4.3. INTRODUCTION TO "BIRD STRIKES IN USSR.

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ANALYSIS OF BIRD STRIKES IN CIVIL AVIATION OF THE USSR: BIOLOGICAL AND TECHNICAL ASPECTS.

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Introduction to "Bird Strikes in USSR"
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I would like to start my report with a few remarks about Thorp's report "Bird strike analysis" delivered in London in [illegible] I972. I realize that I am very late in doing so, but-as russians say-it is better late than never. I would say that Thorp has given an universal scheme of analysis, he describes in details how to carry out an anallysis, but he does not say-what for, what aims it is designed to reach. Unfortunately I could only recently to familiarize myself with Thorp's report at 8 BSCE meeting in Paris in I973. It is excellent analysis, but it doesn't end with any general or particular conclusions, although the biological approach bird strike problem solution is a basis of BSCE activity.

In my opinion, it didn't prove its value the comparison of various parametres of a plane's flight when striking a bird (speed, altitude, strike's spot, time of day, flight phase) with a various bird's weight cathegories. This is a quantitative approach but a qualitative one is needed. Quantitative approach is undoubtedly necessary too, but it is important when one have to solve airworthiness problems. So, for example, the weight's categories may be used to find reasonnable criteria when solving airworthiness of an engine, or cabin's glass. The american DC-3 plane's accident is well known, when american swans striked plane's tail. But if all the planes will be constructed completely steadfast against strike of a bird weighting 6 kgr-such a plane may not be able even to take-off. Besides that not every case of strikes with large birds ends with an accident. For example, I know one case in the USSR when light AN-2 plane striked with a Great bus-

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tard(weighing IO kgr roundly.The bird was killed by tension rope between wings.Plane didn't suffer any harm.But such cases take place extremely seldom.Therefore,when selecting airworthiness criterion it is necessery to proceed from the frequency of strikes with large birds and from economic considerations-is it worth to increase weight of a plane?Comparison of bird stroke energy with harm caused by a stroke makes it possible to find an optimal criterion.This problem is described in the second part of the report to be delivered by Dr.Goryachev.

On basis I)of data cited in table 2)that only 3-IO% of all cases are registered and 3)because of great variation of the number of cases in year depending on methodic of data collection - we came to conclusion that there is no sense to attribute all data on a country scale to the number of plane's landing or taking-off or to IOOOO hours of a flight.One can get comparative data in the years if we take one or several uniformly observed airports.For civilien airports it is enough to attribute these data to the number of plane's take off/landing,because heavy planes on routes are flying at such altitudes,where practically there are no bird strikes at all.

Essentially the best results are delivered by bird strike analysis for specific airports.As an example one can cite a series of works of canadian,german,english,holland,swiss scientists. In Canada for example,one judge about efficiency of the measures being executed by decrease of number of serious bird strikes. The analysis of birds knocked down at runway at Vancouver airport has made it possible to ascertain the danger of owls for planes.Frequently enough are strikes with owls at Leningrad airport.So far as I saw,the analysis of bird strikes at Frankfurt/Main and Cologne/Bonn airports is one of the essential factors for evaluation of ornithological situation and of efficiency of measures being carried out.

On basis of analysis of bird strikes in the USSR a series of airports is selected which in the first turn are to be observed from ornithological point of view and at which it is planned to freighten birds by acustic means.

Later on I will cite several cases of bird strikes which, in my opinion, illustrate most clearly the biological laws disclosed as a result of analysis. I will cite the most impressive facts which confirm the biological conclusions.

I. Airport Kiyev. The rooks just came flying and April I-st 1968 one or two birds got into engine of landing plane at altitude IOO m.

2. Airport Bykovo. September 6-th I97I the Gull Larus fuscus cut by plane's propeller was found on runway. This typically migrative sea gull is "caught" here for the second time. For the first time-in I886.

3. During postnest migration from the gull's (Larus ridibundus) nest colony located 6 klm northern the airport Sheremetyevo, young birds coming for the first time to airport Sheremetyevo and even to Vnukovo (see map of airports) fall victim of birdstrikes. So, Boing 727 struck a gull August 7 1970 when Walter Scheel, FDR foreigh Minister at that time, visited Moscow for the first time. And in July IO-th I972 TU-I04 plane, while taking-off from the Vnukovo airport, struck a flock of Black-headed gulls.

When Sheremetyevo airport will be equipped with acoustic installations to frighten birds away-they will be provided with distress call of Larus ridibundus.

4. Storks have been nested in viccinity of Kharkov airport. When young bird flew out for the first time together with

parents-it was just this bird who was knocked down by a plane.

5.A plane struck a lapwing at Krasnovodsk(Eastern coast of Caspian sea)airport 28 December I97I.Lapwings aren't nesting here and come here only when migrating to winter stay.

6.Nearby Tallin airport's runway there are always 5-6 teal nests,8-9 lapwing nests,9-IO skylark nests.I don't know any case of these bird strikes.The only victims are gulls,who come to airport to take a rest during sea storm or to catch rain-worms after a rain.

7.There are no cases of rook strikes during nesting period at Sheremetyevo airport,although their nesting colony(50-60 nests roundly)is located at the very airport and one can always see 20-25 rooks looking for food on the field.

8.At Moscow's airports and in Riga one can always see 5-IO crows(Corvus corona)looking for food.They don't fall victims of strikes,even at Riga,where they are eating frequently the remains of gull,struck by planes.

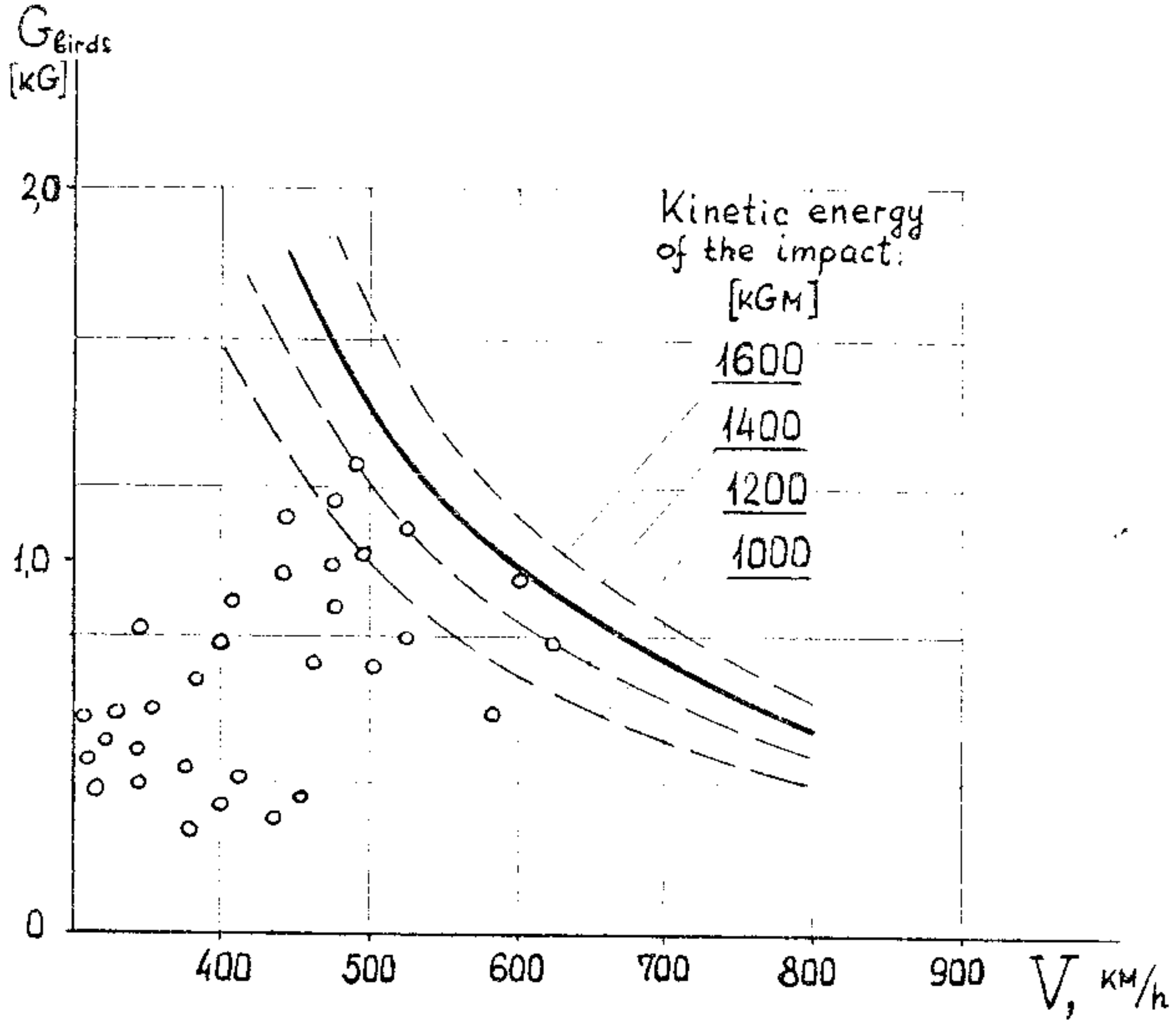
9.Small group of pigeons are living on building in Riga airport They aren't flying over airport's field and they aren't striking planes.In South Ukrainian airport Kherson pigeons were coming in flocks from the city to eat seeds of buckwheat.During this time(second part of the summer)the cases of strikes have been happening more frequently.

IO.In Kingisepp airport(Estonia)gulls are knocked down only by IL-I4 planes having speed of taking-off I80 klm/h,that is two times more than that of AN-2 planes,which are in operation here.The speed of AN-2 flight during aerochemical works reaches I60-I80 klm/h and it strikes birds frequently.

It is to be supported that birds acquire a habit of extrapolation of speed and direction of plane's flight.When making the concrete analysis of each case it turns out,that in the majority of cases the birdstrike occurs as a result of
I.Lack of the experience of such an extrapolation,or
2.Complication of condition of it's realization.
The second point includes:croockline or sloping movement of a plane,sudden(for birds)change of the flight direction(after landing or taking-off),limitation of bird's field of visibility (in darkness,in clouds,sudden appearance of a plane from , lowlevel flight of a plane while birds are at that time in vegetable cover.

The analysis of I527 cases of birdstrikes from this point of view has shown that: II,2% cases occured under crookline flight of a plane(movement in a circle,turn,curve).
- 26,5% cases took place under sloping flight of a plane(losing height or climbing).
-23,9% cases happened as a result of a sudden change of flight direction(after taking-off or after contact under landing).
-I3,7% - under poor visibility and sudden appearance of a plane close to birds(darkness,aerochemical works etc).
-I9,2% cases - during plane's flight on route out of airport.
In 5,5% cases -the places of birdstrikes was not known.

In conclusion I woul like to support the summaries of Thorpe's paper: 1. All strikes should be reported in the greatest detail.The numerous insignificant strikes provide as much useful information,as the comparatively few strikes which cause damage. 2.The continuing long term collection of bird strike data will provide a fuller understanding of the many aspects of the problem.



G birds
[kG]
2,0
1,0
0
Kinetic energy
of the impact:
[kGM]
1600
1400
1200
1000
400
500
600
700
800
900
V, км/h

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I.Methodic of data collection and the information obtained

All cases of dangerous bird strikes(injury of wing,of engine,of cabin glass and forced landing as a result)are registered by Civil Aviation Ministry.According to approximate calculation the number of registered cases amounts 3-I0% of the total number of bird strikes(nearly I500 for year).The other 90-97% remain unnoticed by pilots,don't cause any harm or are noted during afterflight inspection.as a spot of blood,particles of feathers and other remains. The information about such cases is not reported.The most often these cases happen during agricultural works when the light plane AN-2 flies at altitude I0-25 m. with speed I60 km/hour.Sometime such plane has 5-8 strikes with small birds(swallows,skylarks and others)per work season.The information about birds knocked down by planes on runway most often is not reported.Following table shows the number of bird strikes cases at our disposal in present time.

To I963	I963	I964	I965	I966	I967	I968	I969	I970	I97I	I972	I973
I3I	40	50	77	I0I	I26	2I7	22I	I53	I08	II3	I52

During I968-I970 the ornithological inspection of airports of the Baltic region,the Ukraine and the Caucasus has been carried out. The taking into a consideration the number of birds knocked down on runways and the information obtained from interrogation of flight personnel have increased the number of cases collected not only in I968-I970 but a few years before.At the end of I970 the Civil Aviation Ministry ordered that all cases of bird strikes irrespectively of consequences are to be reported.Thanks to this order the number cases obtained from Civil Aviation Ministry during I97I-I973 has increased slightly.

2. Biological aspect of bird strikes analysis

At present time the basic efforts of scientists on bird strikes problem ,including BSCE are directed to reduce the number of birds at airports or to discover the bird species harmful to a plane out of airports.

The analysis of bird strikes makes it possible:

I. To determine the bird species(sometime their age),striking with a plane.

2. To define the seasonal and dayly dynamics of bird strikes number.

3. To detect the places at the airports and in in the air where the birds present the greatest danger.

4. To explain some peculiarities of bird behaviour at the sight of a plane depending from different factors of environment.

5. Poceeding from biological peculiarities of birds-victims of planes a)to outline some measures to reduce their number within airport region; b)to define altitudes and spots out of airport where birds are discovered most frequently; c) to prognose bird's mass migration out of the airport,on plane routes.

6. Proceeding from the decrease of the total number or of the number of harmful strikes relativly to the number of planes taking off/landing at given airport - to define the efficiency of measures carried out here to prevent bird strikes.

Every airport has specific ornitophauna,specific intensity and other peculiarities of plane flights,specific kinds of aircrafts,specific landschaft-geografical condition etc.In accordance with these distinction there are different the measures for bird strike prevention to be taken [illegible] airport. The practice [illegible] [illegible] against [illegible] [illegible] crete time. The analysis of bird strikes [illegible] the first step [illegible] cretization of such measures.

The comparison of bird strikes analysis [illegible] whole with that for the [illegible] to ascertain that [illegible] the most often [illegible] birds which see plane for the first time at short distance. [illegible] happens when birds appear at airports for the first time during spring or autumn migration and post nesting roaming as well as when young, bad flying and bad orienting birds, just leaving [illegible] nest, appear at the airport. It is to be notice that the most [illegible]tive means against these birds are active repellent means ([illegible]tical, pyrotechnical etc.). Adult and settled birds, local [illegible] at airports, apparently learn quickly how to avoid strikes with planes. As a result the bird strikes occur extremely seldom [illegible] when the number of these birds is relating large.

2. There are every reasons to believe that the bird strikes are connected with the peculiarities of the extrapolation by birds the plane's speed and direction of flight. A number of circumstances hinder such an extrapolation and increase the number of [illegible] strikes. These are: a) appearance at the airport of a new plane types having higher speed; b) crookline plane flight (on ring or during turn over) sloping plane flight (taking off, landing), [illegible] change of plane's flight direction (after taking off or [illegible] touch of runway on landing) e) lack of plane's visibility ([illegible] sudden appearance from clouds).

The biological aspects of bird strike analysis has the great importance for prevention of bird hazards on airports.

3.Technical aspect of bird strikes analysis

It is known that the engines and the cockpit glazing are the critical elements of aircraft structure as far as frequency and dangerous consequences of bird strikes are concerned.

A bird(or several birds) getting into turbine engine air-intake first of all causes sharp changes in engine airflow characteristics.It may result in momentary RPM decrease,gase temperature increase behind the turbine,etc.Birds getting into the turbo-prop engine air-intake can cause automatic feathering of the propeller and sharp loss of thrust. It is especially dangerous when a collision with a flock of birds occurs during take-off as simultaneous feathering of several engines can take place.

Mechanical damage to structural elements(especially the compressor blades) in case of a bird strike is characteristic both of turbine and turbo-prop engines.Piston engine failure is usually caused by birds getting into the air-intake lattice of the carburator and air supply to the engine stopping.

Analysis of bird strike cases allows to formulate two main requirements concerning bird resistance of turbine engines:

- firstly,there should occur no engine failures in case of maximum possible quantity of small birds(starlings,for instance)getting into the air-intake;
- secondly, mechanic damage or destruction of power unit elements should not affect essential units and structural elements contiguous to the engine.

There exist different criteria of evaluating aircraft compliance with these requirements: in the first case the main factor is the quantity of birds(the flock density),in the second case it is the kinetic energy of the impact.At a certain level of kinetic enrgy one bird can cause such a damage that will justify engine change.

When finding kinetic energy of the impact it should be taken into account that the aircraft mass and speed are considerably greater than those of the bird.Also it is practically impossible to allow for the direction of the bird's flight. That is why it is possible to substitute bird mass and true airspeed of the aircraft into the formula of kinetic energy without much error.

The cockpit glazing strength requirement may be formulated as follows:

-there should be no holes in the cockpit glazing at the kinetic energy level which is considered to be the maximum possible one.

It is convenient to present the bird resistance standards of engines and cockpit glazing in graphic form(G_{bird}-bird weight,versus V - aircraft speed),giving curves corresponding to certain levels of kineticenergy.The envelope curve for the area of statistical points plotted on the same graphic should be taken as the standard.This method of establishing standards allows to test engines and cockpit glazing chosing the most convenient combinations of bird's weight and speed(birds being thrown with the help of a special cannon).