

Thermal imaging, a new remote sensing technique for nocturnal wildlife studies

L.S. Burma, Es The Hague)

THERMAL IMAGING, A NEW REMOTE SENSING TECHNIQUE
FOR NOCTURNAL WILDLIFE STUDIES

L. S. Buurma
RNLAF Flight Safety Division
P.O. Box 20703
2500 ES The Hague

INTRODUCCION

It is one of the aims of the radar working group to discuss all possible means for remotely sensing bird movements. Besides radar some other techniques have been tested for the observation of nocturnal migration and were reported here. Portable infra red goggles combined with IR illumination have already reached the third generation and are frequently applied in biology. Light amplification is the other candidate that attracted attention during the last two decades. Especially the approach of Gauthreaux (1979) who later combined small radar and light amplification within a spotlight beam, appeared to be successful. Here I report on some preliminary observations with a new challenging technique: thermal imaging.

THE THERMAL CAMERA

The thermal camera or heat picture camera converges thermal radiation (deep infrared, 812, μm wave length) by means of a germanium telelens. The image is scanned horizontally and vertically towards a cooled (-193 degrees Celsius) heat sensitive detector. This detector transforms heat differences (wave length differences) into electric signals, which are used to produce normal video. The grey tones on the TV monitor show heat differences as small as 0.1 degree Celsius.

EXPERIMENTAL SET-UP

During a radar study in October 1983 I had the opportunity to test during one week a new thermal camera of Philips Usfa, type UA 9053. It has a 300 mm germanium lens with a viewing angle of 3 degrees. It gives an image field of 25 x 40 meter at 1 km distance. The camera was mounted parallel to the tracking antenna of a Flycatcher radar (A product of Hollandse Signaal, again Philips): fig. 1. By using the operation facilities of the radar system we could direct

The thermal camera in all directions and register them precisely. The camera was used alone and in combination with automatic radar tracking. The tracking data from the radar computer were processed in a special cabinet in order to store them and to produce flight path plots. It was also possible to videotape the thermal images and radar data in an integrated form: fig. 2.

The image of figure 2 shows a farmer who is loading a lorry at night at 700 meters from the radar. The grey tones of the digger beautifully illustrate the heat radiation: warm hydraulic lines are visible through the metal housing of the grasping arm. The relatively cold grab bucket is virtually invisible because it has nearly no thermal contrast with the nocturnal air. Warm wheel axes and hot air outlet cause the dark tones. The farmers bared head radiates the most heat, while the overlap between his coat and trousers shows the smallest heat loss.

The information on top the image deals with date, time and run number (radar track number). The second line on top indicates the real radar data that are renewed each second. The figures at the bottom line are the calculated flight path data for the tracked target: course, speed, altitude and diving angle. In this particular case we selected the azimuth / elevation direction manually.

RESULTS

Thermal images in combination with radar tracking: Hundreds of birds tracked at night were simultaneously viewed with the thermal camera. Figure 3 gives an example: a flock of medium sized birds. The most common migrants appeared to be *Turdus* sp., as was indicated by

- 1) flight calls noted by humans;
- 2) wing beat patterns derived from fluctuations of the Automatic Gain Control (AGC) of the tracking radar; and,
- 3) wing beat counts directly from the heat picture video tapes (frame by frame analysis - see below).

Migrants approaching the radar were often locked by the radar before their thermal image exceeded noise level. Usually Thrushes became visible on the monitor at distances of around 1 km. This maximum distance increased in the course of the night up to approximately 2 km, as a result of the decrease in air temperature. Lower temperatures at high altitude and differences in heat

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losses between upper and underside of the birds caused high flying birds to be better visible than low flying ones.

The majority of the songbirds fly spatially dispersed and at night appear as solitary individuals, at least to the camera. When the flight patches of two individuals cross it can directly be seen at what distances the AGC signal of the tracked bird is disturbed. A minority of the nocturnal migrants, mostly larger birds such as waders, ducks and geese, appeared to fly in flocks, sometimes very compact: figure 4 (probably curlews).

A flock of 5 geese (figure 5) (family?), seemed to react to the radar at a distance of 1300 m. Firstly, one bird (mother?) shifted to the left, hundred meters further three birds (young?) flying in close formation, follow this bird and finally the last goose (father?) changes direction also and joins the group.

Having detoured the radar, the flock restores the formation and continues in the original track direction.

Thermal camera used alone: We also used the camera separately, and did so in two ways:

- 1) scanning slowly along the horizon (each night a few times) looking for low flying birds; by occasion some time was spent to observe mammals like rabbits, deer, foxes, cats, etc. (figure 6)
- 2) directing the camera to the zenith.

The first method confirmed the impression from radar observations, namely that virtually no nocturnal migrants flew at tree top height. The number of birds on the ground was much smaller than the number of mammals. Judging to the somewhat limited (but still good) visibility of flocks of Lapwings at the runway compared to the very good visibility of mammals, this simply may be a matter of detection range.

Directing the camera vertically upward for one hour during a night with heavy migration provided a beautiful sample of clearly visible "falling stars" at the video tape. Directions could be measured up to 1 degree accuracy. Passage times could be measured up to 1/50 of a second and were transformed into altitude estimated on the basis of the average track speed of migrants during that time from the tracking radar data. Figure 7 is a time photo (1/2 sec) of one passing bird visible at the video tape: 23 video frames cause 23 successive images showing wingbeats (ca 6 Hz).

DISCUSSION

The thermal camera appears to be a very promising and reliable tool, as was reported first by Buurma (1986) and Marti & Heiniger (1987).

Its capacities are only poorly reproduced by the photo's; however, the original video tapes are much better! A detection distance of up to 2 km. for birds flying overhead means that the equipment can serve as a complementary tool for X-band radar studies on nocturnal bird migration. Because birds can be viewed directly, heat images can help to identify the birds tracked by the radar. They offer the possibility to study details about bird behaviour such as flocking and evasive action near obstacles. Also the "behaviour" of the radar with respect of bird detection can be assessed. One point of interest is the fact that insects, in contrast to warm birds, are nearly invisible. In this respect, the technique of thermal imaging differs principally from light amplification and can solve the insect problem for certain radar ornithologists (see Bruderer 1971).

The equipment proved to be very reliable: No malfunction during 7 nights of continuous operation on top of the moving tracking system of the radar. After 1985 the thermal camera has been improved with respect to resolution and new lenses (wider angles, shorter range). Furthermore, the rather expensive instrument will soon become much cheaper because of the market to detect heat leakage from structures and civil security applications.

The wild life biologist may also have large profits from this technological innovation.

LITERATURE

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- Buurma, I.S.. 1986. Nachtelijke vogeltrck in radar- en warmtebeeld. *Voellig Vliegen* 33 (2): 10-13
- Gauthreaux, S.A. 1979. Image Intensification: a new method of studying nocturnal bird migration. *BSCE* 14/ WP 8.
- Marti, C. & F. Heiniger, 1987. Einsatz von Wärmebildgeräten in der Feldornithologie. *Orn. Beob.* 84: 67-69.



Figure 1

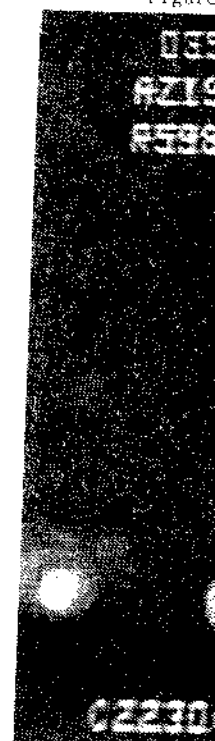


Figure 2

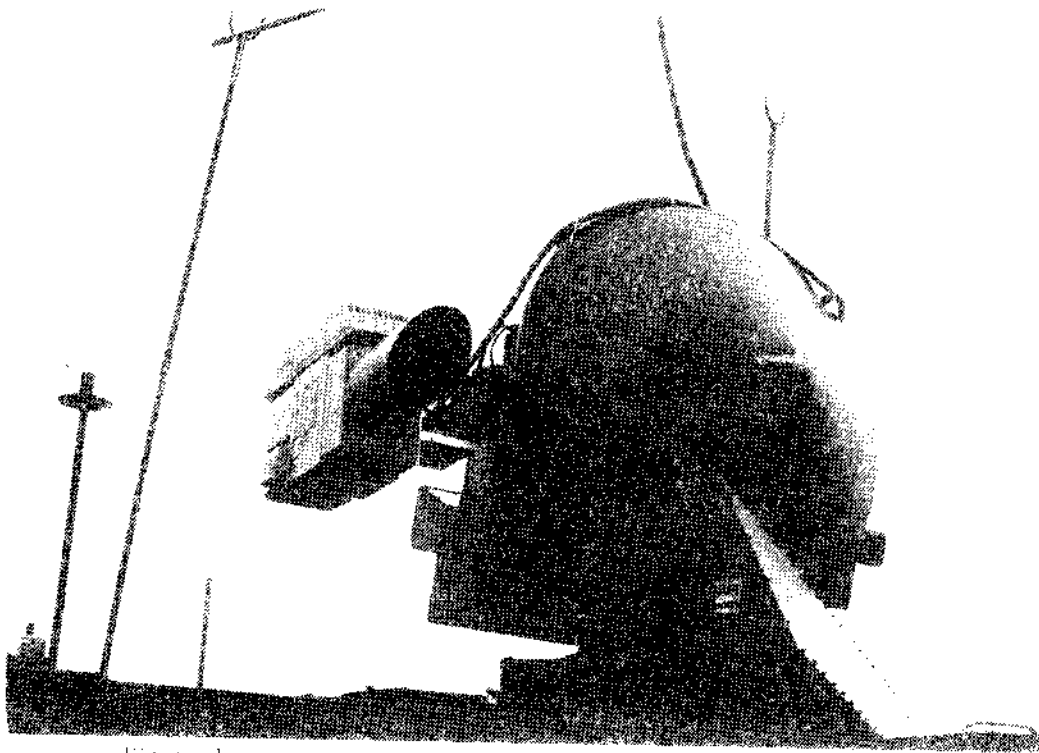


Figure 1

Figure 2



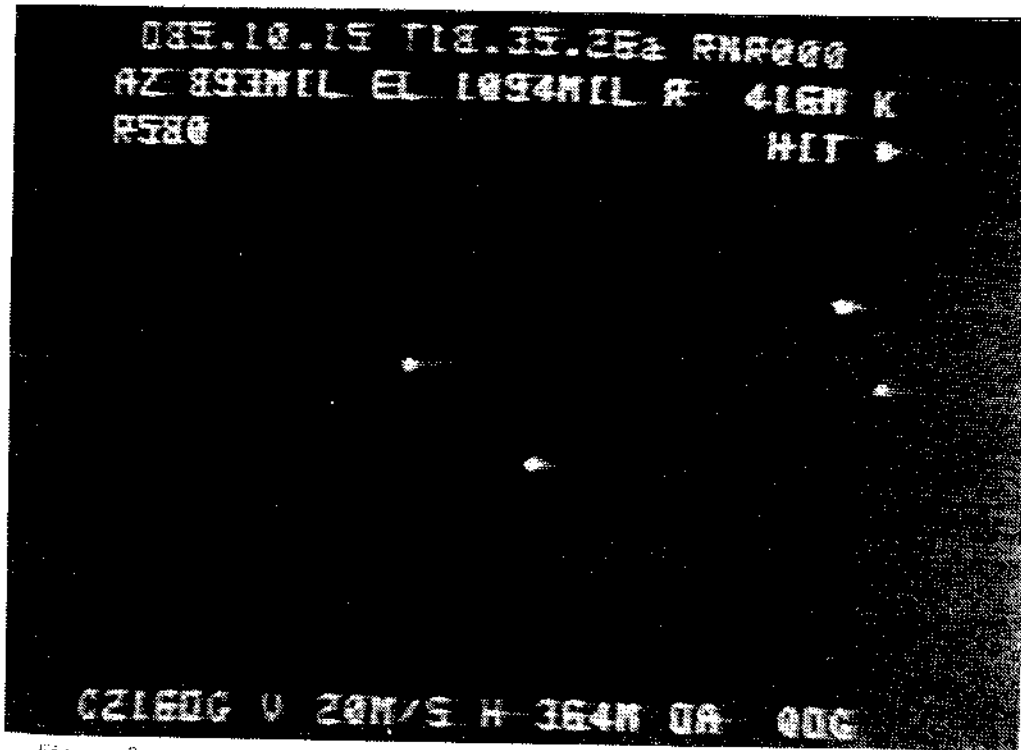
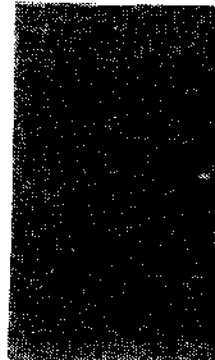
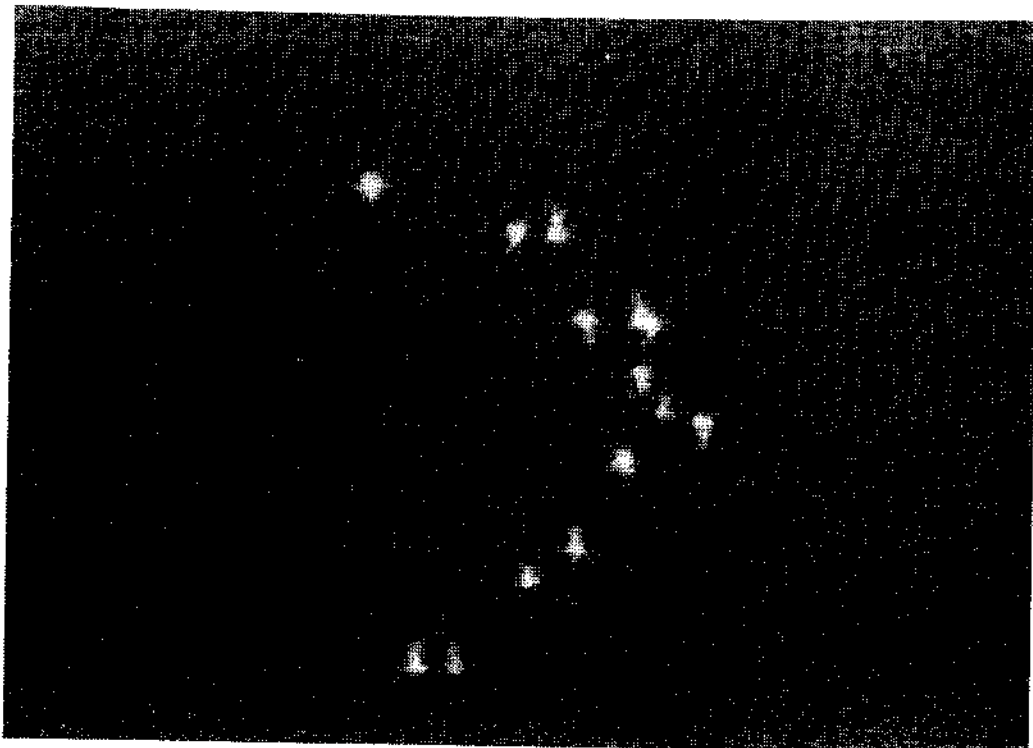
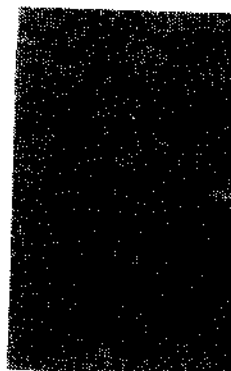


Figure 3

Figure 4



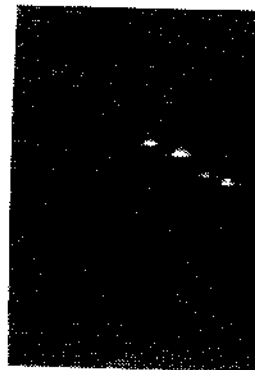
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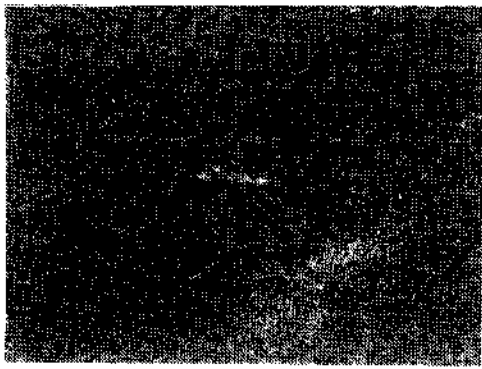


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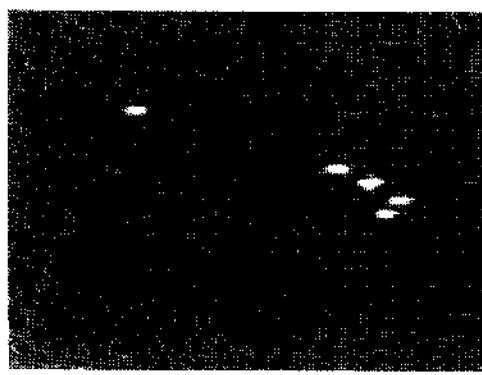


C: 1900 m

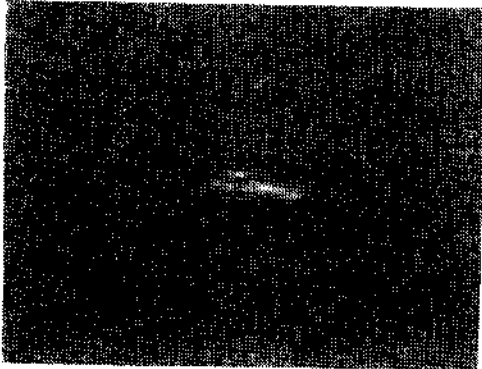




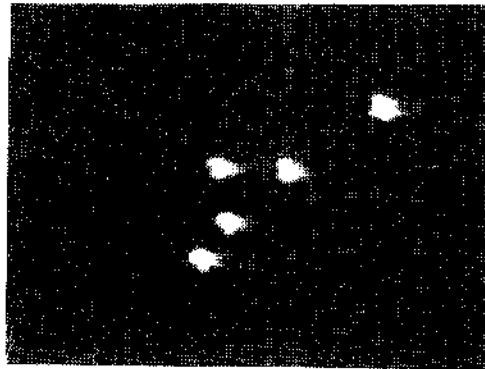
A: 1900 nm



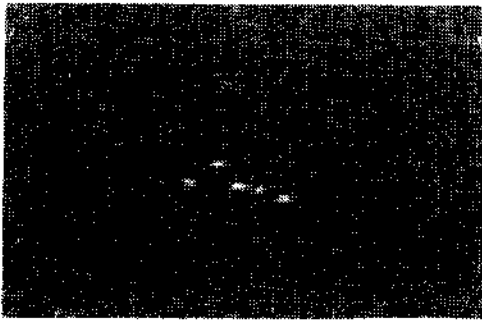
B: 1200 nm



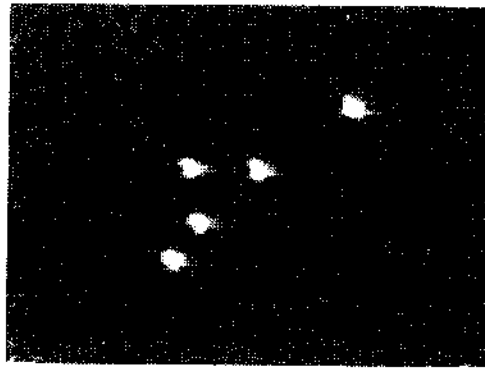
C: 1000 nm



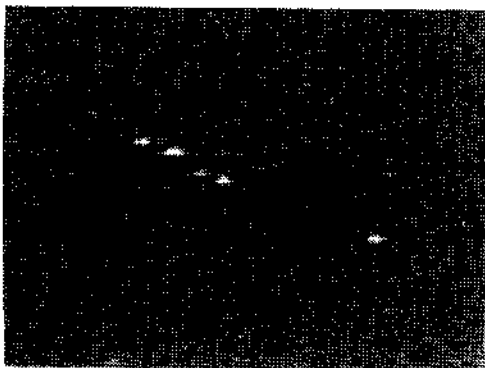
D: 700 nm



E: 1500 nm



G: 730 nm (side view)



F: 1000 nm

Figure 1. Left column shows an
electron micrograph of the
rod-shaped bacterium.

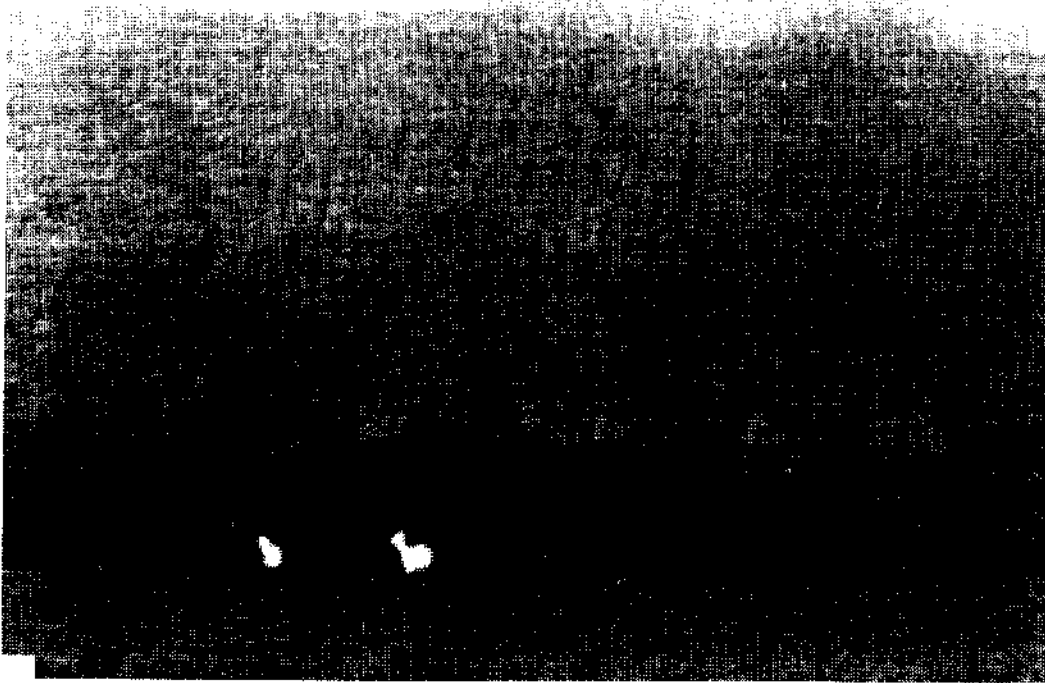
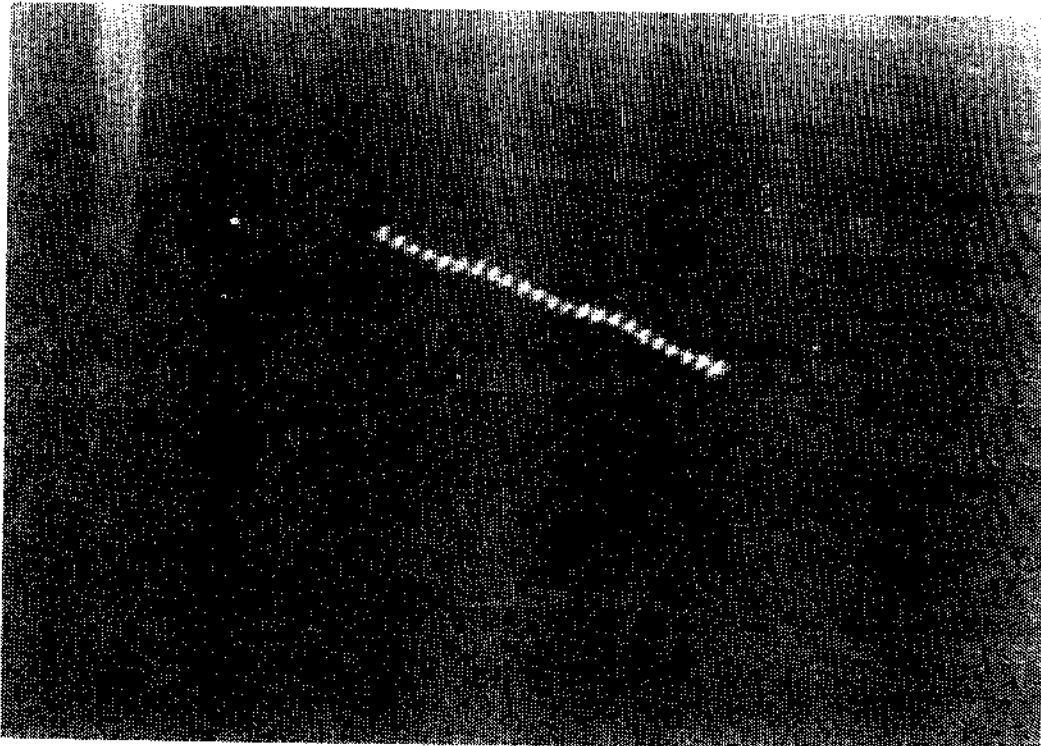


Figure 6

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REPORT OF THE CHAIRMAN

Monday, 23 May 1988

For the first time in the history of BSCCE our Committee convenes in the capital of Spain. The preparations for this meeting was initiated 5 years ago, and it was finally during our 17th meeting 4 years ago in Rome that we were told that the Spanish authorities would be willing to act as host to this meeting.

It is the first time that I have had the experience to have to contribute to a meeting in a country outside my own country, but I can assure you that it has been a very easy job thanks to the spirit of cooperation I have always met when discussing with our Spanish hosts. I think that this spirit of cooperation bodes well for the meeting and further gives an indication of the interest which the Spanish authorities take in our work so that we also in future can be assured of a valuable Spanish contribution to our meetings.

Since our meeting in Copenhagen 2 years ago, the Steering Committee has met only once. It was last September in the Mosel Valley during the wine harvest. Apart from sampling many sorts of the Mosel wine with the good guidance of our old friend, Jochen Hild, we made preparations for this meeting and had discussions regarding the third edition of the booklet "Some Measures ...". I will return to that later on, and further we discussed the BSCCE Index, the result of which you will find in the bound set as AP/3 and which I will present at our meeting on the 26.

Finally, we discussed some changes regarding the chairmanships and vice-chairmanships of our various working groups and we will, later, elect a new chairman and a new vice-chairman of the Bird Movement Working Group and a new vice-chairman of the Analysis Working Group. At the Plenary on Thursday we will elect the chairman and the vice-chairman of BSCCE as a whole for the next period.

The changes from our previous way to structure the presentation of working papers have been maintained as you will see from the bound set which, I hope, you have all collected.

I am fairly satisfied that we this year have received 22 working papers covering 219 pages before the deadline compared with the 15 working papers covering 132 pages we received at our last meeting. But I shall still hope that we can improve this situation especially when I remember what our colleagues from the US accomplished during a meeting in Charleston some years ago.

I shall now turn to the nature of the work performed in the various 3000 working groups.

The **Aerodrome Working Group** was left with only one recommendation from the Rome meeting. It deals with the EEC directive on the conservation of wild birds, especially Article 9, para. 3, and the Committee recommended to EEC member states to keep the Chairman and the Liaison officer informed of the report sent to the EEC Commission about the implementation of EEC directive /9/409 and to maintain contact with the Chairman and the Liaison officer in case the EEC Commission will promote action in the field affected by the BSCG recommendations.

To my knowledge the relevant authorities are still doubtful as to the extent which the EEC Secretariat wishes to have reports. This question was raised some years ago, as far as I remember in Moscow, when the French delegation expressed their apprehension that the EEC measures to conserve wild birds could collide with our efforts to protect our aerodroms against the presence of birds. But till now I have heard of no such efforts and I have received no information.

The Aerodrome Working Group chairman has been busy collecting details for the 3rd edition of the booklet on measures to reduce bird risk around the airport. Such an addition has in fact been finalized and the chairman has brought with him some twenty copies of the booklet to this meeting.

The **Analysis Working Group** was left with 4 recommendations:

1. The first one was a reminder that details of strikes to their own countries' aircraft which occur outside their own country, should be sent to the relevant person in the country in which it occurred.

Response:

A list of names and addresses has now been provided to facilitate this task.

2. The second recommendation was that all members use the following criteria in defining whether a civil strike is on or near an airport;

	CLIMB	APPROACH
ON	0 to 500 ft	200 ft to 0
NEAR	501 to 1500 ft	1000 ft to 201 ft
EN ROUTE	1501 ft and above	1001 ft and above

Response:

This has nothing to do with this

3. The third recommendation was to keep the Chairman and the Liaison officer informed of the report sent to the EEC Commission about the implementation of EEC directive /9/409 and to maintain contact with the Chairman and the Liaison officer in case the EEC Commission will promote action in the field affected by the BSCG recommendations.

Response:

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4. The final recommendation was to keep the Chairman and the Liaison officer informed of the report sent to the EEC Commission about the implementation of EEC directive /9/409 and to maintain contact with the Chairman and the Liaison officer in case the EEC Commission will promote action in the field affected by the BSCG recommendations.

- Working Group

- Dr. J. B. B. B.

Details of a Working Group

Response:

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Further activity

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Response:

This has now been implemented and all members provided their data according to this format.

3. The third recommendation was that maintenance personnel be reminded that whenever evidence is found of a birdstrike, this should be reported on the Birdstrike Reporting Form and any feathers or remains be sent to the appropriate person for analysis.

Response:

This is for individual countries to implement at their discretion.

4. The final recommendation was that BSCE Analysis for 1985 data incorporating ON, NEAR and DAMAGE be sent by 1st November 1986 to
 - Working Group Chairman (J. Thorpe for civil analysis)
 - Dr. J. Hill for military analysis

Details of any serious incidents to civil aircraft should be sent to the Working Group Chairman as soon as possible after the event.

Response:

All the 1985 data has been completed in the manner requested and a paper will be presented during this meeting in Madrid. The 1986 data is not yet complete but it is hoped that it will be available after the meeting with the proceedings of the meeting. Work is in hand on the limited amount of military data.

The serious events are contained in a paper being presented by the working Group Chairman during the meeting.

Further activity:

- a. After holding the position of Vice Chairman for a number of years Mr. R. Van Wessum from the Netherlands has had to resign owing to a change of post. Mr. Bertil Larsson from Sweden has agreed to replace him.
- b. In October 1987 the Working Group Chairman attended the first Central and South American region ICAO workshop on bird hazards in Mexico City and presented a number of papers. There had been very little activity on bird hazards in these regions and apart from ICAO there was only two papers from any of the countries in the regions. Nine countries sent representatives, unfortunately Brazil was not among them.

- c. The Working Group Chairman has produced a "Bird Avoidance" Leaflet in the UK General Aviation Safety Sense series. This is being presented at this meeting as part of The Communication and Flight Procedures Working Group.

The **Bird Movement/Low Level Working Group** was left with the following recommendations:

1. Maps on bird concentrations and migration methods should be revised.
2. Risk maps for airport facility areas should be drawn up.

In Germany the following new maps have been issued last year:

- AIP Germany, RAC 3-6-3 concerning bird concentrations and bird movements in the Federal Republic of Germany (1 May 1987)
- Catalogue/map concerning protected areas with higher birdstrike risk in the Federal Republic of Germany in "Vogel und Luftverkehr" (Bird and Air Traffic), the official journal of the German Birdstrike Committee (August 1987).

The work concerning bird hazard at low level with the aim to develop preventive measures to minimize the bird hazard to low flying aircraft has started with two meetings, one in November 1986 and one in September 1987. The agenda for these meetings included the following topics:

- Progress in the observation of bird movements by radar
 - o Criteria to issue birdstrike warnings/BIRDSTRs
 - o Presentation of birdstrike warnings/BIRDSTRs
- Actual status of flight procedures and restrictions on receipt of birdstrike warnings/BIRDSTRs
- Action to be taken according to bird hazard maps and birdstrike risk forecasts
- Action in the event of a birdstrike.

The Belgian, German, the Royal Netherlands Air Force, and the Canadian Royal Air Force and the United States Air Force in Germany, Europe, participated in the meeting. The reports of the meetings will be presented in a working paper at this meeting.

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Regarding the **Working Group Communication and Flight Procedures**, you will recall that the group was left with the following two recommendations:

- To collect data encompassing methods used for transmission of bird hazard information and flight procedures suggested to reduce or avoid bird strikes to be published.
- To contemplate standardization of flight procedures for helicopters, light aircraft and military low-flying aircraft.

You will also recall that the working group chairman was not able to attend the Copenhagen meeting, and unfortunately we shall also miss his presence at this meeting. He has, however, by telephone informed me that he has not been able to do any work about these recommendations, but as some working papers are assigned to this working group, the working group meeting will be held as planned in WP/2 under the temporary chairmanship of Mr. Kirjonen, Finland, whom I have persuaded to act as chairman during this meeting.

Next comes the **Radar Working Group** which during the Copenhagen meeting expressed the wish that the booklet "Use of Radar for Bird Strike Prevention" should be prepared for the next meeting of BSDF. This recommendation has been met in so far that during this conference a full draft of the booklet is available. Those of you who join the Radar Working Group can get a copy to study before the Radar working Group convenes. Other who wish to receive the printed version can be produced some months after this BSDF meeting should contact the authors, L.A. Sharma and B. Braderen.

One of the key items of the radar booklet and the Radar Working Group meeting, is future developments with respect to electronic assessment of bird densities via radar. Reports on new experiences in the USA, Switzerland, Belgium and Austria will stimulate the discussion. This is urgently needed, especially for military aviation, because low-level training is suffering more and more from bird strikes. Quick and standardized bird measurements and predictions are the only solution to this problem. During the last two years members of the Radar Working Group and the Bird Movement Working Group closely cooperated. For military aviation the increase of the number of member states ratifying a Standard NATO Agreement on BIRDSTAMS is an important development.

The biological aspect of the problem, mainly how to detect, quantify and interpret bird movements at low level, is the second subject to be discussed by the Working Group. In this respect several limitations of the use of certain

radars became apparent only recently. Apart from the applications for flight safety, new ornithological insights may also be at stake. The group hope to stimulate new radar ornithological studies emphasizing on the quantitative aspects. Selection of new study areas is needed, not only to complete existing knowledge with new geographical aspects but also to generate fresh ideas. They are eager to receive news from eastblock countries. According to the last Working Group recommendation "Finland and the Soviet Union should continue to improve the mutual exchange of actual radar information on mass migration of waterfowl in areas of common interest."

This conference will indicate that knowledge about local bird movements represents an important missing link in our understanding and control of the bird problem around aerodromes. Radar and other remote sensing techniques can also play a role here, and therefore contribute to civil flight safety.

The **Structural Testing Working Group** was left with the following recommendations:

- Bird strike tests on Aramid Epoxy Composite Structures be done.
- Tests to study low-temperature effect on the resistance on various wind-shield glasses.
- Testing of NDA and shock absorber materials' bird strike resistance.

I have been informed that the work of this group has run into some snags which has hampered immediate results, but the question as to extend the terms of reference to include study of engines will be taken up in the Working Group.

Regarding the relations between our Committee and other international organizations, I have already mentioned the EEC and the ECC Directive regarding bird conservation. Regarding ECAC we have at each meeting of the Technical Committee reported on our various activities, most recently during a meeting in March this year when the former BSCF vice-chairman, Elisabetta Jario, on behalf of the Committee promised to present the modification to the Aerodrome Working Group booklet to ECAC. We certainly welcome the interest of ECAC, but we shall have to appoint a rapporteur to ECAC as we have been told that Vital Ferry will no longer be able to act as such. Regarding ICAO we are happy to see among us the acting chief of the Aerodromes, Air Routes and Ground Aids section, Mr. José L. Santamaría, from Montréal, and we know that the problem of bird hazard reduction was discussed during the 26th Session of the ICAO Assembly two years ago to the effect that the Assembly suggested that the Secretary General's follow up actions to increase efforts to combat bird strikes

should be accelerated, and that development of measures to combat drug strikes should be given high priority. We are also aware that the European bureau of ICAO has shown a great interest to receive the results of our work to take it into account in the foregoing revision of ICAO Doc 9137. Further, the chairman of the Analysis Working Group has continued to assist ICAO regarding the IBIS system.

As the Chairman of BSCL I received an invitation to attend a ICAO workshop meeting in Mexico last September but was unable to come, and luckily our Committee was represented both by Joseph Hill and John Thorpe.

In the various ICAO papers I have received I have seen that there should be another workshop meeting this autumn in East Africa, but perhaps Mr. Sarti-maria when we arrive at the Plenary meeting Thursday will elaborate a little more on that topic.

As in future we have noticed with pleasure the interest IATA has shown towards our work and I welcome the presence of Capt. Sabando from the Spanish Air line, IBERIA, at this meeting.

I would also like to inform you that the 20th meeting will be held in Rome in the spring of 1990, and preparations are going on to have the 21st meeting in Israel in the spring of 1992. If countries would like to act as host for further meetings, they are most welcome to contact me.

ANALYSIS WORKING GROUP - CHAIRMAN'S PROGRESS REPORT

1. Recommendations from 18th Meeting, Copenhagen May 1986

- a) The first was a reminder that details of strikes to their own countries aircraft which occur outside their own country, should be sent to the relevant person in the country in which it occurred.

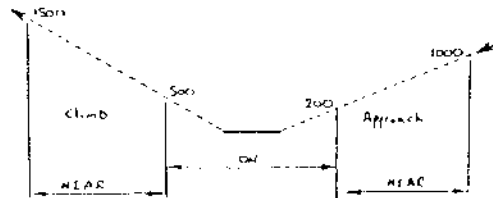
Response:

A list of names and addresses has now been provided to facilitate this task.

- b) The second recommendation was that all members use the following criteria in defining whether a civil strike is on or near an airport,

strike is ON or NEAR an airport:-

CLIMB		APPROACH
0 to 500ft	ON	200ft to 0
501 to 1500	NLAR	1000ft to 201ft
1501ft and above	EN ROUTE	1001ft and above



Response :

This has now been implemented and all members provided their data to this format.

- c) The third recommendation was that maintenance personnel be reminded that whenever evidence is found of a birdstrike, this should be reported on the Birdstrike Reporting Form and any feathers or remains be sent to the appropriate person for analysis.

Response:

This is for individual countries to implement at their discretion.

- d) The final recommendation was that BSCE Analysis of 1985 data incorporating ON, NEAR and DAMAGE be sent by 1st November 1986 to

- Working Group Chairman (J. Thorpe for civil analysis)
- Dr J. Hild for military analysis

Details of any serious incidents to civil aircraft should be sent to the Working Group Chairman as soon as possible after the event.

Response:

All the 1986 data has been completed in the manner requested and a paper presented during the Madrid meeting. The 1986 data is not yet completed but it is hoped that it will be available after the meeting with the proceedings of the meeting. A paper containing the limited amount of military data was also presented at the Madrid meeting.

The Serious Events to Civil Aircraft are contained in a paper presented by the Working Group Chairman during the Madrid meeting.

2. Further Working Group Activity

- a) After holding the position of Vice Chairman for a number of years Mr R. Van Wesson from the Netherlands has had to resign owing to a change of post. Major Bertil Larsson from Sweden agreed to replace him.
 - b) In October 1987 the working Group Chairman attended the first Central and South American region ICAO workshop on bird hazards in Mexico City and presented a number of papers. There has been very little activity on bird hazards in these regions and apart from ICAO there were only two papers (Argentina and Trinidad & Tobago) from any of the countries in the regions. Nine countries sent representatives, unfortunately Brazil was not among them.
 - c) The working Group Chairman has produced a "Bird Avoidance" leaflet in the UK General Aviation Safety Sense series. This is being presented at the Madrid meeting as part of the Communications and Flight Procedures Working Group.
- ### 3. Papers discussed at 19th Meeting, Madrid
- a) The working Group Chairman introduced Bird Hazards to Civil Aircraft on a series of colour slides of accidents and incidents.
 - b) "Analysis of Military Aircraft Bird Strikes 1985/6" was presented by Dr G. Becker, Germany (WP 5). There was considerable discussion on the use and continued collection of these data since few countries were providing information in the correct form. It was agreed that in future low level strikes would be separated out in order to assist the Low Level Sub-group. The loss of a German Air Force F-104 in 1986 when flying over a hole in the ice-covered sea near Bonnair was described. Gulls were ingested, the pilot ejected safely. It was also agreed that an additional paper would in future be provided with a description of accidents and serious incidents to military aircraft, i.e. similar to civil aircraft paper. It was also agreed that considerable efforts would be put into obtaining better and more data from military participants.
 - c) Dr Bruderer introduced "Some proposals for Evaluation of Bird Strike Data" (WP 39). He showed that there was bias in the statistics and proposed that major airlines be requested to provide their movements and strikes at each airport in their route structure. This would highlight those airports with a high number of strikes and low number of movements in a consistent way. By collecting these data from a number of airlines reliable information could become available.
 - d) "How meaningful are Birdstrike Statistics" (WP 35) by Dr C. Thomas, UK, covered the different standards of reporting from pilots, engineers and airport staff. Considerable discussion resulted on whether:
 - dead birds picked up at the airport should be included
 - new misses should be included

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4. Recommendations

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There was considerable variation from country to country in what was used for analysis and it was felt that with computer stored data it would be easy to choose. It was noted that it may be necessary to amend reporting forms to collect this information since the ICAO form did not specifically request the reporter's occupation.

- e) "Bird Strikes During 1985 to European Registered Civil Aircraft" was presented by J. Thorpe, UK (WP 20). Data from some countries was missing and it was requested that this must be provided by 30 June 1988 for inclusion in an analysis of five years of data from 1981 to 1985. This may be available in time for inclusion in the meeting report. 1985 had been a slight improvement on 1984 but 88 engines were damaged. Costs were estimated to be US \$ 35 million for European airlines. There had not been any aircraft losses or injuries.
- f) Mr A. Eudot, France, described the French data storage system using a micro-computer compatible with IBM PC (WP 29).
- g) A paper describing the preliminary results from special markings on the spinner of large fan engines used in B-747SR and B-767 of All Nippon Airways was briefly described by the Working Group Chairman. The paper was obtained via ICAO and was tabled as WP 25. The data was inconclusive, but part of the data indicated the markings had a positive effect. Comparison of the data with other airlines was thought to be the next step. Although the data did not appear to have been statistically checked, participants may consider an approach to their airlines to undertake a similar trial.
- h) "KLM Birdstrikes During 1987" (WP 37) by C. Bakker, Netherlands, described the record of the year. The data showed that there had been a small decrease in the strike rate compared with 1986.
- i) "USAF Birdstrikes 1986/1987" (WP 27) by Capt. R.P. Jefusco, USA, was presented. They had suffered their two worst years with four aircraft lost and six fatalities, and costs of birdstrikes amounting to US \$ 260 million. The aircraft lost were two F4's, an F16, and a B15 bomber. In a serious incident in December 1987 a B747 command post aircraft had collided with a flock of snow geese causing 30 holes.
- j) Mr Santamaría, from ICAO Montreal, gave a resume of the current situation, data available, etc. and stressed the need to use the supplementary form on Damage and Cost, which was not often used. IATA were being approached to obtain better use. All were reminded that if they needed information, they should ask ICAO Montreal for it.

4. Recommendations

- 1) That military "low level" en-route strikes should be analysed separately by BSCE members. A separate set of forms will be necessary.
- 2) That details of military accidents and serious incidents should be sent by BSCE members to the German Geophysical Office (Dr Becker) for inclusion in a paper describing serious strikes to military aircraft.
- 3) BSCE members should urge that means be provided to enable civil data to be analysed by reporter's occupation. Members who already have this information should urge the appropriate authorities to provide it to ICAO.

- 4) That the civil BSCE members should ask their major airlines for their movement data at airports in their system. These data would be combined with Strike Reports from airports and be passed to the Working Group Chairman so as to indicate those airports where a bird strike problem exists.
- 5) BSCE analyses should be sent by BSCE members as follows:
 - Civil Data to Working Group Chairman
 - for 1985 by 30 June 1988
 - for 1986 by 30 June 1988
 - for 1987 by 30 November 1988
 - Military Data to Dr Becker
 - for 1987 by 30 November 1988
 - for 1988 by 30 November 1989

John Thorpe
Analysis Working
Group Chairman

1. Agenda

The following

- a) Approval
- b) Chairman
- c) Presentat
- d) Presentat
- e) Recommend
- f) Other bus

2. The green book

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3. Working paper

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AERODROME WORKING GROUP - CHAIRMAN'S REPORT

1. Agenda

The following was proposed and approved:

- a) Approval of the agenda
- b) Chairman's report on progress since previous meeting
- c) Presentation of "The green booklet"
- d) Presentation of working papers
- e) Recommendations
- f) Other business

2. The green booklet

The 3rd edition of the green booklet was available at the meeting. It was presented by Mr. O. Stenman. It was suggested by Mr. Stenman that a fourth edition should be prepared for the next BSCE meeting.

3. Working papers presented

- WP 5 & 13: Radio-controlled bird defense system STEFFAN.
(H. Hauff and H. Fürbela - FRG)
- WP 17: Birds at Copenhagen Airport Kastrup.
(A.M. Glenning - Denmark)
- WP 19: The development of an effective bird detection and dispersal programme (C. Thomas - UK)
- WP 23: The use of synthetic noise generators on French airports
(J.L. Briot - France)
- WP 21: Evaluation of bird population at Spanish airports: outline and results. (P. Monera - Spain)
- WP 25: Advantages and limitations of radio-controlled aircraft in bird dispersal (A.E. Bivings - USA)
- WP 30: Bird strikes at Israel Ben-Gurion Airport 1982-1986
(S. Swartz, I. Agat, E. Shy - Israel)
- WP 12: Characterization of the birdstrike hazards to the space shuttle orbiter (J.J. Short - USA)
- WP 26: Overview of bird control in U.K.
(T. Brough - UK)

Mr. Bruderer presented some preliminary information about "Altered ground cover and bird presence at Zurich Airport". This paper will not be published in the minutes of this meeting.

Mr. Ferrari (Italy) presented at video-film on the experiment of "ultra-sonic noise for bird dispersal".

Due to lack of time during the meeting two working papers have not been presented.

WP 28: Visual lapwing counts versus aircraft-lapwing strikes
(A. Dekker & L. Buurma - Netherland)

WP 42: Means and methods of bird number reduction within the airport area (USSR)

Working paper 28 will be presented at the plenary meeting.

4. Recommendations

The working group proposes the following recommendations:

4.1 That BSCE members be reminded that new methods of scaring birds should be tested scientifically and not subjectively.

4.2 BSCE members should send their contribution for the next edition of the green booklet to the chairman of the aerodrome working group not later than the 30th June 1989.

1. TITLE

Radar and

2. TERMS OF REFERENCE

Matters as
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3. PROGRESS REPORT

3.1 work in progress

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RADAR WORKING GROUP - CHAIRMAN'S REPORT

1. TITLE

Radar and other sensors

2. TERMS OF REFERENCE

Matters associated with the use of radar and other sensors in the surveillance, the identification and the assessment of bird presence and movements.

3. PROGRESS REPORT

3.1 work done since last meeting

In line with the Copenhagen recommendation about the mutual exchange of information on mass migration in areas of common interest, Finland and Estonia intensified radar and visual observations. They informed each other about the starts of peak passages of arctic migrants. A meeting concerning these matters took place in Tallin.

According to the second recommendation of the Copenhagen meeting, a first draft of the proposed booklet on 'The Application of Radar for Bird Strike Reduction' was discussed among a few members of the Working Group. A second draft was prepared for the present meeting.

Discussions on the need of calibration of different radars used for bird warnings took place twice in Traben-Trarbach during the Low-Level Sub-Group. Information was exchanged about technical and operational aspects of electronic counting systems. The need for standardization was supported by further ratification of a Standard Nato Agreement on the international coordination of bird migration messages (Birdtams). The Netherlands, acting as custodian, delivered the background information, also on behalf of BSCG.

Research on migration in the areas of the North Sea and the Alps continued with special emphasis on altitudinal distribution and the influence of environmental conditions. Cooperation with visual observers demonstrated the high importance of migration at extremely low levels (below radar coverage) in the lowlands of Holland and Northern Germany.

3.2 Work done during the meeting

The following papers nicely combined the technical and biological aspects of radar ornithology, going from large to small scale:

- a) R.P. Larkin illustrated the fascinating capacities of pulsed doppler weather radars for bird detection in combination with modern computer technology. Dedicated software is presently in preparation for the Next Generation Weather Radars (NEXRAD) for the USA.
- b) L.S. Buurma showed a series of slides explaining the echo pattern analysis within the new Dutch bird extractor ROBIN, becoming operational this year.
- c) The small scale observations by tracking radar in Switzerland (B. Bruderer) have now reached a stage where bird tracks and bird numbers can be directly fed to a personal computer.

The second sequence of papers switched to more biological (field) work:

- d) B. Larsson told about Swedish expeditions to Greenland where field observers and a big radar station revealed spectacular flights across the inland ice towards WNW and ESE.
- e) B. Bruderer reported on radar observations at six sites in southern Germany and Switzerland. Radar constant headings resulted in southward deviating tracks under the influence of the frequent westerly winds in southern Germany, while in the Swiss lowlands the birds flew WSW.
- f) Nocturnal observation of migrating birds up to two kilometers by means of a new technology, thermal imaging, demonstrated surprisingly new possibilities for wildlife studies. This heat camera was used by L.S. Buurma in combination with a tracking radar.

Report from other countries

- g) Germany reported the continued use of polaroid photos. A video tape nicely illustrated the additional filming system on some airport radars.
- h) The BOSS system in Belgium is still working as reported in Copenhagen enlarging their reference data set.
- i) USA: after a serious multiple bird strike with a Galaxy at Dover Air Force Base the USAF evaluated several radar types in order to monitor permanently bird movements. A GNP 20 fan beam radar was selected.
- j) Denmark: the FAUST system is still in operation at three radar stations.
- k) Norway continued to use polaroid photos at three ATC radars.
- l) Finland: Visual and radar observation has been used operationally in cooperation with Estonia.
- m) Israel: Realtime warnings to pilots are given on the basis of radar data from Ben Gurion airport. Altitudes and routes of soaring birds are studied by means of a motor glider.

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Special discussion on a dedicated bird radar

A number of specialized working group members formulated design criteria for a small pencil-beam radar (side view range for a gull (6 100 cm²): 10 km) fully dedicated to bird detection and quantification in three dimensions. The need for such an automatically operating instrument has been stated already in the early seventies, but ideas were divergent. Now, the agreement is surprisingly full. The bird radar should serve, in the first place, at locations with a clear bird problem such as certain airports and shooting ranges. Combined into networks they also could monitor large scale bird migration. Finally, they can help to calibrate the bird counting systems at existing larger radars. The booklet "The application of radar for bird strike reduction" will contain a chapter on this important agreement.

4. RECOMMENDATIONS

- a) The BSCE members should urge that international cooperation with respect to further development of electronic assessment of bird hazards by radar be intensified.
- b) When quantifying bird movements, the BSCE members should urge the appropriate authority to put emphasis on the proper inclusion of bird numbers at low level.
- c) BSCE members should approach the industry to develop, commercially, a small bird radar according to BSCE specifications being drafted for inclusion in the radar booklet.

Luit S. Bunnia & Bruno Bruderer

BIRD MOVEMENT LOW LEVEL WORKING GROUP - CHAIRMAN'S REPORT

1. Title

Bird Movement Low Level Working Group

2. Terms of Reference

Study of bird concentration and movements, drawing up of special bird hazard maps for informal and planning purposes, and develop preventive measures to minimize the bird hazard to low flying aircraft.

3. Progress report

- a) The working Group elected Dr. J. Becker, GMDG, as new chairman and Mr. A. Dekker, RN-LAF, as new vice-chairman.
- b) Some countries, e.g. France, Germany, and Greece, had revised the birds concentration maps for their national AIP, others will issue a new map collection within the next 4 years.
- c) Two other types of maps are existing in several countries:
Maps concerning bird sanctuaries, wildlife reserves or other protected areas of ornithological importance as well wetland areas of international importance.
Maps concerning bird concentrations and movements in the airport vicinity according to special guidelines.
Other countries are planning such maps, and will decide on own responsibility whether there is a need of such maps.
- d) A survey of the existing procedures for military low level flights was given during two meetings "Bird Hazard at Low Level" in 1986 and 1987. The participants emphasized the necessity of regular radar observations, standardized birdstrike warnings (BIRDTAM) as well as standing procedures for low flying units.

4. Future programme

- a) Periodically updating of bird hazard maps for the national AIP according to Annex 15 of the ICAO Aeronautical Information Services, and with regard to recent knowledge of bird concentration areas and bird movements.
- b) Local bird movements and bird concentrations in the vicinity of international airports, should be published in airports vicinity maps as part of the national AIP.
- c) Issuing maps of protected areas and other areas of ornithological importance with the purpose of bird hazard prevention and bird protection.
- d) Exchange of actual data concerning medium and high intensities of bird migration as well as birdstrike warnings (BIRDTAM) in a standardized format via the civil and military ATC or WX-networks.

5. Recommendations

- a) BSCE members are requested to urge the appropriate authorities to revise existing national maps according to Annex 15 of the ICAO Aeronautical Information Service. Members of the BSCE working group are urged to send copies of the maps to the chairman of the working group.

Deadline: 1st January 1990

- b) BSCE members are urged to ask the appropriate authorities to work up recent information concerning bird sanctuaries, and areas of ornithological importance for drawing up a corresponding European map, but the appropriate authority should decide its own responsibility whether there is need for publication of such maps.

Deadline: 1st January 1990

- c) BSCE members are urged to ask the appropriate authorities to draw up airport vicinity maps according to ICAO Annex 15, in close cooperation with airport authorities. BSCE members should send copies of such maps to the chairman of the working group.

Deadline: 1st January 1990

- d) BSCE members are urged to ask the appropriate authority to improve the procedures of birdstrike prevention for aircraft flying at low level on the basis of standardized radar observations and exchange birdstrike warnings (BIRDIAM) concerning largescale bird movements in a standardized format via the ATC or WX-networks.

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COMMUNICATIONS AND FLIGHT PROCEDURES WORKING GROUP - CHAIRMAN'S REPORT

TERMS OF REFERENCE

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.

AGENDA

1. Approval of Agenda
2. Appointment of Vice Chairman
3. Brief Introduction of Participants
4. Chairman's Report on Progress since Previous Meeting
5. Radar and Visual Observations of Sea Duck's Mass Spring Migrations in West Estonia and the Transmission of Birdtam from Tallin Airport to Helsinki-Vantaa Airport (WP 18). V.E. Yacobi (USSR).
6. Bird Avoidance (WP 19). John Thorpe (UK).
7. Other Business
8. Recommendations

1. AGENDA WAS APPROVED

2. Capt. Sonnette was elected as a vice-chairman of the meeting
4. The Chairman went through the recommendations from BSCE 18. The working group noticed that there has been no progress on the previous recommendations. (BSCE 16 and 17).
5. Olavi Slerman from Finnish Delegation gave a short report of the co-operation between Tallin Airport and Helsinki-Vantaa Airport of bird migration information. This is a good example of good development in Aerodrome Working Group.
6. John Thorpe presented his working paper WP 19 "Bird Avoidance for General Aviation" which resulted in recommendation 3.
The group agreed that the contents was meant only for General Aviation. There was also some discussion concerning commercial aviation (recommendation 4.).
7. Questions were raised about the effect of strobe lights on birds. No studies have been made yet, except an US analysis by S. Gauthreaux (not yet published) with the conclusion that the strobe lights have no effect; it did not attract or repel birds. The conclusion has to be confirmed by future studies.

8. Recommendations:

1. That work be continued by the BSCE Working Group to review ICAD Annex 15's specifications concerning information on bird hazards.
2. That BSCE members are urged to ask the appropriate authorities that bird hazard warnings, e.g. NOTAM or ATIS, only be issued for significant hazards and for a short time.
3. That BSCE members should pass WP/19 "Bird Avoidance for General Aviation Pilot" to appropriate authorities in their country for possible inclusion in their documentation for general aviation pilots.
4. That BSCE members should urge the appropriate authorities in each country to take steps to inform their pilots, air traffic controllers, and airport authorities that birds are hazard to aircraft, e.g. by lectures, posters, leaflets, video, etc.

List of Participants

BELGIUM:

Gilbert Dupont

FRG:

D.J. Becker

FINLAND:

Seppo Kirjonen (Acting Chairman)

Reijo Lamberg

Olavi Stenman

FRANCE:

Jean-Claude Sonnette (Vice-Chairman)

ITALY:

Augusto Rossi

Salvatore Visconti

SPAIN:

Elvira Abajo

Juan A. Plaza

SWEDEN:

Bertil Larsson

UK:

John Thorpe

USA:

Major Ron Merritt

IATA:

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1. PRESENT

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WORKING GROUP "STRUCTURAL TESTING OF AIR FRAMES"

Report of the 24 May 1988 Meeting

1. PRESENTATION OF WORKING PAPERS

WP/9 - Improving birdstrike resistance of aircraft wind shields.
By Ralph Speelman, Air Force Wright Aeronautical Laboratories,
USA.

As at previous BSCE meetings Ralph Speelman presented the ongoing efforts to improve the windshield system bird strike resistance of aircraft assigned to high speed and low altitude missions.

Over 3000 bird strikes per year occur for USAF and during the past 18 years 13 aircrew members have been killed and 21 aircraft have been destroyed due to bird impact.

New polycarbonate windshields have been developed for F4 - A7 - F16 - F38 with studies of composite and magnesium frames, and moulded transparencies.

The flight dynamics Laboratory has also developed a 0,5 M \$ device to carry out fatigue tests with cold and hot effects on the windshields.

WP/31 - Engine bird strike tests at CEPR SACLAY.
By J.P. Devaux, DGA/DCAe/CEPR Saclay (France).

CEPR Saclay, French Ministry of Defense, official engine test center presented the improvements which it has recently achieved in the test methods to avoid test installation failures.

In particular Mr. Devaux presented results from studies on projectile type (test now uses gulls instead of chickens for 1,5 and 4 lb bird official tests) and multiple impacts avoidance (several birds striking the same blade).

Some tests including the new test methods were shown on TV video.

The encouraging results encountered by the high level test technology developed by CEPR is now being used for propeller FOD* tests.
(* Foreign Object Damages).

2. OTHER ITEMS

- The group decided to increase its activity field by including the engine testing
- New title proposed for the Working Group:
"Testing of Airframes and Engines."

3. ACTIVITY OF THE GROUP BETWEEN BSCE MEETINGS

As indicated in previous recommendations, it is important to promote the work of the group by giving the names and addresses of specialists from the different countries to the Working Group Chairman (for frames and engines).

The French members of the group will study the opportunity to organize a meeting in Paris during spring 1989 for testing airframes engine specialists.

The Vice-Chairman of the group:

R. Peresempio (Italy) will again be able to act in the group next month.

4. RECOMMENDATIONS OF THE GROUP

BSCE members should seek information on the retention of birdstrike capability after extended in service usage of engines and airframes.

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REPORT ON THE MEETING OF THE SUB-GROUP ON FEATHER IDENTIFICATION

Rapporteur: Tim G. Brom

During the BSCE meeting in Rome in 1984 it was decided to form a sub-group on Feather Identification within the Analysis Working Group.

Here in Madrid, this sub-group came together for the second time. After some confusion and re-scheduling there was a working lunch with 13 participants from seven countries. Working paper 24 was discussed, entitled "The Analysis of Feather Remains: Evaluation and Perspectives," and more general information was exchanged between the participants.

A questionnaire was compiled in order to make an inventory of the persons working in this field and of the methods they employ.

The participants reached the following conclusions:

- 1) proper identification of bird remains is essential and fundamental to bird strike statistics,
- 2) within BSCE there is a growing interest in the methods of identification and the wish was expressed to establish contacts between people working in this field.

Based on these conclusions, the participants in the meeting of this sub-group would like to put forward two suggestions to this meeting and to the Steering Committee:

- 1) that this group be raised to Working Group level, in which case the name probably better be changed from Feather Identification to Bird Remains Identification Working Group,
- 2) that the meeting of this Working Group or Sub-group will have a place of its own on the agenda of BSCE 20 in Helsinki before the start of that meeting.

RECOMMENDATIONS

AERODROME WORKING GROUP

1. BSCB members be reminded that new methods of scaring birds should be tested scientifically and not subjectively.
2. BSCB members should send their contribution for the next edition of the green booklet to the chairman of the aerodrome working group not later than the 30th June 1989.

ANALYSIS WORKING GROUP - CHAIRMAN'S PROGRESS REPORT

1. That military "low level" en-route strikes should be analysed separately by BSCB members. A separate set of forms will be necessary.
2. That details of military accidents and serious incidents should be sent by BSCB members to the German Geophysical Office (Dr Becker) for inclusion in a paper describing serious strikes to military aircraft.
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4. That the civil BSCB members should ask their major airlines for their movement data at airports and be passed to the Working Group Chairman so as to indicate those airports where a bird strike problem exists.
5. BSCB analyses should be sent by BSCB members as follows:
 - Civil Data to Working Group Chairman
 - for 1985 by 30 June 1988
 - for 1986 by 30 June 1988
 - for 1987 by 30 November 1988
 - Military Data to Dr Becker
 - for 1987 by 30 November 1988
 - for 1988 by 30 November 1989

BIRD MOVEMENT LOW LEVEL WORKING GROUP - CHAIRMAN'S REPORT

1. BSCB members are requested to urge the appropriate authorities to revise existing national maps according to Annex 15 of the ICAO Aeronautical Information Service. Members of the BSCB working group are urged to send copies of the maps to the chairman of the working group.

Deadline: 1st January 1990

2. BSCB members are urged to ask the appropriate authorities to work up recent information concerning bird sanctuaries, and areas of ornithological importance for drawing up a corresponding European map, but the appropriate authority should decide its own responsibility whether there is need for publication of such maps.

Deadline: 1st January 1990

3. BSCB members report via airport chairmen

Deadline:

4. BSCB members procedure the basic findings (format)

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RADAR WORKING GROUP

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3. BSCE members are urged to ask the appropriate authorities to draw up airport vicinity maps according to ICAO Annex 15, in close cooperation with airport authorities. BSCE members should send copies of such maps to the chairman of the working group.

Deadline: 1st January 1990

4. BSCE members are urged to ask the appropriate authority to improve the procedures of birdstrike prevention for aircraft flying at low level on the basis of standardized radar observations and exchange birdstrike warnings (BIRDTAM) concerning largescale bird movements in a standardized format via the ATC or WX-networks.

COMMUNICATIONS AND FLIGHT PROCEDURES WORKING GROUP - CHAIRMAN'S REPORT

1. That work be continued by the BSCE Working Group to review ICAO Annex 15's specifications concerning information on bird hazards.
2. That BSCE members are urged to ask the appropriate authorities that bird hazard warnings, e.g. NOTAM or ATIS, only be issued for significant hazards and for a short time.
3. That BSCE members should pass WP/19 "Bird Avoidance for General Aviation Pilot" to appropriate authorities in their country for possible inclusion in their documentation for general aviation pilots.
4. That BSCE members should urge the appropriate authorities in each country to take steps to inform their pilots, air traffic controllers, and airport authorities that birds are hazard to aircraft, e.g. by lectures, posters, leaflets, video, etc.

RADAR WORKING GROUP

1. The BSCE members should urge that international cooperation with respect to further development of electronic assessment of bird hazards by radar be intensified.
2. When quantifying bird movements, the BSCE members should urge the appropriate authority to put emphasis on the proper inclusion of bird numbers at low level.
3. BSCE members should approach the industry to develop, commercially, a small bird radar according to BSCE specifications being drafted for inclusion in the radar booklet.

WORKING GROUP "STRUCTURAL TESTING OF AIR FRAMES"

BSCE members should seek information on the retention of birdstrike capability after extended in service usage of engines and airframes.

1. OPENING BY THE CHAIRMAN

The meeting was opened by the Chairman.

2. WORKING GROUP COMMUNICATION AND FLIGHT PROCEDURES

The Vice-Chairman of the working group "Communications and Flight Procedures", J.C. Sonnette, France, presented the report from the working group paying tribute to Mr. Seppo Kirjonen, who with a very short notice agreed to act as chairman for the working group.

To a question from Bakker, the Netherlands, regarding the effect of landing lights, J.C. Sonnette informed the meeting that the problem had been discussed and that the conclusion was that in most cases landing lights did have a positive effect but there are some problems with the landing lights during night.

Whereas A. Ferrari, Italy, indicated that both landing lights and strobe lights were not particularly useful in order to scare the birds, J. Thorpe, UK, indicated that because of the problem with the crowded skies throughout the world all pilots would wish to use landing lights in the aerodrome area and strobe lights as well so that other aircraft and the air traffic controllers could see them and therefore there was no need within IACU to prolong this discussion.

Bruderer, Switzerland, added that to him as a biologist it was clear that if an aircraft is made visible at an earlier stage to a bird, avoidance would be easier for the bird. On the other hand it was also a well known fact that in foggy situations you can trap birds with lights because they fly towards the lights. That goes for the landing lights but not for the strobe lights which are not steady lights and consequently do not attract birds. He added that some trials concerning strobe lights are going on in Swissair.

After some discussions, particularly as to who should make the recommendations and to whom the recommendations should be made, the recommendations mentioned below were adopted by the meeting:

1. That work be continued by the BSCE working group to review ICAO Annex 15's specifications concerning information on bird hazards.
 2. That BSCE members are urged to ask the appropriate authorities that bird hazard warnings, e.g. NOTAM or ATIS, only be issued for significant hazards and for a short time.
 3. That BSCE members should pass wp/18, "Bird Avoidance for General Aviation Pilot", to appropriate authorities in their country for possible inclusion in their documentation for general aviation pilots.
 4. That BSCE members should urge the appropriate authorities in each country to take steps to inform their pilots, air traffic controllers, and airport authorities, that birds are hazards to aircraft, e.g. by lectures, posters, leaflets, video, etc.
3. WP/7 "SPANISH BIRDS AND THEIR INFLUENCE ON FLIGHT AND MISSION PLANNING"
- C. Ros, Spain, presented wp/7, "Spanish Birds and their Influence on Flight and Mission Planning" and paid tribute to the co-author, Maria Jesús Mingarro, who had just given birth to her baby and was at home. Some one hundred slides were shown and C. Ros particularly mentioned the use of falconry near airport runways.
4. WP/15 "FUNDAMENTAL EXPERIENCES AND SUGGESTIONS FOR BIOTOPE-MANAGEMENT-PROCEDURES ON INTERNATIONAL AIRPORTS"
- J. Hill, FRG, presented wp/15, "Fundamental Experiences and Suggestions for Biotope Management-Procedures on International Airports".
5. WP/22 "SERIOUS BIRDSTRIKES TO CIVIL AIRCRAFT 1985 TO 1987"
- J. Thorpe, UK, presented wp/22, "Serious Birdstrikes to Civil Aircraft 1985 to 1987".
- To a question from Santamaria, ICAO, as to the use of the wording "serious birdstrikes" instead of "significant birdstrikes" J. Thorpe indicated that the list only contained the worst cases from the list of significant strikes.
- Caithness, New Zealand, deplored that there was not enough information as to the costs of the bird strikes, to which J. Thorpe agreed adding that it was nearly impossible to find out the true costs. His estimates for the BSCE reports, e.g. European airlines, reported to him would show that the European costs due to bird strikes in one year were 35 million US \$.

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6. WP/39 "ROBIN, THE NEW BIRD EXTRACTOR ON RNIAF LONG RANGE SURVEILLANCE RADAR"

L.S. Bourna, the Netherlands, presented wp/39, "Robin, the New Bird Extractor on RNIAF Long Range Surveillance Radar". He referred to the discussion in the Radar Working Group and indicated that there was a need to put up criteria for special bird radar adding that it should be recognized that medium and even small birds flying rather low can be a hazard to aviation, especially to military aviation.

7. WP/21 "PRESENT STATE OF BIRD STRIKE HAZARDS AT SPANISH AIRPORTS"

J. Reiz, Spain, presented wp/21, "Present State of Bird Strike Hazards at Spanish Airports". A video tape was also shown.

8. WP/31 "BIRD STRIKES PREVENTION IS BETTER THAN LEGAL LIABILITY"

T. Scorer, UK, presented wp/31, "Bird Strikes Prevention is Better than Legal Liability", and indicated that the failure to exercise proper care in bird control at an airport environment will render the operator liable under civil law to make compensation to those who suffer loss as a result of their failure. In the context of bird control it could be said that not only is it desirable from a safety point of view to have a safe environment for aircraft to operate but also if civil liability is to be avoided it is very important that the airport operator adopts proper procedures and can show that he has exercised those procedures before the time an aircraft takes off. If it later suffers a bird strike, a failure to exercise that proper care will expose the airport operator in most countries to liability and such a claim can have serious financial consequences to the airport operator and his insurers.

To a question from J. Thorpe T. Scorer answered that in law there is no difference between a flock of hazardous birds and a vehicle on the runway in terms of the airport's liability.

To a question from Broderer who questioned the idea that the airport would have to prove that it is not guilty contrary to Roman Law according to which it is always the burden of the plaintive to prove that someone is guilty and has been negligent T. Scorer explained that when a process of litigation starts there is an obligation on both parties to produce for the court later at the hearing all the documents which they

have in connection with their defence and all the documents for the claimant to prove his claim. The important thing for the defendant i.e. the airport is to be prepared for the time when you are accused of being liable because of some alleged negligence.

J. Seubert, USA, envisaged problems in cases where because of the insurance the airport authority and the airport authority employees have no personal problem when a bird strike occurs because they were negligent.

T. Scorer maintained that first of all it is the responsibility that airport authorities take reasonable steps and ensure that their employees are taking reasonable steps. If such steps are not taken the airport operator can exercise a personal sanction. As far as the airport itself is concerned in many cases airport authorities agree that they will take for themselves the first so many dollars, etc, of any liability and only the balance above will be down to the insurer. Consequently it is a correct financial penalty to airport authorities, and here lies the incentive to ensure that the bird strike job is done properly.

To a question from P. Vuillermet, France, T. Scorer answered that the result of the bird strike efforts will give good indications of how effective your work is done. You find two airports with a similar bird strike problem and you can relate the two losses of the airports due to bird strikes. It was recognized that the amount which an airport will spend on bird strike prevention measures must be related to its income and to the probability of a bird strike hazard.

9. SWEDISH VIDEO

B. Martinsson, Sweden, showed a video indicating the work being done in Sweden just now.

P. Bentz, Norway, added that the experiments showed that trays with hawk-eyes repelled birds similar to the work done in Japan. In Norway balloons with painted hawkeyes have been ordered from Japan and the Norwegian authorities intend to try them in the approach path where thousands of gulls frequently are soaring. Such balloons are very cheap and are frequently used in garden in order to repel birds so they do not eat apples, etc. P. Bentz promised to report on the trials at the next meeting.

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13. BIRD MOVEM

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B. Larsson, Sweden, asked if trials in order to get rid of the worms in the airport areas had been made elsewhere and added that as part of an experiment electric wires have been installed in different depths along the runway to prevent the worms from entering it.

P. Bentz added that snails are an attraction to birds in Norway and asked if snails also constituted a problem elsewhere.

10. WP/42 "SELF-CONTAINED PORTABLE LASER TRANSMITTER"

J.D. Soudaze-Soudat, France, presented wp/42, "Self-Contained Portable Laser Transmitter" and added that electricity was supplied by portable battery supplies. The cost of the transmitter should be 6300 US \$ per item. J.D. Soudaze-Soudat promised that the results of the trials which are going on will be published later by the French administration.

11. WP/27 "VISUAL LAPWING COUNTS VERSUS AIRCRAFT-LAPWING STRIKES"

A. Dekker, the Netherlands, presented wp/27, "Visual Lapwing Counts Versus Aircraft-Lapwing Strikes".

To a question from T. Jørgensen, Denmark, A. Dekker explained that he hoped that the reduction of the number of lapwing strikes from 3.5 to 1.0 would be a continuous tendency as it had been from 1985 and onwards.

12. WP/3 "REVISED INDEX FOR BSCE WORKING PAPERS ISSUED DURING THE PERIOD 1966-1988 INCLUDING PAPERS PRESENTED AT THE 1977 WORLD CONFERENCE IN PARIS WHICH WAS ORGANIZED PARTLY BY BSCE"

H. Dahl, Denmark, presented wp/3, "Revised Index for BSCE Working Papers Issued during the Period 1966-1988 Including Papers Presented at the 1977 World Conference in Paris Which Was Organized Partly by BSCE".

It was agreed that the index paper should be updated after each conference and H. Dahl indicated that wp/3 in the final report would include all the papers presented at BSCE 19th.

13. BIRD MOVEMENT LOW LEVEL WORKING GROUP

The Chairman's report on the activities of the working group was presented by the new chairman, J. Becker, FRG.

After some discussions the recommendations mentioned below were adopted:

a) BSCE members are requested to urge the appropriate authorities to revise existing national maps according to Annex 15 of the ICAO Aeronautical Information Service. Members of the BSCE working group are urged to send copies of the maps to the chairman of the working group.

b) BSCE members are urged to ask the appropriate authorities to work up recent information concerning bird sanctuaries, and areas of ornithological importance for drawing up a corresponding European map, but the appropriate authority should decide on its own responsibility whether there is need for publication of such maps.

c) BSCE members are urged to ask the appropriate authorities to draw up airport vicinity maps according to ICAO Annex 15, in close cooperation with airport authorities. BSCE members should send copies of such maps to the chairman of the working group.

Deadline: 1st January 1990 (regarding a), b), and c)

d) BSCE members are urged to ask the appropriate authority to improve the procedures of birdstrike prevention for aircraft flying at low level on the basis of the standardized radar observations and exchange birdstrike warnings (BIRBTAM) concerning large-scale bird movements in a standardized format via the ATC or WX-networks.

III. COOPERATION WITH ICAO

Mr. Santamaría informed the meeting about the actual status of the ICAO birdstrike information system stating that about 45000 cases are collected each year and that an analysis of all the cases are reported to the states. He invited all the members of BSCE to urge their administration to send the reports as soon as possible. He at the same time indicated that ICAO would like to collect all the data in the middle of the year so that the analysis could be completed by the end of the year. Furthermore ICAO is trying to revise the airport manual through the cooperation with experts coming from Canada, Australia, and the US.

Regarding the question, "ICAO Workshops on Bird Hazard to Aircraft", the Chairman informed the meeting that there was to be a workshop in Nairobi next autumn (1989) and that BSCE at the last workshop meeting in Mexico

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City was represented by Mr. Thorpe and Dr. Hild and that the observations made by the latter concerning the running of the meeting were contained in wp/35.

On behalf of ICAO J.L. Santamaria thanked Dr. Hild for the wp. He added that ICAO would pass the information as soon as possible regarding future workshop meetings and would rely on the BSCE Chairman to pass the information to members of BSCF likely to attend.

15. "EEC COUNCIL DIRECTIVE ON BIRD CONSERVATION". ACTUAL STATUS OF THE IMPLEMENTATION"

After the presentation by the Chairman it was agreed to retain the recommendation from the previous meetings although the chairman had not had any response from other countries as to the question from the EEC.

C. Thomas, UK, mentioned that there might be plans to take certain land out of milk production in the EEC and he wondered if anyone was monitoring this so that if there was land surrounding an airport the bird-strike hazard question would be included in the consideration for removal of certain types of land.

The Chairman was aware of the trend in the EEC countries to reforest agricultural land and indicated that if the plans did materialize the Danish delegation would present a paper on this subject at the next meeting.

16. COOPERATION WITH ECAC

The Chairman mentioned that in the past both Vital Ferry and Elisabeth Datto were the contact persons to ECAC. The Chairman indicated that he most probably would be in a position to act as rapporteur to ECAC the Danish Director General of Civil Aviation being the chief of the Technical Committee of ECAC.

17. WORKING GROUP AERODROME

The Chairman's report was presented by H. Helkamo, Finland.

The new third edition of the green booklet "Some Measures Used in Different Countries for Reduction of Bird Strike Risk Around Airports (May 1988, Helsinki), was prepared by the Working Group and delivered to BSCF members during the meeting.

After some discussions the following recommendations were adopted by the meeting:

- a) BSCE members should be reminded that new methods of scoring birds should be tested scientifically and not subjectively.
- b) BSCE members should send their contribution for the next edition of the green booklet to the Chairman of the Aerodrome Working Group not later than 30th June 1989.

18. COOPERATION WITH IATA AND OTHER ORGANIZATIONS

The Chairman pointed out that IATA has been represented at the meeting and took this as a token of the good relationship with IATA.

19. WP/10 "TERMS OF REFERENCE OF THE STEERING COMMITTEE OF BSCE"

The Chairman presented wp/10, "Terms of Reference of the Steering Committee of BSCE" indicating that the reason for change is that the Steering Committee would like to strengthen the work done within the Steering Committee and be able to retain J. Hild as member.

The meeting approved the proposal by the Steering Committee.

20. WORKING GROUP ANALYSIS

The Chairman's report on the activities of the Working Group Analysis was presented by J. Florpe, UK, who especially mentioned that B. Wissjan from the Netherlands had resigned as a Vice-Chairman and was replaced by B. Larsson, Sweden.

The following recommendations were adopted by the meeting:

- a) That military "low level" en-route strikes should be analysed separately by BSCE members. A separate set of forms will be necessary.
- b) That details of military accidents and serious incidents should be sent by BSCE members to the German Military Geophysical Office (Dr. Becker) for inclusion in a paper describing serious strikes to military aircraft.
- c) BSCE members should urge that means be provided to enable civil data to be analysed by reporter's occupation. Members who already have this information should urge the appropriate authorities to provide it to ICAO.

d) That the civil BSCE members should ask their major airlines for their movement data at airports in the system. The data would be combined with strike reports from airports and be passed to the Working Group Chairman so as to indicate those airports where a bird strike problem exists.

e) BCSL analysis should be sent by members as follows:

Civil Data to Working Group Chairman

for 1985 by 30 June 1988

for 1986 by 30 June 1988

for 1987 by 30 November 1988

Military Data to Dr. Becker

for 1987 by 30 November

for 1988 by 30 November

21. WORKING GROUP STRUCTURAL TESTING OF AIRFRAMES

The Chairman's report on the activities of the working group for Structural Testing of Airframes was presented by P. Chalot, France.

To a question from T. Brough, UK, Mr. Devaux answered that the gulls used during the experiments, mentioned in wp/31, were Herring gulls coming from the South of France. It was found that the gull was a more representative flying bird than the ducks used until now. That was the reason for choosing the gulls.

Mr. Chalot added that they were planning for a meeting to take place in Paris for testing airframes and urged people who wanted to attend the meeting to give him their names and addresses.

On the request of Mr. Chalot the meeting agreed to change the name of the working group to "Testing of Airframes and Engines".

R. Speelman, USA, informed the meeting that a conference is planned to take place in the week of the 16th January 1989 in Monterey, California, which will address specifically the subject of aircraft windshield systems, both civil and military, the design, the design process, the testing, testing requirements including the specific target of bird strikes and cover performance measurements and performance assessment technics, testing relative to performance and maintenance and durability. Applications for attending the meeting should be send to R. Speelman.

The following recommendation was adopted:

BSCE members should seek information on the retention of birdstrike capability after extended in service usage of engines and airframes.

The Chairman would see to that the terms of reference of the working group were changed according to the change of the title of the working group.

22. SUB-GROUP ON FEATHER IDENTIFICATION

The rapporteur's report on the activities of the sub-group was presented by Tim G. Brom, the Netherlands.

According to the wish of the participants in the sub-group meeting the meeting agreed that the sub-group be raised to working group level and the name changed from "Feather Identification" to "Bird Remains Identification Working Group".

The meeting unanimously elected Tim G. Brom as a Chairman of the above-mentioned working group.

It was understood that after consultations with the chairman of the working group the Chairman of BSCE should work out the terms of reference of the set group.

23. THE RADAR WORKING GROUP

L. Buurma, the Netherlands, presented the chairman's report from the Radar Working Group and added that the radar booklet would be issued in the second half of this year. It would be available to interested persons who approached Buurma and would be presented at the next BSCE meeting.

The following recommendations were adopted by the meeting:

- a) The BSCE members should urge that international cooperation with respect to further development of electronic assessment of bird hazards by radar be intensified.
- b) When quantifying bird movements, the BSCE members should urge the appropriate authority to put emphasis on the proper inclusion of bird numbers at low level.

- c) BSCE members should approach the industry to develop, commo- ally, a small bird radar according to BSCE specifications being drafted for inclusion in the radar booklet.

24. THE MIKE KUHRING AWARD

On the motion of H. Dahl it was decided that the 7th Mike Kuhring Award be conferred on Jochem Hild, FRG, in recognition of his activities during the whole existence of the BSCE from the very beginning and especially for his activities as the Chairman of the "Bird Movement Working Group" and for having represented the BSCE at various ICAO workshop meetings.

J. Hild said that he was most honoured to receive the award and expressed his sincere thanks for it. He considered himself as one of the oldest disciples of Mike Kuhring who was the locomotive of all progress and effort in BSCE for many years. He went through the founding and history of the organization beginning with the bird hazard meeting which was arranged in 1963 in Nice and followed by the first civil military bird strike meeting in 1966 in Frankfurt. He paid tribute to the first BSCE chairman, Colonel Bessel, the Kethel Jewer, and to the succeeding chairmen, hoping that the success for flight safety would continue in a period where it will be more necessary than ever to reach a mutual and effective cooperation and coexistence between the interests and demands of flight safety and environmental protection.

25. PLANNING FOR FUTURE MEETINGS OF BSCE

H. Dahl announced that the 20th BSCE meeting would be held in Helsinki, Finland, in the week that starts on 21 May 1990. He had also been in touch with delegates from other countries in order to make arrangements for future meetings of the network.

On behalf of the Finnish delegation Holkanen invited the meeting to Finland.

26. ELECTION OF CHAIRMAN OF BSCE

The meeting reelected H. Dahl for another period.

27. OTHER MATTERS

T. Caithness, New Zealand, informed that an international congress would be held in New Zealand in December 1990. The title is "The World Of Birds - A Southern Perspective" and it will comprise the 20th International

Ornithological Congress and the 20th World Conference of the International Council for Bird Preservation. The congress will be held in Christchurch, New Zealand, from 2-9 December 1990. Applications for attending the meeting should be forwarded to Mr. Gaithness.

At the request of B. Larsson, Sweden, the Chairman undertook the task of working up a list of contact persons from each country in order to facilitate the contact between the various countries. This list would be presented as a working paper by the Chairman at the next meeting.

A video film "Following Soaring Bird Migration from the Ground, Motorized Glycer and Radar at a Junction of Three Continents" was shown by Y. Leshem, Israel.

26. TERMINATION OF THE MEETING

H. Dan' expressed the gratitude of all the participants of the meeting, especially his own gratitude for the work done by the Secretariat of the meeting and presented a gift to each member of the Secretariat. He paid tribute to the very effective way in which the meeting had been arranged by the Spanish Administration and to the social arrangements such as the ladies' trip and the evening with dinner and Flamenco dances. He also thanked the City of Madrid for giving them the possibility of tasting the delicious Spanish wines and thanked the Halkor Company for providing the meeting with coffee and cookies during the whole meeting.

He thanked all the participants for the work they had done during the meeting and added that he was quite impressed by the number of working papers which amounted to 43 and said that although the meeting had not succeeded in adopting the final instrument in order to solve the bird strike problem in the various countries a good step forward had been taken during the conference. He paid in particular tribute to the valuable Spanish contribution to the working papers.

His special thanks went to the members of the Steering Committee and especially to the Vice-Chairman, J. Thorpe, and E. Schneider who had been of utmost help to him during the meeting.

The Secretary General of the Civil Aviation Administration in Spain, Don Mederas, said goodbye to the participants of the meeting with the following words:

"We have had the honour to be the country that has organized this 19th BSCE meeting that ends today. The fact of having the presence of representatives from countries with a high level of skill and experience in the BSCE in conflicted areas with bird strike control has permitted this meeting to benefit from it. We have realized that bird strike against aircraft is a problem which can be foreseen to a certain extent. But at these meetings information is exchanged between different countries and therefore we get to know the success of different systems to reduce this potential hazard. The line of defence balance to guard the different specimen in the ecological system for human and cultural benefits have been maintained at this meeting. I wish to animate you to persist in the improvement of the system you are working on. This 19th BSCE meeting has had a high level and which sometimes is more important it has been held with future prevision. I cannot assure you that the General Director of Civil Aviation will take into consideration and will apply each recommendation proposed by the working groups. Finally I wish to thank everybody for this meeting and for the cooperation of companies and congratulate the authorities in Spain for their organization of this meeting".

El Dori finalized the meeting by declaring the meeting closed.