App. II

NATIONAL RESEARCH COUNCIL

CONSEIL NATIONAL DE RECHERCHES

DIVISION OF MECHANICAL ENGINEERING

MEMORANDUM:-

TO
A Mr. M. Kuhring

MICROWAVES VS. BIRDS - A NEW APPROACH TO THE BIRD HAZARD PROBLEM IN AVIATION

The problem of dispersing birds from the flight paths of present day high speed aircraft has reached serious proportions. Microwave radiation at certain intensities has been found to have a profound effect on bird behaviour. Experiments are being conducted to determine the physiological mechanisms involved with a view, ultimately, to designing the microwave field to have the greatest possible effect for the least expenditure of power. Some of the findings and their implications are as follows:

1. Birds exposed to pulsed X-band and Ku-band microwave fields in the "slightly thermal" range (20 - 50 mW/cm^2) respond with an escape or avoidance reaction within a few seconds of the onset of radiation. Birds tested were chickens (Old English Games, Leghorns) pigeons and seagulls (Ringbill).

2. Birds exposed to a CW microwave field of "slightly thermal" intensity registered no specific reaction until they had been exposed for several minutes. The same effect was observed for infra-red radiation.

3. Different reactions were obtained with pulsed microwaves depending on the part of the animal irradiated. When irradiated from above a clear distinction has been observed between the distal dorsal and tail regions of the bird, and the head, and the neck to proximal dorsal regions. Little or no reaction apparent when bird irradiated from below.

4. Tests on the microwave absorptive and shielding properties of feathers stripped from chickens, pigeons and gulls showed no sensible absorption of microwave energy.

5. Tests on intact chickens shielded so that only the tail feathers were exposed to the pulsed microwave field revealed an intense escape reaction.

6. Follow-up tests on the piezo-electric properties of chicken feathers revealed complex vibration modes of the quill when a feather is subjected to an alternating electric stress. (Paper forward for publication)

7. Tests to determine the interaction of a microwave field with the vestibulocochlear apparatus of a chicken were conducted by systematically sectioning the appropriate cranial nerves. The results suggested that although interference does occur it is not a major contributing factor.

8. Tests conducted on the threshold and velocity characteristics of isolated sciatic nerve (rana catesbiana) exposed to pulsed and CW microwave fields revealed no sensible change over a period of minutes. (This finding has been corroborated by other investigators). The implication is that microwaves do not interact with the axonal processes of peripheral nerves. However, an investigator in Japan has very recently shown that the firing patterns of intact peripheral nerves can be influenced by X-band radiation.

9. Tests to determine the changes in feeding behaviour that can be effected by radiating their feed container revealed that chickens quickly learn to avoid a radiated area. There was also strong evidence to suggest that the birds became conditioned to stay away from that area even when the microwave field is removed for a period of days. (Paper forward for publication).

Present research is concentrated on a systematic exploration

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of Nos 4 - 9 over a wider range of microwave frequencies, pulse repetition rates, pulse widths etc. This work is being conducted in close collaboration with the Department of Anatomy of Queen's University.

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Non-thermal Effects of Microwave Radiation on Birds

MICROWAVE radiation produces both thermal and non-thermal effects on biological systems[1]. The thermal effect is manifested as a rise in temperature of the irradiated system and is accompanied by physiological responses depending on the intensity and duration of the field. Non-thermal effects are manifested as changes in cellular electrolytic transport by both resonance absorption and induced EMF's and, when neural structures are involved, are often accompanied by a specific behavioural response. To demonstrate a difference between thermal and non-thermal effects is a matter of great urgency. Chickens exposed to a "slightly thermal" microwave field (20–50 mW/cm²) respond with an escape or avoidance reaction within a few seconds of the onset of radiation[2].

The rapidity and compelling nature of this reaction led us to investigate its occurrence in relation to the bird strike problem which is now reaching serious proportions in airline operations. Experiments are being conducted to determine the effectiveness of microwave radiation as a means of deterring birds from feeding on the vicinity of airport runways and of discouraging birds from commercial flight lanes.

The physiological correlates of this behavioural pattern have been studied to develop the escape reaction further and to determine the most effective form of microwave field. Experiments were conducted on three species of chicken using a 9.3 Gc/s microwave generator pulsed at 416 pps with a pulse width of 2·3 μsec. Peak power into the horn antenna is 64 kW and the average power is correspondingly 61 W. The field intensity in the calibrated test range at shoulder level (which the floor is set at 46 mW/cm² (average value).

The general pattern of behaviour of both young and fully grown chickens in the test cage is as follows. At the onset of radiation the wing outside the field of radiation becomes collapsed and the opposite wing is extended. A similar phenomenon is observed with the legs. The chickens rotate their heads so that the eye closest to the field of radiation is ventral to the field and the sagittal axis of the head is kept in line with the appropriate axis of the body. The bird turns down to the outside of the field following this axis of the body. It is apparent that in this turning reaction the outer side of the animal is paralysed and on reaching the floor of the cage the reaction is manifested by increased extensor reaction of the inner (field) side and the head is turned to face the centre of the field.

On occasions this pattern of behaviour has not occurred and the following observations have been made. It seems that some animals present a hyperactive side. When these animals are radiated with the weak side facing the centre of the field they rapidly orient themselves so as to present the strong or hyperactive side to the field. The previously described behavioural pattern then ensues. Some birds are excited at or before the time of radiation because of outside influences, for example, handling, change of cages. These animals continue to be excited and at the onset of radiation move along the field so that one side of the head and body will be alternately outside and inside the field. Chickens in these conditions either reach a terminal state in the experiment by remaining quiet for a few seconds and then collapsing to the corresponding side, or in their agitation activate flight.

During all these experimental procedures we have observed that different reactions can be obtained from a bird depending on which surface is irradiated. Very little or no reaction is detected if the bird is irradiated from below, thereby affecting its ventral surface. When irradiated from above, however, a clear distinction has been observed between the distal dorsal and tail regions of the animal and the head, and the neck to proximal dorsal regions. In the first case, an excitatory effect is obtained which can lead to the animal changing position or flying. The second case usually ends in a collapsing action as previously described.

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