



Spring 1935; Ljubomir Ilić (dark suit) and Kosta Sivčev proudly pose for the camera in front of their first prototype, the IK-L1 at Zemun. (Photo: Yugoslav Air and Space Museum). Unless otherwise stated, photographs are via the authors

IK Fighters (Yugoslavia: 1930-40s)

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assisted by Malcolm Passingham and Waclaw Klepacki

LIKE certain people, some aircraft have qualities which single them out from the mass and which conspire to hold the interest of successive generations. Into this “star” category fits the gull-wing family of IK fighters of the 1930–40s. Yet only a mere handful of 14 ever flew. More important, historically, the next design – the successful IK-3 low-wing monoplane – had a promising career cut short by the German attack of April 1941. Only 13 had left the production line by then but in combat, briefly, the IK-3 was a fighter to be reckoned with. After the war, a much-improved successor, the S-49, was put into series production for the Yugoslav Air Force.

The student of military aviation history will discover new facets to the IK fighters in this *Profile*. For, let it be said, for many years and far too long, the Yugoslav IK fighters have been inadequately and incorrectly chronicled in the English language. – EDITOR

ORIGINS IN YUGOSLAVIA

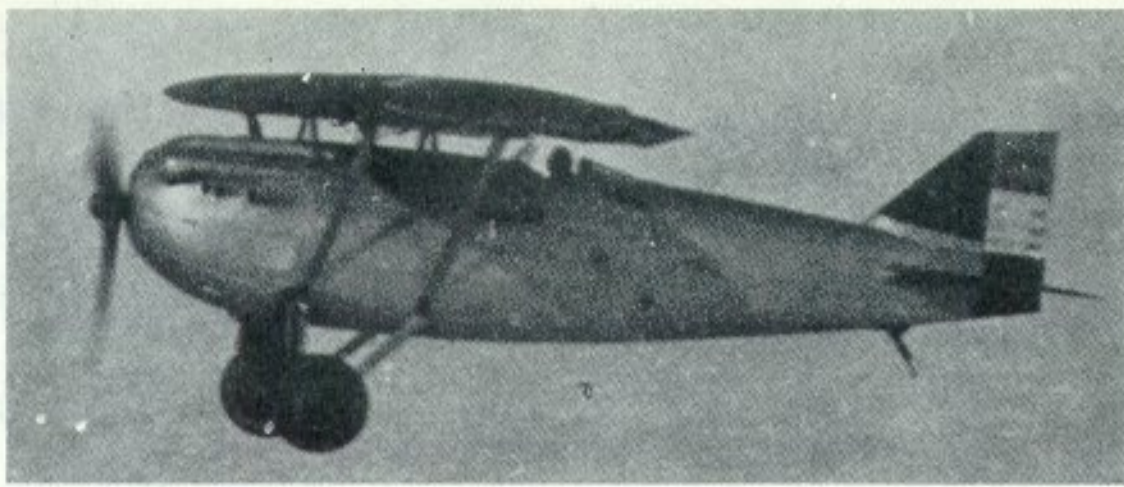
The earliest record of powered flight in Yugoslavia dates from the pioneering flight in November 1909 by Eduard Rusjan at Nova Gorica, w. of Ljubljana (then Laibach, in the southern territories of the old Austro-Hungarian

Empire). Other early pilots and aircraft designers of the Austro-Hungarian era had included Dr Vladimir Aleksić, Mihajlo Merdjep, Slavoljub Penkala and Ivan Sarić.

It was not until 1923 – and some four years after the formation of the *Kraljevina Jugoslavija* or Kingdom of the Serbs, Croats and Slovenes – that a home aircraft



The men behind the IK initials; Ljubomir Ilić (left) and Kosta Sivčev in uniform as a military pilot.



Fighters of the Yugoslav Air Force. Top to bottom, the French Dewoitine D.1 and D.9 and the Czechoslovakian biplane Avia BH 33E.

industry came into being to satisfy the needs of the fledgling Yugoslav Air Force (initially known as Military Aviation). Two manufacturing companies, both employing high percentages of skilled craftsmen, between them built under-licence Brandenburg biplanes (10 to 20 only) and small quantities of nationally-designed trainers and maritime aircraft.

The two companies involved in national production were *Ikarus A.D.* (*Akcionarsko Drustvo*) of Novi Sad, and *Prva Srpska Fabrika Aeroplana Zivojin Rogožarski A.D.* of Belgrade. During World War One, several native-born designers had worked in German and Austro-Hungarian aircraft factories. Some of them later applied their expertise in the formation of the Yugoslav aircraft industry. In particular, they helped in the production of the Rogožarski (Fizir-designed) military types and the Ikarus flying-boats which appeared in some numbers.

THE FRENCH INFLUENCE

A new chapter was opened in 1928 when the Ikarus plant at Novi Sad (subsequently complemented by a second factory, this time at Zemun) began licence production of the French-designed Potez 25 reconnaissance

biplane – of which no fewer than 240 were built. Also at Zemun, French licence-built Hanriot H.32 landplane and H.41 seaplane trainers. Dewoitine all-metal fighters and Gourdou-Leseurre B 3 fighter-trainers were produced by the *Fabrika Aeroplana i Hidroplana "Zmaj"*. The state-owned aircraft factory at Kraljevo, the *Fabrika Aeroplana Kraljevo* was to licence-build the Breguet XIX general-purpose biplane. Impressively the total was to exceed 400 examples constructed.

An important policy decision was taken in the late 1920s. At that time, the Air Force Command and the Royal Aero Club of Yugoslavia (founded 1922) promoted a scheme whereby selected aeronautical engineers still at the academic stage would be offered the opportunity of being sent to France to advance their theoretical and practical knowledge. On return from academic and research centres, factories and design bureaux, the candidates would be offered specialist posts within the Air Force or the Industry.

After this fashion, two young men were to come together to share their newly acquired aeronautical knowledge. They were Ilić and Sivčev. In Paris, Ljubomir Ilić had graduated at the *École Nationale Supérieure de l'Aéronautique*. Kosta ("Koča") Sivčev, on the other hand, as a pilot had worked both in design bureaux and at the French Air Force's *Centre d'Essai du Matériel Aérien* at Villacoublay.

Both Ilić and Sivčev had their initial bright hopes dashed by being given administrative posts on their return home. Office work, they reasoned, was not what they had been trained for in France and they resolved to pool their energies and enthusiasms in a joint venture. They were to devote their spare time to a project which began to take theoretical shape in a quiet basement in Belgrade. The first drawings of an IK fighter were produced under these conditions.

DEVELOPMENT HISTORY: IK-L1

The basic fighter aircraft of the Yugoslav Air Force in 1931 was the Czechoslovak Avia BH 33E, powered by a 480 h.p. Bristol Jupiter VII permitting a top speed of 294 km/h (182.7 m.p.h.). The replacement of this equipment was the objective of Ilić-Sivčev private-venture fighter project. Progress was kept a closely guarded secret even when the young designers moved their drawing boards into Ilić's apartment at Novi Sad and worked on into the early months of 1932. During all this time their efforts were limited to their spare time after a day's work in their offices.

The original concept had been a low-wing monoplane with a retractable undercarriage, but in deference to current prejudices, a strut-braced high-wing monoplane was evolved, armed with a hub-firing cannon and fuselage-located synchronised machine guns. These needs were met by the French-built 20-mm Hispano-Suiza 404 cannon, incorporated in the 12-cylinder Vee 860 h.p. Hispano-Suiza 12Ycrs "Moteur Canon".

Emphasis was placed on engine power, speed, manoeuvrability, climb and fire-power. Accordingly, Ilić and Sivčev accepted what was regarded at that time as an extremely powerful aero-engine. They realized that this decision would provoke opposition from contemporary Air Force experts who considered that high power was inappropriate for fighter aircraft. The considerable weight of the engine and the centrally-located

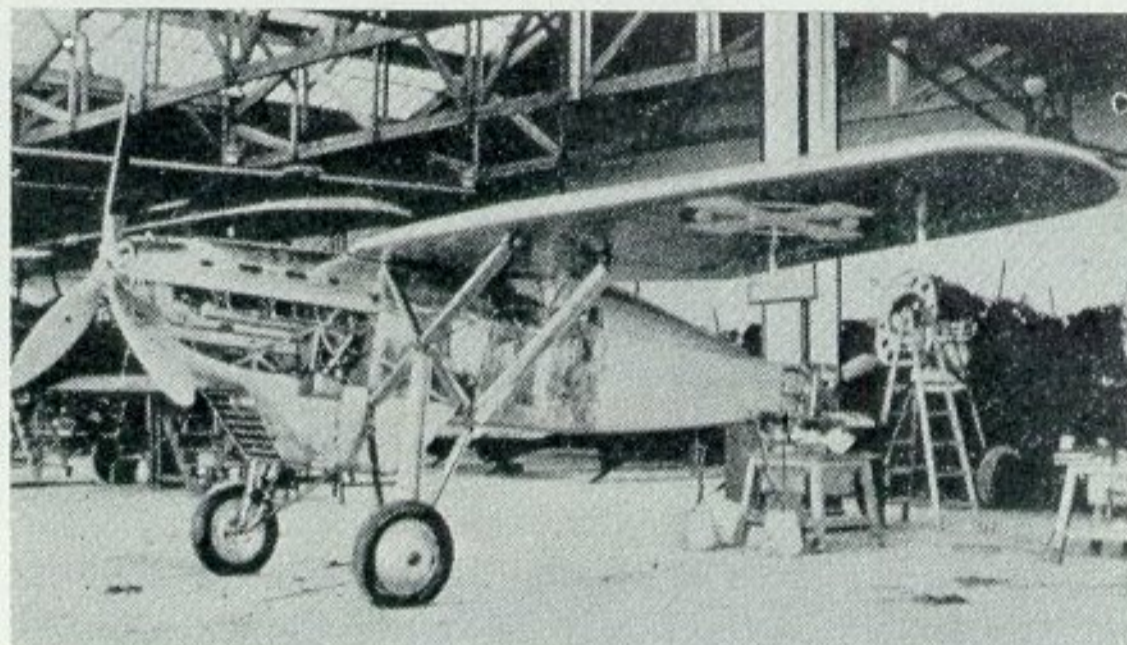
armament were factors which dictated a metal fuselage structure. Thus, the first Yugoslav all-metal, cannon-armed fighter was initiated. In addition to the cannon, two 7.7-mm. synchronized French Darne machine-guns, the type then standardized by the Y.A.F., were proposed.

Although the concept was clear to the designers and was firmly based on aerodynamic, tactical and flying considerations, even so, much was required to be done before the first Yugoslav-designed fighter could be ready to patrol its native skies. Pre-project, basic aerodynamic and other necessary evaluation work was completed by early 1933. An accurate wooden scale model was prepared and Ilić went to Paris to test it in the Eiffel wind-tunnel. During all these stages the designers received no outside financial assistance and were forced to borrow from relatives to keep their efforts going. After extensive testing of the model and consequent aerodynamic improvement of the project and redrawing of plans, work started on the detailed part drawings.

The designers eventually took the decision to reveal to their chief the existence of their private venture. Ing. Srbobran Stanojević, with the rank of Potpukovnik (Lieutenant Colonel or RAF Wing Commander) was a veteran pilot who had studied aeronautics in France and was then in charge of the Technical Department of the Chief of the Air Force Command. After his initial surprise, he gave his approval, indicated his delight at the detailed drawings and promised all possible support for the project. A report proposing the building of the fighter was officially presented on September 22, 1933.

Initial opposition came from some older and senior Air Force officers whose flying careers had reached their zenith in obsolete biplanes. Such experts could hardly be expected to put their trust in the monoplane, especially an all-metal aircraft with a hub-firing cannon! In every respect the new fighter conflicted with their preconceptions.

One of the most vocal critics was the currently

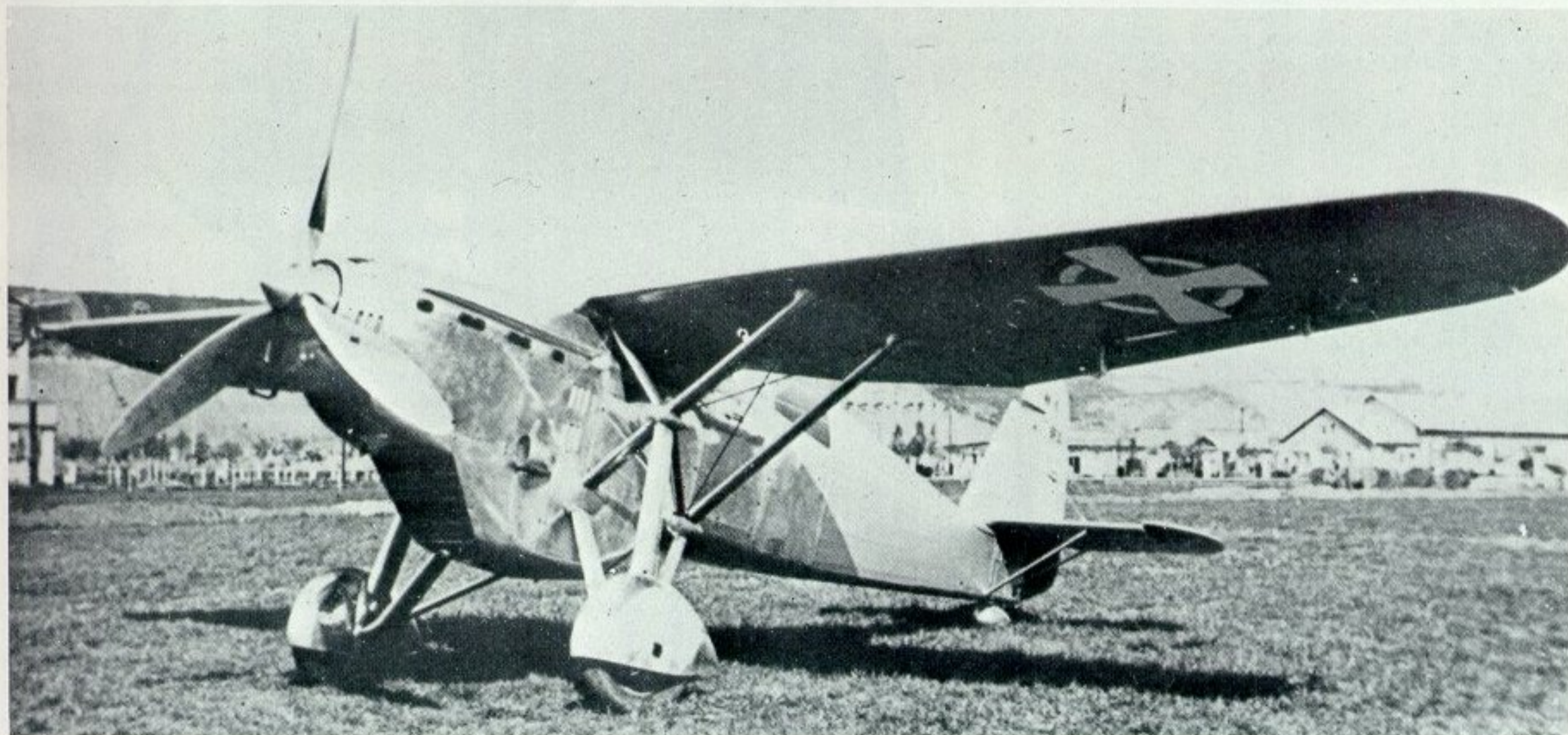


Two aspects of the IK-L1 prototype nearing completion at the Ikarus factory, Zemun.

acknowledged outstanding exponent of fighter tactics, Leonid Bajdak. He regarded the biplane of up to 600 h.p. as the last word in fighter design. It was also contended that the small and relatively undeveloped Yugoslav aircraft industry was incapable of producing its own successful metal prototype.¹ Nevertheless, with support

¹ Argument could have been promoted on basis of "more power equals increased weight"; however the "metal prototype" argument could be countered by reference to existing licence-built construction of Dewoitine D.1, D.9 and D.27. — Editor.

At an early stage, the IK-L1 was equipped with handsome streamlined main and tail wheel spats. These are said to have enhanced performance by about 8–10 km/h (5–6 m.p.h.). No armament on this prototype. (Photo: Passingham-Klepacki Collection)





Without wheel spats, the prototype IK-L1 in April 1935 at Zemun airfield.

(Photo: Yugoslav Air and Space Museum)

from younger and more far-sighted pilots and the prestigious backing of the Head of the Technical Department, official blessing was finally forthcoming for the project.

The prototype was ordered in 1934 from the Ikarus factory at Zemun (now virtually a suburb of Belgrade), with contract delivery at the end of the year. The fighter was designated IK-L1 and bore the manufacturer's number 01. The letters I and K in the designation stood for the initials of the two designers Ilić and Kosta ("Koča") Sivčev. The L1¹ indicated "fighter single-seat" in the style of the "Armée de l'Air"; the number 01

indicated that this was the first prototype. Later with the decline of French influence, functional designators such as L1 were abandoned.

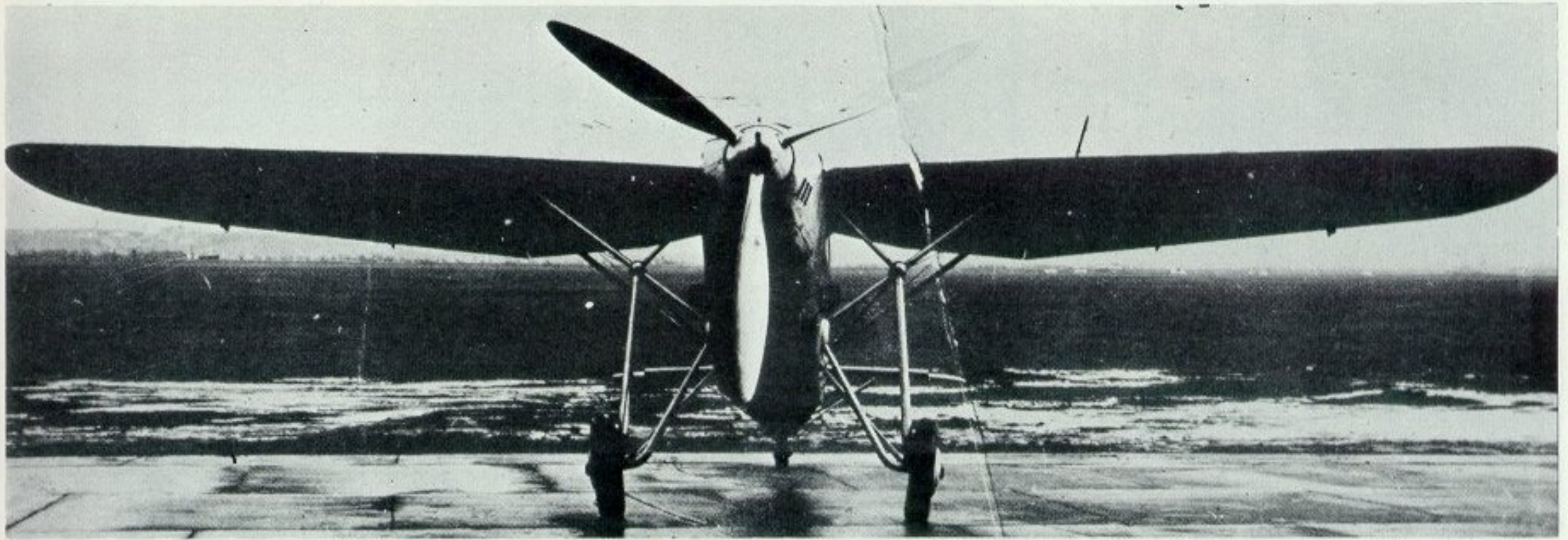
It is believed that the construction stage was completed during September, 1934, but modifications delayed the first flight and meanwhile the wing structure was subjected to rigorous static testing, underlining official doubts about this feature of the design and their requirement of a safety coefficient higher than those acceptable in Great Britain, France and Germany.

¹ "L" stood for "Lovac" = "Chasseur" = Fighter.

Another view of the IK-L1 in April 1935 at Zemun.

(Photo: Yugoslav Air and Space Museum)





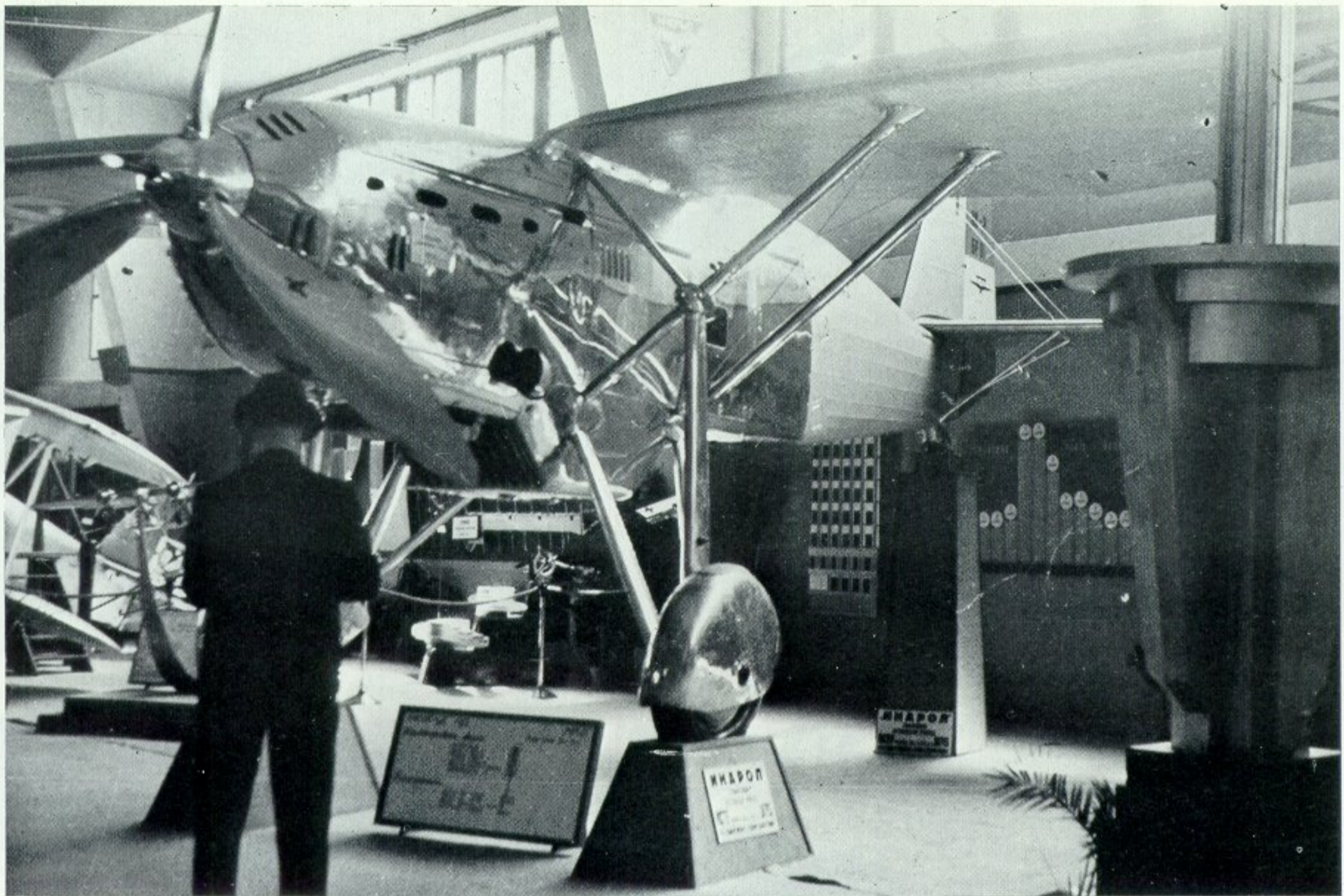
Spring 1938, with traces of snow beyond the hardstanding at Zemun airfield. The second prototype, the IK-02 shows for the first time the hub-firing cannon. The ventral oil cooler is visible because the radiator bath originally incorporating it has been considerably cut back. Test pilot Janko Dobnikar provides the signature as well as these two photographs.

In October 1934 Kapetan Bajdak was appointed test pilot for the IK fighter. This might be regarded as an unfortunate choice since he had so clearly been opposed to the whole concept of the new design! He failed to co-operate in the final stages of the work preparatory to the first flight and refused to accept the mandatory flight test programme. Instead he decided his own programme and in so doing sealed the doom of the first prototype.

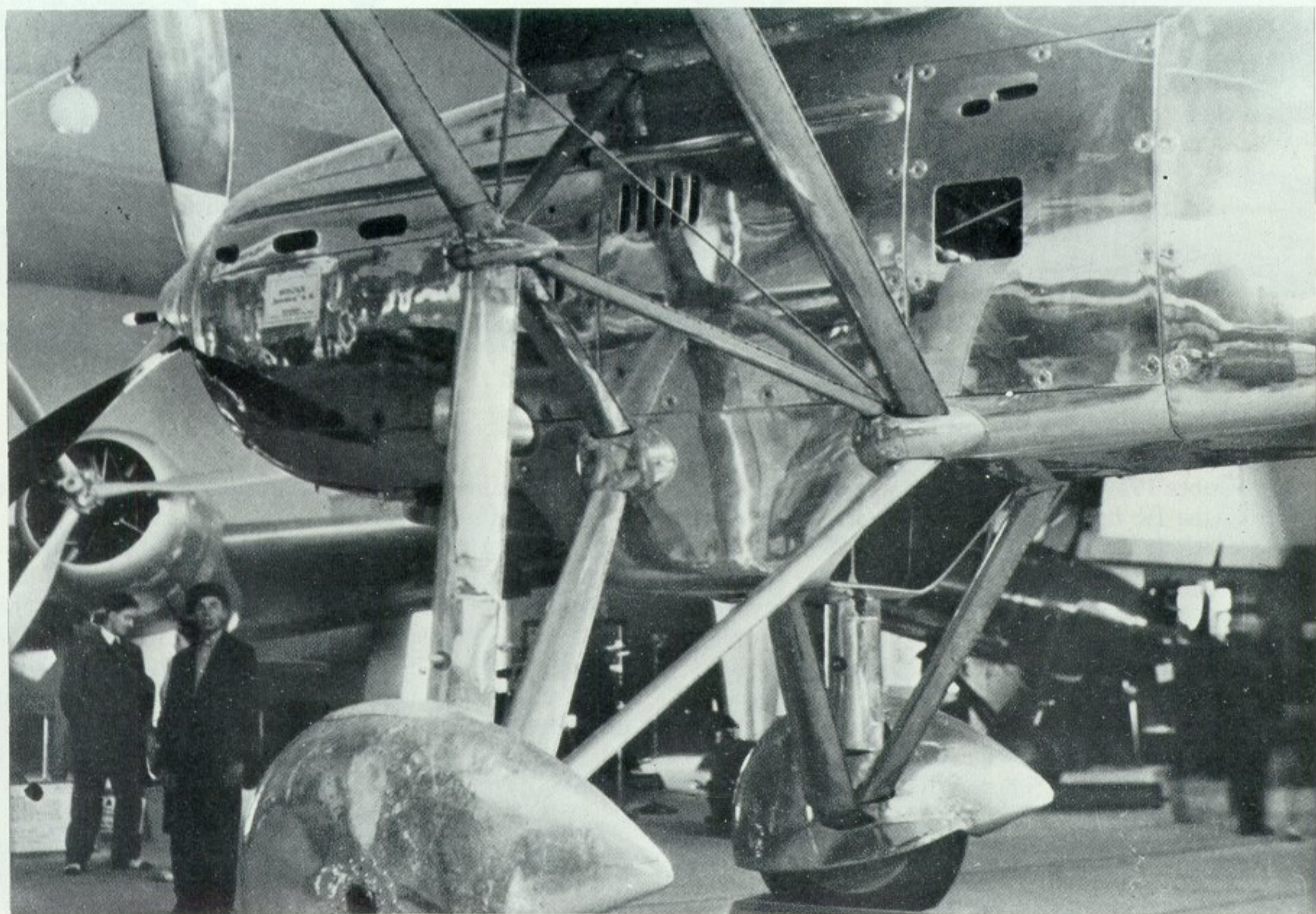
Permission for a test flight was given in April 1935 and the IK-01 took-off for the first time on April 22 from Zemun airfield. The designers stipulated a take-off weight of 1.650 kg. (3,630 lb.) for the flight. No armament was installed and the fuel load was reduced (to about 150/200 l. or 33/44 gal.), the object being to reduce

possible strains on the aircraft during the test flying. The first flight was uneventful.

The following day, Bajdak put the fighter into unplanned manoeuvres and aerobatics. After he had landed, the fabric wing covering was observed to be rather slack. A responsible official of Ikarus A.D. gave his opinion that the fabric would stretch satisfactorily as soon as the varnish which was applied had fully dried out. The third flight on April 24 included more aerobatics. At 1,000 metres (3,300 feet), the IK-01 went into a shallow dive and then pulled out abruptly and at high speed. The resulting strain was too much for the fighter. A gap appeared in the fabric covering of the starboard wing leading-edge, rapidly widening so that the fluttering of the torn material could be seen clearly from the ground.



First prototype IK-2 (the Br.01) was displayed at the first-ever Belgrade international aero show in June 1938. The lower photo shows to advantage the Messier long-stroke main undercarriage and the radiator bath. Both photos reveal a touch of showmanship in that the hub-firing cannon (or dummy) is surmounted by an electric light bulb. (Photos: Alex Imrie Collection)



This photograph, the last of Alex Imrie's trio of rare shots of the IK-2 Br.01 taken at the 1938 Belgrade Show, permits examination of the metal-covered mainplane and the streamlined stubs to the aileron mass balance arms. (Photo: Alex Imrie Collection).



The aircraft dropped away in a spin to starboard. Bajdak baled out safely and the abandoned aircraft crashed.

Experts and eye-witnesses confirmed that the coming adrift of the fabric from the wing leading-edge had been the cause of the accident. The hand-sewn seam failed to stand up to the strain imposed on it. Bajdak must be blamed for ending the career of IK-01 before it had even proved itself in level flight and before serious testing had been started.

The crash gave the critics their chance to voice open dislike of the whole concept and the designers and their supporters came under heavy attack. Opponents concluded that the IK fighter had been brought forward too soon and that current state of the Yugoslav aircraft industry rendered it incapable of constructing a modern fighter aircraft!

In his accident report Bajdak emphasized the IK-01's obedience and precise response to the controls and then went on to stress the poor visibility from the cockpit during take-off and landing, with the pilot located immediately behind the wing. He referred to the take-off and landing runs as "too long", but the 300 metres (1,000 ft) landing run was not excessive for an aircraft with a top speed of 400 km/h (250 m.p.h.), unless the judgment was being made by a pilot accustomed to flying outdated biplanes! Bajdak concluded that the IK was similar to the Polish P.Z.L. fighter.

Despite Bajdak's view, however, it must be emphasized that the IK's maximum speed was higher and that it bore only a superficial resemblance to the Polish fighter.

After only three flights it was not possible to give a considered verdict on the IK-1¹ and the experts were naturally divided in the ensuing fierce debate. The designers came under considerable pressure not only because of the crash itself but because of the widespread criticism of every aspect of the fighter's design which followed. Eventually the view that the aircraft had been well designed, but had reached an imperfect stage of development and required much more testing, prevailed and once again full support was given to the IK project. The next move actually came from the Ikarus A.D. factory, which constructed a second prototype as much to vindicate the standard of its own workmanship as to

prove the skill of the designers. Although the aircraft was lost, the short career of the IK-1 fighter heralded a new era in Yugoslav aircraft design.

SECOND PROTOTYPE: THE IK-02

Work on the construction of a second prototype, designated IK-02, lasted 10 months. Again collaboration between the designers was on an equal participation basis. The essential difference between IK-1 and IK-02 was in the introduction of metal sheeting as the wing covering. Consequently the whole aircraft, apart from the fabric-covering for the rear fuselage and tailplane, was of metal.

At the request of the Air Force the new wing had been tested with fabric as well as with metal covering. Three wing halves had been constructed, one for static testing. The wing proved free of structural weakness. The fuselage was better streamlined than its predecessor, with a radiator of reduced size and improved shape. The air intakes were also extensively modified and improved. In addition many minor modifications were included in the design.

Following delivery the first flight took place on August 24, 1936. The new test pilot was Poručnik² Janko Dobnikar, who had maintained close co-operation during construction of the aircraft and was in constant touch with the designers. In fact, some of his suggestions for improvements in cockpit layout had been incorporated in the new prototype. In accordance with the contract the IK-02 was to be subjected to a completely new rigorous programme of testing and underwent trials at the hands of a newly-formed Test Group. A Test Centre was organized on the lines of that maintained by the French, with equipment for calibrating speed, climb, load and other characteristics. The IK-02 was the first Yugoslav aircraft design to be subjected to such a detailed examination. On one flight the accelerograph recorded a force six to seven times that of gravity – 6 to 7g. Flying strictly in accordance with the agreed programme. Dobnikar had gradually gained complete mastery of the aircraft. On one occasion he made an inverted Immelmann turn (a half-inverted loop) and, during the visit of the Turkish statesman Ismet Ineni to Yugoslavia, he put on a display which included a complete inverted loop. On that occasion he aroused considerable admiration with a sequence

¹ IK-L1 was commonly known as the IK-1, both designations being correct. The designation IK-01 was never used, but Br.01 indicates the construction number of the first prototype. Br. also represents an abbreviation for "broj" = "number."

² See list of ranks and British equivalents at end of Profile.

of daring aerobatics. In mid-October 1936, Dobnikar attained a speed of 435 km/h. (272 m.p.h.), breaking the unofficial European speed record for aircraft with fixed undercarriages and, at the same time, establishing a Yugoslav absolute speed record.

The 12Ycrs engine in practice developed greater power at heights of between 4,000 and 5,000 metres (13,000 to 16,500 ft) than had been claimed by Hispano-Suiza. During tests with IK-02, it attained 15 h.p. more than the estimate at these heights. Subsequently Hispano-Suiza corrected their performance graph.

The engine efficiency and aircraft speed was enhanced by the adoption of air intakes of optimum form. Flight with the cockpit hatch open was found to reduce speed by 15 km/h (9.3 m.p.h.) and removal of the streamlined wheel spats resulted in a loss of a further 8 to 10 km/h (5-6 m.p.h.).

After the initial flights, Dobnikar concluded the next part of the test programme successfully and reception of the prototype by an Air Force Commission took place in September 1936. Testing continued until November 8, 1936, providing basic data relating to climb characteristics, speed and behaviour of the aircraft in all stages of flight, including aerobatics. Diagrams showing climb rate and speed under various specific loads were elaborated at the Test Centre.

Dobnikar submitted his final report on May 23, 1937. After Air Force acceptance, a group of some of the most proficient officer pilots flew the IK-02 under simulated combat conditions between June 13 and June 24, 1937. In sixteen mock dogfights the IK-02 outclimbed, out-turned and showed greater speed than the Hawker Fury I (*see Profile No. 18*), establishing its overall superiority. Each pilot flew the Fury I and the IK-02 alternately. Their report suggested the equipment of one Grupa¹ with the IK fighter.

During the course of these comparative flights the designers and the prototype's test pilot achieved their hour of triumph. In spite of the successful completion of test, Kapetan Bajdak was still not fully convinced and on one occasion expressed his doubts too loudly. Thus provoked, Dobnikar challenged Bajdak to a duel – the IK-02 versus Bajdak's mount, the Fury I. Bajdak had no alternative but to accept.

The terms of the contest were:

1. Climb to an altitude of 4,000 metres (13,000 ft) with a barograph for recording purposes;
2. A there-and-back race over an 87-mile (140-km) course Belgrade-Novi Sad-Belgrade;
3. Finally, "combat" over Zemun airfield.

On the appointed day the contestants took off together. The IK-02 won the first round, climbing at a steep angle to reach the stipulated altitude first and then heading for Novi Sad and back to Belgrade to take the second round. It was the encounter over Zemun, however, which provided a fitting climax to the contest. Two daring and skilful fighter pilots were pitted against each other and despite Bajdak's attempts to position his Fury advantageously, the IK-02 caught its opponent and kept it in its gunsight, defeating every effort to escape. Bajdak was finally forced to give up and conceded victory to the IK-02.

On November 20, 1937, a formal proposal was made to order a batch of IK fighters, War Ministry approval

Key to colour illustrations

- 1 First prototype. Legend on rudder reads: (Cyrillic letters) IK-L1 Br.01; (Latin letters below Ikarus trade mark) HS-YCRS indicating the type of Hispano-Suiza engine.
- 2 Second prototype: (Cyrillic) IK; (Latin) No. 02 HS-YCRS.
- 3 Production IK-2 (No. 2108) of the 34th Grupa, 4th Puk, Yugoslav Air Force in 1941.
- 4 Production IK-2 of the Croatian Air Force in 1942.

was given the following month and Ikarus was requested to build 12 aircraft. This initial or "zero" series would be treated as on continual test and, if the type proved itself in service, a further production series was to follow. The test pilot's observations, the Commission report and the comments of the experts, particularly of the designers, resulted in the incorporation of a number of new modifications in the production version, the IK-2. Dobnikar's final report put an end to various tendentious opinions previously expressed about the new fighter. Besides making minute in-flight checks, he carried out air-to-ground test firing. The results proved the deadly accuracy of the centrally located armament. They were considerably better than had ever previously been achieved in the Yugoslav Air Force.

Test flying of the production aircraft and subsequent adoption by the official commission occupied a further year before the type entered service. Meanwhile the biplane versus monoplane debate had reached its climax with the acknowledgment of the supremacy of the low-wing monoplane.

The accident to the prototype IK-01 had created an atmosphere of caution. The loss of time before the design was accepted and the slow rate of construction and acceptance resulted in the production IK-2 failing to reach the fighter units until it was already obsolescent. In these circumstances it is not surprising that only the single series of 12 aircraft was procured.

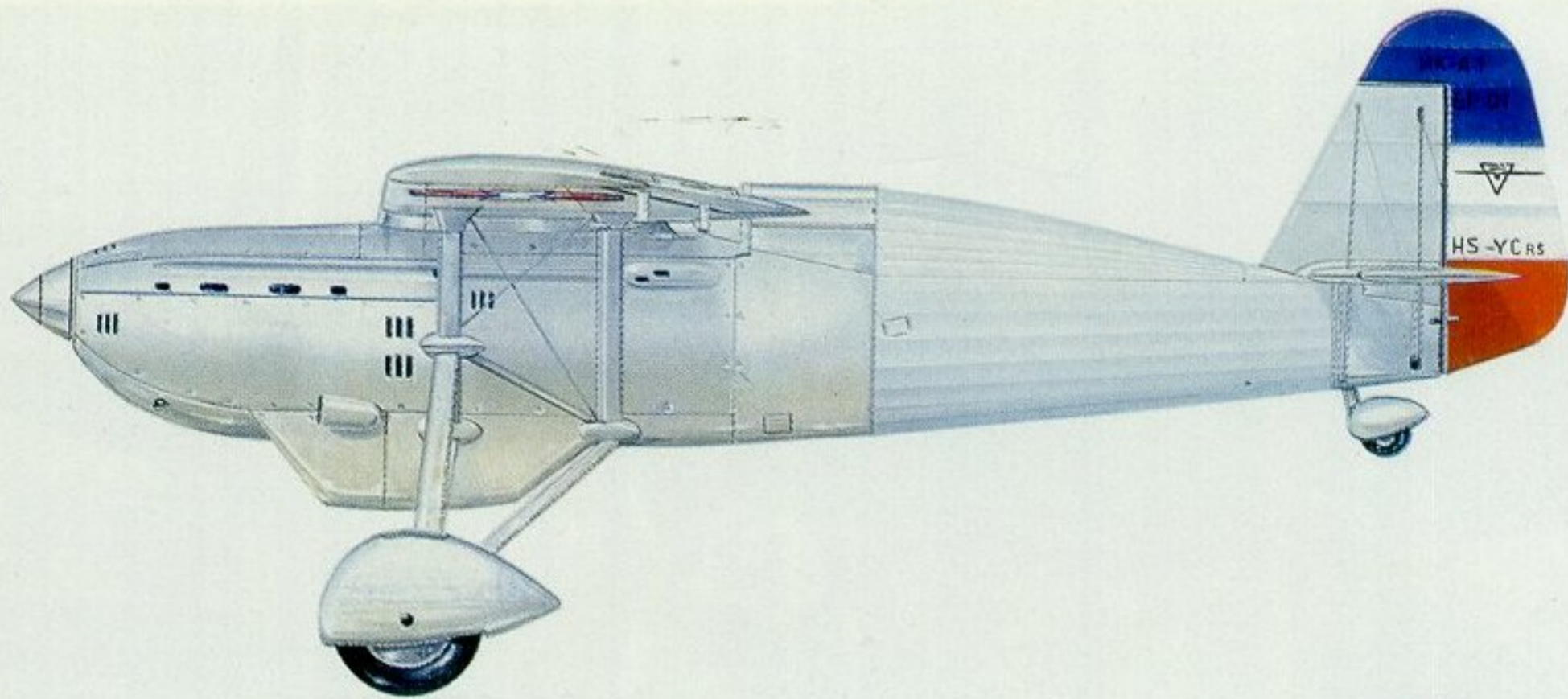
The fate of the IK-02 prototype is uncertain. It is known that Test Group Kapetan Bjelanović got into difficulties while flying through a storm and had to parachute from a burning IK fighter. What is not certain, however, is whether this was the IK-02 or a production aircraft.

IK-2: A LATE ARRIVAL

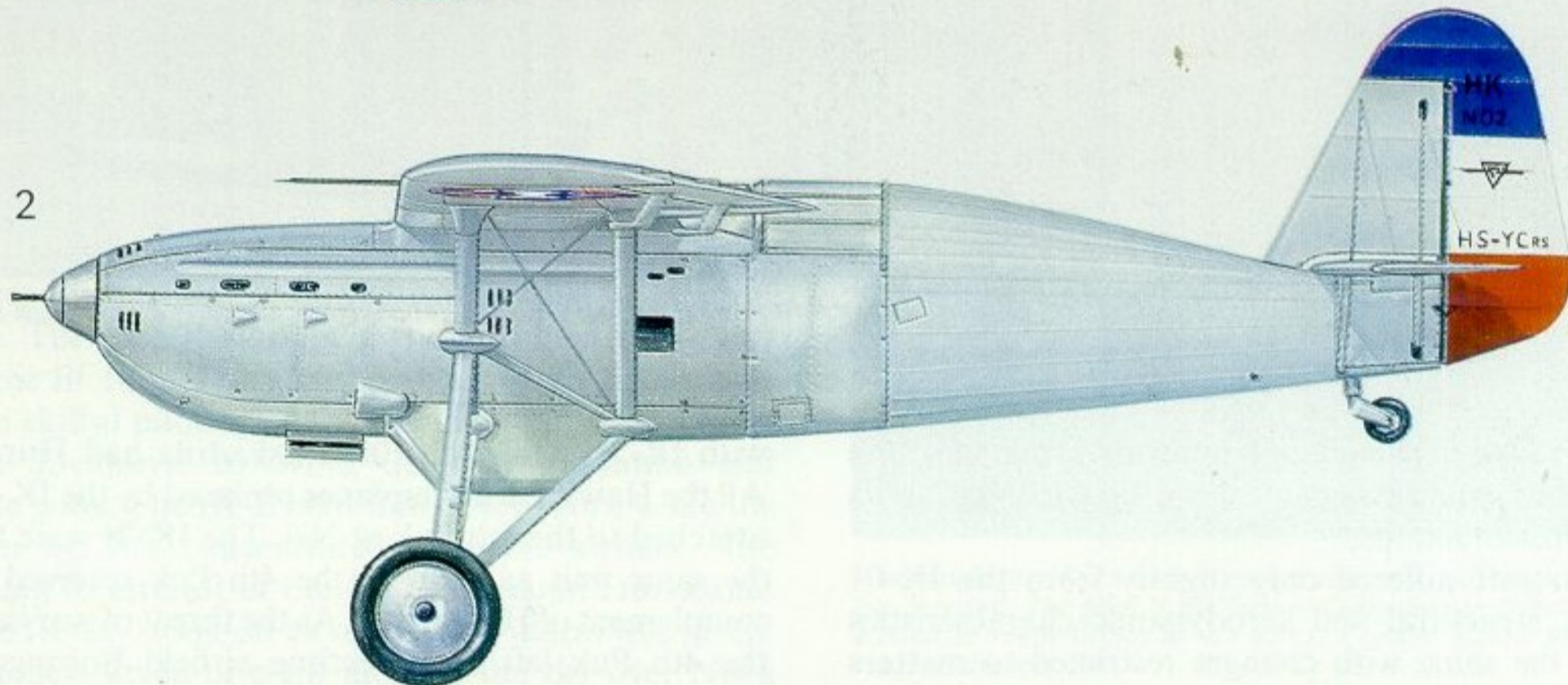
The production IK-2s were delivered in early 1939, the first six forming the equipment of the 6th Puk based at Zemun. The service pilots tested all the aircraft successfully, but gave special attention to the first one delivered, subjecting it to a most detailed examination. By mid-1939 these six aircraft were on normal unit strength and the rest of the series entered service during the year. The

¹ For strengths of various units and R.A.F. equivalents, see the end of this Profile.

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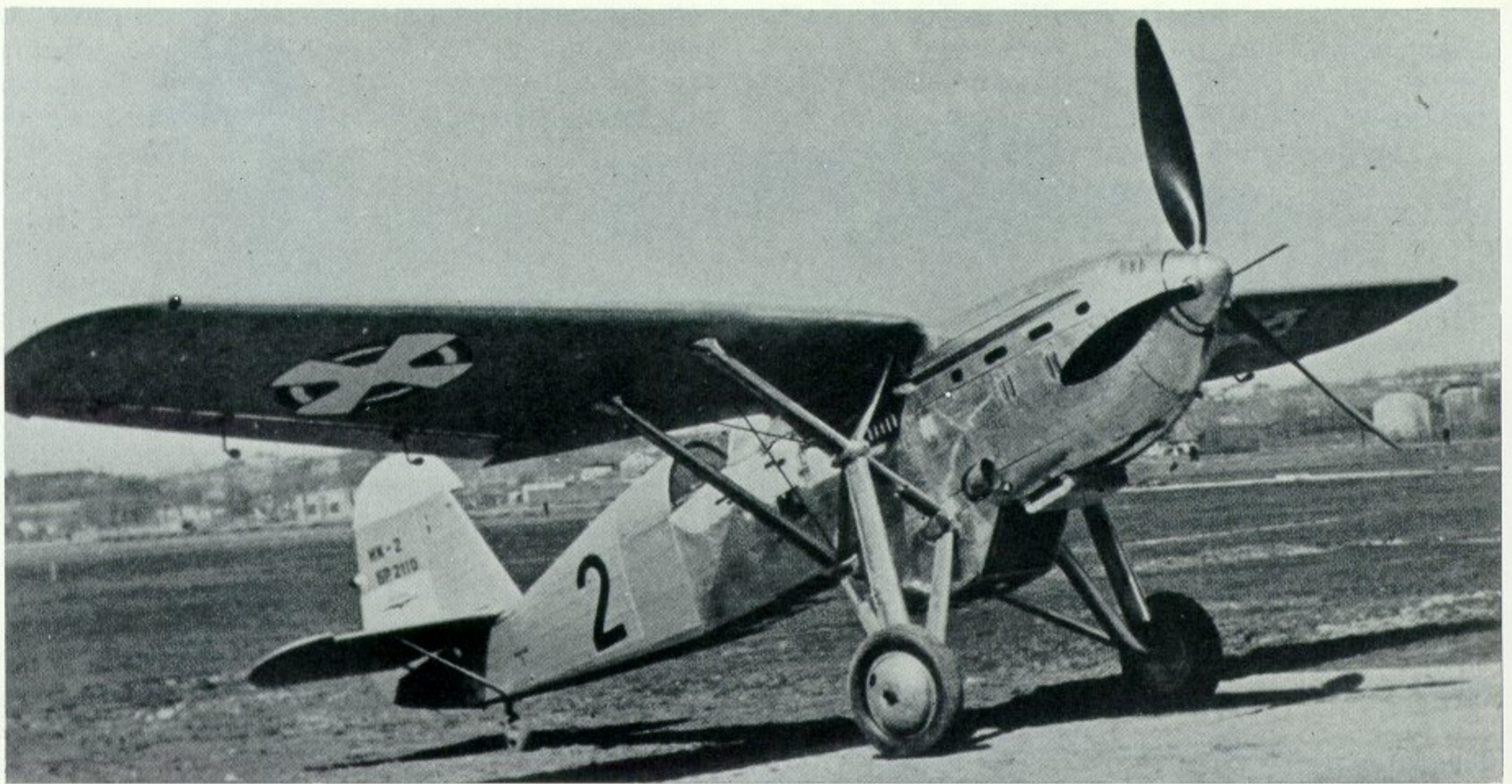


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Production IK-2 (No.2110) has no projecting hub-firing cannon but incorporates wing leading-edge navigation lights; similarly a navigation light is on the rudder. Note that the propeller blades are dark painted.

aircraft were received without radio or armament, the installation of which was carried out by Air Force units in their own workshops.

These aircraft differed only slightly from the IK-01 and IK-02, structural and aerodynamic characteristics remaining the same with changes restricted to matters of detail such as instrumentation and equipment.

In October 1939 the IK-2s moved to Zagreb to bring the 4th Puk to full strength until licence-built Hawker Hurricanes (*see Profile No. 111*) arrived from Zemun. Afterwards, it was planned that the IK-2s should join the 5th Puk at Niš.

By the end of 1940 all IK-2s were concentrated in the 34th Grupa. Its 107th Eskadrila was wholly equipped

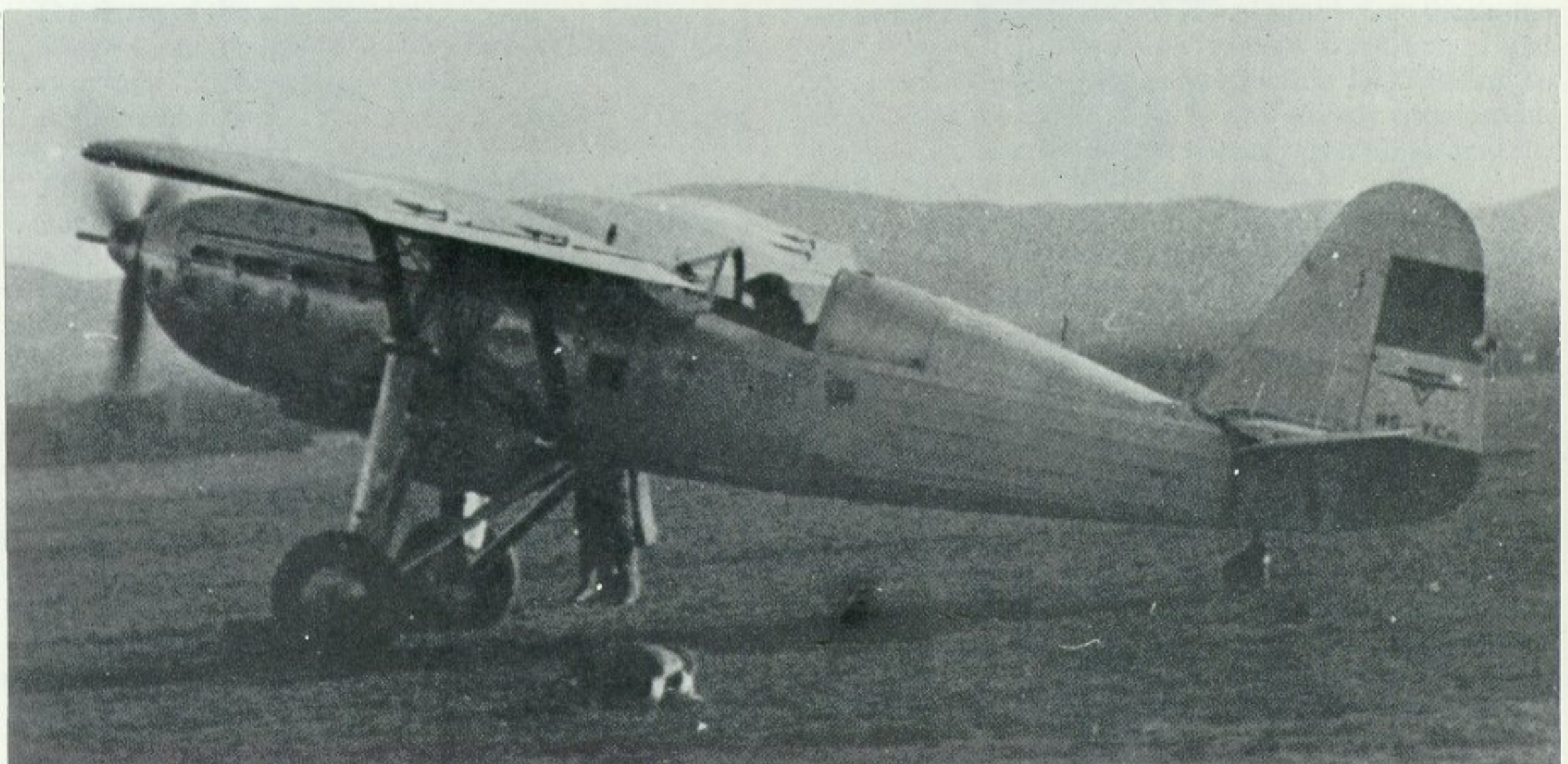
with IK-2s, while the 108th Eskadrila had Hurricanes. All the Hawker Fury biplanes replaced by the IK-2s were attached to the 5th Puk at Niš. The IK-2s were to go to the same unit as soon as the 4th Puk received its full complement of Hurricanes. As the threat of war increased the 4th Puk left its peacetime airfield Borongaj, near Zagreb, and moved to Bosanski Aleksandrovac near Banja Luka on March 13, 1941.

IK-2 IN OPERATIONS

At the time of the German-Italian invasion, eight IK-2s were in flying condition. One other had been badly damaged in a landing accident, two were in the Zagreb repair shops while another, at Bosanski Aleksandrovac,

Another production IK-2 (No.9). Hub-firing cannon has been fitted and ring-and-bead sight is just visible.

(Photo: Janko Dobnikar)



was in a badly damaged state. The Commanding Officer of the 4th Puk during this period was Kapetan Žarko Vukajlović, who has provided much valuable help in the preparation of this Profile.

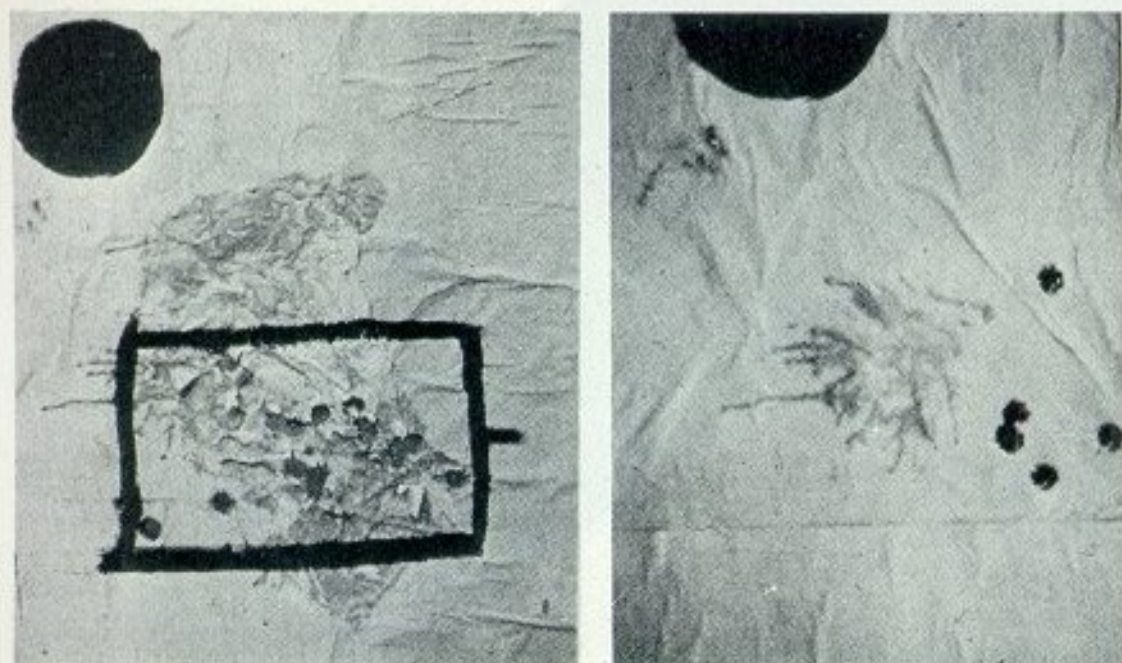
On the first day of war, April 6, 1941, the 107th Eskadrila policed the Bosna district without establishing contact with the enemy. One pair of IK-2s formed a protection patrol over the Nova Topola airfield of the 8th Bomber Puk. The short range of the IK-2s meant that only intermittent patrols could be mounted over Bosna the following day. No German aircraft was observed. Guard was maintained by a detached pair of IK-2s over Nova Topola.

The third day, April 8, IK-2s gave chase to a single German reconnaissance aircraft, but without success. Later one IK-2 forced-landed, leaving seven in operational service.

Defying the bad weather on April 9, IK-2s took off in pursuit of several enemy observation aircraft. Then at 14:00, 27 yellow-nosed Messerschmitt Bf 109s were observed heading for Nova Topola just as two IK-2s were landing from patrol. One IK-2 overshot and climbed to intercept the raiders, but the other aircraft had already touched down and was unable to take off in time. The lone IK-2 pilot was confronted by no less than nine Bf 109s. The good qualities of his fighter and his own skilful piloting enabled Podnarednik (Sergeant) Branko Jovanović to avoid the enemy cannon and machine guns. The IK-2 went into a steep turn while the German fighters concentrated over the airfield. The remaining 13 aircraft of the 4th Puk – eight Hurricanes and five IK-2s – took off as soon as the alarm was given. For the next seven or eight minutes the sky over Nova Topola was full of Yugoslav and German fighters engaged in a fierce struggle, then the Messerschmitts broke off, leaving two of their comrades shot down. In addition several of the German aircraft had been badly damaged. The Yugoslavs had lost two Hurricanes and one IK-2. Only six aircraft of the 107th Eskadrila remained.

The next day one IK-2 was forced to land due to engine failure, but despite the reduced number of aircraft available and the deteriorating weather, combat patrols were maintained. At midday on April 11 all flying ceased. The worsening military situation and the proclamation of the separatist pro-Axis state of Croatia led to the collapse of the Yugoslav armed forces. The curtain fell finally on the Y.A.F. IK-2s on April 12. Aircraft of the 4th Puk, including the surviving IK-2s, were put out of action by their own crews. Not all the aircraft, however,

Ground target 20-mm. cannon shell grouping assessment was conducted with the IK-02 during this prototype's trials.



A camouflaged IK-2 with hub cannon removed and standard spinner nose cap inserted. The pilot is the former Commanding Officer of the 107th Eskadrila (34th Grupa of 4th Puk), Captain Zarko Vukajlović, who supplied this snapshot.

were wrecked and the Croatian separatist forces managed to render three or four serviceable by utilising other captured aircraft for spares. It is known that on Rajlovac airfield at Sarajevo an IK-2 bearing the Ustashi¹ serial 2903 was seen in flying condition in 1942. However, no IK-2 survived the end of the war.

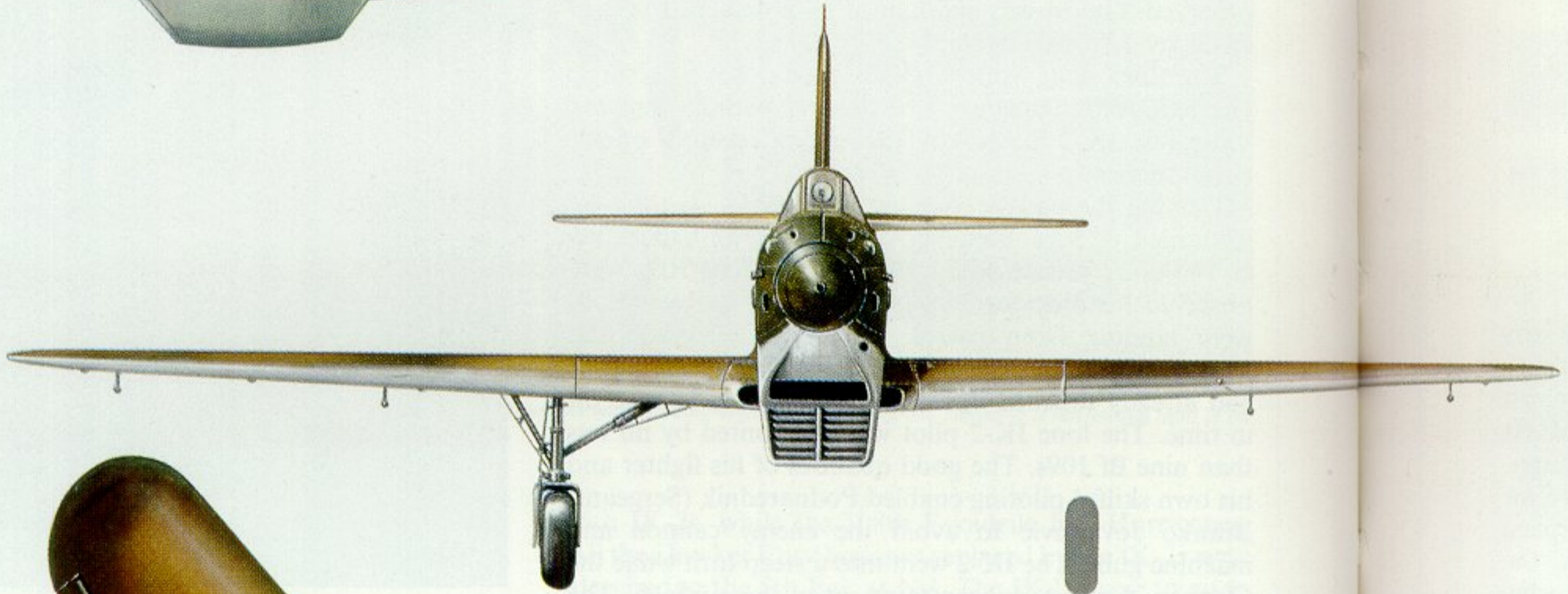
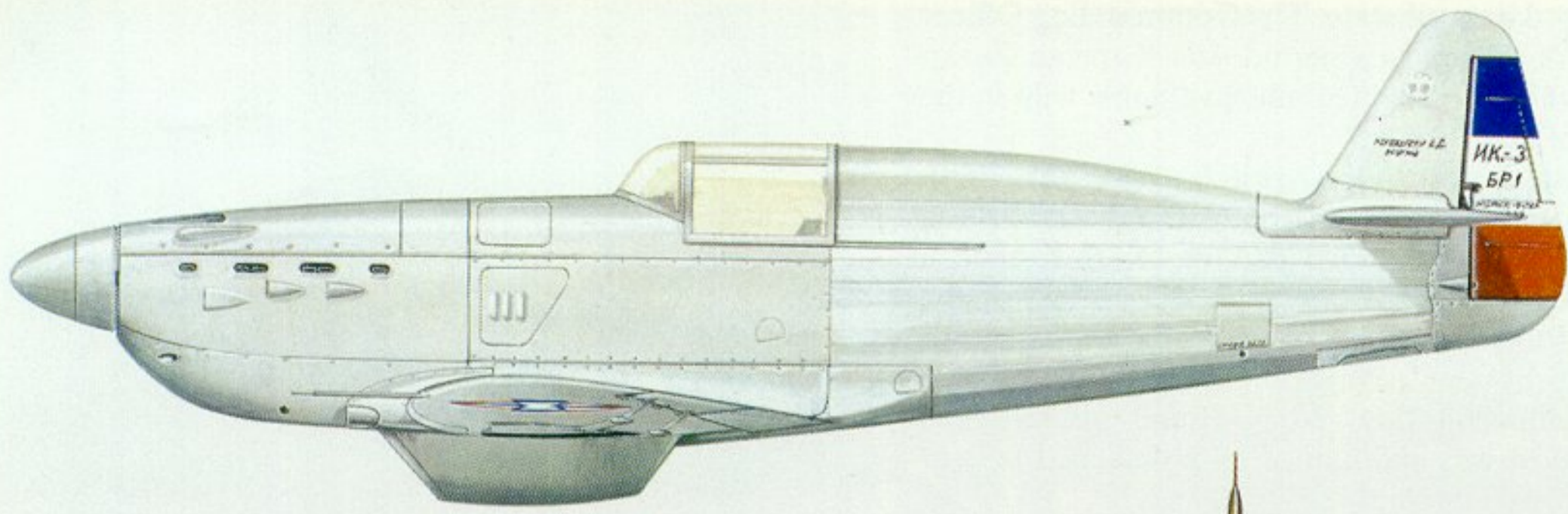
THE IK-4 TWO-SEAT TRAINER

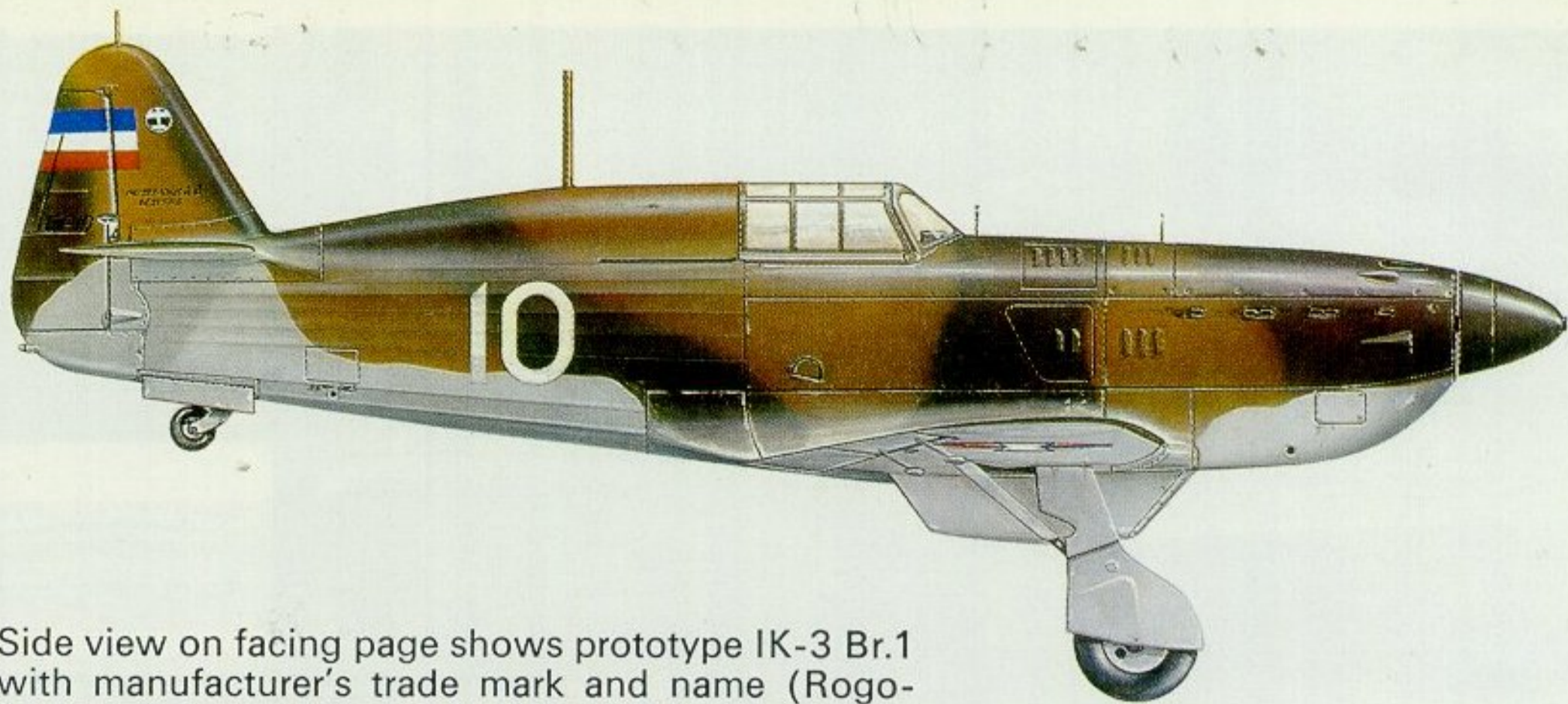
With the IK-2 entering service and plans under active consideration for more of the type to be built to equip other fighter units, there was an apparent need for a suitable advanced trainer. The straightforward solution was to modify the IK-2 into a dual-control two-seat aircraft. Such a conversion of one or two series IK-2s was considered. Besides its training role, the new trainer, designated IK-4, was to be employed for high-speed reconnaissance, since it would be faster than types like the Henschel Hs 126 then in service.

All the characteristics of IK-4 were to be similar to those of the IK-2, differing only in fuselage and cockpit layout. The rear seat for the instructor or observer was to be located behind the pilot's cockpit and in a raised position so as to provide clear visibility.

However, the IK-4 project did not pass beyond the discussion stage and was abandoned when delivery of the series version of the IK was delayed and the obsolescence of the high-wing monoplane fighter had been acknowledged.

¹ "Ustashi" was the name taken by the Croatian nationalist forces; literally it meant "rebels".

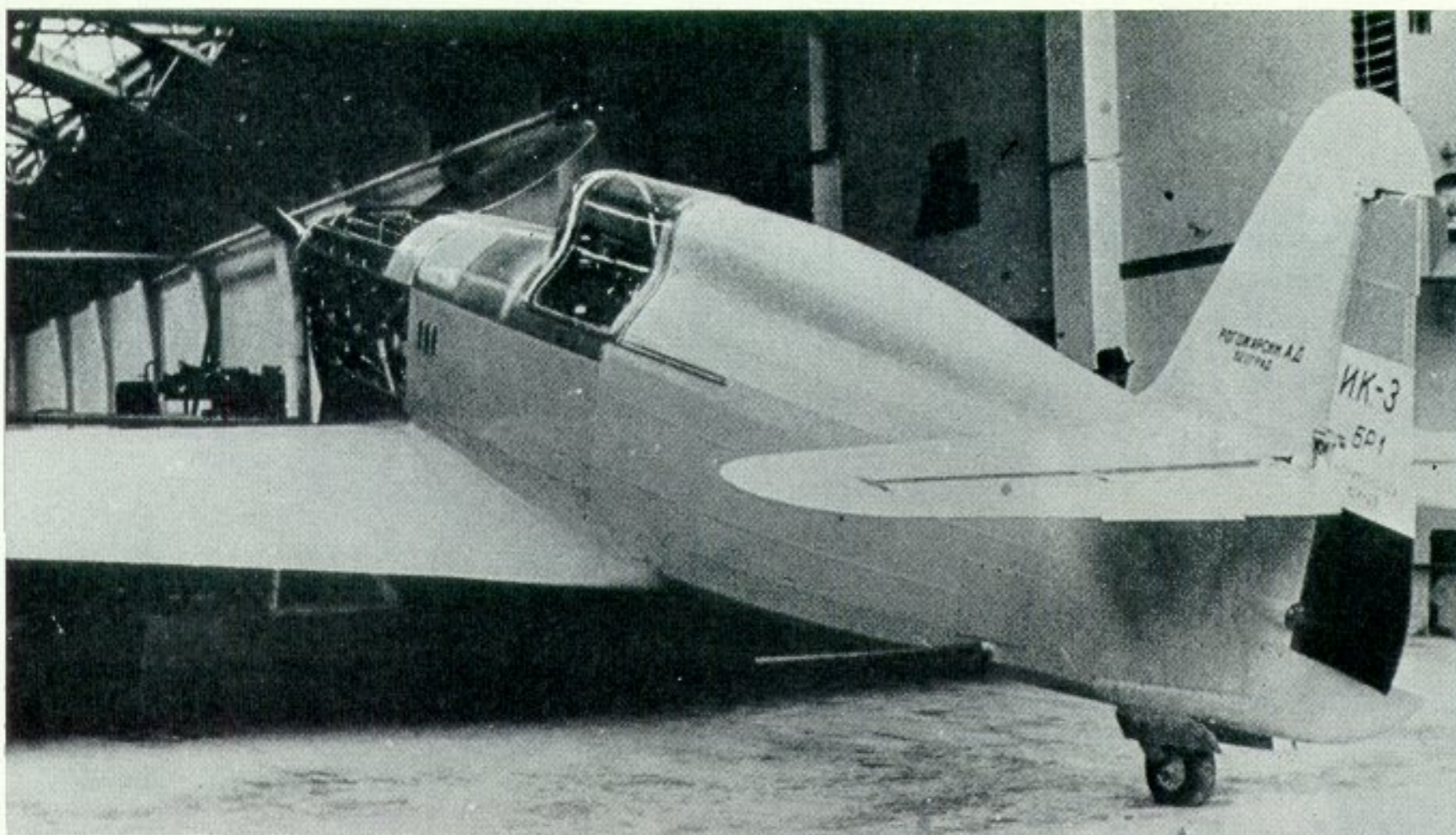




Side view on facing page shows prototype IK-3 Br.1 with manufacturer's trade mark and name (Rogožarski A.D.) on the fin. Production IK-3 in camouflage paint provides the comparison. Note that the Rogožarski symbol is retained on the fin. This particular IK-3 of the Yugoslav Air Force's 51st Grupa took part in the defence of Belgrade during the April 1941 attack. Pilot was Potporučnik Dušan Borčić who gained one victory while flying this IK-3.

M. Trim © Profile Publications Ltd.





The prototype IK-3 at Zemun prior to flight testing. The rudder is of the inset type.

THE IK-3 PROTOTYPE

Ilić and Sivčev initiated preliminary studies of a new fighter project as soon as 1933 brought a relaxation in the pressure of work on the IK-1 prototype. Convinced that the era of the high-wing monoplane was past, they concentrated on developing a cantilever low-wing monoplane, aerodynamically streamlined and with a retractable undercarriage. Only such an aircraft could achieve the high speed and climb rate which were the only answer to the challenge of the high performance bomber prototypes then making their appearance.

The new fighter, designated IK-3, was again developed as a private venture and again the initial planning was carried out secretly. A scale model was tested in the Eiffel wind tunnel as had been the case with the IK-01. The great strain imposed by the complexity of the static evaluation and working out the structural details of the aircraft brought Ilić and Sivčev to the realisation that a third member was essential if the design team were not to collapse from sheer exhaustion! The new recruit was Ing. Slobodan Zrnić. He had worked as a specialist in France and had become Head of the Construction Bureau of the State Aircraft Factory at Kraljevo or *Šef Konstrukcionog Biroa Fabrike Aeroplana Kraljevo*. Zrnić had played a leading part in modifying and improving the long series of licence-built Breguet XIXs turned out by the factory and as a result possessed considerable experience in the application of materials in aircraft structures. Consequently, the work load was redistributed – 40% to Ilić and 30% each to Sivčev and Zrnić. The original project designation was changed to IKZ, the “Z” standing for Zrnić. This change did not survive in official documents, presumably due to the confusion between the original figure “3” and the letter “Z”, written as “3” in the cyrillic alphabet. The authors have retained the designation “IK-3” throughout this Profile.

Power was to be provided by the improved and more powerful Hispano-Suiza 12Y29 engine, delivering 980 h.p. at 5,000 metres (16,200 ft). Manoeuvrability was given preference over speed, this decision being made in deference to the currently prevalent pilot attitude that in individual combat outstanding manoeuvrability offered

an advantage which more than compensated for any speed advantage enjoyed by opposing fighters.

The IK-3 emerged as a compromise between British and German concepts of the modern fighter aircraft. It had a smaller wing area than either the Hawker Hurricane or the Supermarine Spitfire (*see Profile No. 41 for Spitfire I and II*), thus achieving a relatively higher speed for a specified engine power. Compared with the Messerschmitt Bf 109 (*see Profile No. 40*), the Yugoslav fighter had a shorter fuselage and possessed a smaller turning radius. The IK-3, however, concentrated its armament in the fuselage – an engine-mounted cannon and two machine-guns.

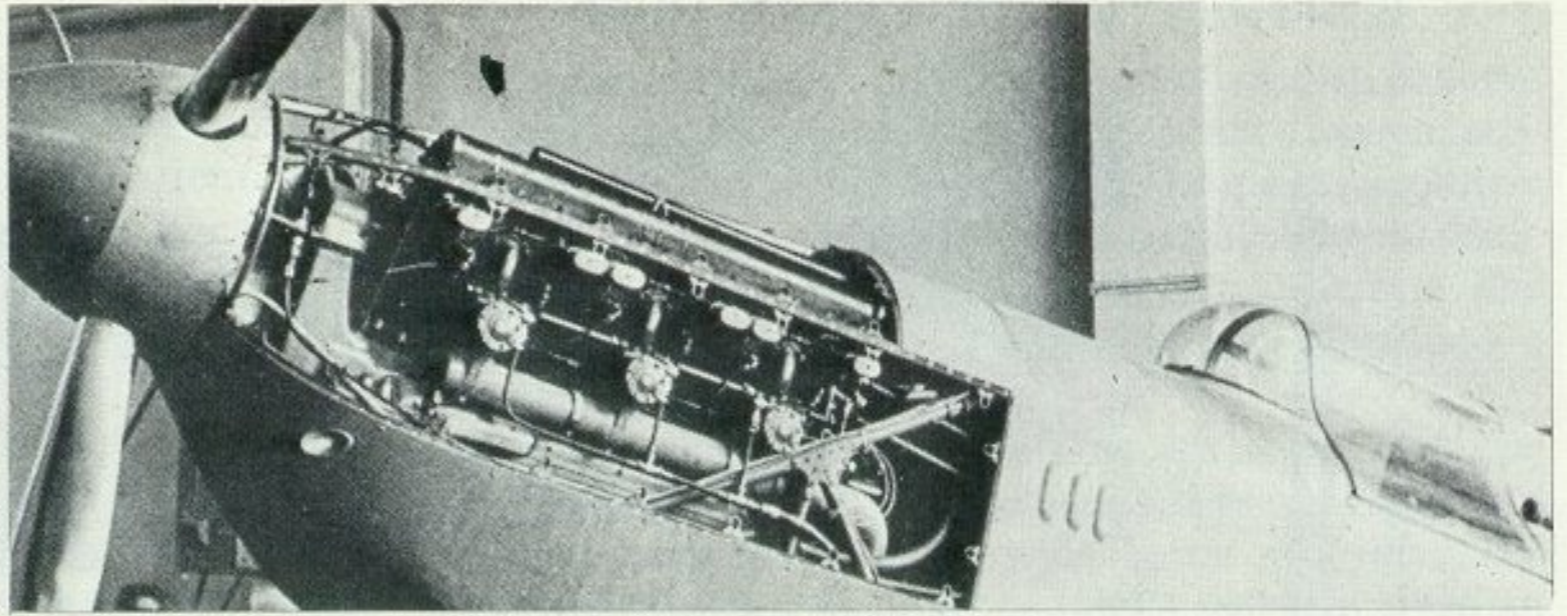
All the documentation relative to the IK-3 had been delivered to the Air Force in time for the design to be adopted in mid-1936, but continuing scepticism about this courageous indigenous fighter concept led to unnecessary delays and the contract for the construction of a prototype was not signed with the Rogožarski company of Belgrade until late in March 1937. The factory had a well-appointed and experienced wood construction department with a degree of craftsmanship which guaranteed a high quality finish for the wooden structure and plywood skinning of the IK-3 wings, fin, and tail-plane.

The first aircraft was completed by the Spring of 1938 when it was dismantled for its journey from the workshops to Zemun airfield. The first flight was towards the end of May. Flight trials were entrusted to Test Group pilot Kapetan Bjelanović and first stage testing was completed by the end of the Summer. The next part of the test programme was flown at the Test Centre. Besides detailed flight evaluation, the cannon and machine-guns were test-fired. A group of selected Air Force pilots took over with the aim of establishing the best method of exploiting the characteristics of IK-3 and its application to Yugoslav conditions. Trials so far had fully confirmed the designers' claims for the aircraft, particularly with regard to manoeuvrability.

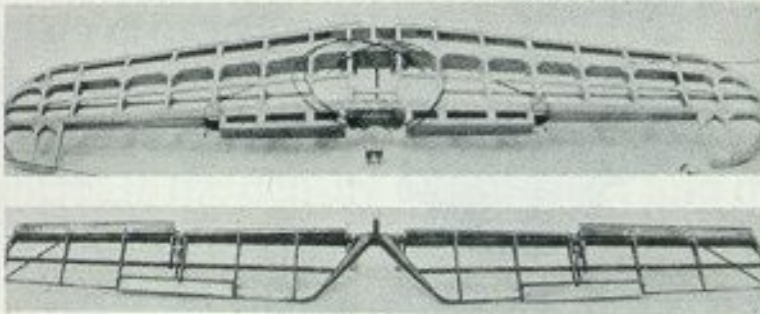
The report submitted by Bjelanović emphasized the effectiveness of the controls in all manoeuvres and in aerobatics at all speeds. “The elevator control is if anything too sensitive and especially in looping when only a minimal pull on the control column is required. If the column is pulled back abruptly, the aircraft snatches



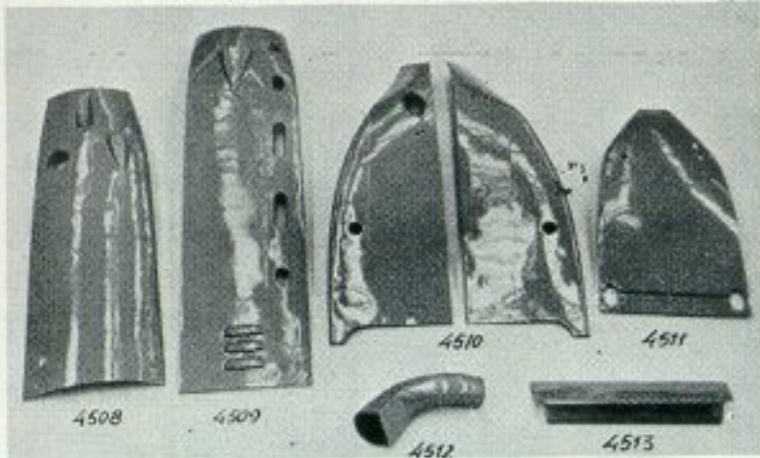
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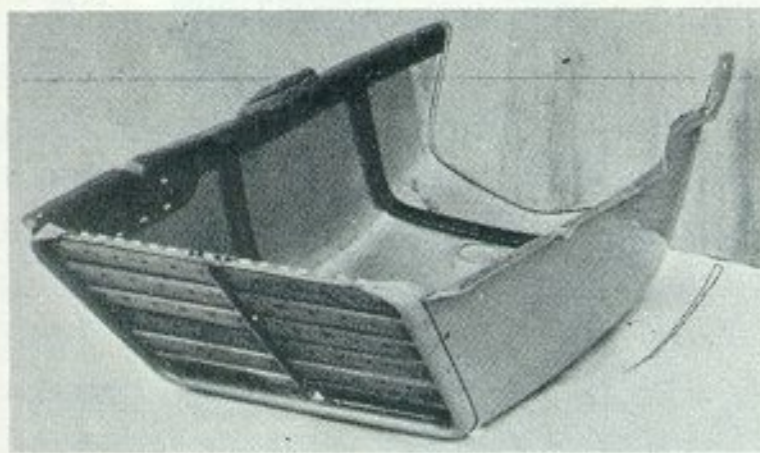
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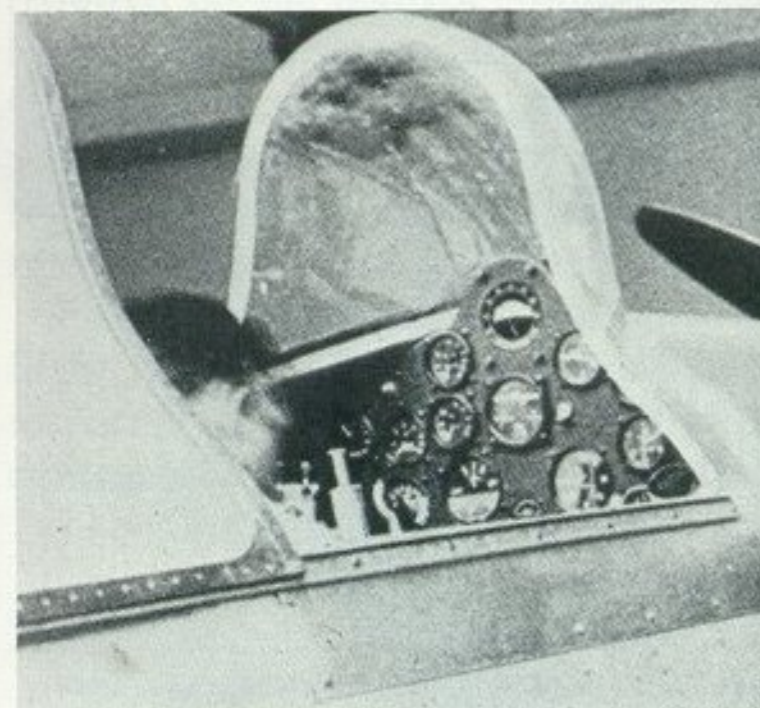
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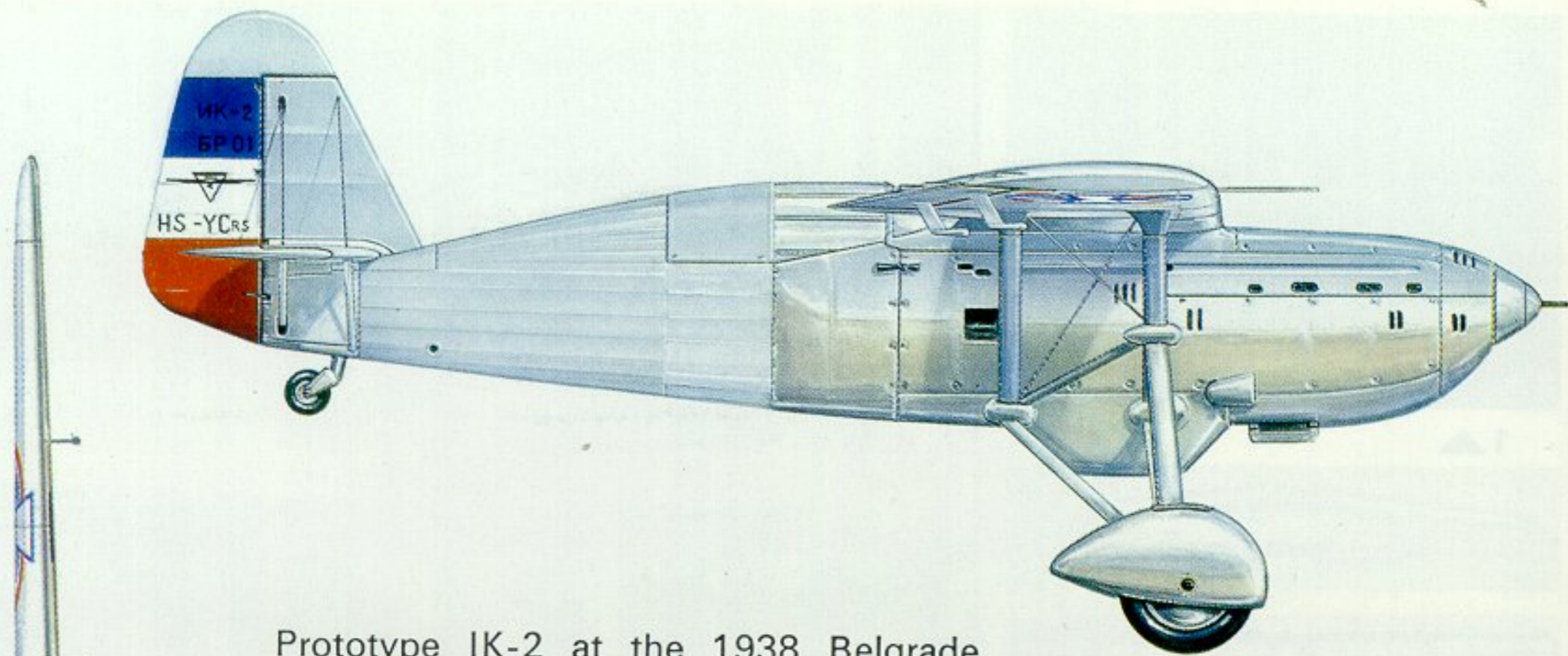


IK-3 IN CLOSE-UP: (1) Atrapa (or wooden mock-up) with H-S 12Y29 installed; (2) Horizontal stabilizer (or tailplane) and elevators; (3) Engine cowling panels; (4) Radiator bath; (5) Bent propeller being removed. Note simple jacking method; (6) Cockpit dials; (7) Engine details; (8) Mainwheel cover (left), retractable tailwheel (centre) and inscriptions on fin and rudder. (9) Paint finish appears darker than earlier views; (10) Two of the three vee-shaped intakes have been deleted. Also has revised canopy. Note: Atrapa is of Serbo-Croatian origin. This is the first production IK-3 and the only one fitted with radio. (Photos: Yugoslav Air and Space Museum)



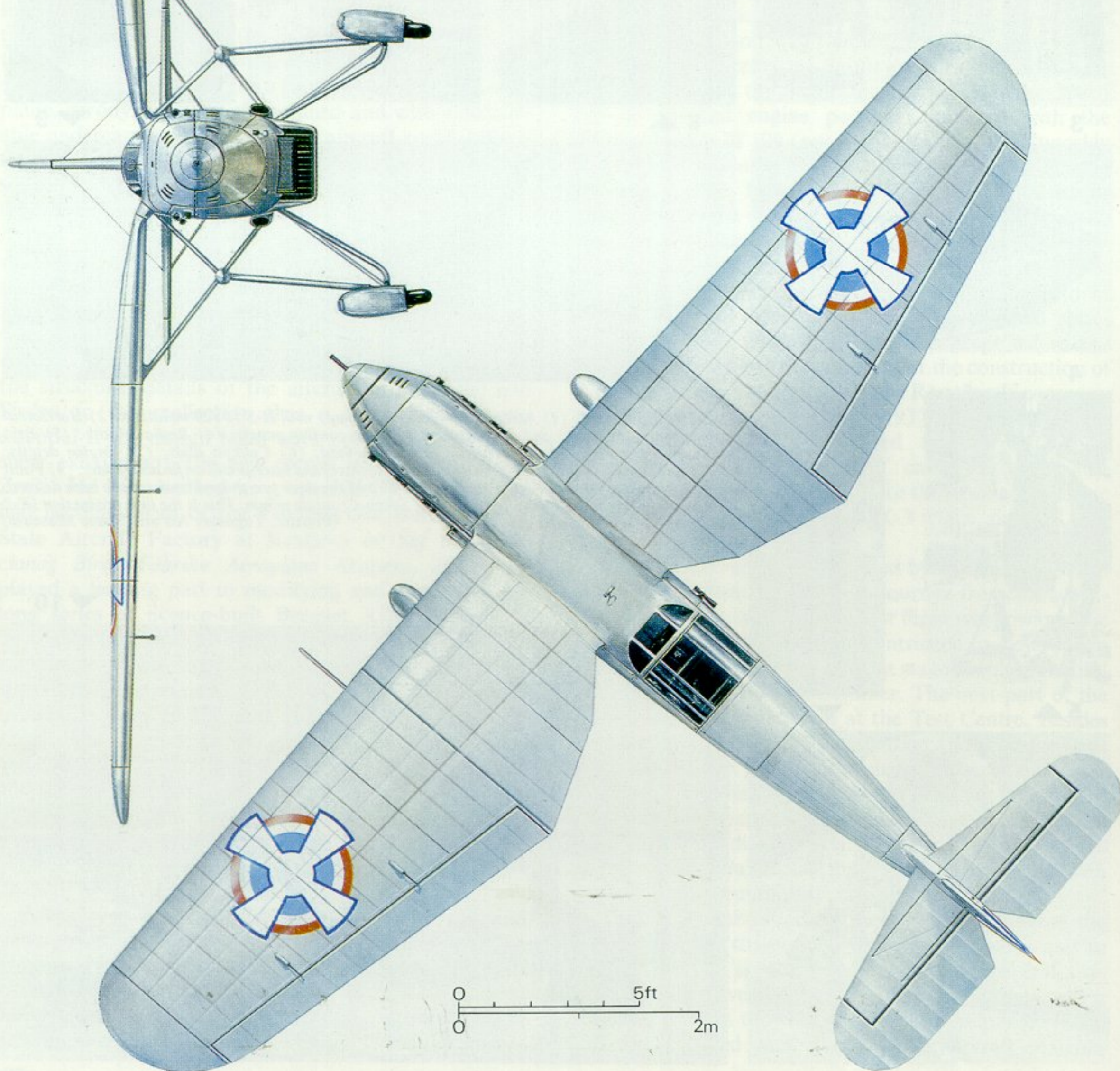
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Prototype IK-2 at the 1938 Belgrade International Aero Exhibition.

M. Trim © Profile Publications Ltd.



away (that is, stalls), and goes into a spin. During aerobatics, recovery was easy and the aircraft could easily be returned to straight and level flight. After going into a spin, the aircraft would begin to recover after only a quarter- or half-turn. During take-off it behaved normally and on landing required to be levelled out low down immediately before touchdown."¹

Every Test Group pilot emphasised the need for gentle handling of the very sensitive controls. In fact, every aerobatic manoeuvre could be achieved without moving the control column outside the circumference of an imaginary circle 10-cm. (4 inches) in diameter. The main criticism was of the distorted visibility through the convex/concave panels of the canopy. Several pilots suggested two more wing-mounted machine-guns to increase the density of firepower and overcome blockage problems.

The Test Group pilots were also required to compare the characteristics of the IK-3 with those of the Hawker Fury, Heinkel He 112, Morane-Saulnier MS 405 and Hawker Hurricane, each of which they had flown previously, either in Yugoslavia or abroad. The general conclusion was that IK-3 was faster and more manoeuvrable than the other fighters. The aircraft having the most closely comparable characteristics was the MS 405, but IK-3 with the same engine delivering the same power was 40 km/h (25 m.p.h.) faster than its rival. Later, when in service, IK-3 was evaluated against the Bf 109 E-3, but this is referred to later.

With flight trials nearly concluded, the aircraft met with an accident which resulted in the death of the test pilot, Kapetan Milan Pokorni, on January 19, 1939. The Commission which investigated the crash ascertained that the aircraft had been put into a steep dive over the airfield and at a height of some 400 metres (1,300 ft) had shed its windscreen. In the resulting confusion it appeared that the pilot had pulled the control column back too sharply, causing structural strain and torsion which led to the breaking away of half the starboard wing. The fighter struck the ground at high speed and the unfortunate Pokorni was killed instantly. Various modifications aimed at improving pilot visibility had been made before the fatal flight and most of these had involved the removal and subsequent replacement of the windscreen, actions which may well have contributed to its failure at the critical moment.

Checks of the mathematical calculations of stress factors were carried out by Yugoslav experts as well as by Ing. Eugene Meyer and some French advisers. The results indicated that the structural strength of the IK-3 gave a satisfactory safety coefficient for its category. It was clear, however, that the very slight pressure required on the control column had deceived the pilot. He was thus given no tangible warning of the enormous strain his actions were imposing on the wings and structure in general. He apparently failed to realise how sharply he was pulling the IK-3 out of its dive and as a result the crash was inevitable.

Fortunately, however, the favourable progress of flight testing prior to the crash had already resulted in an order placed with Rogožarski for 12 IK-3s, the contract having been signed in November, 1938.

IK-3: PRODUCTION VERSION

Loss of the prototype and various constructional changes subsequently introduced delayed the start of series production until the late Spring of 1939. To make absolutely certain on the score of structural strength, rigorous static tests were made on the modified wing structure. The wing cell tested at the Rogožarski works withstood a strain of more than 14 g.

Other modifications included the use of flat Plexiglas panels in the fabrication of the windscreen and the pilot's sliding canopy so as to provide better visibility. The upper rear fuselage behind the pilot's seat was given an improved shape and the folding sections of the undercarriage leg covers were replaced by simple single plates. New Flettner tabs fitted to the elevator increased the sensitivity on the control column, layout of instruments and controls was improved and various other modifications carried out. The French-built Hispano-Suiza engine was replaced by a modified version of the 12Ycrs, built under licence by the Czechoslovak Avia firm. The French HS 404 engine-mounted cannon was replaced by the Swiss 20-mm. Oerlikon FF cannon. German Telefunken radios were to be installed, but in fact only one transmitter-receiver was delivered which was fitted in the first production aircraft. The remaining radio equipment never arrived from Germany.

The aircraft bore the serials from No. 2 to No. 13 (the prototype having been No. 1). After construction in the Rogožarski workshops the aircraft were assembled in the company's hanger at Zemun airfield. The first six aircraft were delivered by late March 1940, but the second batch of six was delayed by hold-ups in the supply of equipment and instruments ordered from abroad. With these problems finally solved, deliveries were resumed and completed by July.

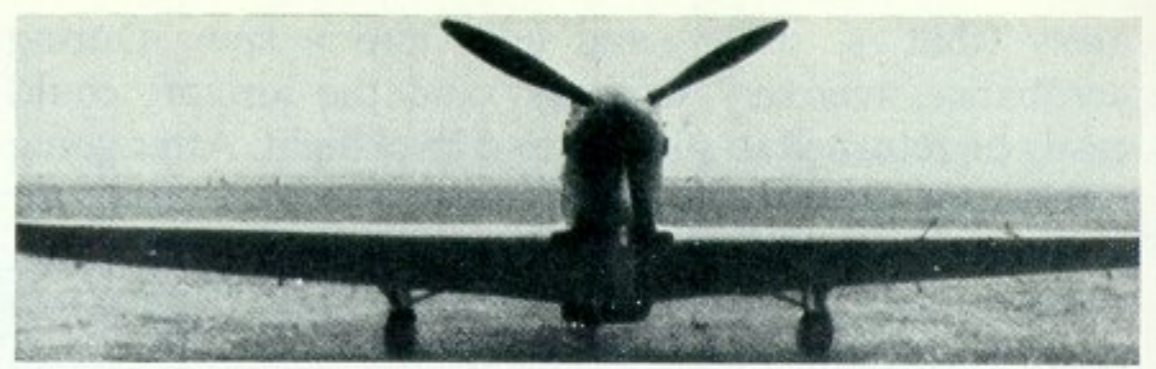
At the request of the Air Force the first production fighter was delivered to the official Test Centre. There it proved free from the imperfections of the prototype. Maximum speed, estimated at 540 km/h (335.5 m.p.h.), was found to be 527 km/h (327.5 m.p.h.). Once in service, however, minor equipment and instrument faults required repairs and modifications. These were occasioned by shortcomings in the Yugoslav accessory industry, resulting in both home-produced and foreign instruments and equipment being utilised in the same cockpit. The result was a certain lack of harmonisation, to put it mildly!

The War Ministry accepted a programme for the production of 48 IK-3s during 1941 and 1942. At the time of the Axis attack on Yugoslavia a series of 25 IK-3s was in course of construction at the Rogožarski factory with delivery promised by the end of 1942. Further modifications had been incorporated in these aircraft with the aim of further improving the flying characteristics of the IK-3.

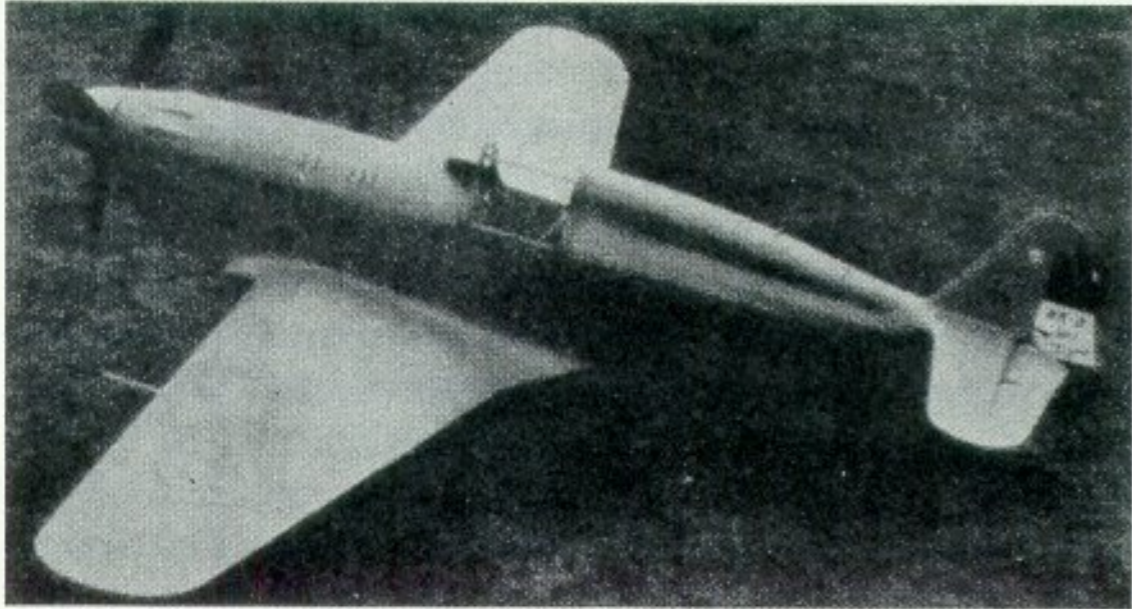
IK-3 VARIANTS

The success of the IK-3 gave considerable impetus to its designers and to the Yugoslav aeronautical industry generally. Production of the airframe was a relatively easy task for the industry, but shortage of power plants prevented really large scale production. In order to develop the design, increased speed, combat load and firepower were essential. The lack of an aircraft engine

¹ From Yugoslav Air and Space Museum archives relating to IK-3.



Four views of the IK-3 Br.1 in modified form. Inset elevators show in rear plan view.



industry imposed severe difficulties on the Yugoslavs. The designers were forced to pursue a continual search for engines which were both suitable and available so as to achieve necessary improvements in aircraft performance.

IK-3 with Daimler-Benz DB 601 A

The adaptation of the IK-3 to take a DB 601 A engine was suggested in February 1939. It is perhaps a little known fact that work on the project led to the mounting of a DB 601 A on the airframe of a standard Yugoslav Air Force Hurricane I. Kapetan Miloš Bajagić flew 100 hours on this modified Hurricane during the summer of 1940. The aircraft proved some 20 km/h (12.4 m.p.h.) faster than the standard Hurricane. The adaptation of the Hurricane had been carried out by an IK design team which then moved on to modify an IK-3 to take the German engine. The airframe was modified, with a new engine mounting and cowling, the radiator was repositioned and various minor modifications made. Firepower was to be maintained by fitting additional wing machine guns to replace the engine-mounted cannon of the original IK-3. For the future, it was planned to redesign the DB 601 A in Yugoslavia so that a 20-mm cannon could be mounted to fire through the hub.

A series IK-3 airframe had been modified to take the engine originally intended for the Messerschmitt Bf 109 E-3. In fact, 50 surplus engines were available, having been delivered from Germany along with the Messerschmitt fighters.

When the Germans closed in on Belgrade, the unfinished aircraft and the rest of the IK-3s then in the Rogožarski workshops were destroyed by the factory personnel.

IK-3 with Rolls-Royce Merlin II

As well as complete Hawker Hurricanes, a number of

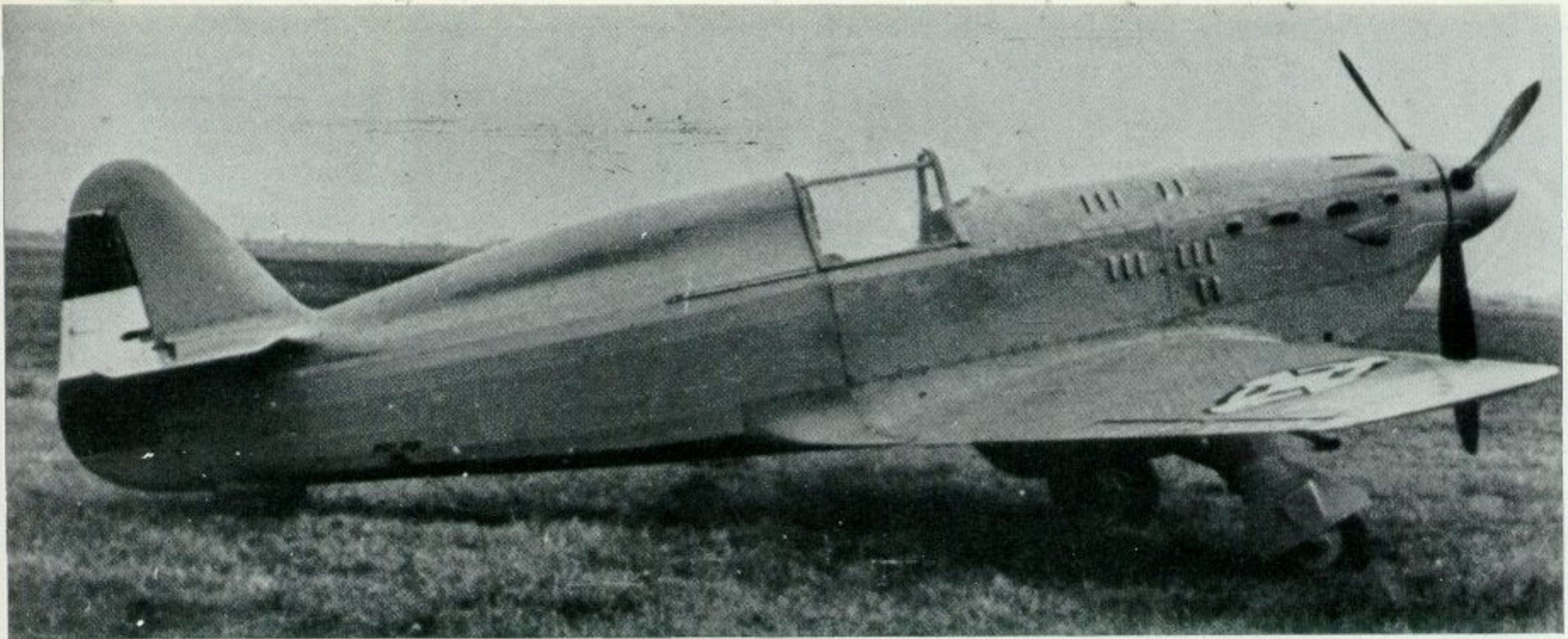
spare aero-engines had been ordered from Britain. At a meeting of the Air Force Staff in February 1939, the possibility of fitting IK-3s with the Rolls-Royce Merlin as an alternative to the DB 601 A engine was suggested. The increased power of the Rolls-Royce engine was estimated to be capable of raising the top speed of IK-3 by some 30 km/h (19 m.p.h.) and increasing considerably its rate of climb. Armament, however, presented a problem. The wing structure would have to be strengthened if additional wing guns were to compensate for the engine-mounted cannon. The Merlin-powered IK-3 was to be armed with two synchronised fuselage-mounted machine guns, plus two or four wing-mounted machine guns. There is no record of the fate of this project.

IK-3 with Hispano-Suiza 12Y51

One of the engines considered for the IK-3 was the French 12Y51, weighing approximately the same as the engines already fitted on the fighter. The new engine was estimated to add between 35 and 50 km/h (22–31 m.p.h.) to the top speed of the IK-3.

IK-3/2 TWO-SEAT TRAINER

The modern new IK-3, differing greatly from contemporary Y.A.F. fighter equipment such as the Hawker Fury and Avia BH 33 E biplanes, required more experienced pilots with specialised training. Pilots who have flown the IK-3 prototype emphasised that the sudden change from biplanes to low-wing monoplanes fitted with retractable undercarriages and flaps and with maximum speeds increased by some 100 km/h. (60 m.p.h.) was courting disaster and at best would slow down the training programme for the new fighter. There being no suitable



Again, the IK-3 Br.1 in modified form.

aircraft available. Rogožarski in early 1939 offered a dual-control two-seat advanced training version of IK-3. The trainer would retain the main characteristics of IK-3 and so the instruction period before soloing on the IK-3 or Hurricane would be shortened.

Late in 1938, the design trio of Ilić-Sivčev-Zrnić finished their study of the project and produced the necessary basic drawings. They divided their efforts 50%: and 25% each: Sivčev and Zrnić.

The modifications included an additional cockpit, dual controls, and the necessary extra instrumentation. The new disposition of weights entailed the moving of the radiator 0,50 metre (1.64 ft) further back.

The IK-3/2 would normally be unarmed, but it could be transformed into a combat aircraft by dismantling the rear cockpit and installing cannon and machine guns.

Pressure on the design team and then the Axis invasion prevented the realisation of this project.

Post-war Development

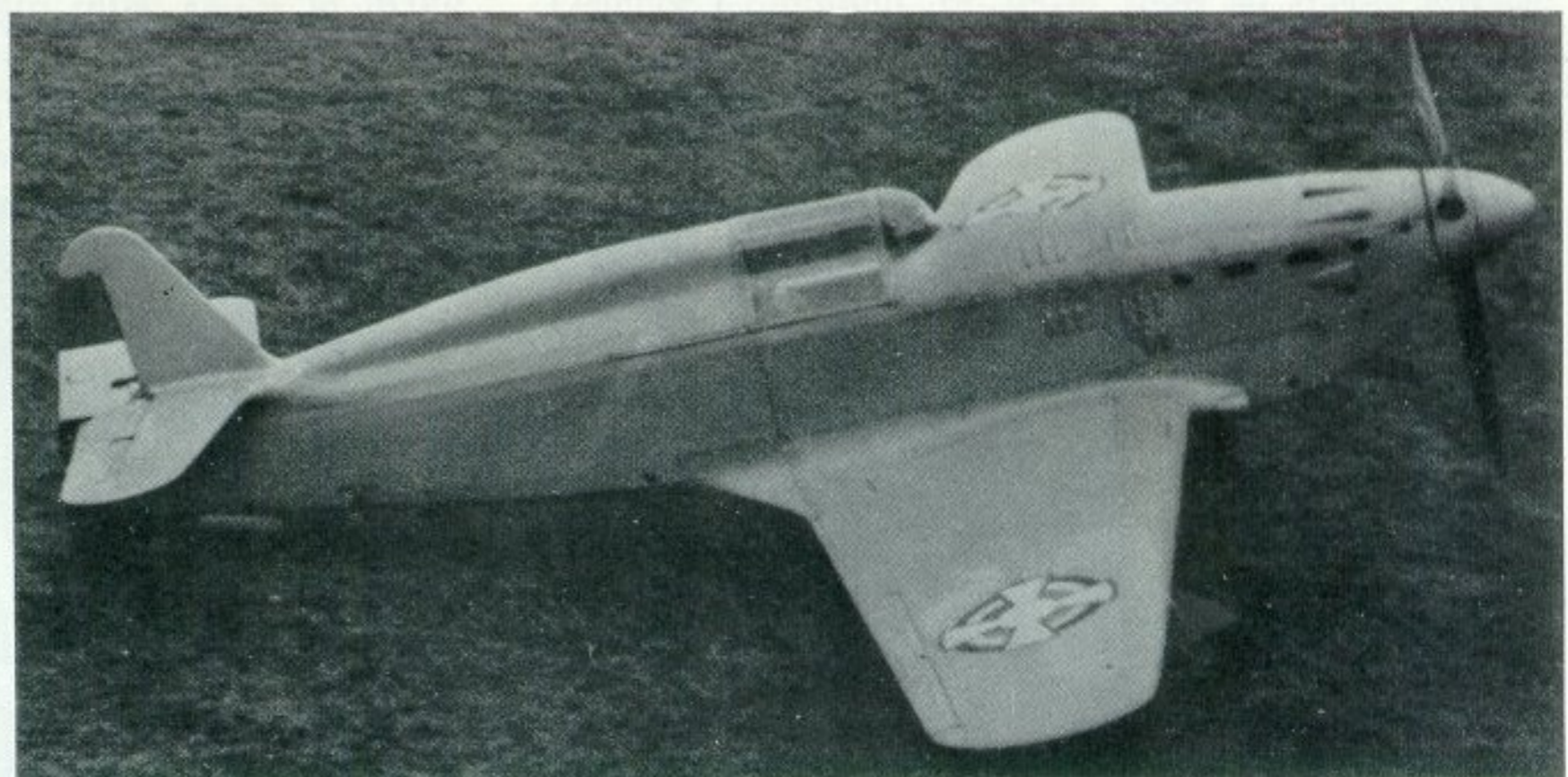
The IK-3 design was the basis for the outstanding post-war Yugoslav fighters, S-49A and S-49C, which were developed by the same engineers Sivčev and Zrnić, together with Svetozar Popović. The S-49C had the high maximum speed of 650 km/h (403.9 m.p.h.) and inherited the manoeuvrability and other good qualities

of the IK-3. 175 "S" series fighters were built between 1949 and 1953 and played their part in guaranteeing the independence of Yugoslavia at a very critical period in that country's history.

IK-3 IN SERVICE

The 12 aircraft of the first IK-3 series were allocated immediately after delivery to the 51st Samostalna Grupa (Independent Squadron) on Zemun airfield. This Grupa comprised the 161st and 162nd Eskadrila equipped with six IK-3s each. (This Grupa was strengthened by the addition of the Bf 109 E-3 equipped 102nd Eskadrila from Mostar on April 5, 1941). The pilots mastered their IK-3s very effectively, building up a flying time averaging 100 hours each.

At Zemun airfield the IK-3 was evaluated against the "Emil" (Bf 109 E-3) in mock dogfights. In these "combats" Ing. Boris Cijan, the well-known Yugoslav aircraft designer, flew a Bf 109 E-3 while the IK-3 was piloted by Kapetan Sava Poljanec, who was later to command one of the IK-3 combat units. The IK-3 demonstrated particular qualities which gave it the advantage of its adversary. Poljanec observed that even with the Bf 109 on his tail he could take control and go over to the attack after making two or three steep



The prototype IK-3, modified, makes positively its last appearance in this Profile.
(Photo: Musée de l'Air, Paris, ref. MA 4218)



December 1940 at Zemun airfield and a school's visit to the Air Force. Camouflaged IK-3 has hub-firing cannon in position; but no radio. Yugoslav Air Force Bristol Blenheim Mk.I may be seen in background. (Photo: "Vreme"). Snapshot of IK-3's nose (right) shows smooth finish to mainplane – complete with reflection! Hatless pilot is Potporučnik Dušan Borčić with his ground crew. (Photo: Family Borčić)

horizontal turns. This special tactic in flying the IK-3 against the Messerschmitt was carefully worked out and proved valuable during real battles against German Bf 109s over Belgrade in April 1941.

The IK-3s suffered one loss during their first year in service. On September 3, 1940, Kapetan Anton Ercigoj, the Commanding Officer of one of the IK-3 eskadrila, was making a mock attack on a solitary Potez 25 over the delta of the Rivers Sava and Danube. After a low pass beneath the Potez, he went into a zooming climb with the intention of performing a loop. Climbing too steeply, he fell into a spin at low altitude and failed to recover before hitting the water. The IK-3 dived straight into the river just beneath the walls of the ancient Belgrade fortress of Kalemegdan.

As war threatened Yugoslavia, the 51st Grupa was added to the strength of the 6th Puk, responsible for the defence of the Belgrade area. At the time of the invasion – April 6, 1941 – only six IK-3s were in serviceable condition, three in each eskadrila. Remaining aircraft of the type were under repair in the workshops except for one undergoing conversion in preparation for the installing of the Daimler-Benz DB 601 A engine.

On that first day the initial wave of 234 German *Luftwaffe* bombers – mostly Junkers Ju 87s from I./St.G.2, III./St.G.2 and III./St.G.3, Dornier Do 17 Z-2s from I./K.G.2, II./K.G.2, III./K.G.2 and I./K.G.3, with Heinkel He 111 Hs of II./K.G.6 from Turnu Severin in Rumania – was over Belgrade at 07:00 with

an escort of 120 fighters. The alarm given by the Yugoslav Intelligence Centre¹ 12 minutes earlier had "scrambled" (ordered aircraft into the air) all six available IK-3s, but one failed to take off due to engine trouble. Thus five aircraft joined the Yugoslav "Emils" of the 102nd Eskadrila. While still climbing to altitude the IK-3s met German formations coming in from the Rumanian border. On the basis of eye-witness accounts it is known that fighter pilots Poljanec, Borčić and Semiz destroyed one bomber each in this first encounter. Then the bomber escort of Bf 109s, sent as reinforcements for the invasion from the North African Front, went into the attack.

The distinctive silhouette of the KI-3 attracted all the German fighters. The Yugoslav and German Bf 109s, differed externally only in respect of their markings and the yellow noses of the German aircraft. As recognition of the national insignia was difficult, the Yugoslav Bf 109s were less involved than the IK-3s. Single IK-3s found themselves disputing with pairs or even whole flights of Bf 109s. Individual combats began to emerge from the general engagement. Kapetan Poljanec, who knew something of Messerschmitts, succeeded after a couple of sharp turns in getting a Bf 109 in his gunsight and keeping it there until he had shot it down over the city. Poljanec continued the fight against his fallen adversary's wingman, but his own aircraft had been hit and the radiator pierced. The engine began to vibrate badly and he was forced to break off combat. This was not easy with so many German fighters circling about him at his altitude of 3,000 metres (10,000 ft). The Yugoslav pilot avoided his adversaries by putting

¹ The Belgrade Air Defence Zone was one of five covering the whole of the country. The zone control centre in turn had 13 intelligence centres supplying it with information.

Pilots all. (Left to right) Todor Gogić, C.O. of an IK-3 eskadrila became commander of the 51st Grupa during the 11-day April (1941) war. Eight missions with IK-3s; destroyed one and helped shoot down another enemy aircraft. Miloš Bajagić, 51st Grupa, tested Daimler-Benz DB 601-powered Hurricane I. (centre) Top scorer with four "kills", Milisav Semiz flew 17 combat sorties in IK-3s. Dušan Borčić was unofficially credited with one victory but engaged Bf 109s as well as accounting for a Do 17 Z. Finally, Sava Poljanec was C.O. of 261st Eskadrila; two "kills" flying IK-3

(Photos: S. Oštrić Collection, Family Bajagić and Mme L. Semiz)





The first-line IK-3 in the summer of 1940. Most apparent revision is the strengthened windshield and cockpit canopy also seen in Photo No. 10 in the earlier photo-page, "IK-3 in close-up". Some of the pilots of this, the 51st Grupa, also appear on the facing page.

his aircraft into a spin from which he only pulled out at minimum altitude. He made straight for Zemun airfield, with glycol spraying out behind him. On landing he was strafed by a Bf 110 and a cannon shell exploded immediately behind his seat. Wounded and with his aircraft in very badly damaged condition Poljanec nevertheless managed to land safely.

In the continuing struggle over the capital an IK-3 was shot down on the bank of the Danube some 15 km. (9½ miles) to the north of Belgrade and its pilot, Dušan Borčić, killed. Pilot Eduard Bamfić was wounded and with his IK-3 seriously damaged was forced to break off combat. With wheels lowered and flaps down for landing, he was attacked by two Bf 109s. To avoid certain death, Bamfić was forced to go into a series of steep turns, with his wingtips almost touching the ground. He crash-landed near the airfield, his IK-3 being completely destroyed.

After the German Bf 109s had turned for their home base at Segedin, the two remaining IK-3s returned safely to Zemun. Three more waves, each of about 100 German bombers, attacked Belgrade that day; Bf 109s and IK-3s of the 6th Puk were in action again and again intercepting the enemy. There were three IK-3s in flying condition, one of them, piloted by Podnarednik (Sergeant) Vujčić, being the fighter which had been unserviceable with engine trouble earlier that morning. With Kapetan Todor Gogić, commanding officer of the 162nd Eskadrila, he claimed the destruction of a German bomber. The third pilot to get his IK-3 into action was Milislav Semiz. On April 6, the Luftwaffe had mounted 484 bomber sorties on Belgrade alone.

On the second day of war, April 7, Belgrade was bombed by small groups of bombers escorted by large numbers of fighters. The IK-3 pilots averaged between 5 and 6 sorties that day and shot down three more bombers. The final attack of the day was at 17:00 and Semiz took on a tight formation of three bombers, his aircraft receiving a total of 56 hits, twenty of them in the engine and airscrew. He considered himself lucky when he

managed to land his fighter in one piece. However, at the end of the day there were still three IK-3s available, one having arrived after repairs at the Rogožarski workshops.

Further activity by the remaining aircraft of the 51st Grupa was almost impossible since Zemun airfield was very near Belgrade and was thus subjected to repeated air attacks. On April 8, the surviving aircraft flew over to the auxiliary airstrip at Veliki Radinci, 50 km. (31 miles) north-west of Belgrade, where the remaining fighters of the 6th Puk were concentrated. Bad weather prevented air activity until April 11, when Semiz shot down a Bf 110 which was strafing aircraft on the airfield. Later Gogić and Vujčić each destroyed a Ju 87 while protecting the airfield of the 1st Reconnaissance Grupa near Ruma.

During the night of April 11-12, German columns closed in to within 15 km. (9½ miles) of the airfield. Next morning take-off from Veliki Radinci was impossible because of fog. All the aircraft of the 6th Puk were burnt on the airfield by their own personnel, thus bringing to an end the combat history of the IK-3.

According to Potpukovnik (Wing Commander) Srdan Krmpojić, at that time C-in-C of the Belgrade Air Defence Command, no fewer than 40 enemy aircraft were shot down in two days over the city, 26 falling to anti-aircraft fire and 14 to fighters.

IK-5 TWO-MOTOR FIGHTER

The success of the IK-3 gave renewed zest to its designers in initiating work on a twin-engined fighter project. The two-motor configuration had been chosen because of the advantages of higher speed and climb rate offered by the doubling of engine power. Ing. Stanojević, as Chief of the Air Force Command Technical Department, took part in formulating the specification for the new fighter.

The decision to order the IK-5 prototype was taken at a meeting of Air Force Command experts with



The highly polished wooden wind-tunnel model of the IK-5 still survives today. (Photo: Yugoslav Air and Space Museum)

representatives of the Yugoslav aircraft industry early in July 1939. A powerful two-motor fighter appeared the only possible means of meeting the requirement for an aircraft capable of carrying out a wide variety of tasks in single- or two-seat configuration, including fighting, long-range reconnaissance, photographic reconnaissance, in the "destroyer" role (on the lines of the German "Zerstörer" such as the Messerschmitt Bf 110) and, finally, for training with dual controls.

Work on the IK-5 project was carried on at the same time as the production IK-3 fighters were leaving the Rogožarski factory, but the firm nevertheless offered the services of its own design bureau members to assist with the new project. Ilić had undertaken 50% of the design work-load, while Sivčev and Zrnić undertook 25% each. As with the previous designs by the group, a model of the IK-5 was subjected to detailed wind tunnel tests.

The first flight of IK-5 was planned for the autumn of 1941. At the time of the German invasion the single-seat configuration fuselage had reached an advanced stage and many parts for the aircraft had been completed.

During the visit of Igor Sikorsky, the famous American aircraft designer of Russian birth, to Belgrade in 1940, he was given very full details of the IK-5 and in an interview with the correspondent of the Yugoslav aeronautical journal "Naša Krila" ("Our Wings") he gave it as his view that the IK-5 would prove to be one of the outstanding aircraft in its class in the world.

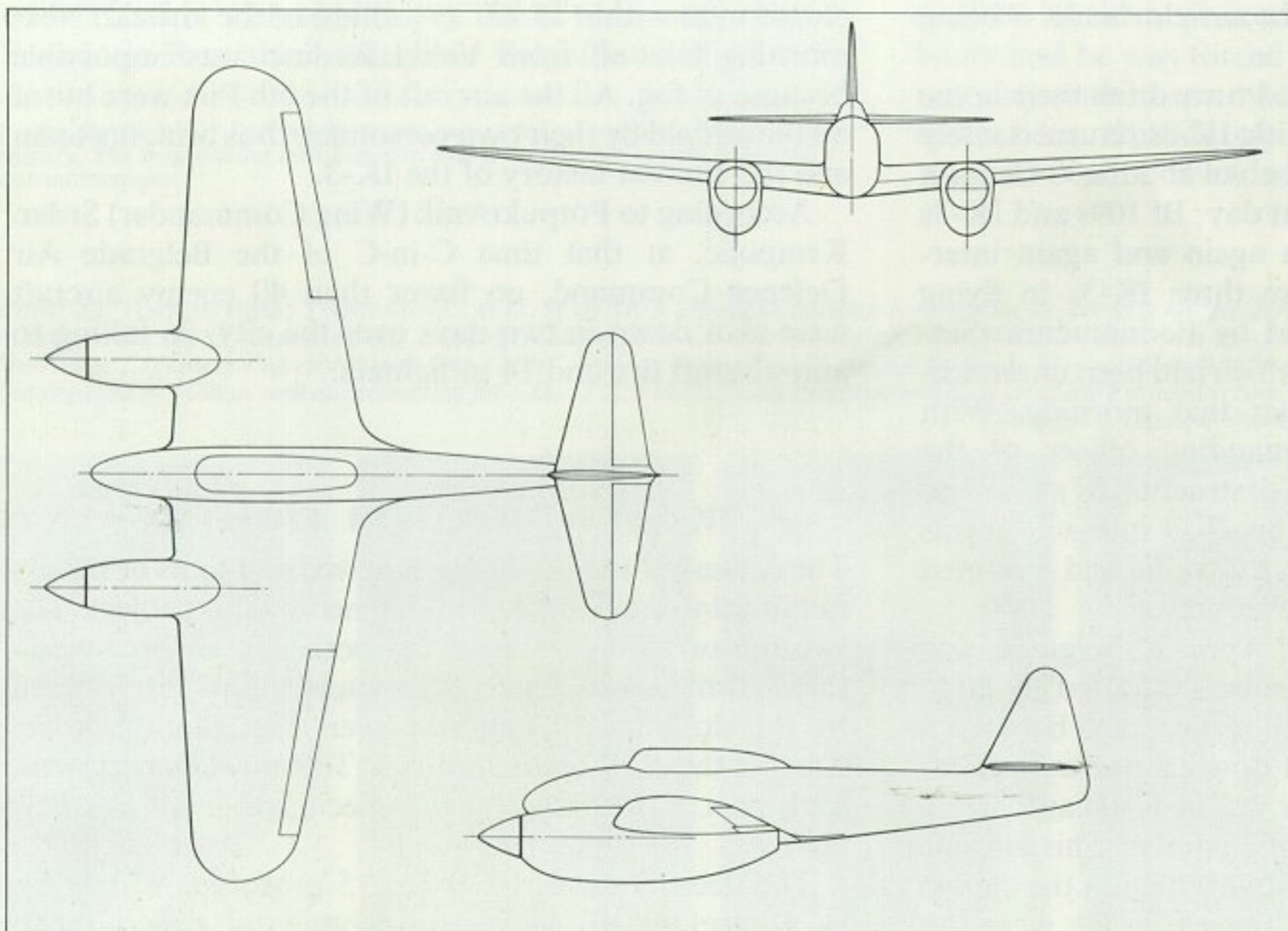
In fact, with an estimated maximum speed of 670 km/h. (420 m.p.h.) the IK-5 would clearly have represented the cream of Yugoslav aircraft design. Of all-metal construction, with a considerable horsepower, capable of increase by the installation of more and more powerful engines, and with a formidable armament of fuselage-mounted cannon and machine-guns supplemented by a useful bomb-load, this was indeed an ambitious and promising project.

Of the 30 H-38 and H-39 aero-motors ordered for the IK-5 only one pair was delivered. No provision was made for spare engines in the initial order and it appears that the first series was intended to be 15 aircraft.

Series Editor: CHARLES W. CAIN

ACKNOWLEDGEMENTS

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THE IK-5

From evidence collected by the authors, Waclaw Klepacki has created these general-arrangement drawings specially for this Profile.

Post-war successor to the IK-3 was the S-49. Currently at the Zagreb Technical Museum is an S-49C (serial 2400) built at Zemun in 1953 with a 1,500 h.p. Hispano-Suiza 12Z11Y engine. (Photo: John Wegg, Air-Britain)



IK FIGHTERS: STRUCTURAL DATA

IK-L1 prototype

Fuselage: Chrome-molybdenum steel tube structure with sheet metal panelling and fabric covering fore and aft respectively. Feature of pilot's cockpit was the segmented Plexiglas canopy. This slid down into fuselage side pockets not unlike automobile side windows.

Mainplane: Characteristic "gull-wing" configuration. The shoulder high-wing was of all-metal construction with fabric covering over front and rear box spars, ribs and dummy ribs fashioned from duralumin. Semi-cantilever type with attachment of wing roots to upper fuselage and wing struts to lower fuselage. The metal-frame, fabric-covered ailerons located on a dummy spar were aerodynamically- and mass-balanced. A feature of the ailerons was that they could be employed as landing flaps (to a maximum of 15°).

Tail assembly: All metal framework with fabric covering. Control surfaces aerodynamically- and mass-balanced. Wires (upper) and struts (lower) braced the tailplane which was adjustable.

Undercarriage: Fixed main gear and tailwheel. Main undercarriage employing French Messier oleo-pneumatic shock absorbers and lever-operated (on pilot's control column) wheel brakes. Each mainwheel unit comprised a single vertical shock absorber leg with the upper end attached to the forward wing strut and the lower end hinged to the fuselage by axle and radius rod. Point of attachment of main leg/forward strut braced by short strut to top of the fuselage and to the base of the aft (wing bracing) strut. Tailwheel fixed (Messier oleo-pneumatic shock absorber) but steerable. Spats (streamline fairings) encased all three wheels.

Powerplant: 860 h.p. Hispano-Suiza 12Ycrs Moteur-Canon, a liquid-cooled, 12-cylinder upright-Vee inline engine with supercharger and reduction gear for the three-blade Ratier propeller. This forged duralumin unit could be pre-flight pitch-adjusted. The right-hand auxiliary drive shaft was provided with a propeller-arc machine-gun synchronizing drive. Engine cooling achieved by means of a Chausson ethylene-glycol radiator system located under the fuselage, the front face of which was equipped with louvres operating automatically to regulate the air intake. Both the fuel and the oil tanks were housed in the fuselage immediately forward of the pilot's cockpit.

Armament: Prototype crashed before armament installed for trials. Standard armament was to have comprised one hub-firing 20-mm. Hispano-Suiza HS 404 cannon with a 60-shell spiral drum and two fuselage-mounted French 7,7-mm. Darne machine-guns with 250 rounds per gun and easily accessible during flight by the pilot. The standard Yugoslav Air Force Kretien gunsight (similar to the British Aldis tube sight with two optically flat lenses) measured 630 mm. (length) and 46 mm. (diameter).

IK-02

Basically as the IK-1 but replacing metal skinning for the fabric covering employed on the wings of the prototype IK-11

Armament: The two 7,7-mm. Darne machine-guns were replaced by a pair of 7,92-mm. Browning-FN machine-guns from Belgium's *Fabrique Nationale d'Armes de Guerre S.A.* At a later date, armament tests were conducted with a Swiss 20-mm. Oerlikon FF cannon in place of the Hispano-Suiza HS 404.

IK-2 production

The IK-2 for production represented a further development differed only in minor details from the earlier IK-L1 and IK-02. The efficiency of the Hispano-Suiza 12Ycrs was enhanced by a revision to the air intakes.

IK-3 prototype

Fuselage: Steel tube structure with flat-plate fittings and tubular rivets; also wooden stringers. Forward covering in sheet metal and

aft in fabric. Pilot's sliding canopy of Plexiglas but with concave-convex side panels said to adversely affect visibility.

Mainplane: One-piece, mixed construction cantilever structure comprising two wood-laminated main spars, front and rear, with wooden ribs and steel-tube drag bracing, the whole area being covered with Bakelite-glued plywood sheeting tapering in thickness towards the wingtips and protected by synthetic resin varnish. Balanced ailerons of similar construction. Trailing-edge split flaps of duralumin.

Tail assembly: Cantilever-type and of similar construction to mainplane. Movable surfaces (rudder and elevators), metal frames with fabric covering. Trim tabs incorporated.

Undercarriage: Fully retractable. Messier shock-absorber units for main legs and tail fork.

Powerplant: 910 h.p. Hispano-Suiza 12Y29 Moteur-Canon, a liquid-cooled, 12-cylinder upright-Vee inline engine with supercharger and reduction gear for the three-blade Hispano-Suiza licence-built Hamilton Standard constant-speed propeller. The diameter of the propeller was 3,20 m. (10 ft. 6 in.) and the blade pitch between coarse and fine was 29° to 49°. Ventral engine-cooling radiator system developed from IK-2.

Armament: One 20-mm. hub-firing cannon and two machine-guns; see IK-3 production variant.

IK-3 production

Some strengthening of the mainplane and fuselage structures was incorporated before production started; also, the powerplant was changed from the Hispano-Suiza 12Y29 to the Czechoslovak licence-built (by Avia) Hispano-Suiza 12Ycrs. The first six were fitted with Hamilton Standard (Hispano-Suiza licence-built) three-blade propellers and the next six with Ratier units.

Armament: One hub-firing 20-mm. Oerlikon FF cannon and two 7,92-mm. Browning-FN machine-guns (each with 500 rounds per gun) installed in the engine cowling in the manner of the IK-2 Ring-and-bead gun sight forward of windshield.

Radio: German Telefunken FuG VII transmitter-receiver (voice) equipment was to have been standard for the production IK-3s but, in the event, only the first production aircraft was equipped.

IK-5 two-motor fighter project

Fuselage: Steel tube frame faired to an oval section by formers. Sheet metal covering. Plans were in hand to introduce a monocoque structure. Fuselage ventral air brakes were to have been fitted. The enclosed cockpit was to have been equipped for all-weather operations. Cameras were also specified and dual controls for a trainer variant.

Mainplane: One-piece, two-spar wing with sheet metal covering NACA 230-series aerofoil section. Ailerons and flaps also metal sheet-covered.

Tail assembly: Conventional structure; control surfaces fitted with trim tabs and Flettner tabs.

Undercarriage: Retractable. Main legs, Messier-type, retracted into engine nacelles.

Powerplant: Two 1,100 h.p. Hispano-Suiza H-38/H-39 (left- and right-hand turning to counteract torque) liquid-cooled, 12-cylinder upright-Vee inline engines driving three-blade propellers.

Armament: To be housed in the nose of the fuselage, a battery of two 20-mm. Oerlikon cannon and four 7,92-mm. Browning-FN machine-guns. Heavier calibre machine-guns (12,7-mm.) could replace the Browning-FNs. An alternative battery of four 20-mm. cannon complemented by two machine-guns was under consideration. For attacking ground targets, 4 x 50-kg. (110-lb.) bombs were to be mounted on external carriers under the fuselage.

SPECIFICATIONS

		IK-2 (2nd. prototype)	IK-3 (production)	IK-5 (project)
Powerplant		1 x Hispano-Suiza 12Ycrs 810/860 h.p.	1 x Hispano-Suiza Avia 12Ycrs 910/980 h.p.	2 x Hispano-Suiza H-38/39 1,100 h.p. each.
Dimensions	Span	11.40 m. (37 ft 4 4/5 in)	10.30 m. (33 ft 9 3/4 in)	12.13 m. (39 ft 9 1/2 in)
	Length	7.88 m. (25 ft 10 1/4 in)	8.00 m. (26 ft 3 in)	—
	Height	3.84 m. (12 ft 7 1/8 in)	3.25 m. (10 ft 8 in)	—
	Wing Area	18.00 m ² (193 3/4 sq.ft)	16.50 m ² (177 1/2 sq.ft)	—
Weights	Empty	1,502 kg. (3,311 lb.)	2,068 kg. (4,560 lb.)	—
	Loaded	1,857 kg. (4,094 lb.)	2,630 kg. (5,799 lb.)	—
	Fuel	240 kg. (529 lb.)	330 l. (72.6 gal)	—
	Oil	20 kg. (44 lb.)	38 l. (8.4 gal)	—
Speeds	Max. @ sea level	360 km/h (223.7 m.p.h.)	421 km/h (261.6 m.p.h.)	—
	Cruising	250 km/h (155.3 m.p.h.)	400 km/h (248.5 m.p.h.)	—
	Maximum @ height	435 km/h (270.3 m.p.h.)	527 km/h (327.5 m.p.h.)	Estimated 670 km/h (416.3 m.p.h.)
	Landing	130 km/h (80.8 m.p.h.)	160 km/h (99.4 m.p.h.)	—
Take-off run		130 m. (426 ft)	200 m. (656 ft)	—
Landing run		300 m. (984 ft)	—	—
Climb to 5,000 m. (16,400 ft)		5 min. 25 sec.	7 min.	5 min.
Endurance	@ cruising speed	2 hr. 20 min.	2 hr. 26 min.	—
	@ maximum speed	—	1 hr. 15 min.	2 hr.
Cruising Altitude		4,000 m. (13,100 ft)	3,600 m. (9,800 ft)	6,500 m. (21,300 ft)
Ceiling		12,000 m. (39,400 ft)	9,400 m. (30,800 ft)	11,000 m. (36,100 ft)
Range		700 km. (435 miles)	785 km. (488 miles)	Approx. 1500 km. (930 miles)

* Various sources differ as to the length of IK-3. Of 25'9" (7.85 m.); 26'3" (8.00 m.); 26'6 1/8" (8.10 m.); 27'4 3/8" (8.34 m.); and 27'4 3/4" (8.35 m.) — the figure given, from a reliable but little-known official source is preferred.

IK DESIGNERS & TEST PILOTS

Design team

Ing. Ljubomir Ilić
Ing. Kosta Sivčev
Ing. Slobodan Zrnić

Test Pilots

IK-L1 — Kapetan Leonid Bajdak of the Opitna Grupa

IK-02 — Poručnik Janko Dobnikar, Opitna Grupa

IK-2 — Kapetan Vasilije Stojanović of the Air Force detachment at Ikarus A.D. factory

IK-3 (prototype) — Kapetan Milan Bjelanović, Opitna Grupa

IK-3 (production) — Kapetan Miloš Gagić, attached to the Rogožarski plant

51st Grupa on April 6, 1941

Messerschmitt Bf 109 E-3	10 in flying condition (with 2 or 3 in reserve)
Rogožarski IK-3	6 in flying condition (with 1 or 2 in reserve)
Potez 63	2 in flying condition
Breguet XIX*	2 in flying condition
Bücker Bü 131 Jungmann*	2 or 3 in flying condition
Rogožarski PVT*	1 or 2 in flying condition

*As trainers.

Unofficial claims by IK-3 pilots

Narednik M. Semiz 4 victories
Narednik Vujičić 2 1/2 victories
Kapetan S. Poljanec 2 victories
Kapetan T. Gogić 1 1/2 victories
Potporučnik D. Borčić 1 victory

PREWAR YUGOSLAV AIR FORCE RANKS

Commissioned Ranks

Brigadni General
Pukovnik
Potpukovnik
Major
Kapetan
Poručnik
Potporučnik

Commanding Unit

Brigada
Puk
Puk
Grupa
Eskadrila

Approx. R.A.F. Equivalent

Air Commodore
Group Captain
Wing Commander
Squadron Leader
Flight Lieutenant
Flying Officer
Pilot Officer

Non-Commissioned (Sub-Officer) Ranks

Narednik Vodnik
Narednik
Podnarednik

Warrant Officer
Flight Sergeant
Sergeant

PRE-WAR YUGOSLAV AIR FORCE UNITS

Eskadrila This was the basic combat unit, comprising 9 to 12 aircraft.

Grupa The basic tactical unit, consisting of 2 or 3 Eskadrilas.

Puk Made up of 2 to 3 Grupas in the case of fighters; 2 Grupas in the case of bombers.

Brigada Comprised 2 or 3 Puks; bombers or fighters.