hourly migration

traffic rate for each night (the dependent variable) was analyzed in terms of 19 weather parameters (independent variables) gathered at the beginning of each night by several Statistical Analysis System (SAS) procedures: simple rank correlation, stepwise regression, and discriminant analysis. When necessary the data were transformed as recommended by Richardson (1974b).

Nine weather variables were found significantly correlated with migration traffic rate. Dry bulb temperature accounted for 37 per cent of the variation in migration traffic rate; the best model included four variables--aloft wind velocity, dry bulb temperature, synoptic weather, and nightly precipitation--that together explained 54 per cent of the variation in nightly migration traffic rate. When synoptic weather was eliminated the best regression model contained only two variables, surface wind direction and dry bulb temperature, and explained 44 per cent of the variation in nightly migration traffic rate.

The stepwise discriminant function analyses showed that dry bulb temperature, velocity of winds aloft, precipitation during the sample night, and general synoptic weather contributed most significantly to the discriminant model for predicting no migration or migration. The discriminant model for separating the categories no migration, medium migration, and heavy migration relied strongly on just three variables: dry bulb temperature, general synoptic weather, and relative humidity.

ACKNOWLEDGMENTS

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TABLE 1

STEPWISE REGRESSION ANALYSIS FOR SPRING MIGRATION

Number in Model	R-Square	Variables in Model[a]
1	0.38	DTEMP
2	0.44	DTEMP GENW
3	0.49	DTEMP NPPT GENW
4	0.54	AVEL DTEMP NPPT GENW
5	0.55	AVEL DTEMP DLDTMP NPPT GENW
4	0.54	AVEL DTEMP NPPT GENW

[a] The variables in the above model have all been deemed significant at the 0.05 significance level.

TABLE 2

INFLUENCE OF WEATHER VARIABLES ON SPRING MIGRATION (MULTIVARIATE ANALYSES)

	Temp	Wind	Cloud	Rel Hum	Bar Press	Precip	Gen Weath	R^2 or Rc^2
Lack (1960b)	*	*	*			*		
Lack (1963b)	*	*	*				*	
Nisbet & Drury (1968)	*	*		*	*	*		0.60
Richardson (1971, 1974b)	*	*	*					0.62
Geil et al. (1974)[b]	*	*		*	*			0.61
Geil et al. (1974)[c]	*	*	*			*		0.43
Richardson (1974a)[d]		*			*			0.51
Richardson (1974a)[e]		*						0.40
Alerstam (1976)		*		*	*		*	0.44
Gauthreaux (1976)	*	*				*	*	0.54

[a]Specific weather variables (e.g., 24-hour change in temperature, temperature departure from normal) are included in general variable (e.g., temperature); [b]March; [c]April; [d]offshore; [e]overland.

TABLE 3

INFLUENCE OF WEATHER VARIABLES ON FALL MIGRATION (MULTIVARIATE ANALYSES)

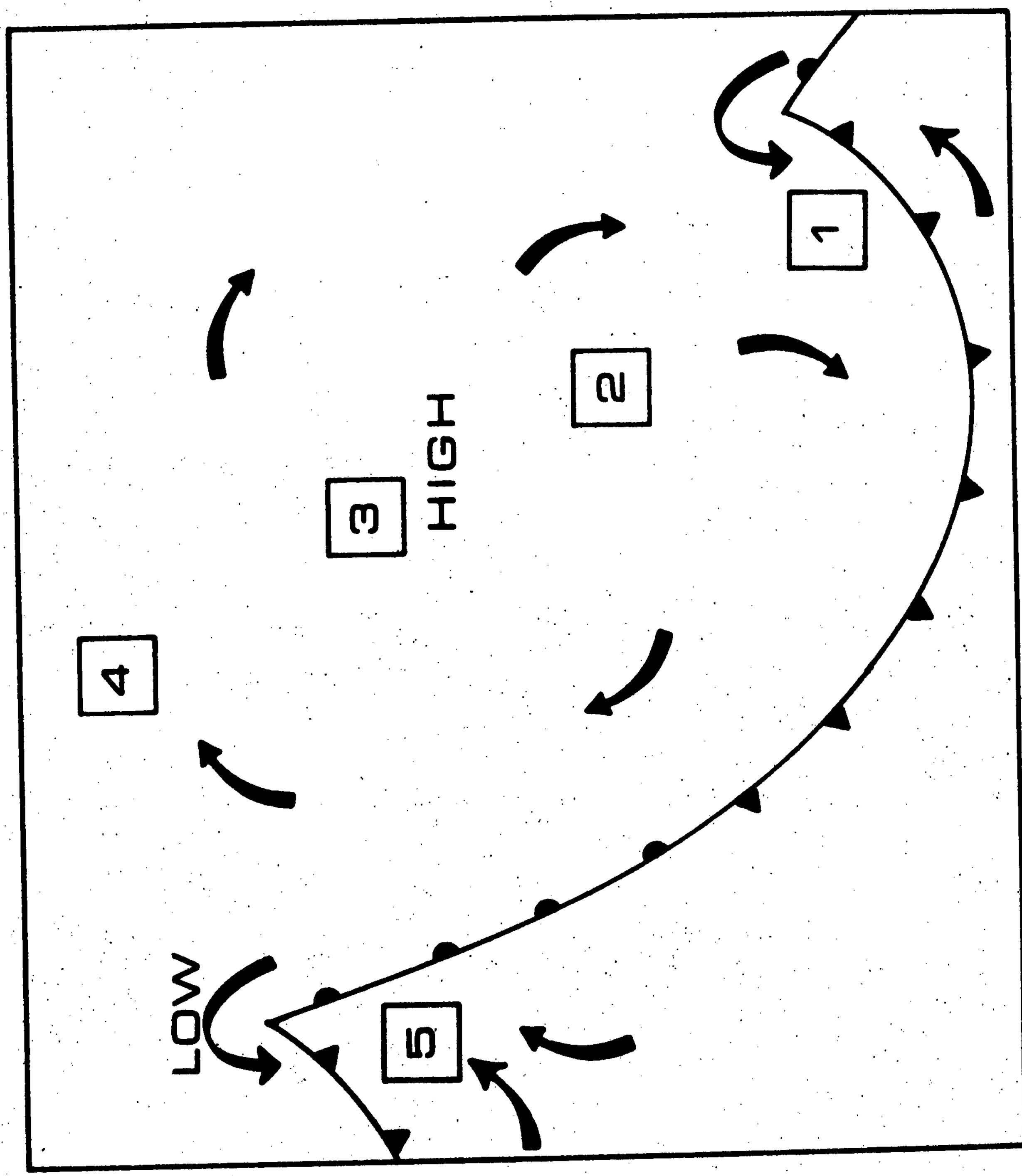
	General Weather Variables[a]									
	Temp	Wind	Cloud	Visibil	Rel Hum	Bar Press	Precip	Gen Weath	Mag Dist	R^2 or Rc^2
Lack (1963a)[b]		*								
Lack (1963a)[c]	*	*	*					*		
Able (1973)	*	*						*		0.54
Geil et al. (1974)[b]	*	*				*				0.44
Geil et al. (1974)[d]	*			*	*					0.48
Richardson (1974b)	*	*			*	*	*			0.51
Alerstam (1976)	*	*	*	*	*	*		*		0.61
Richardson (1976)		*				*			*	0.26

[a] Specific weather variables (e.g., 24-hour change in temperature, temperature departure from normal) are included in general variable (e.g., temperature); [b] September; [c] October-November; [d] November.

Figure 1. Synoptic weather chart used to assign values to the variable general weather (GENW). The value (in square box) given to GENW was that most closely associated with the synoptic weather pattern over the study site based on examination of the actual surface weather map for 19:00 EST.

Figure 2. Discrimination between nights with no migration and migration on the basis of weather. Nights are plotted in relation to the first and second canonical variables. Open circles are cases of no migration, and solid circles are cases with migration.

Figure 3. Discrimination between nights with zero, medium, and heavy migration on the basis of weather. Nights are plotted in relation to the first and second canonical variables. Open circles are cases of no migration, half-shaded circles are cases of medium migration, and solid circles are cases of heavy migration.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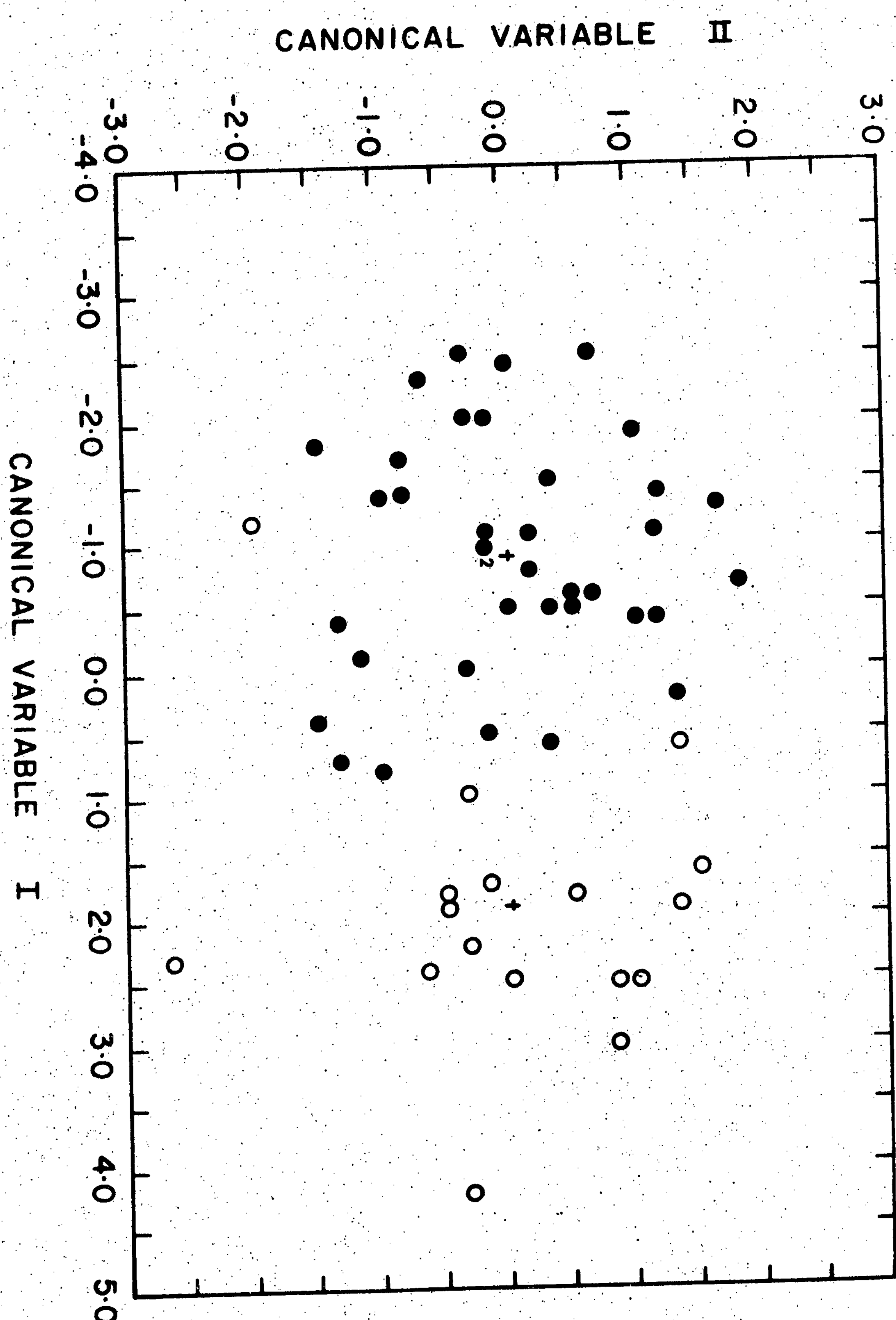
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CANONICAL VARIABLE I
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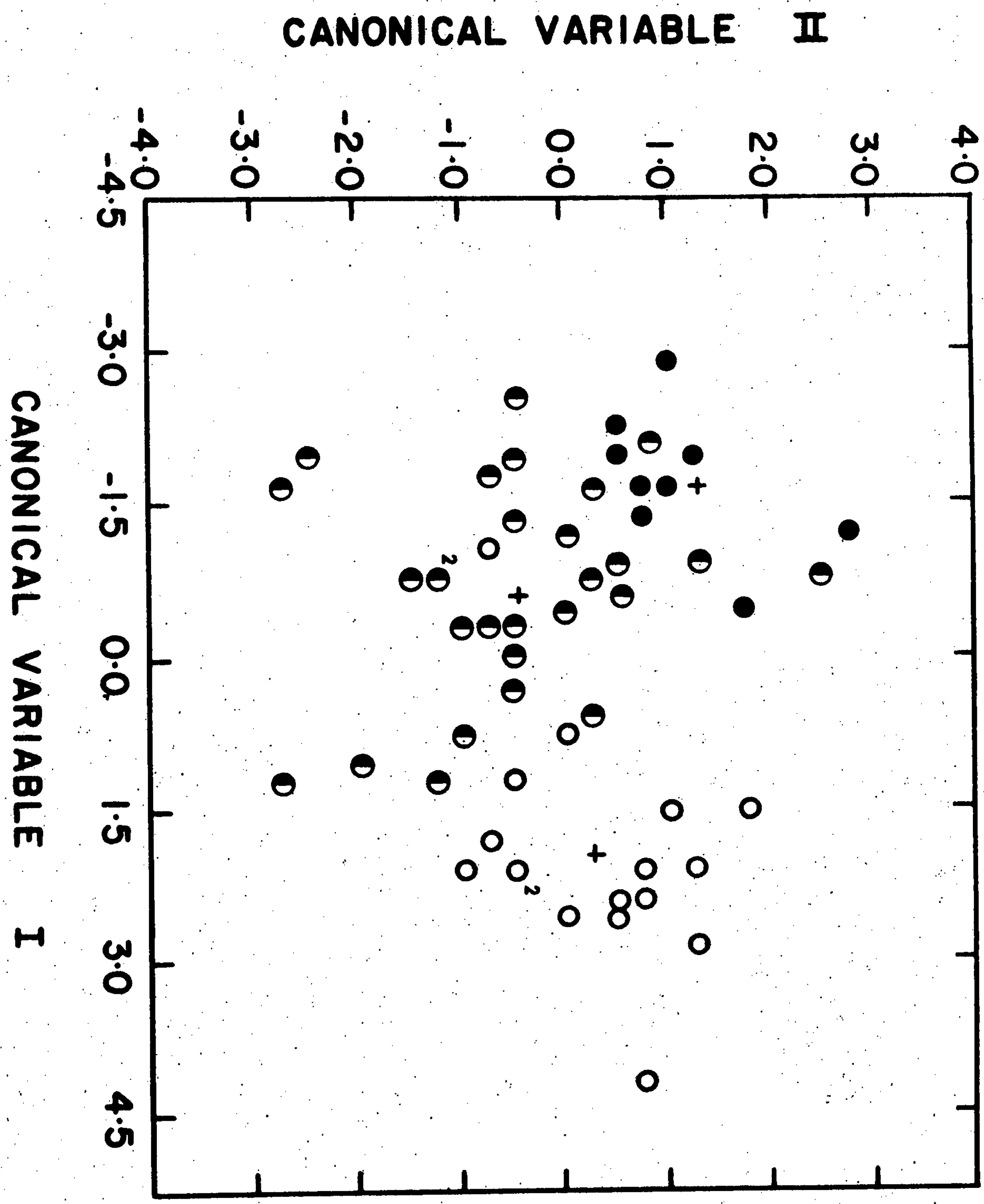
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2.0
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CANONICAL VARIABLE I
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1.5
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4.5

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BIRD STRIKE COMMITTEE EUROPE

Paris, October 1977
BSCE / WP No 25

Weather-dependence of Height, Density and Direction of Migration in Switzerland

Bruno Bruderer, Switzerland

Proposals for action arising from this paper

- Raw video information is necessary for bird observations. Besides all digitalisation this information should be kept accessible at every larger radar center.
- If operational use of radar data on birds is previewed, speeding up evaluation (e.g. by electronic counting systems) seems to be necessary.
- A possible preference of larger birds for higher flight levels has to be tested by echosignature-analysis.
- Cooperative studies of France, Germany and Switzerland should be carried out in order to find out, how far from the Alps their deflecting influence is still recognicable.
- The possibility that small passerines may be concentrated along pronounced leading-lines should be tested with long range lo cm radars in Switzerland.
- Predicting models for intensity of bird migration in Switzerland should be improved.

1. Introduction

Since bird hazards to aircraft have become a real problem for flight safety, the interest of aviation people in the old field of bird migration research has increased rapidly, and the interest of biologists in radar observations has opened a wide field of cooperation.

If cooperation shall go on, it is necessary that radar technicians are aware of this cooperation and take care that, besides all digitalisation of modern radar arrays, the possibility to work with raw video displays will be maintained.

If radar information on birds should be used in an operational manner, even further support by radar specialists is necessary, in order to speed up the evaluation of radar data (e.g. by electronic counting systems).

Biologists have to interpret radar data, to transform it into biological information and to make this knowledge available for flight safety again.

The probability of a bird strike depends on the density of birds at the flight level of the aircrafts. In the present paper I try to summarize the present knowledge on vertical and horizontal distribution of migration above Switzerland, to show the problems of forecasting day-to-day variation in migratory activity in an Alpine environment and to indicate the gaps in our knowledge.

2. Methods and Acknowlegments

Our knowledge on migration in Switzerland is based on field observations in the lowlands and at observatories in the Jura and the Alps, on surveillance radar studies at Zurich airport and on studies with the tracking radar "Superfledermaus".

Aiming the pencil-beam of the tracking radar vertically upwards or moving it up and down in a plane perpendicular to the principal direction of migration, we got information on the height distribution of birds and on density variations in time. These quantitative data were complemented by qualitative data on direction, speed, altitude and wing-beat pattern of single migrants and on upper winds: we tracked about 15o birds and 2 to 3 pilot balloons per night.

Most of the studies have been supported by the Swiss National Foundation or by the Dr. Fritz Hoffmann-La Roche Foundation. The tracking radar was made available to us by the Firm Contraves AG, Zurich, and by the Swiss Army.

3. Altitudinal distribution of bird migration

a) in the Swiss lowlands

The average height distribution shows highest concentrations of birds at levels below 500 m AGL (about 60% of day migrants and about 40% of night migrants). The bird density decreases with altitude. 90% of the birds fly below the limit of 2000 m AGL. Besides the slightly higher median of night migration and the tendency of the lowest birds to fly farther off the ground at night, the adaptation of flight levels to environmental conditions seems to be similar in day and night migration.

In disturbed weather the altitude of migration decreases. Close to a pronounced frontal system, nearly all birds may be concentrated within the lowest 500 m, especially when bad weather is combined with opposed winds.

In fine weather flight levels are generally higher than in the mean distribution. Highest densities of birds may be found at levels up to 2500 m AGL. The optimal flight levels are primarily determined by the distribution of winds: During the first hours of the night birds seem to search favorable flight levels. During the following part of the night they concentrate at altitudes with strongest tailwinds or weakest side- or headwind components.

b) in the Alps

In fine weather the upper limit of migration reaches 5500 m ASL, while the main mass of migration passes at or slightly above the mean level of the Alpine ridges (about 3000 m ASL). Under tailwind conditions even at a pass at 2000 m ASL the visible part of migration may be negligible.

In disturbed weather and opposed winds, migration is concentrated in valleys and passes. At an observatory in the western part of the Swiss Alps the number of birds passing per day may reach half a Million.

c) open questions

There are indications that larger birds prefer higher flight levels. We hope to get information to this problem in the near future by the analysis of echo signatures.

4. Horizontal distribution of bird migration

It is often assumed that important leading-line effects are confined to diurnal migration and that, apart from the soaring birds (using updrafts along mountain ridges), inland guiding-lines are negligible compared to the effects of coast-lines. However, observations on immens concentrations of passerines at Alpine passes during day and night and new radar observations suggest that inland leading-lines have been under-estimated during the last years.

a) concentration of rooks along the Rhine valley and the Jura
Unpublished observations by Sutter with the 23 cm radar at Zurich airport show that rooks (Corvus frugilegus), probably migrating in a height band of 1ooo to 15oo m AGL had a strong tendency to follow the lowest parts of the landscape along the Rhine. Approaching Basel, where the Rhine turns northward, many of the flocks left the Rhine valley and crossed the low hills to the north of the Jura. They reached the first higher ridges of the Jura about 25 km SE of Basel, and followed again the lowest parts of the Jura-Highlands (basin of Delsberg).

b) local concentrations of small songbirds
It is difficult to judge whether the impressive masses of birds at an Alpine pass are primarily due to a vertical compression of the broad front migration above the Alps into the valleys, to a horizontal concentration of birds by local leading-lines, or by a large scale effect of the Alps.
Tracking radar studies in the Alps showed that leading-line effects may be very common also for passerines. Many of the night migrants, even when flying 1ooo m or more AGL, are prone to follow a valley, the slope or the top of a ridge, or even an artificial element like a funicular.
The possibility of leading-line effects on passerines in the lowlands has to be re-considered, using the new 1o cm surveillance radars at the Swiss airports. After the experience in the Alps it may be assumed that also in the lowlands pronounced topographical elements deviating at a small angle from the principal direction of migration cause concentrations of passerines.

c) large scale deviation of bird migration along the Alps
Surveillance and tracking radar studies in the Swiss lowlands showed that the principal direction of night migrants is in the order of 24o to 25o° in autumn and about 6o° in spring, regardless of visibility and flight level. In contrast to this finding the flight directions of night migrants to be expected from cage experiments and ringing results are in the order of 21o to 22o° in autumn and

about 3o° in spring. Thus, the densities of night migration in the Swiss low-lands may be somewhat higher in autumn and somewhat smaller in spring compared to the smoother landscape north and west of Switzerland. Further studies in collaboration with Germany and France are necessary to show, how far from the Alps their influence is still recognicable.

5. Measurements of bird numbers

a) parameters for the intensity of migration

The intensity of migration may be indicated as the frequency of birds passing a certain line perpendicular to the principal direction of migration. Adding all the frequencies found for the different altitudes we get the migration traffic rate (MTR = birds per km of front per hour). MTR depends on the ground speed of the birds and hence on the prevailing winds; it may be considered as a measure of the progress of migration during the night in question.

With respect to the bird strike problem it is more important to know the density of birds airborn above a certain surface or within a certain volume of air. In order to get figures comparable to MTR we calculate the volume of migration (VM = birds within an air column above a surface of 1 km in breadth and 5o km in length).

b) densities of nocturnal migration at 4 height bands under optimal meteorological conditions

height band km AGL	birds/5o km^2	spring average birds/km^3	spring fine weather birds/km^3	autumn average birds/km^3
o-1	225o	45	11	13o
1-2	18oo	16	45	5o
2-3	4oo	8	2o	25
3-4	1oo	2	5	6
total (= VM)	35oo	7o/km^2	8o/km^2	2oo/km^2

In the day-time the total number of birds may be similar, but they are not distributed uniformly throughout the air space; instead they are congregated in flocks. If we assume a mean flock size of 1o in spring, we get 1oo to 175 targets/5o km^2. In autumn the number of migrants may reach three times the spring numbers, but the number of flocks increases less, because of larger average flock size.

6. Variations of migratory activity from night to night

A comparison of the changes in MTR and VM from night to night with the corresponding synoptical weather maps indicates that in spring and autumn there is a tendency for highest intensities of migration to occur when a high-pressure area lies to the right and/or a low-pressure area lies to the left of the main vector of migration in the area considered. However, in Switzerland this general tendency seems to be somewhat concealed by deflecting or concentrating effects of the mountain ranges of the Jura and the Alps.

Our first trials with multiple regression analyses presented at the BSCE meeting in 1974 failed to support the general theory. In the mean time we tried to exclude possible sources of errors by: 1) taking as dependent variable only the movements in the main sector of migration (in autumn SW), 2) accounting for the seasonal change in the amount of migration, 3) improving the exclusion of insects, 4) introducing square terms for the independent variables, in order to get better approximations of non-linear relationships.

The preliminary results given in the Table below (based on 60 autumn nights) come closer to the general theory than the results of 1974: Positive correlation with tailwind and negative correlation with crosswind can be explained with respect to the synoptical situation, but the correlation with the square of the pressure trend is far from any explanation, and the low correlation coefficients are not very convincing.

DEPENDENT VARIABLE: Volume of SW-migration

	weather factor	simple r	r^2	multiple R	R^2	predicting value in final equation
step 1	tailwind 1 km)^2	0,50	0,25	0,50	0,25	36%
step 2	pressure trend ^{2}	-0,25	0,06	0,61	0,36	23%
step 3	crosswind surface	-0,05	0,00	0,65	0,42	14%
step 4	date	-0,31	0,10	0,69	0,47	14%
step 5	crosswind 1 km)^2	-0,13	0,02	0,73	0,52	13%

regression equation:

$$VM = 0{,}62 \cdot tailwind^2\ (1\ km) - 0{,}39 \cdot pressure\ trend^2 - 0{,}25 \cdot crosswind\ surface - 0{,}24 \cdot date - 0{,}23 \cdot crosswind^2\ (1\ km)$$

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BSCE 12

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Autumn radar study of the coastal migration in Western Holland.

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Royal Netherlands Air Force

Introduction.

Prevention of birdstrikes "en route" is only possible by avoiding those parts of the airspace in which the density of birds exceeds a certain level.
En route birdstrikes form 60% of damage-strikes in the RNLAF. Although the risk of fatalities is believed to be less than in collisions which occur on and near airfields, the economic loss due to "en route"-birdstrikes is, if we exclude the total crashes, much bigger.

For estimating the chance of collisions and for formulating flight restrictions we need knowledge about flight envelopes of both aircraft and birds.
The envelope of bird activity is very difficult to describe taking into account the many discrepancies between studies on bird movement patterns and also the differencies in reported relations to weather variables.
The main reason for the discrepancies are the different methods and tools used in birdmigration studies. The biggest sources of bias come from total sample size, mesh width and especially the differencies in detectability of all potential heightlevels at which the birds are able to fly under varying conditions. The last aspect was the motive for a rather detailed radarstudy carried out during autumn 1976 along the North Sea-coast of Holland. The collected data are still under analysis and only some first (preliminary) impressions can be given. But the problem and the chosen setup of the study may be of interest to you.

The problem.

For better understanding of the variation of ideas and approaches to the problem first some historical remarks.
The earliest bird migration studies were visual ones. Difficulties to organise an extended fieldobserversnetwork and to overcome variation in observationquality hinders the getting of a good overall picture. But slowly it was discovered that higher flying birds did not always fit into the described visible migration patterns. Thanks to ringing data the visual impression more and more began to lose its place of importance. The old models could not solve the newly raised questions satisfactorily.
The use of search radars for birdmigration research resulted in a big step forward. The fortunated ornithologists, who got the chance to use radar, made lots of radarfilms.

-They sometimes -

They sometimes produced long descriptions and built new models sometimes strongly contrasting with the ones of researchers not using radar. But, in spite of much new data, the whole picture did not become clear. Nowadays, after a period of nearly 20 years radarwork we still have to conclude that many already published results should be partly reanalysed.

It becomes clear more and more that in many studies the registration methods was not studied or described critically enough and, as a result, we do not know what part of the migration was detected, and thus what bias is included in the results.
As far as height levels of bird flights are concerned one have to conclude that in general long range surveillance radars will miss the lowest flightlevel. On the other hand most visual studies did not look high enough. Depending on the situation (important variables being flatness of the country, capabilities, programming of the radars and also fieldobservers) sometimes a certain overlap between visual and radar approach could be reached but even if both registration methods were more than complementary, they never were comparable quantatively.

Turning back to the birdstrike problem: in several countries ad-hoc radar warnings are in use for "en route" birdstrike prevention. On average this means that the measurements mainly sample the high birdmigration. In many cases this high level migration also will be very strong and because of the aircraft-flight-envelope very dangerous. But it is not sure that on other days, on which the radar gives no or weak movements, no strong low level migration are occurring. This could be the reason for birdstrikes in very low level fighter training outside the detected peakmigration days.
In very flat countries the radar will be able to pick up more of the lowest migration than in hilly areas. The relations between actual birdstrikes (if the aircraft were not highly restricted to less dangerous areas and height levels) and measured migration by radar then will be present. This was shown rather convincingly in Holland and Denmark.
But if weather conditions influence heightlevel choice of migrating birds strongly, then the comparison of weather factors and the total number of migrants (that is the birds of all heights added up thanks to the use of search radars) will become difficult, even impossible.

For both "ad hoc" birdmigration warnings and (especially) the establishment of forecast systems more quantitative data are needed.

This does not mean that the ways of monitoring have to be altered, but the outcome has to be reinterpreted.

Two questions were stated in the Dutch study:

1) What are the differences in altitude choice under varying conditions, especially in relation to winds?

2) What is the influence of the coastline (and the difficulties to cross the North Sea) on the spacial and directional aspects of migration. Especially the forming of concentrations is important.

The set-up of the study and some preliminary results will be shown with help of slides.

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28 Octobre 1977

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SURVEYS OF BIRD CONCENTRATION AREAS AS A TOOL IN AVIATION SAFETY WORK - WITH AN EXAMPLE FROM SWEDEN

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SURVEYS OF BIRD CONCENTRATION AREAS AS A TOOL IN AVIATION SAFETY WORK – WITH AN EXAMPLE FROM SWEDEN

If given the choice, any pilot would prefer to fly his aircraft through areas with a low number of birds in order to diminish the risk of bird collisions.

To facilitate such a choice great efforts have been made to map bird concentration areas. The bird density, when measured on a country-wide basis, varies considerably; consequently, what is meant by a "concentration area" must vary too. Accordingly, an area with a certain number of birds may be considered a "concentration area" in one region but not in another. This circumstance makes it difficult to lay down international rules for what, by definition, should be meant by a bird concentration area.

Scientific and practical problems

Different "standards" have been used when collecting and furnishing data on where high bird concentrations are to be expected. In this context I will restrict the discussion to concentrations of resident birds, thus excluding different methods of forecasting or measuring the intensity of birds on migration. Furthermore, since Blokpoel (1976) has reviewed the situation up to about 1974, I will concentrate the present discussion to the work done since then.

We know that many bird species occur in large flocks and that many birds congregate at certain places (often considered as good bird localities), either for the reason that they are especially rich in food or are suitable as breeding places for colonial nesters or as roosting areas for social species. Such sites are typical concentration areas. But before distributing information about these areas, e.g. on maps, the following questions must be considered.

1. How many birds have to be present in a defined area to be considered a "concentration" and how shall birds of different size and behaviour be judged from the flight safety point of view?

2. How is an "area" to be delimited? Is it, for example, possible to set up limits for a minimum number of birds per unit (area or volume), or is it enough to define "area" in the subjective manner used by ornithologists?

3. For how long have the birds to use a "concentration area"? An example: It is known that geese usually rest at a suitable feeding site for a period of about five days during their migration, which takes place within the course of a month. Is that enough to justify the decision to regard this area as hazardous for low flying aircraft during the whole month?

4. Some aggregations of birds, e.g. roosting assemblages, only exist for part of the day. Shall such daily patterns be included in the information given?

5. At what accuracy level is the information most suitable for the user? It is obvious that the information may be too detailed, but, of course, also too rough to be useful. Furthermore, it is very likely that the demands differ depending on the user; for instance, different requirements as to exactness can be expected in military and in civil aviation.

Attempts to construct standards for bird concentration maps

For many years it has been on the working agenda of the international cooperation on bird hazards to aircraft (especially within Bird Strike Committee Europe, Bird Movement Working Group), to produce standardized bird concentration maps. There has, however, been great difficulties to come to an agreement on the answers to many of the questions raised above. How to define "concentration" was for many years left to the individual countries to decide, and this of course made it hard to compare and coordinate the results.

At a meeting with the BSCE Bird Movement Working Group in December 1974 criteria for drawing up "Birdstrike Risk Maps" were agreed upon. It is worth noting that a new term is introduced here, as we are no longer discussing "concentration areas/sites" but "risk maps", which means maps indicating the risk (roughly equivalent to the bird density) of bird strikes. The criteria are presented in the following table (from Heirman 1975).

Total number of birds/1000 km^2			Bird category*		
Heavy risk	moderate risk	light risk	A	B	C
> 100 000	> 60 000	> 60 000	+	+	+
or > 50 000	or > 30 000	or < 30 000		+	+
or > 25 000	or > 15 000	or < 15 000			+

*A: 80-260 g, B: 261-1000 g, and C: > 1000 g.

In a paper given at the BSCE meeting in Stockholm 1975, Heirman (1975) presented an attempt to draw up bird risk maps for Belgium, based on these criteria. Several problems arose: The number of homing pigeons in Belgium was larger than the total estimated number of breeding birds (larger than 80 g); the season with the highest number of birds present differed in different parts of the country; if the homing pigeons were included about 80 % of the Belgian territory should be considered having "heavy risk" (during the whole year).

These serious drawbacks of the proposed rules for the preparation of bird risk maps was also pointed out by Holm-Joensen (1975). When he applied them to Denmark, it appeared that the whole country including most of the surrounding waters should be considered having a high bird strike risk. It is obvious that such coarse information is of little value. Furthermore, it ought to be stressed that information on the density of different birds in different areas is not available for most countries in Europe. Two other serious objections against the proposed methods may be raised, namely that they do not take into account the seasonal fluctuations in bird numbers, which makes the situation look worse than it really is, and that this type of maps does not tell the reader where the really black spots are.

Work on concentration maps in Sweden

The following requirements were set up as a general goal for the work on making bird concentration maps for Sweden: The maps shall give information on where and when concentrations of birds may be expected (birds on migration excluded). The information shall be designed to suit military as well as civilian purposes. The following restrictions were then introduced:

1. "Area" is subjectively defined in the way that most ornithologists define a bird "site". This implies that the area can be clearly defined on a large-scale map. On this definition breeding colonies of gulls and auks, roosting sites for jackdaws and gulls, feeding points such as garbage dumps and roosting/wintering areas for water birds are included.
2. An area should only be taken into consideration if it contains at least 1 000 large birds or at least 10 000 small birds for at least a fortnight. The difference between large and small birds was set at 100 g.
3. Information should be given on which time of the year and of the day the birds are present in the area. Approximate number of birds involved should be given.
4. Relevant information of the behaviour of the birds at a given locality should be given in the text accompanying the maps.

Apart from published data, the bulk of information has been provided by local or regional ornithological societies in answer to an inquiry. The knowledge about the occurrence of birds in most parts of Sweden is good enough to fulfil the demands for accuracy necessary for the present purpose. One easily recognized weakness of course is that there are yearly and seasonal changes in the birds' abundance, and this implies the necessity of keeping the information up to date by regular revisions of the maps.

With the described limitations, about 200 areas in Sweden have been recognized as concentration areas. Most of these areas of course are located in the southern part of the country. As a first step the concentration areas will be presented on large-scale maps (1:500 000), accompanied by written information about the time periods, the number of birds, the species involved and some comments on the behaviour of the birds. The information given on the maps is intended to be used directly for different purposes in the planning of military flying and to be converted into maps suitable for presentation in civil AIP.

One example of how the maps will look is given in Figure 1, showing the island of Gotland in the Baltic. This island measures 3 000 km^2 and is rather rich in birds during large parts of the year. An overview map of each area will include the whole year, but special maps for different time periods of the year can be extracted, see Figure 2 for an example. Each map is accompanied by comments as mentioned above.

References

Blokpoel, H. 1976. Bird Hazards to Aircraft.

Heirman, J. 1975. A Belgian Birdstrike Risk Map based on numbers of birds to the unit of area. (Proceedings) 10th meeting Bird Strik Committee Europe. Stockholm 1975.

Joensen, A.H. 1975. European Bird Hazard Map (Denmark). (Proceedings) 10th meeting Bird Strike Committee Europe. Stockholm 1975.

28 Octobre 1977

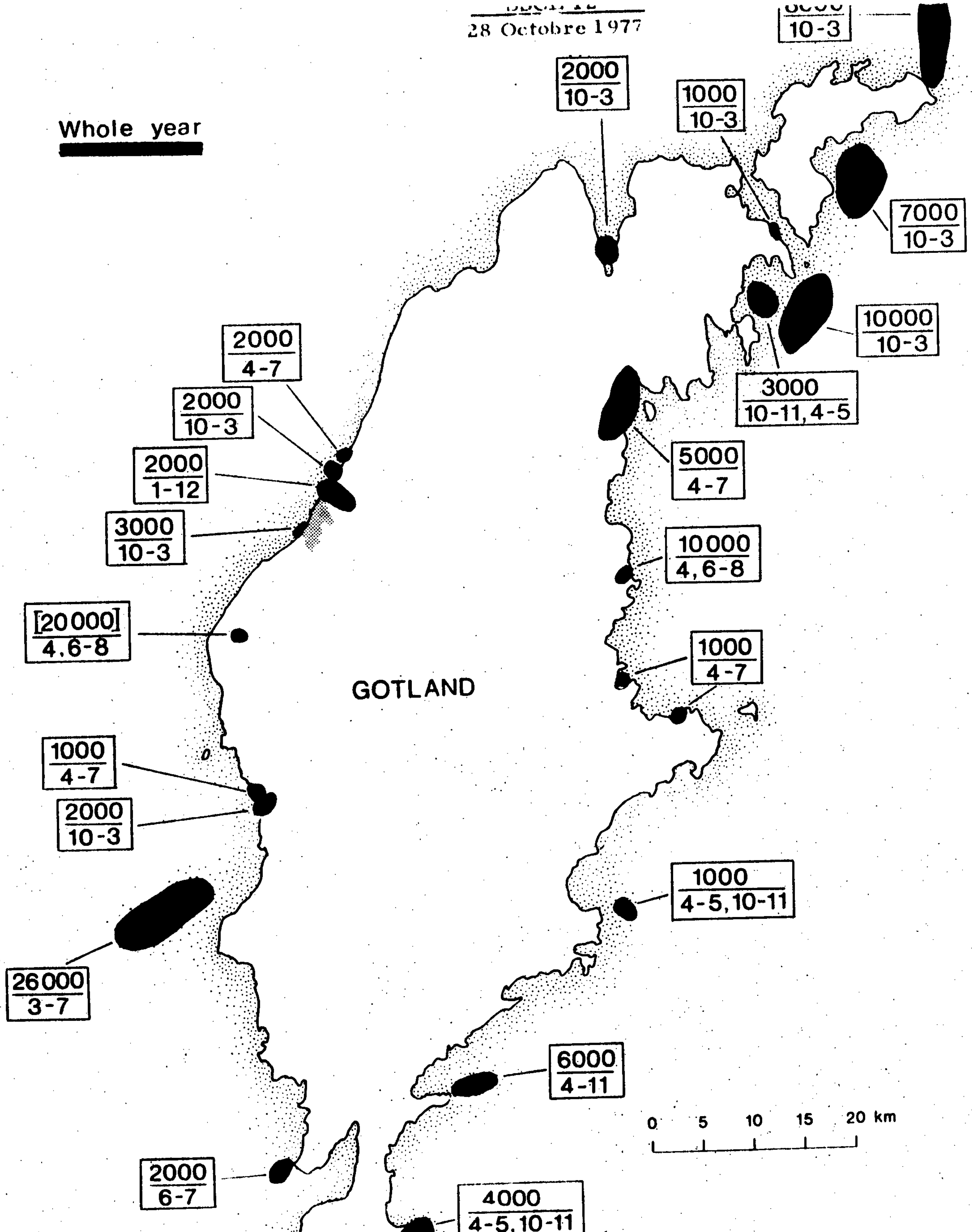

Figure 1. Bird concentration areas on the island of Gotland, Sweden. Upper figure gives the number of birds and the lower the time period (months numbered from 1 to 12).

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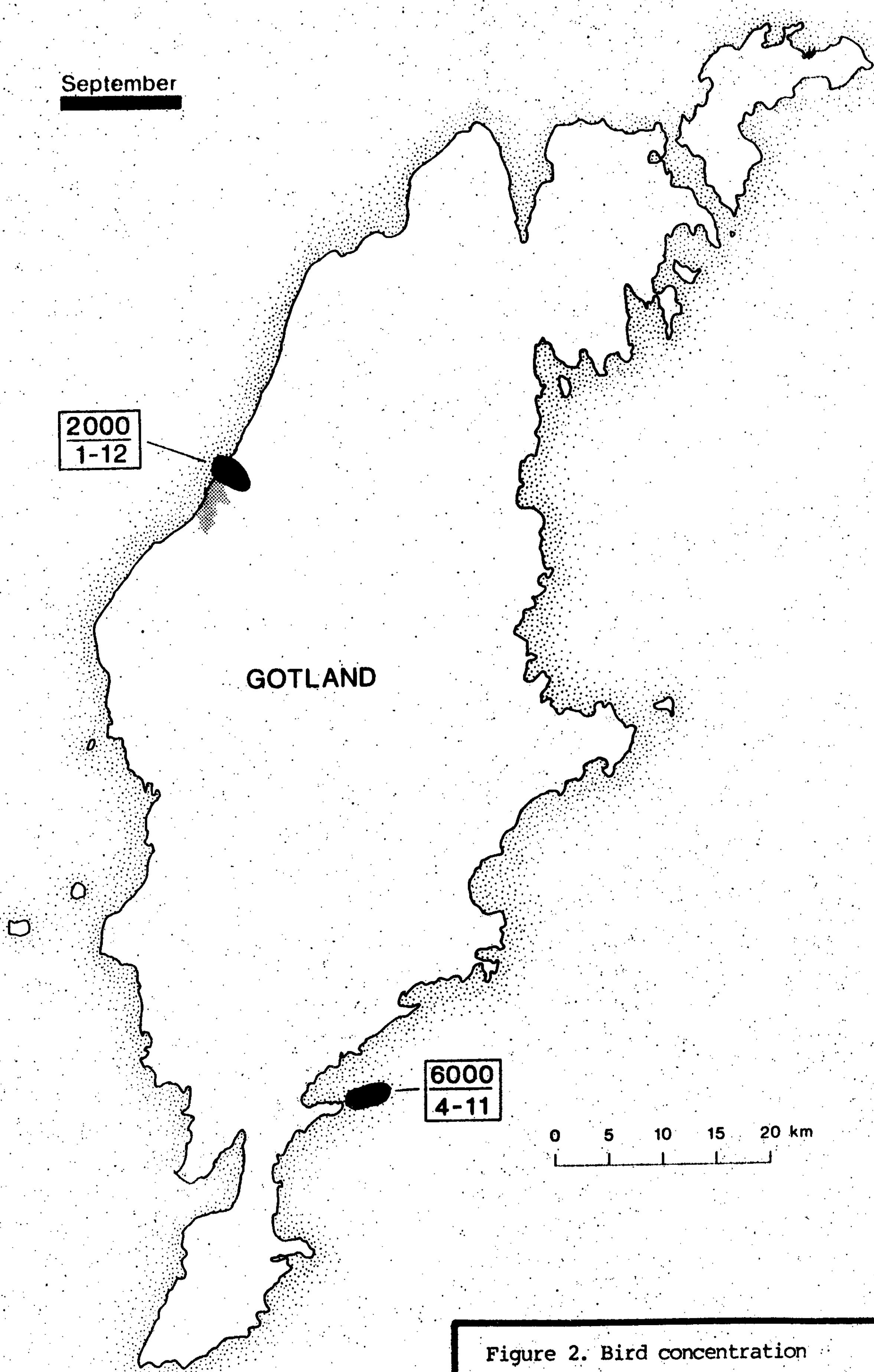

Figure 2. Bird concentration areas in September on the island of Gotland, Sweden. Explanation as in Figure 1.

BIRD STRIKE PROBLEMS AT BEN-GURION INTERNATIONAL AIRPORT, LOD - ISRAEL.

by Sh. Suaretz, Israel.

There were not many bird strikes at Ben-Gurion airport, but from time to time there was an incident, usually when a bird was sucked into a jet engine during landing or take-off. Of four cases when remains of birds were found, three were of partridges which proves that not only the gulls (Larus ridibundus), which are here in winter only, are a potential danger but mainly the partridges which are present throughout the year, and of course also some other species of birds.

Unfortunately, the airport management agreed to employ only one of our people to operate the measures against bird strike, and for a limited period of 3-4 months only, as they believed that only the gulls are dangerous, whereas I insisted time and again that it is necessary to employ a man all the year round.

Therefore I cannot present to-day any new proposals or ideas for the prevention of bird strike, as our work was confined to the day-to-day operation of the usual preventive measures such as gas-cannons, distress calls, models etc. and was mainly based on experiences abroad with little opportunity to develop new methods suitable to our local conditions.

At the same time trials with the bird repellent "Reta" were continued, not only with "Reta" alone but also combined with the other above mentioned measures so as to employ every possible means to avoid accidents altogether or at least to reduce the risk of damage. Unfortunately, so far the results are not conclusive, and we cannot yet say definitely that it is worthwhile to use this repellent. Based on our limited experience I have come to the conclusion that there are species of birds which - under certain conditions - are more affected than others, but in many cases the effectiveness depends very much upon the availability of a suitable and convenient alternative for the birds with regard to food, roosting etc.

As the spraying with "Reta" was partly done without the supervision and control by a biologist and a great part of the treatment was only studied by the suppliers, I have some doubts as to the reliability of the results. With all due respect for their know-how, we have to remember that their commercial interests are involved. My policy in this respect was to encourage their work in every way but to keep an open mind and draw may own conclusions. As a matter of fact, I know only of one case of reliable and significant success:- On the 19th February 1976 after several treatments and sprayings with "Reta" on the municipal garbage dump of Yahoud which is near one of the main runways of the airport (26-08) we employed all the different deterrent methods at our disposal and succeeded within an hour to get rid of about 200 gulls (Larus ridibundus) which had settled on the garbage dump. I am sure that the strong effect was due to the combination of all measures, "Reta", gas-cannons, distress calls and shot-guns. There is no doubt, however, that the proximity of the huge garbage dump of Hirya at a distance of about three kilometres from the airport provided a convenient alternative, and the gulls which were driven away probably joined the thousands of gulls there. We have to ask ourselves:-

(1) Would we have achieved the same effect without this alternative?
(2) Would we have achieved the same effect with "Reta" alone?

These questions will have to be checked properly.

As I pointed out, so far our possibilities in this respect were limited, but I hope that we shall be able to do so in the near future.

The experience in many countries has shown that the cheapest and easiest way to reduce the possible dangers of bird strike is to remove the sources of food for the birds from the vicinity of the airport. Unfortunately, the people who fix the budgets are not easily convinced and, therefore, plans are either not executed at all or postponed, at great expense in terms of risk and damage and also in cost of the measures necessary to avoid these dangers.

Thanks to a budget for research on this subject which we have now obtained for the first time, we shall try - within the framework of the Nature Reserves Authority - to solve our special problems, in addition to our regular work at the airport. One of the subjects will be to study the effectiveness and reliability of the bird repellent "Reta" on different species of birds and, of course, at different seasons under the special conditions of the area.

In addition we shall look into the possibility to find or to develop suitable sources of food which will attract the birds and draw them away from the area of the airport, thus contributing to the success of our operations.

I hope that at the next meeting I shall be able to present a summary of our work with definite conclusions which will help us to achieve our most important aim:-

To avoid accidents and damage.

Shalom Suaretz

Chief Ornithologist,
Nature Reserves Authority.

BSCE 12
28 Octobre 1977

ADF 616165

Plane as a deterrent and attractant

V.E. Jacoby, USSR.

At present time one can speak about new direction in ornithological researches, that is - about the aviation ornithology. Its basis is formed by researches of bird behaviour on airports and at the sight of a plane; control of bird behaviour under these conditions; birds detection and forecasting of their behaviour and possibilities of mass birds accumulations on plane flight routes. The main aim of these researches and measures is - to decrease the bird strikes number and to lessen the bird danger for planes.

As it was well said by one of the aviation ornithology experts - it is necessary to keep birds far from planes at airports and to keep planes far from birds on plane's routes. In accordance with all this the evolution of aviation ornithology researches can be traced back after an example of the international conferences on bird danger in Nice (1963), Kingstone (Canada 1969) and of the BSCE meetings. The first World Conference - Colloquium in Nice - was named "Birds at airports". It discussed problem - how to keep birds away of planes at airports. The series of questions discussed at Kingstone Conference was extended considerably. Besides the purely technical questions of bird's airworthines, the series of reports was devoted to bird detection with help of radars and to forecasting the appearance of mass bird's accumulations on plane's routes in order to prevent strikes. For the first time the Kingstone Conference examined in Tanner's report quite new on principle possibilities to frighten birds away of flying plane with help of micro-wave radiation. The further researches, however, have shown that utilization of this way to frighten birds away of, flying plane is unpracticable. I know an attempt to frighten birds in this way at runway. However, other means of scaring away at airports are more profitable.

During last years the scientists are paying ever growing attention to the quite new aspect of bird strikes prevention: the intensification of plane's effect on birds as a deterrent. It is implied naturally that birds are not suicides and they try to fly away of plane fast flying against them.

I think I will not commit any mistake if I say that majority of bird's world population have already seen a plane flying in sky and it represents an indifferent irritant for them. However, when a plane flies against a bird - only fast upward flight and flying away can save the life of a bird. The analysis has shown that more often as a victism of strike become the birds who see for the first time a plane flying at close distance; migrating young birds who appeared at an airport for the first time and who don't know how to extrapolate the direction and very high speed of a plane. Adult, local nesting birds and the birds settled at airports learn fast to take off and to avoid in time a strike with a plane by: 1. Seeing other birds knocked down by planes. 2. Being thrown off by plane's air wave. 3. Following upward flight of the other more experienced birds. In this case the plane is a typical deterrent. Some of these trained birds turn in time away of the plane flying out of an airport, too. However there are some situations when a bird cannot extrapolate the speed and direction of the plane, flying against, because she doesn't see it in darkness or the plane appears suddenly nearly from a cloud. In these cases there can arise panic reaction, which increases the possibility of a strike. Finally the possibility of a strike is increasing also when a plane changes sharply its flight direction: when taking - off or making contact. 25% of all bird strikes within the airport's area occure just in these two points. Night flights of the turboprop planes form 10% of the day flights, while the number of strikes in the night forms, according to our data, almost a half - for TU-104 and TU-124, 90% - for TU-134 and two times more than during the daytime - for TU-114 plane.

The illumination of the front part of a plane in the night (Larkin, Torre-Bueno, Griffin, Wallkott, 1975) the utilization of various winking flashes of white, blue and other colours at a plane (Belton, 1976), scanning of lazer ray (Laty, 1976) are increasing the distance from which a bird can detect a plane in the night as well as deterrent characteristics of a plane. I consider these works as extremely perspective since we can suppose that a bird has more possibilities to see plane and to turn away than a pilot of fast flying plane to see birds on plane's way and to turn aside in time.

In the night the pilot can not see birds at all. The visual observations of bird migrations against a moon discuss background as well as radar observations (Bruderer, 1971) have shown that the majority of night migrants fly one by one. This first of all increases the probability of the night strike with one bird from a tremendous friable flock, in which the distance between individual birds amounts to 300-500 metres (Bruderer, 1971) and secondly only powerfulground radar can discover individual birds and all flight in order to warn pilot about such a danger. At plane's radar these birds cannot be seen by a pilot. This stresses one again the necessity of researches to increase the deterrent characteristics of a plane. It is necessary to keep in mind that in the series of cases the plane can act as a attractant. First of all this is a motionless standing plane. I have observed sparrows to begin to inspect 4-motors plane which just stopped at airport; they apparently have found plant seeds in plane's hatches and holows. In the winter a pigeon climbed to warm himself on the carburator's net airintake of the AN-2 plane. In the southern districts of the country starlings construct their nests in the cavities of wings of the AN-2 plane. And they even start to lay eggs. Swallows following the plane moving on runway have caught insects in the whirlwinds of warm air. In one case a turtle-dove has made her nest from pieces of soft wire behind propeller and in front of the airintake of the IL-18 plane. The plane has been standing for repair during several days. Setting the engine into operation after repair could end with getting of iron nest into engine and consequently with serious damage. Birds are attracted by moving planes, too. The hen-harrier has flown along the run-way and has caught the locust insects and possibly mouse-like rodents frightened out by whirl-winds of planes sweeping past runway. In these cases a plane instead of being a deterrent or an indifferent stimulus (when a bird sees it high in the sky) becomes an attractant thanks to positive confirmation by food, nesting and so on.

Judjing from pilots information the aggressive reaction of birds of prey against a plane is possible. The Buzzards have attacked flying motorless plane models. Golden eagles have attacked gliders in mountains. One of the possible reasons for such an attraction is the attack of bird of prey against a prey. And glider's pilots were provided with pistols to repulse the eagle's attack.

The experiments have shown that young hawks are attacking disproportionate big prey. Judjing from the time of attacks of birds of prey against gliders - these were young birds who committed attack by mistake.

And finally one more kind of bird attraction to a plane is the light of landing lights in the night. It was meant that the light of the landing lights increased deterrent characteristicts of a plane. As a result in some countries one recommended to switch on the landing lights beforehand at 3000 m altitude. So long as this recommendation has practical importance. I shall dwell on it in details. At present time there are many researches which show that in particularly dark nights the number of birds being hurt badly against lamp glasses of a beacon comes to maximum. In India hunting gives maximum of results when birds are attracted by lamp light just in dark nights. From the other part the illumination of all beacon building decreases considerably the number of birs being hurt badly.

From this point of view there is of interest to consider series of cases of bird strikes when birds most probably were attracted by landing-lights. This first of all relates to bird's getting into litten landing-lights of the TU-planes. The head lights of these planes move out of the case only when they are switched on. The area of section of two landing-lights makes less than 1% of the fron part of a plane. Correspondingly the getting of birds into landing-lights under even distribution of hitting over the front part should amount to 1% of the night strikes. If one take into consideration that during the flight the landing-lights are switched on for a short time only, directly before landing - the possibility of bird getting into landing-lights comes to minimum. In fact the getting of birds into litten landing-lights and their damage have happened in 8 cases from 53 known night bird strikes with TU-planes. This points clearly that the light of landing -lights attracts birds and they fly towards the light as towards the beacon light. However it is much easier for a bird to fly towards beacon light than towards fast flying plane. Therefore the percentage of getting into landing-lights mentioned above, is startlingly high. In some cases pilots had firstly seen a bird in the light of landing-lights and only after the strike occured. The birds got not only into landing-lights but also into front part of the fuselage, in cockpit glasses, wing surface and engine's airintake. In such a way the light of planes landing-lights attracts birds, increasing thereby the possibility of their strike with a plane. Therefore the landing-lights of a plane should be switched on not beforehand at the high attitude, but only when coming to the last straight directly before landing. This doesn't reject illumination of a plane as a means to increase its deterrent characteristics ny analogy with the illumination of a beacon which decreases the number of birds perished there.

B. [signature]

BIRD STRIKE COMMITTEE EUROPE

Paper Sent to Members prior to twelfth Meeting.

Terms of Reference of the Committee, and Editing Committee, Work Programmes of Working Groups, and Guildelines for the Preparation of Working Papers.

V.E. Ferry - France, Chairman BSCE.

This Paper is not printed here, the Terms of Reference are printed as Section 7 of this Report.

BIRD STRIKE COMMITTEE EUROPE

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Board of Civil Aviation
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N/Ref. BSCE/VC/080577

Norrköping, 10 August 1977

To Lecturers at the combined World/BSCE-conference on birdhazards to aircraft in Paris, October 1977.

Subject: Information about papers and the presentation of papers at the World/BSCE-conference.

Dear Sir,

As you know from a recent BSCE-letter to all members of BSCE and to ICAO memberstates, no less than 45 papers are announced to BSCE for presentation at the combined World/BSCE-conference in Paris, 19-28 October 1977. Both ICAO and BSCE are very pleased for the fact that such a great interest has been shown to the purpose of the planned meeting.

In order to make possible the presentation at the meeting of so many papers it has been found necessary to divide the material into three groups: papers to be presented at the world wide part of the conference, at the BSCE-part of it and at the BSCE working groups. The principles for such a division are stated at page 2 of letter BSCE/VC/072977. You will receive the result of the definite division around 1 October.

Also after a suitable division of the material of papers it will be necessary to take certain measures so that all lecturers will have available appropriate space of time for their respective presentations. BSCE wants to give you here som recommendations, the aim of which is to facilitate and make more stringent the presentation of papers:

1. Reading of the full text of papers should be avoided.
2. Try to direct the attention of the audience to the most important parts of the paper. This can be done easier by the aid of available facilities (projectors for overhead pictures and slides etz).
3. Try to cover the essential part of your paper in 15 minutes or less (if you have an absolute need of more time you can get another 5-10 minutes).

It might also be mentioned, once again, that there will not be any special discussion following each lecture. Instead the intention is that a wider discussion will be able to realize after the end of all lectures belonging to a whole session. In order to make discussions as valuable as possible a so called "Moderator" for each session will have the task to manage the discussion in a way that all important questions will be treated in an efficient and instructive way.

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A special course for "Moderators" will be given by the ICAO regional office in Paris by the end of September.

In order to help you to write your paper in a way that makes it as easy to read as possible some guidelines for the preparation of working papers to a conference are attached to this letter as appendix 1. The guidelines are worked out by ICAO and distributed on 21 September 1976 to all members of all ICAO Technical Committees and Panels.

Only a few of you have so far submitted your papers to BSCE and rather many have not yet sent in abstracts. May I therefore, on behalf ot the chairman of BSCE, urge you to provide papers as soon as possible and definitely not later than 20 September. BSCE Editing Committee needs material about all lectures to be given at the conference in order to place them in correct group according to the division mentioned in the beginning of this letter.

Yours faithfully,

Lars-Olof Juresson

Lars-Olof Juresson
For the chairman BSCE

GUIDELINES FOR THE PREPARATION OF WORKING PAPERS

1. General

The success of a meeting is closely related to the quality of documentation with which it is provided.

To be of maximum service to the meeting, documentation must meet two seemingly conflicting criteria:

a) each agenda item and each individual problem related thereto needs to be supported by adequate documentation; and

b) the sum total* of the documentation needs to be kept within limits that will enable delegates readily to give the time and effort necessary for its understanding.

To overcome this apparent conflict Members/Observers, when submitting documentation on the agenda items, are requested to make each contribution as concise as is compatible with a clear exposition of the matter being presented. It is suggested that when the documentation contains proposals for action, such proposals should appear as the first element of the paper and should be followed by a statement of the purpose of the proposal. If the views presented in any documentation are supported by background information (for exemple, evidence gained by experience, trial applications, etc.), the reduction of such material to basic essentials may well strengthen rather than weaken the force of the documentation.

2. Style of Writing

In the interests of accurate communication, it is recommended that Working Papers be expressed in simple direct language with avoidance, as far as possible, of jargon and unfamiliar technical* terms and acronyms unless these are effectively explained, one way or another, in the text. Authors of papers may find it helpful to bear in mind that:

a) Working papers have a fairly wide circulation, which includes many persons without specialized technical qualifications;

b) even amongst technical personnel, the papers are read by many in a language which is not their native tongue; and

c) each paper submitted should be capable of accurate translation into other working languages of ICAO.

*Note: The word "technical" could equally well be replaced by "scientific", "economic", "sociological" or any othe adjective referring to a specialized field of study.

3. Development of Proposals for Action

Wherever possible, it is desirable that a Working Paper include, either at the beginning or end, a definite proposal for action by the Committee/Panel. This not only gives the meeting a firm point at which to direct discussion, but also provides some wording that the meeting may be able to adopt, or adapt, as the text of its own decision without having to engage in the time-consuming process of detailed drafting. Incidentally, judging from personal experience, the discipline of developing a concisely worded proposal can provide a useful exercise in thought clarification for the author himself.

4. Length of Working Papers - Provision of a Summary

The advantages of conciseness and brevity have already been mentioned in paragraph 1 above. At the same time, there may be cases in which fairly lengthy papers are appropriate and unavoidable - for instance, reports submitted by Working Groups or by Members who have been allotted special tasks. Even here, it is suggested that the basic paper be kept reasonably concise, with background information, detailed data, etz being placed in separate attachments where possible. In the case of any paper exceeding four to five pages in length, it is requested that the author also provide a summary comprising not more than one page.

5. Diagrams, Tables, etz - Translated Texts

To facilitate rapid processing of Working Papers by ICAO, authors are requested to ensure that the material forwarded to the Secretary (and particularly all diagrams, tables of figures, etz) be in clear and legible form suitable for reproduction without the need for re-drawing or re-typing. Where translation of texts are available in one or more of the other working languages of ICAO, copies of such translations would also be appreciated.

- END -

SECTION 7

Terms of Reference

7.1 Terms of Reference of the BSCE (Reproduced from Working Paper No. 1)

7.2 Terms of Reference of the Editing Committee (Working Paper No. 1)

7.3 Terms of Reference of Vice Chairman

Terms of Reference of the B.S.C.E.

The Bird Strike Committee Europe

shall :

a) collect, analyse and circulate to all concerned data and information related to the bird strike problem in the European Region ;

Note : This data and information should include the following :

1. Civil and or military data collections and results of analyses on bird strikes to aircraft.
2. Results of any studies or examinations undertaken by States in the various fields related to the bird problem.
3. Any information available in the field of design and structural testing of airframes related to their resistance to birdstrikes.
4. Any other information having a bearing on the bird strike question and the adding to the solution of the various problems involved.

b) study and develop methods to control the presence of birds on and near aerodromes ;

c) investigate electro-magnetic wave sensing methods (e.g. : radar, invisible light, etc) for observing bird movements ;

d) develop procedures for the timely warning of pilots concerned where the existance of a bird hazard has positively been established ;

e) develop procedures, if appropriate, for the initiation by air traffic control of avoiding action where the existance of a bird hazard has positively been established ;

f) develop procedures enabling a quick and reliable exhange of messages regarding bird hazard warnings ;

g) develop any material (e.g. : maps, back-ground information, etc) intended for inclusion in Aeronautical Information Publications ;

h) aim at a uniform application, throughout the European Region, of the methods and procedures and the use of material developed in accordance with b) to g) above, provided suitable trials have proved their feasibility, and monitor developments in this respect".

Terms of Reference of the Editing Committee, B.S.C.E.

1. An Editing Committee is appointed as a policy steering committee to assist the Chairman of the B.S.C.E. between and during Meetings. The main tasks of the Editing Committee are :

   a) study, evaluate and select papers to be presented to the Working Groups and the Plenary Meeting

   b) during each B.S.C.E. Meeting participate in preparing recommendations, proposals for text for inclusion in the Report, and, where necessary, any other papers of a general nature.

   c) at the end of each B.S.C.E. Meeting participate in preparing the Report of the meeting and prepare the follow-up action of recommendations.

   d) assist the B.S.C.E. Chairman in formulating B.S.C.E. Policy Statements.

2. The Editing Committee should consist of :

   (i) The B.S.C.E. Chairman

   (ii) The previous B.S.C.E. Chairmen, if possible

   (iii) The Chairman of each B.S.C.E. Working Group

   (iv) The observer from ICAO

   (v) A representative of the host State.

3. The B.S.C.E. Chairman acts also as the chairman of this committee and is entitled to call meetings of the Editing Committee as and when required during B.S.C.E. Meetings.

4. The conclusions of the Editing Committee should be presented to the Plenary Meeting of the B.S.C.E. for action. Alternatively the members of the B.S.C.E. should be kept informed of the activity of the Editing Committee between full meetings of the B.S.C.E.

/DL

BSCE 12.7.3

Terms of Reference of Vice Chairman

Responsibilities of the Vice Chairman

1. To assist the Chairman to carry out the work of BSCE.

2. To take over the responsibilities of the Chairman in the event of the Chairman being unable to carry them out.

3. To represent BSCE when so designated by the Chairman.

Terms of Office

4. Vice Chairman is elected by the Committee for a 2 year period at a different time from the Chairman. More than two successive periods of Vice Chairmanship is not normally allowed

SECTION 8

REPORT OF THE MEETING by the Chairman of BSCE,
M. V.E. Ferry, France.

Introduction

Part 1 - Chairman's Report

Part 2 - Report on the 12th BSCE session

Part 3 - Conclusions resulting from Section 9 of the 12th Meeting Report

BSCE 12 - 8

15 January 1978

REPORT ON THE TWELFTH MEETING OF THE BSCE (PARIS 20-28 OCTOBER 1977)

1 INTRODUCTION

1.1 This report is composed of the following four parts:

a) The chairman's Report (Part 1)

b) The report on the work done inside Working Groups of BSCE (Part 2)

c) The conclusions resulting from b) (Part 3)

d) The conclusions resulting from 3rd World Conference on Bird Hazards to aircraft (Part 4).

1.2 The Chairman's Report, mentioned under a) above, contains a brief description of the proceedings of the Meeting, the organisational and administrative arrangements for the conduct of the Committee's business and for its future work.

1.3 The report on the work done inside working groups mentioned under b) above supplements and/or supersedes the previous reports on this subject. It consists of a summary of the points made during the discussion in BSCE WG's on the subjects considered during the 12th Meeting and as such it serves to support the conclusions reached and the Recommendations which have been agreed by that Meeting.

1.4 The conclusions resulting from this Report, as contained in its Part 3 were reviewed by the Committee during its 12th session, and amended slightly by the chairmen of WG's for editorial purposes. As a consequense of this, Part 3 is in fact superseding the draft circulated during the meeting, included in this report for information only (Section 1 of the Report refers).

1.5 The conclusions resulting from the 3rd World Conference on Bird Hazards to aircraft appear here because they have emerged from the lectures and discussions held either in WG or during session of BSCE and its Editing Committee. Although they do not represent a very different point of view, they appear to give a complete coverage of the steps to be achieved in order to have a relatively good control of the bird problems.

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PART 1

CHAIRMAN'S REPORT

1 GENERAL

1.1 The Twelfth Meeting of the BSCE and its Working Groups was held from 20 to 27 October (including 3 days for the world conference) at ICAO-Paris office in Neuilly . A list of participants with addressees is attached in Section 2, of the Report.

1.2 At the opening meeting, the meeting accepted the following agenda:

Item 1: Presentation of papers

2: Report of the work done by each Working Group

3: Review of the existing terms of reference of BSCE

4: Review of the existing terms of reference of Editing Committee

5: Review of the existing terms of reference of BSCE WG's

6: Review of the need for a Vice Chairman for each W.G.

7: Election of W.G's chairmen and vice chairmen where appropriate

8: Report from the Chairman

9: Election of BSCE Chairman

10: Establishment of new Working Group

11: Future work

12: Next meeting

13: Any other business

1.3 The meeting was chaired by Mr Ferry reelected for a one year period at the end of 11th meeting. (see 2.4.4 part 2 of the report 11th meeting.

The vice-chairman (L-O Turesson) diligently assisted the chairman and took over everytime it was felt necessary as the organization of the 3rd World Conference took some special attention.

1.4. Mr Attig of Inspection Génerale de l'Aviation Civile acted as Secretary and was in charge of the administration, typing, printing and social events.

2 COMMITTEE ARRANGEMENT

2.1 The Committee, at the end of the 11th meeting found it necessary to elect a Vice Chairman - see Section 8. Part 2, para 2.4 of the report of 11th meeting.

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2.2 The chairman ending his term at the 12th meeting, was elected for a further period of one year.

2.3 Each working group elected a vice chairman, and these elections have been approved by the committee.

3 PROCEEDINGS AT THE MEETING

3.1 Discussions on the objects considered by the Committee in accordance with the Agenda are reported in Section 8, Part 2, and the recommendations formulated as a result of these discussions are contained in Part 3.

4 WORK PROGRAMME UNTIL THE NEXT MEETING

4.1 At the end of this meeting, the Committee agreed on the following work programme until the next meeting:

4.1.1 Work to be done inside Working Groups

1) Work to be done inside Bird Movement Working Group:

i) check if Bird Hazard maps (BSCE/10 WP 30 page 2.3 referring to Annex 15, Appendix 1 and Doc 8126-AN/872/2 Appendix G pages AGA 0.2.1, RAC 6.1 and 6.4 (refer) are published by all State Members of BSCE.

ii) prepare a revised edition of bird concentration and movement maps already in use.

iii) study and prepare more specified airport surrounding maps where it is wanted and seems useful.

iv) organize an informal meeting with pilots in TRABEN - TRARBACH (Federal Republic of Germany) with the aim of collecting their views on the usefulness of existing maps.

2) Work to be done inside Communications Working Group:

i) circulate the following list of addresses for Birdtam circulation. Explore the possibility to forward these messages to Airline Operations rooms:

EDDYZQ, EDAAYO, EDEEYO, EDDZZO, EDDZYN, EGVCYO, EGZMMKK, EHMCYO, LFZZNH, LFYXYRSM, LIIAYN, LIJJYA, LIZZNA, EHZZNH, LXGBYN, EDANYO, EBWMYM, LEZZNE, EPWAYG, EHMRYX, EDZXYT, LTAAYN, ESDAYM, ESMMZP, ESGGZP, UUZZNK, EDNVYO, ESSAZP, EKMCYO, EBMIYO

ii) test of the circulation of NOTAM dealing with bird movement during Spring Migration 1978 under the procedure already used during 1974 and 1975.

iii) prepare a compilation of the already agreed practice (format of the message, code used, prefixes) to be published when possible with the final aim of becoming a part of Documentation published by ICAO.

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iv) Collect "Flight Procedures" already used for bird avoidance, and study their effectiveness taking full account of experiences gained by crews.

v) change the title of the working group to "Communications and Flight Procedures".

3) work to be done inside Aerodrome Working Group:

i) ensure that all information about bird dispersal devices in use in each state is available and prepare a summary giving the assessed efficiency.

ii) collect national regulations applying to garbage dumps and controllable bird movements.

iii) study and prepare a document to be used as a check list by airport managers on measures used and remarks made about them. This document will be based on WP24/BSCE11 (the Airport Manager's Brief), revised and extended.

4) work to be done inside Analysis Working Group:

i) continue the special analysis on strikes to engines, with an investigation oriented to the ability of intakes and engines to withstand birdstrikes with a liaison with AEA Technical Affairs Committee.

ii) study the effectiveness of the use of aircraft landing lights during daytime for scaring bird away from the aircraft flight path.

iii) arrange if agreed by a sufficient member of States for the UK CAA Computer Services Branch.

iv) continue the publication of the Serious Civil Incidents

v) explore the possibility to publish a special analysis on small turbine powered aircraft.

vi) produce a revised Analysis Form on Costs.

5) work to be done inside Radar Working Grop:

i) migration research covering: statistical analysis of improved data on weather and bird migration, comparison of densities and height distribution over land and sea, analyses of the movements of different species or groups of birds, analyses of bird movements along leading-lines, weather dependance of density, height and direction of migration.

ii) improvement of methods: 1) electronic counting, 2) calibration of different types of radar with respect to bird numbers and types of birds, 3) birds recognition by signature analysis, 4) means of quantifications in terms of height

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iii) application on 1) forecasts(longtime, day to day), 2) actual information to pilots, 3) echo signatures for the recognition of behavioural differences (e g different flight levels for birds of different sizes) 4) training of flight controllers in bird recognition.

6) work to be done inside <u>Structural Testing working group:</u>

i) arrange a meeting between the RAE and CEAT to discuss the results of their separate test programmes and correlation of methods of analysis.

ii) collect, analyse and group together methods of analysing the bird impact resistance of structures in order to draft a manual on "Design Guidance".

4.2.1 <u>Other Activities</u>

1) to continue studies aimed at the use of a warning network (combination of radar or visual observation on the spot, NOTAM code, communication system, interpreting centre, phraseology to be used by controllers) for aircraft in the vicinity of aerodromes.

2) to continue studies aimed at a uniform method of displaying permanent information in order to obtain a uniform coverage of Europe and its immediate vicinity.

3) to develop a common basic policy with other organisations in order to standardise BSCE methods (or improved methods) aiming at reducing the bird hazard whenever possible.

4) to continue studies on the actual cost of bird strikes and the cost effectiveness of the use of the aforesaid methods.

5) to establish and maintain close connection with Pilot's Associations in order to improve the efficiency of the information of the bird avoidance procedures.

4.2 <u>Work on the above subjects was assigned as follows:</u>

a) if not differently stated in the following, work on subjects listed on 4.1.1 from 1) to 6) is assigned to each WG's chairman.

b) the Chairman of the BSCE will take part in work assigned in para 4.1.1 under 1) i) 2) iii) 3) iii) 4iii) 6) ii), the work being undertaken primarily by the WG's chairmen (recommendations BSCE/10, D5, BSCE 11, Section 1 and BSCE 12 Section 1 refers).

5. ARRANGEMENTS FOR THE NEXT MEETING

5.1 The Committee did not develop a specific Agenda for its next meeting because this depends to a considerable degree, on the progress achieved by each working group on the work programme outlined in para 4 above.

5.2 It was however agreed, that for the time being, the following points retained for possible consideration at the end of 11th meeting should be explored.

a) tentative list for future meetings

b) preparation of a generally acceptable document regarding

i) a check list for airport managers when a problem dealing with bird activity appears on an aerodrome.

ii) the evaluation of the bird risk in large areas in terms of biomass

iii) the ability of a certain aircraft, parts of aircraft, and engines to withstand birdstrikes.

iv) guidance on Structural Testing of Airframes for eventual inclusion in the ICAO Airworthiness Technical Manual.

c) future organisation of BSCE (possibility of a permanent secretariat).

d) submission of reports for future BSCE meetings.

e) election of BSCE Chairman and vice-chairman

5.2 The Committee accepted that the various Working Groups would present to the Committee reasonably firm proposals on the subjects listed in 5.2 b) so that at its next meeting, the Committee would be able to make firm recommendations.

5.4 Regarding the subject of Working Group tasks it is accepted that

i) the report presented by the Working Group's Chairmen to the Committee will have three sections:

1) review of the work already completed and the recommendations from the previous Working Group.

2) progress report of the work done during the previous year

3) chairman's report on discussions, with recommendations reached.

ii) the Report will be available and circulated before the opening of the plenary session of each BSCE meeting.

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5.5 As to the venue for the next meeting of the Committee, it was noted that this problem will, in the future, be difficult to solve satisfactorily. The chairman proposed to publish a list showing, according to actual practice, the tentative programme for the next five years. As new countries are now fully participating. the list could be extended. For the time being Switzerland has started arrangements for a meeting at the end of May 1978. Denmark and Netherland will investigate if the meeting for 1979 can be arranged in either of these states. Belgium is planning for a meeting for 1980.

5.6 As proposed by ICAO, a third World Conference on bird strikes was arranged conjointly with BSCE annual meeting in order to provide first hand information to countries willing to participate in the establishment of a Regional Committee in other ICAO regions.

African (Uganda, Niger, Zaire,..) and some Asian states have shown a real interest.

5.7 A BSCE "Code of practice" is under preparation at the request of ECAC (European Civil Aviation Conference). Some chairmen of working groups have given contribution concerning their resp. sections of the work.

6 PRESS COVERAGE

"Air et Cosmos" gave publicity to the BSCE meeting. In its 12 November issue it gave a large coverage to the conference and its conclusions.

"The UK newspaper The Guardian of 29 October and subsequently of 30 December contained articles on the subject of bird strikes and quoted extracts and drawings from some of the papers presented at the Paris Conference".

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PART 2

REPORT ON THE BSCE TWELFTH ANNUAL SESSION

1 INTRODUCTION

1.1 The 12th report on the BSCE annual session relates to the work done inside Working Groups, which assembled at the same time, and by the Committee as a whole when dealing with its specific tasks.

1.2 As all papers presented during the session appear in Section 6 of the Report, this part will cover the following subjcts:

a analysis of work done by each Working Group

b review of the administrative problems

c review of actions to be performed following the recommendations

d special problems

2 DISCUSSIONS OF SUBJECTS RELATED TO THE BSCE

2.1 Before entering into the discussion of specific items mentioned under para 1.2 above, the Chairman felt that the tasks given to him each year, if properly dealt with, do not leave enough time to think about the future of the BSCE and act as a representative of the BSCE to International Organisations. This last work, deemed urgent, calls for frequent interviews in different located headquarters. The Editing Committee is now firmly established and provided guidance during the session. The routine was assured by the vice chairman who showed to be a fairly good assistant specially during the preparation of the World Conference. The team so constituted worked closely and efficiently.

The problems raised during the 11th Meeting have not been solved as the key of a better administrative structure and of the location of the next meeting seems to be closely connected with funds availability.

Although these matters have not direct influence on the work carried out during the session, it has been noted that they should be recorded in a proper way and be part of the Report. They appear under item b) under para 1.2 above.

2.2 Even though the Committee recognized that some shortcomings existed in its way to solve problems, it has been felt unnecessary to enter into too abrupt changes without having time to test the validity and the efficiency of the modifications. It was expected that, if still necessary, members would raise this matter again at the next suitable opportunity.

2.3 Reports on working groups, and special features related to them

2.3.1 These appear under Section 5 of the main Report and reflect the nature and specific tasks of each Group.

2.3.2 The vice chairman succeded in collecting all comments made by States or experts to Airport Services Manual, Part 3, Bird control and Reduction published by ICAO (Doc 9137 - AN 898). The comprehensive list of proposed amendments was sent to ICAO-Montreal on October 27.1977.

2.3.3 Attention of participants was drawned to a draft EEC directive on bird conservation. This document, if accepted, will affect the bird control techniques permitted on airfields. Because all aviation authorities were not aware of the implications, the following recommendation was prepared by WG Aerodrome and fully endorsed by the committee.

1 The Committee notes that the proposal of a Directive from the E.E.C dealing with bird conservation provides for derogations to protect economic activities from damage caused by birds but reaffirms its demand that aviation safety shall be mentioned in the list of reasons for which Member States may derogate from the measures of protection of birds foreseen in the Directive.

2 The Committee recognized the necessity of a wise and controlled utilization of this possibility but asks the Council of Ministers to adopt such provisions dealing with this point as the responsible authorities of the Member States would be allowed to take measures within a sufficient range of action to prevent the damages to aviation safety.

3 The Committee asks that when the Commission examines the measures taken by the Member States in implementation of the provisions for derogation, it will be advised by competent experts in reduction of bird hazards to aircraft such as National Bird Strike Committees.

4 The Committee notes with interest that the Directive provides for the development of research in order to allow a satisfactory implementation of the Directive in particular dealing with behaviour and migratory movement of bird. In this context the Committee asks that aviation safety will be mentioned in the list of themes of research.

2.3.4. The analysis WG Chairman made the following statement on behalf of Civil Aviation Authority (U.K.)

The UK CAA Computer Services Branch have made a cost and feasibility study of the draft specification which was circulated to you. This study shows that for the UK bird strike data the cost is not justified and we would not proceed. However, if the data base were to include European participants, with the extra cost being shared by the European participants, then we would proceed.

The costs are as follows:

(i) programming and setting up cost of £ 6,000 to be shared by UK and European participants.(the US Air Force is prepared to consider £ 1,000 of this).

(ii) annual cost of £ 1,000 to be shared by European participants. All countries have different numbers of bird strikes, however, since everyone would have equal access to the data it is suggested that all countries should contribute equally. Each country would be expected to provide the data already coded on the forms (or cards) which would be provided.

The meeting agreed that the question be raised by correspondance, and wished that all States answer positively.

2.4 The Committee has revised its Terms of Reference and work programme of Working Groups. The Terms of Reference appear in Section 7 of the Main Report and the Work Programme in Section 8, Part 1, para 4.

2.4.1 Attention has been called to the number of Working Papers, which are steadily increasing in number and complexity. The Chairman was asked at the 11th meeting to prepare a summary of all Working Papers published from the 1st annual session to the present day with a classification following the Working Groups' Terms of Reference. The summary will be published as a BSCE circular and will provide a basis for the Editing Committee to select Working Papers.

However the task appears to be really important it is doubtful that such a compilation could be available for the 13th meeting.

As regards the 12th meeting, due to the necessity to give as wide a coverage as possible, to the items already selected for the 3rd World Conference, many lectures prepared for BSCE were added to the list of the Conference. These papers will be published separately by ICAO and all concerned will be warned in due time. However the reprint will not be made available free of cost.

2.4.9 The problem of a permanent Secretariat, proposed during the 10th session of the BSCE, has not progressed. However as some international organisations have shown an increasing interest in the work done and because they are now asking BSCE to prepare notes or documents it has been felt that a beginning of a solution could be offered by these organisations.

2.4.3 According to normal practice the chairman of BSCE is elected for a period of two years, which could be renewed. After a discussion at the end of the 11th meeting the actual chairman agreed to be reelected for one year, in order to provide an overlap with the vice chairman. But the same situation reappered during the 12th meeting and again the chairman was reelected for another year, leaving the question open if a change of philosophy has to be envisaged.

2.5 Action to be taken:

2.5.1 The chairman of the BSCE or the vice chairman has been charged to visit all relevant authorities at a convenient level, to obtain better liaison and understanding. Experience acquired last year has brought confirmation that minor problems can easily be solved in so doing.

2.5.2 According to this policy the Committee agreed that BSCE provides experts in order to help ICAO with aspecial - work shop on reducing bird hazards, the first of which will be held in Bangkok during March 1978. Subject to state approvals, BSCE propose to take charge of the following items; Strike rates/ accident records, Airport Environmental management, Radar, AIP and NOTAM communication procedures, Organization of a Committee (Need for a regional bird strike Committee: experience of one region).

If this meeting is successful, other workshops can be organized in other ICAO-Regional offices.

2.5.3 It was suggested that in order to get more participation from engine manufacturers the structure working group could become "Structures and Engines".

2.5.4 Recommendations emerging from the Working Groups are included in Section 1 of the main Report.

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PART 3

CONCLUSIONS RESULTING FROM SECTION 8 OF THE 12TH MEETING REPORT

1 As a routine, BSCE meetings end with the adoption of recommendations. Only those of general nature are shown below because some are addressed to the Chairman as assigned tasks on behalf of the Committee and reflect the conclusions of the meeting:

Section 1, Recommendation

A 1 to 7	Bird concentration maps (to be delt mainly with ICAO)
B 3	Analyse of birdstrike data using ICAO ADREP facilities
C 1	Joint studies of bird concentrations along the Alpine ranges.
D 1	Designation from each country of an expert responsible for reporting to Structural testing working group about progress in this field of work.
D 2	Deterioration of windscreen strength.

2 The time lapse as usual being too short to allow a general consultation on the presentation of this Report and the redrafting of recommendations issued by Working Groups and approved by the Committee the only conclusion formulated by the Chairman is:

Conclusion 1: As International Publications (see ICAO Doc 9137-AN1898 edition 1975 Airports Service Manual, Part 3) and BSCE code of practice are available and agreed, all States are requested to ensure that methods used on airports are in full accordance with the above documents.

As it was noted this recommendation emerged from the 11th meeting and is still valid.

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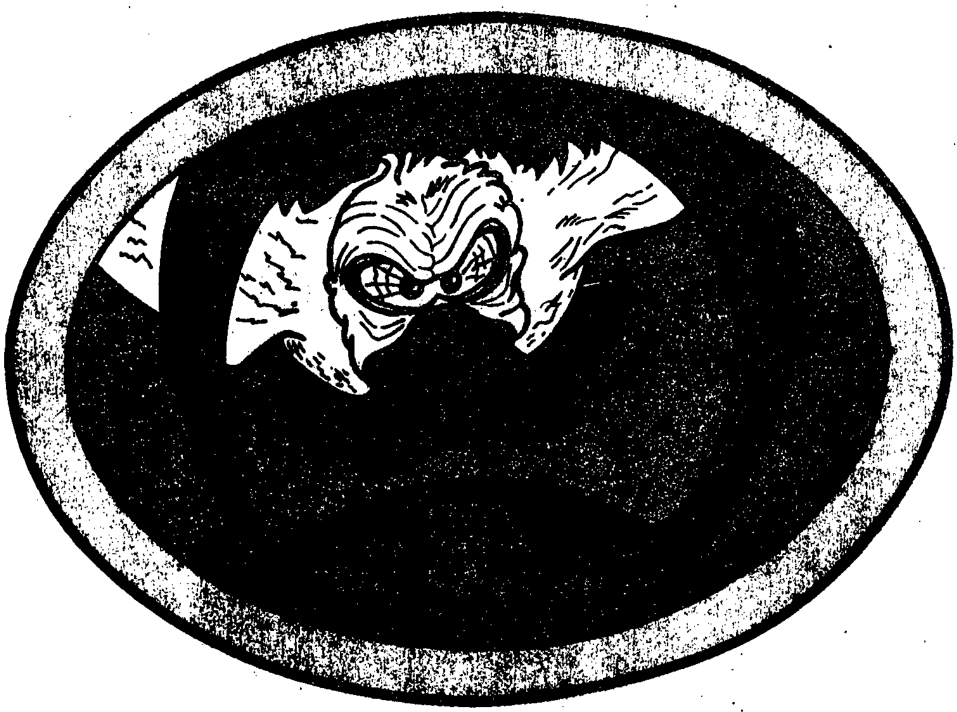

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