AEROPLANE

DATABASE

POLIKARPOV U-2/Po-2

WORDS: MIKHAIL MASLOV

ABOVE: A standard Polikarpov U-2VS, coded 20, in flight.

17 IN-DEPTH PAGES

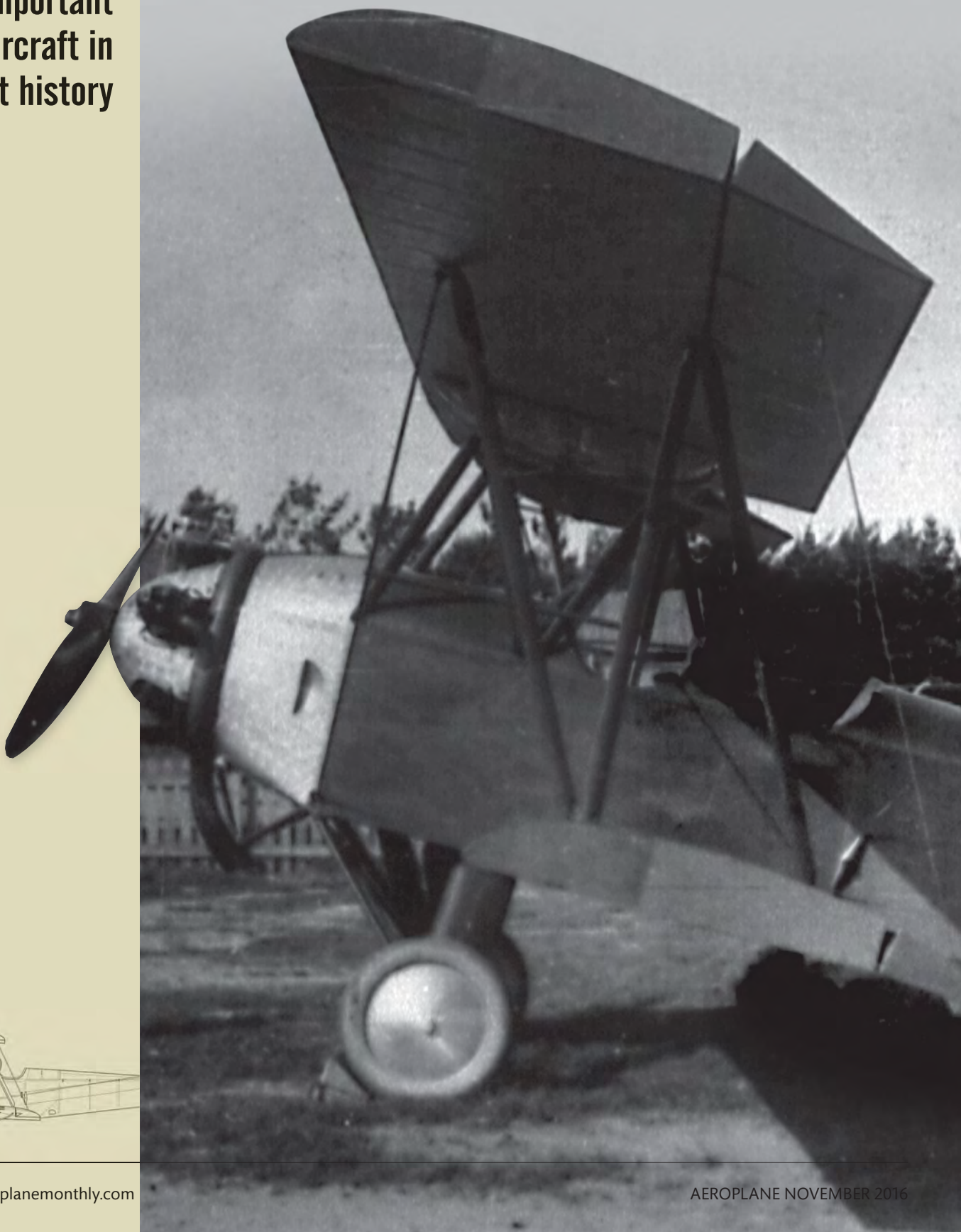
Development

How Nikolai Polikarpov created one of the most important aircraft in Soviet history

This aircraft, known as the U-2 from 1927 and as the Po-2 after the death of designer Nikolai Polikarpov in 1944, boasts the most complete official history of any Soviet type. A factor of no small significance here is that the U-2 never belonged to the 'secret list'. It was known extensively to the general public and widely used. Employment of the U-2 as a night bomber throughout the Great Patriotic War became the aircraft's most impressive role. In fact, this unpretentious biplane turned out to be such an indispensable governmental asset that it is almost impossible to imagine the Soviet military apparatus during the feverish war years functioning without it.

More than 30,000 U-2s were manufactured in just over 20 years from 1929. They underwent dozens of modifications, and left behind a vast history of operations.

The appearance of a new Soviet biplane trainer was expected as early as 1923-24. Initially the gap was



filled by production of a copy of the British Avro 504K, under the designation U-1. This was brought about by the successful purchase of approximately 4,000 Le Rhône rotary engines in France. The said units had been stored since the First World War in two depots in the Paris suburbs, and their owner had a great desire to sell them. Military pilot Leonid Minov, sent to France as an adviser on aviation materiel orders in 1925, managed to buy the Le Rhônes at a price almost equal to that of scrap metal. As a result, the stock of engines for the U-1s became sufficient for years to come. The manufacture of such aircraft continued until the late 1920s.

At the same time, the air force command recognised that the U-1 was not quite up to the requirements for the primary training role. It was able to perform all the required evolutions; however, it demanded considerable attention to control, and did not forgive any piloting mistakes. The need to design a dedicated platform only heightened.

On 23 August 1924, the Air Force Scientific Committee approved a specification for a trainer aircraft. It called for a biplane of simple design, the structure of which was not expected to contain any difficult-to-obtain materials. The aircraft was to have a 100hp engine and be able to carry a pilot and a trainee with a total weight of 160kg (353lb) and sufficient fuel for two-and-a-half hours of flight. Its highest speed in level flight was not to exceed 120km/h (74.6mph), the cruising speed 90km/h (56mph) and the landing speed 60km/h (37.3mph).

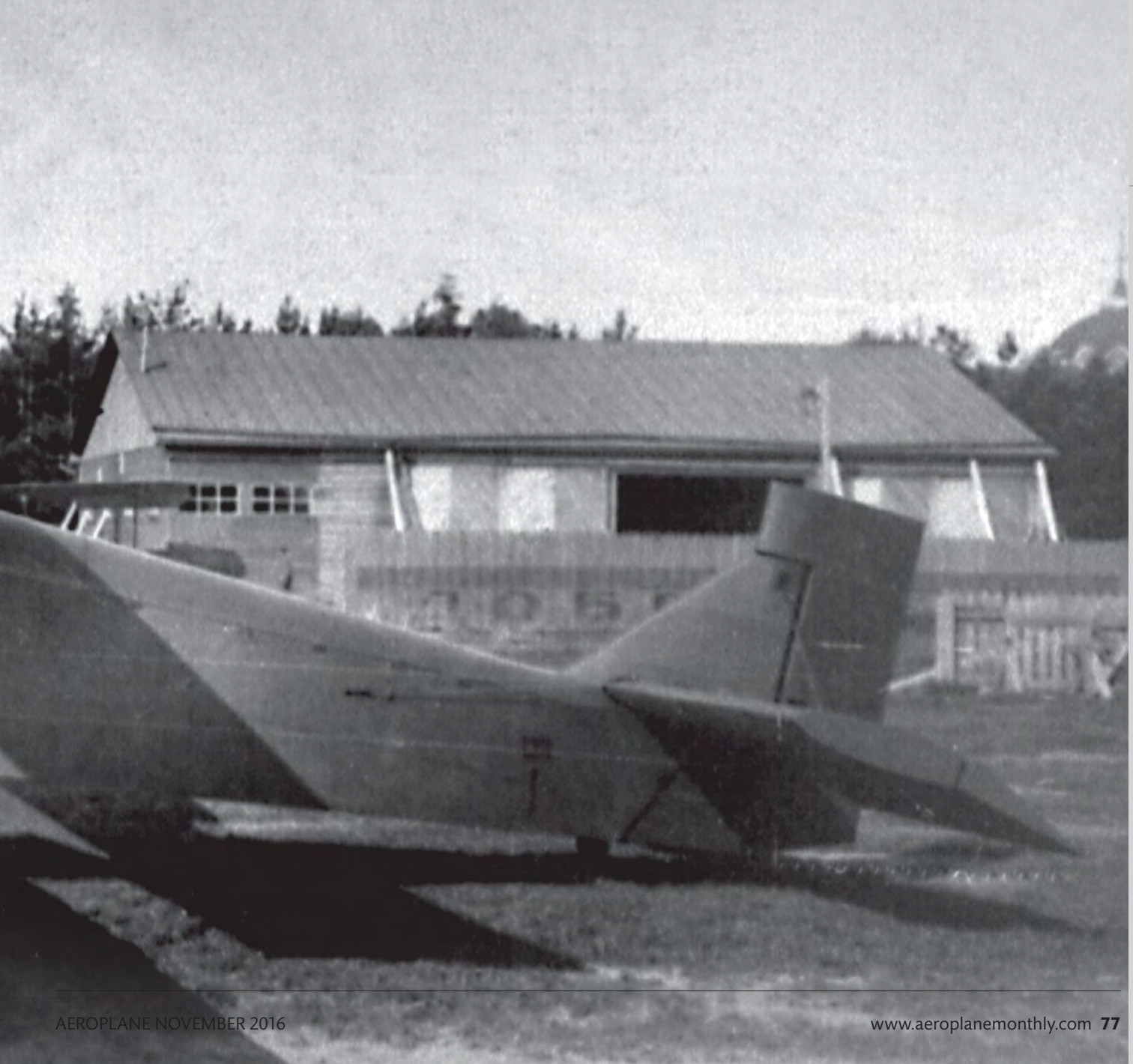
The process of creating such a machine under the designation U-2 began as late as summer 1926. The preliminary design was prepared under the supervision of Nikolai Polikarpov, and was approved at a meeting of the AVIATREST (State Aviation Industry Trust of the Chief Administration of the Metal Industry) Technical Council on 6 December 1926.

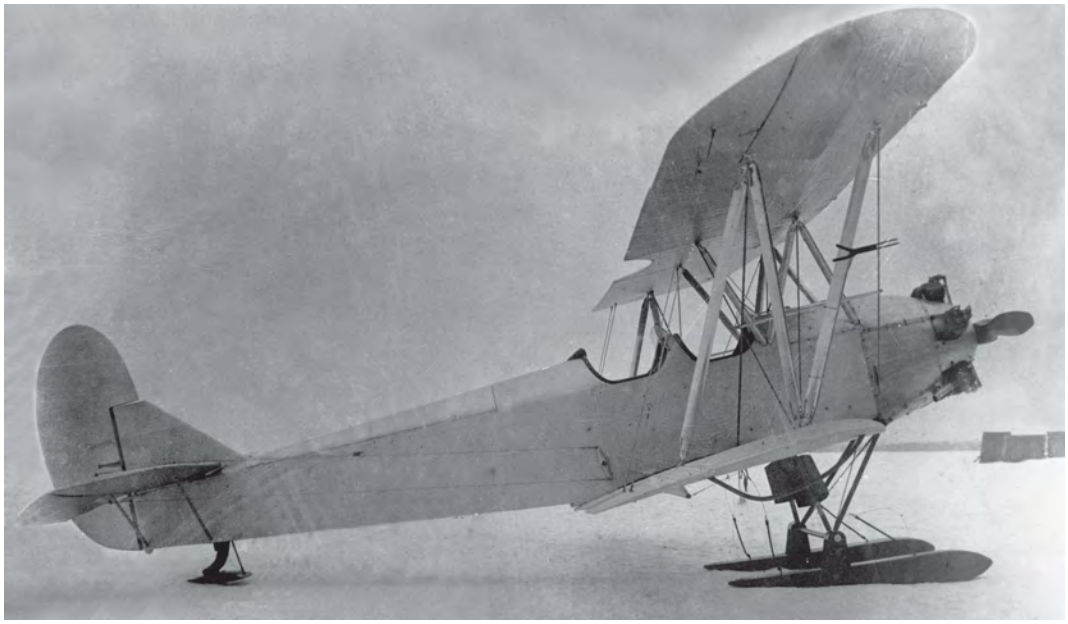
As the powerplant was chosen the new 100hp M-11 engine, designed by Arkady Shvetsov, which was put into production at Factory No 29 in Zaporozhye during 1928. The prototype aircraft, built according to Polikarpov's design, was fitted with a pre-production M-11.

Test pilot Mikhail Gromov made the type's maiden flight on 24 June 1927. According to his report, the U-2 fully corresponded to its purpose, and he "was able to do whatever could be done in that aircraft."

Factory tests were completed in early September 1927. Then the aircraft was handed over to the NII VVS (Scientific Test Institute of the Air Force), where it was tested until 20 October. Except for its rate of climb, the machine fully complied with the air force's specification. A decision was therefore made to manufacture a prototype series of the U-2 M-11.

BELOW: The first prototype U-2, with a rectangular wing utilising the Prandtl aerofoil, during testing in June 1927.





ABOVE: The second prototype U-2 with elliptical wingtips, pictured in February 1928. The aircraft is equipped with a small headrest behind the co-pilot's cockpit, a cowling fully covering the engine crankcase, and skids taken from earlier Russian aircraft of the 1910s.

ABOVE: Nikolai Polikarpov as a young man. In 1927-28, by the time the U-2 was created, the 35-year-old engineer already had several developments of his own in his portfolio. The most significant were the II-400 (I-1), 2I-N1 and I-3 fighters.

All of a sudden, Polikarpov objected. It turned out that from late July 1927 he had been designing the second U-2 prototype, using many successful elements of his earlier aircraft. The design was revised so as to reduce weight and improve its shape; on the request of the NTK UVVS (Scientific and Technical Committee of the Air Force Administration), the strength of the wing cellule was enhanced. In the new configuration, the low rate of climb was rectified; it thus complied with the air force's requirement to climb to 2,000m (6,562ft) in 13 minutes.

According to the available testing records, the second U-2 prototype was sent to the airfield on 16 January 1928, and it first flew on one of the days that followed. However, there are other reports in respect of the date. The famous Soviet expert Vadim Shavrov recorded the following version: "We aviation historians of the 1950s had great difficulty in finding out the date of the U-2's maiden flight in its final configuration, which was then put into mass manufacture. There were no documentary materials in any of the archives; it was only known that the maiden flight had taken place either in very late 1927 or in the very beginning of 1928. Test pilot Gromov did not remember the date. In one of the letters by N. N. Polikarpov we found a phrase to the effect that on Christmas Day [as observed in Russia] God had sent him a joy, namely a successful flight of the new aircraft. That means it was 7 January 1928."

NII VVS state testing was conducted in March 1928. The aircraft, with a gross weight of 870kg (1,918lb), reached a maximum speed of 140km/h (87mph); its landing speed was 60km/h (37.3mph). In these and

BELOW: Aeroflot U-2SPs of the mid-1930s with three open cockpits. The aircraft in the foreground features a 'faceted' forward pilot's windscreen and flat passenger windscreens.

other performance parameters, the U-2 conformed fully to the design specification. Pilots' opinions were unanimously positive too. It was decided to launch mass production at Factory No 23 in Leningrad, which had been building trainer aircraft for several years.

The first mass-manufactured U-2s began to reach flying schools in 1930. In spite of certain drawbacks, as are experienced with many new designs, the aircraft immediately won high praise from both instructors and trainees. It was far more efficient, the percentage of trainees rejected due to poor airmanship being notably reduced.

Approximately 1,400 U-2s were built in the first three years of manufacturing in Leningrad. This allowed the almost complete replacement of the worn-out U-1s in the training institutions of the Red Army Air Force and the Civil Air Fleet; some aircraft were also provided to the flying schools operated by Osoaviahim (the Society for Promotion of Defence, Aircraft Building and Chemical Construction). At that time, the Civil Air Fleet ran three flying schools, one each in Bataisk, Tambov and Balashov. They received several dozen U-2s, but the lion's share went to the Air Force, which had 597 as of January 1933.

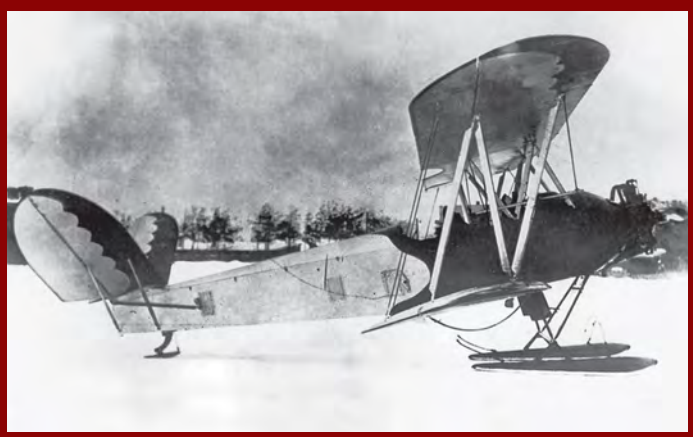
Almost immediately, the U-2 proved its suitability for other applications. The first special-purpose version was the U-2AP (Aeropyl) agricultural aircraft, intended for fighting locusts and other plant pests, which had become a real plague in southern regions of the Soviet Union. The agricultural U-2s were also used successfully for aerial sowing. In 1933 alone, 138,000 hectares were sown from the air.

Some 1,255 U-2APs were built by 1941. During the Great

ONE-OFF VERSIONS

• Inventor Filatov suggested replacing the standard tail unit of the U-2 with a V-shaped ('butterfly') tail. A prototype was tested successfully in 1934. Stability and controllability of the aircraft were unaffected; however, there were no obvious advantages either, and the modification never entered production.
• In 1937, engineer Konstantin Shcherbakov equipped U-2 c/n 5342 with special skids, fitted with servo-assisted steering gear. This device could turn the skid downwind in any flight regime, seeking to improve the aircraft's stability.
• To improve the U-2's take-off and landing performance, in 1937 engineer Nikolai Chechubalin replaced the standard wheels with a caterpillar assembly. Each caterpillar was essentially a chain of textolite rollers, 50mm in diameter and 3m (9.8ft) long, arranged between guides along the sides. The caterpillar undercarriage worked well during testing, with only slight increases in weight and drag.
• During 1937, designer Yevgeny Agitov converted an 85hp six-cylinder powerplant into an aero engine; it was referred to as the GAZ-AVIA. The following year, it was mounted on a U-2. Flight-testing showed that use of the engine, which weighed 200kg (441lb) and produced just 85hp, led to a considerable deterioration in flight performance. It was not pursued.
• In 1939, specialists at the NII VVS experimental shops devised and tested a prone-pilot arrangement. Trials showed that it was feasible, and could be recommended for use on record-setting aircraft and interceptors. However, work was discontinued, since no aircraft projects that could benefit from such a configuration had been or were being developed at that time.

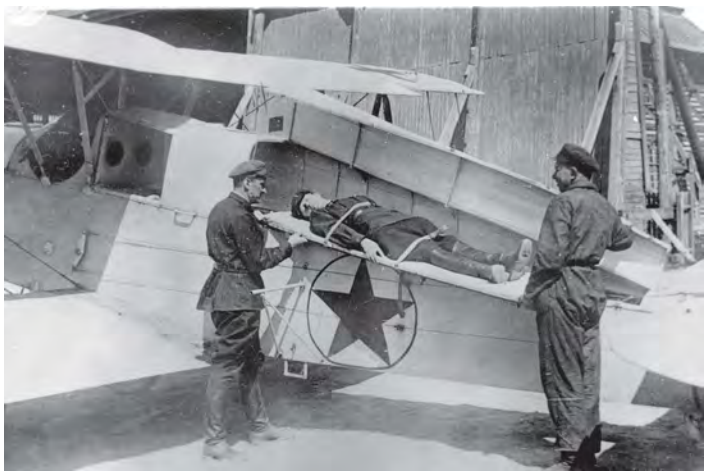
BELOW LEFT: The U-2 with the V-shaped tail designed by Filatov.
BELOW RIGHT: The testing of the prone-pilot U-2, 1939.
BOTTOM LEFT: The caterpillar undercarriage devised by Chechubalin. With such 'footwear', a U-2 could take off and land from ploughed fields.
BOTTOM RIGHT: A U-2 with an 85hp GAZ-AVIA car engine.



ABOVE: An S-3 air ambulance with the original mottled camouflage.

Patriotic War, these aircraft were — after fairly simple modifications were made — used instead for urgent transport tasks. Several new agricultural Po-2 variants appeared post-war, some of them modified from military aircraft; later 'Aeropyls' were based on the Po-2L passenger version.

In 1931, the U-2AP became the basis for a version fitted with an enclosed passenger cabin. It was designated as the U-2SP (Special Purpose). From 1934 the factory manufactured the U-2SP with three open individual cabins, the pilot and passengers sitting one behind the other, protected by standard windscreens. More than 830 U-2SPs had come off the Leningrad line by 1940.



ABOVE: The S-1 air ambulance was the first U-2 adapted for the role. The encircled red star emblem was typical for special-purpose units.

Air ambulance U-2s with the designation SS (Sanitarny Samolyot, Russian for 'air ambulance aircraft'), or S-1, emerged from the factory from 1934. The derivative featured a raised fuselage top — referred to as a 'grotto' — right behind the cockpit. This could carry a patient on a stretcher and an accompanying physician. The Leningrad plant manufactured 99 S-1s from 1934-36.

While no air ambulance U-2s were built in 1937-39, a vital Red Army need for them arose during the Winter War. An improved version, built in 1940 and designated S-2, featured a larger 'grotto' with additional windows and the 115hp M-11D engine.

The high wartime demand for air ambulance aircraft was satisfied in part by making use of removable cabins designed by Bakshayev and Shcherbakov, and by conversion of U-2s, U-2APs and U-2SPs into the S-3 version. The latter, constructed at the suggestion of technician Filatov (and thus sometimes referred to as the SKF, Sanitarnaya Kabina Filatova — Russian for 'Filatov's air ambulance cabin'), was notable for its simple and original design. Almost any version of the U-2 could carry, instead of the standard raised 'grotto', a new box-type plywood container fairing with a central partition. Projecting beyond the fuselage sides, it could accommodate two casualties instead of one. Nor did it alter the aircraft's flying characteristics in any way.

Factory No 23 began to build the U-2VS (Voiskovaya Seriya, meaning 'Army Aviation Series') in 1933. These aircraft were equipped with bomb racks and bow and turret-mounted machine guns. The U-2VS was used for training in military aviation schools. Approximately 600 had been made in Leningrad by 1938.

WARTIME PRODUCTION

Production of the U-2 — together with the necessary tooling — was handed over in 1940 to another Leningrad factory, No 387. This led to a considerable reduction in the production rate. However, the outbreak of war entailed great demand for U-2s, and manufacture was launched at several new factories. From 1941-45, more than 17,000 were built, many being operated as night bombers.

A pre-war decision on building transport gliders led to the appearance of new enterprises specialising in wooden aircraft. Among them were four factories that built the U-2.

• Factory No 387 was, upon the outbreak of war, evacuated from Leningrad to Kazan. Initially there was a shortage of materials, engines and components; aircraft lacquer and casein glue were not available. Gradually, many of the problems were solved by means of the substitution of different materials and cost savings in the manufacturing process. These steps allowed a 39kg (86lb) reduction of ferrous metal consumption per aircraft.

In 1942, the factory's design office was working on conversion of the aircraft into a bomber under the U-2VS designation. The number of DER-7 beams for the attachment of bombs under the lower wings was increased from four to six. That armament, with a total load of 300kg (661lb), became a standard configuration from mid-year. A folding seat was fitted in the rear cockpit to facilitate gun operation. Instead of the DA machine gun, an ShKAS belt-feed machine gun was installed. Of more than 2,000 aircraft manufactured during 1942,

U-2/Po-2 mass production 1941-45

Factory	1941	1942	1943	1944	1945
No 387*	1,245	2,225	2,733	3,045	2,155
No 464	-	-	71	736	557
No 471	-	-	53	657	417
No 494	-	18	270	695	427
Total	**1,245**	**2,243**	**3,127**	**5,133**	**3,556**

Overall total for this period: 15,304

** – In 1940, Aviation Factory No 387 manufactured 50 U-2s.*

938 were equipped with a multi-purpose pintle mount; of those, 771 were fitted with an ShKAS gun. To enable night missions, a new instrument panel with an AG-1 or AGP gyro horizon was installed; the aircraft were given navigation lights and a FZS-155 landing light.

Considerable work was carried out in the name of saving materials. In particular, the wingtips, empennage and landing gear fairings were made from wood and plywood, while engine cowlings were manufactured from sheet iron.

The Kazan Aviation Factory kept building combat aircraft until October 1945. Later, it began turning out Po-2S air ambulances, production of which was transferred from Factory No 494. The Po-2S featured a new instrument panel, modified wiring and a new high-quality paint coating. Some aircraft were manufactured in Po-2L configuration, with space in the cabin for two passengers, though the labour-intensity of this modification was estimated at 15 per cent higher.

In late 1946, manufacturing of the Po-2 was transferred to Factory No 168 in Rostov-on-Don, when the Kazan factory began to make combine harvesters.

ABOVE: U-2VS c/n 641115, manufactured at Factory No 464, during acceptance testing in August 1944. The aircraft is in standard configuration.

• Factory No 464 moved in 1943 to Dolgopruny in the Moscow region. It began to build U-2s in mid-year. During 1944, it turned out a batch of U-2NAK night artillery observation aircraft. The plant ceased to manufacture the Po-2 in 1945, switching that June to the Yak-10 liaison aircraft.

• Aviation Factory No 471 was set up in 1941 at woodworking facilities in Shumerlya, western Russia. Manufacturing of the U-2 was launched there in accordance with technical documentation already prepared at Factory No 387. In July 1945, this was discontinued, and the factory was handed over to the People's Commissariat of Forestry.

• Aviation Factory No 494, in Kozlovka on the River Volga, began work in July 1941. During August 1942, it started to manufacture S-2 air ambulances, and in 1944 the U-2L passenger version with an enclosed cabin.

ON FLOATS

Early work on a U-2 floatplane was carried out at Factory No 25 in Moscow under the supervision of Sergey Kocherigin. The aircraft, designated MU-2 (or U-2M), was fitted with a single central wooden float and two small floats for lateral stability.

Testing was conducted on the Moscow River in spring 1931. It was found that the main disadvantage was in starting the engine: it was extremely uncomfortable to turn the propeller manually (there was no other way of starting the engine on the U-2 at that time) while standing on one of the side floats. Furthermore, after the appearance of the Sh-2 flying boat, the demand for small floatplanes in the USSR was basically satisfied. Work on the U-2 seaplane conversion was temporarily discontinued.

It resumed nine years later, with the appearance of the more powerful M-11D engine featuring a pneumatic self-starter. At the same time, the Central Aerohydrodynamic Institute (TsAGI) conducted an extensive investigation into floats for aircraft of different gross weights, speeds and roles. For the U-2, they selected floats that became known as the Model 10 design for twin-float seaplanes. They were intended to have a high lift-drag ratio at low speeds.

In 1940, Factory No 23 in Leningrad built a seaplane version of the U-2 using such floats. Then the war began, and again floatplane development was suspended. However, the single-float Po-2M was built at Aviation Factory No 51 in Moscow during 1944. It was designed on the initiative and under the supervision of Nikolai Polikarpov. Based on wartime experience, he decided to create a special-purpose combat aircraft to carry out military operations in areas rich in rivers and lakes. So as to hang bombs under the wings, he chose an arrangement involving a single central float and two small auxiliary floats. Armament included 100kg (220lb) of bombs – four FAB-25s on underwing racks – and a pintle-mounted DT machine-gun. The new NP-Po-2 night bombsight was used.

The Po-2M generally proved successful in testing. It was recommended for application by Air Force units operating from rivers and lakes with at least 500m (1,640ft) of take-off and landing space, and with open approaches. So simple was the aircraft to operate that it was deemed suitable to be flown by pilots of below-average skill. However, in spite of the positive opinions, this version was not further developed.

A passenger-carrying Po-2LP (c/n 327118) with an M-11D engine was equipped with floats at Aviation Repair Base No 402 in Bykovo, Moscow area, during 1945. The floats were manufactured in repair shops of the USSR's NKVD border troops according to drawings from Aviation Factory No 23. Waterborne take-offs and landings were quite possible with three passengers on board, and at a maximum take-off weight of 1,300kg (2,866lb). The aircraft got onto the 'step' at an indicated speed of approximately 60km/h (37.3mph), and lifted off from the water with ease at 80-85km/h (49.7-52.8mph). Both in level flight and turns or manoeuvres, flight performance of the float-equipped aircraft was almost identical to that of an ordinary Po-2. The seaplane was stable on landing, too.

It was suggested that such floats should be manufactured for use on Po-2s in the north of Russia and in Siberia. An unknown quantity of float sets was fabricated for operations from river basins in border areas. During the summer of 1946, five Po-2s (c/ns USSR-N402, -N403, -N404, -N405, and -N406) were fitted with floats and handed over to the Igarka Aviation Group of the Chief Administration of the Northern Maritime Route (GUSMP).

ABOVE: The float-equipped Po-2LP at Aviation Repair Base No 402 at Bykovo in the Moscow area.

ABOVE: Osoaviahim U-2s taking off during an aviation festival at Tushino, August 1934.

The trainer that was transformed into a combat aircraft

In the Osoaviahim flying clubs, the U-2 played a remarkable role in training would-be pilots during the pre-war period. At that time, the slogan 'Young Communists, Learn to Fly!' was very popular in the USSR; it was part of a propaganda campaign. From 1931-36, the Osoaviahim aircraft fleet grew 19-fold. As of 1936, the Society for the Promotion of Defence had as many as 150 flying clubs, 8,000 pilots having completed their training in 1935 alone. Enthusiasm for aviation was promoted by aviation parades and festivals, which became regular occasions from 1932.

The U-2 trainers were of great significance in the massive aviation boom that swept the entire country. The Osoaviahim flying clubs put approximately 50,000 people through initial training on the U-2 alone. The majority continued training in flying schools and then remembered with gratitude the small biplane, which had given them a 'free pass' to flying.

The summer of 1941 brought a quite unexpected turn in the fate of the peaceful biplane trainer. Major aircraft losses during the first days of the war against Germany forced the Soviet government to take urgent measures, among them a search for new weapons. Given the enemy's air superiority, one idea was to use obsolete aircraft types as night bombers. An order from the Supreme Command stated that several dozen night bomber regiments should be formed on ageing multi-purpose R-5 and R-Z biplanes and U-2 trainers.

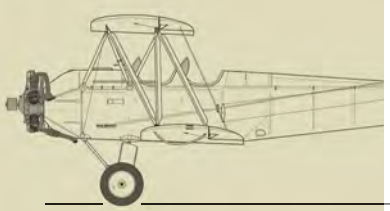
The highest hopes were pinned on the R-5s and R-Zs — by contrast, the U-2 was viewed as being of secondary importance. No-one could have expected that this seemingly harmless little machine would prove the most useful in the role.

Determining the exact number of active U-2s at that time is difficult due to various factors. Of slightly more than 14,000 U-2s produced, in excess of 10,000 were built as trainers. Over the course of 12 years, the early examples were subjected to more than one overhaul, and some were written off. Some were lost in accidents; however, when a crash involved no fire, the aircraft was almost always restored. Furthermore, the U-2s were often listed in aviation fleet inventories under "other aircraft types", rather than as an individual type. Still, a general idea can be gained.

The majority of U-2s, of course, were posted to the Air Force. As of late September 1940, the Red Army Air Force had at its disposal 3,424 U-2s (of which 2,496 were serviceable) and 29 U-2S air ambulances (22 serviceable). Naval Aviation had 384 U-2s and several air ambulances. The author has no data as to the number of Air Force U-2s in summer 1941. However, given the low number of deliveries in the winter of 1940-41, we can assume that the figure only slightly exceeded some 3,600 or 3,800 aircraft.

As of 1 April 1941 the Civil Air Fleet had 426 U-2s, 533 U-2APs, 42 S-1s (plus four more in the NKVD), 178 S-2s and 524 U-2SPs. At the same time, Osoaviahim had 3,175

ABOVE: An instructor explains the purpose of the few instruments in the aft cockpit to his trainee. The forward cabin features a non-standard instrument panel accommodating a starting magneto.



U-2s; several more U-2 trainers were at the disposal of agencies including the Border Troops (16 aircraft) and NKVD (22).

The number of U-2s in various versions posted to different non-military agencies totalled, in April 1941, 5,551 aircraft. Thus, the quantity of reasonably serviceable U-2s available in the USSR just before the war may be estimated at 9,200-9,400 aircraft, though the very first month of military hostilities resulted in a considerable reduction of this figure.

The flight and groundcrews operating the U-2s are worthy of special mention. Upon formation, the individual regiments were manned initially by pilots and technicians from flying schools, the Civil Air Fleet and Osoaviahim. Later there arose a practice to post to the U-2 units pilots who had been wounded, reservists, or those unfit to fly fighters or bombers for health reasons. However, almost immediately after the start of the war, U-2 aircrews began to be trained at separate schools. The principal objective was to learn all types of flying in bad weather or at night, since the type remained the main liaison and air ambulance aircraft for the Red Army.

During wartime, 22,227 pilots completed their training on the U-2 at Civil Air Fleet schools; 18,704 of them were posted to Air Force and Long-Range Aviation units.

IN ACTION DURING THE GREAT PATRIOTIC WAR

Once the panic surrounding early combat losses had subsided — and as the summer nights became longer — the Red Army began to employ increasingly efficient techniques for fighting the enemy, from partisan warfare and sabotage operations to night-time aerial bombing raids. As far as is known, U-2s were first used for night bombing missions on the Southern Front in July and August 1941. However, the time soon came when fully equipped U-2 units were active on almost all fronts. By the end of 1941, up to 20 new light bomber regiments had entered action.

The most active combat use of U-2s took place near Moscow in late 1941. A group was formed for operations around Mozhaisk under the command of Col Sbytov. It included a squadron of hastily armed U-2s. From 8-19 October they flew 508 sorties around Yukhnov, inflicting considerable damage to German troops.

More U-2s began to arrive at the front. Re-equipment usually involved the attachment of DER-7 underwing bomb racks. Four such racks — which had long before been used on the Polikarpov R-1 — could take up to 100kg (220lb) of bombs. Later, the number of racks was increased to six; the bomb load grew too, with individual bombs of up to 50kg (110lb) or even 100kg (220lb) being used.

Early night bomber operations involved much improvisation as crews developed better tactics and new fighting methods. The results were sometimes far from impressive; the bombing accuracy suffered, and the lack of proper flight training and night flying practice was felt. But, as experience grew, the situation changed considerably.

The 46th Back-up Regiment was formed at Alatyr, Chuvashia, in June 1942. Its task was to train U-2 crews for flying in difficult weather conditions and at night. The main problem had been the total absence of aircraft specially equipped for night flying. Initially, the few aircraft that were fitted with autopilots and illuminated instrument panels were allocated for training purposes.

ABOVE: U-2VS c/n 4504 with an M-11D engine, manufactured at Factory No 387 in October 1943. The photo was taken during state testing, which took place from 21 November 1943 to 13 January 1944.

ABOVE: A U-2 being refuelled in the field. The 50kg (110lb) bombs under the wing indicate preparation for a combat sortie.

As the U-2 production rate increased, so manufacturing began at nearby factories in Shumerlya and Kozlovka. There thus developed what amounted to a U-2 training centre at Alatyr, which received new combat-equipped aircraft. The flying practice available there typically did not exceed 15 hours, meaning crews had to acquire experience at the front, often at a heavy cost. For example, operational service testing of the U-2NAK in 1944 was conducted using pilots trained by the 49th Back-up Regiment at Bogorodsk. The said 15 hours of practice proved evidently insufficient for the young pilots, since three aircraft out of five crashed when the pilots lost their bearings.

It was not an easy task to fly the U-2 at night. A nocturnal mission was full of hazards; crews had to act with particular prudence, and stick scrupulously to the established rules. On a sortie to the Germans' rear, the aircraft had to approach the front line at an altitude of at least 1,500m (4,921ft), then throttle back to idle, and glide almost silently as far beyond the front line as possible. At 300m (984ft), the pilot applied full power again.

About a year after the outbreak of hostilities, U-2s began to be fitted with mufflers for the M-11 engine. At first, makeshift devices appeared on the front line; later, they were mounted on newly manufactured aircraft too.

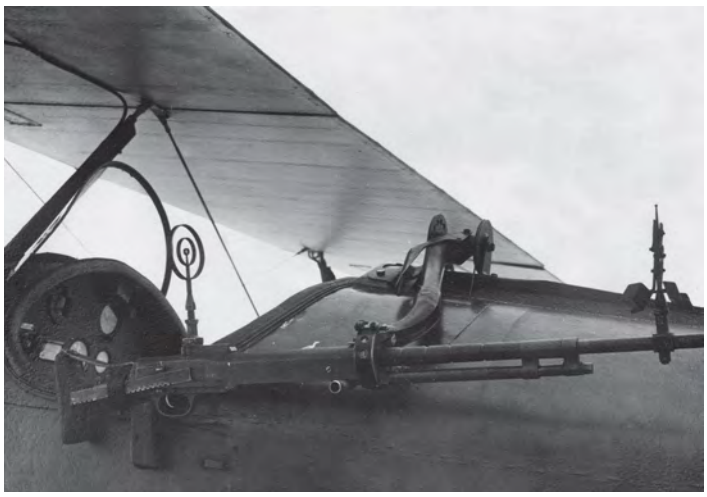
The practical use of mufflers and flash reducers showed that the enemy was unable to detect an aircraft so equipped at an altitude of 700-800m (2,297-2,625ft). There were many cases when a U-2 with such devices proved undetectable at lower altitudes as well.

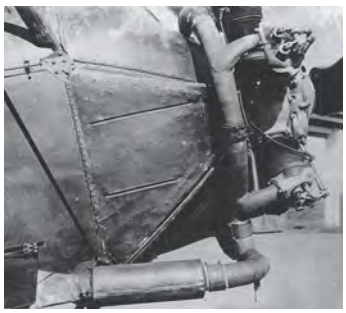
A flight leader from the 23rd Guards Regiment, Guards Master Sgt Sinyakov, reported: "From May 1942 up to now [April 1943], I have been flying U-2s fitted with AKS-2 mufflers. The latter have shown themselves to advantage in a combat situation. The engine sound becomes softer; this allows flying with impunity over large facilities protected with all air defence weapons. I have flown a lot of reconnaissance sorties. I flew across the front line at an altitude of 800-1,000m [2,625-3,281ft], closed the muffler's shutter, descended to

100 or 150m [328 or 492ft], and felt like a master of the area: the running vehicles did not switch on their lights; large railway stations conducting the unloading of troops did not attempt to camouflage themselves against an unexpected raid; sometimes, the enemy took me for their 'cuttlefish' [the Henschel Hs 126]."

Guards Capt Mankevich of the 23rd Guards Regiment stated, "The muffler/flash reducer plays a positive role in night conditions, since it ensures acoustic covertness and the element of surprise in approaching the target. In our raids against large pockets of resistance, where the enemy's air defence weapons are concentrated, the aircraft fitted with mufflers/flash reducers approached the target and left without hindrance, whereas the aircraft which were not fitted with mufflers/flash reducers were detected on approaching the target and met by anti-aircraft artillery.

"It is peculiar that, on the appearance of aircraft fitted with mufflers/flash reducers, the enemy does not take any defensive steps until the moment of bombing, especially in areas where the enemy's aircraft operate. The sound of a muffled engine is […] identical to that of the Ju 87's engine. There were cases when the enemy from its airfield gave signals to land to our aircraft flying over."





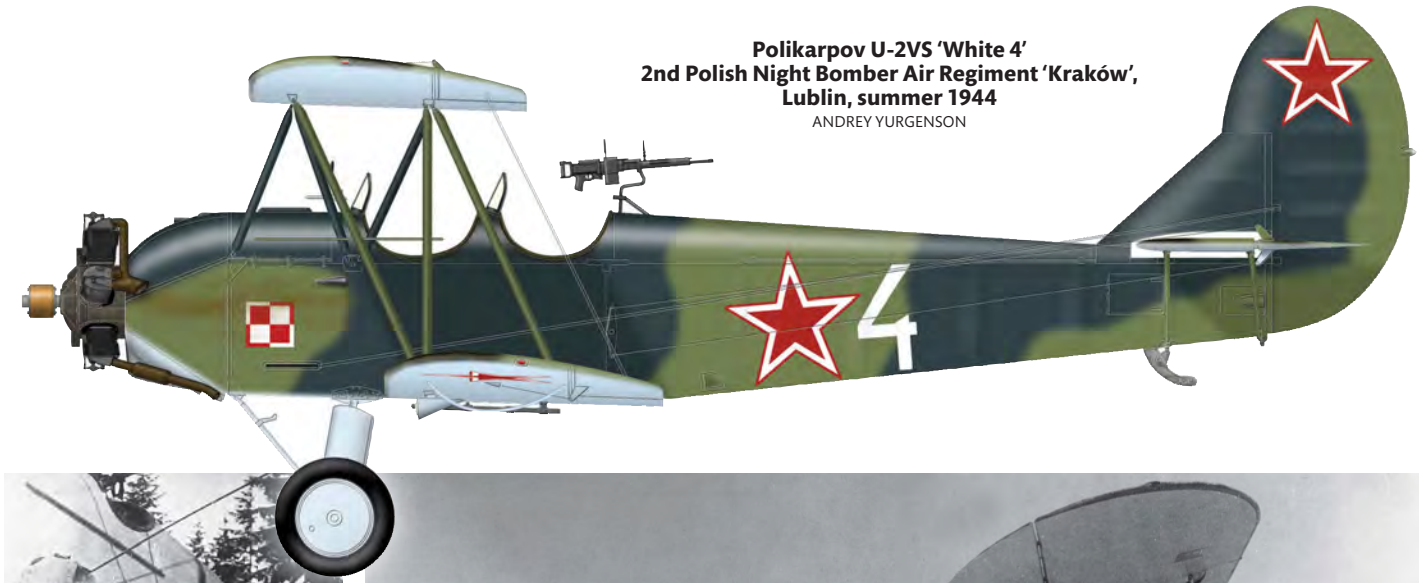
ABOVE: An MAKF-4 muffler/flash reducer on an artillery observation U-2 in autumn 1943. LEFT: A DT machine gun (without its cartridge tray) in the stowed position on the pintle mount of U-2VS c/n 4504.

In 1943, MAKF-4 mufflers appeared, acting as a high-frequency acoustic filter. In accordance with an order dated 21 July 1943, such mufflers were installed on some of the U-2 M-1Ds of the 213th Night Bomber Division led by Maj Gen Molokov, Hero of the Soviet Union and a famous polar pilot, who himself flew U-2s a great deal.

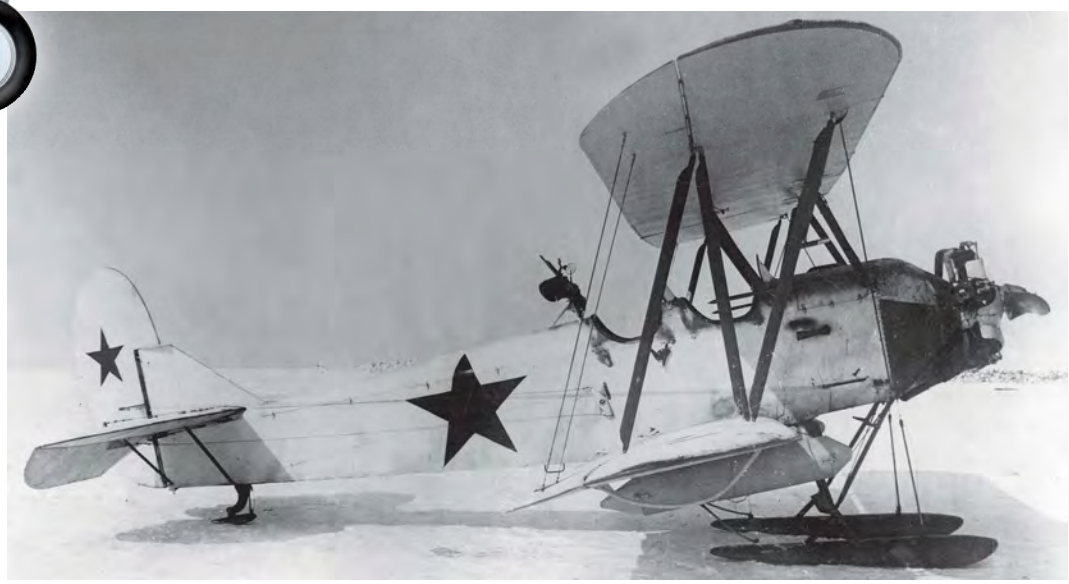
Aircraft with MAKF-4 mufflers/flash reducers underwent operational service tests in combat conditions until 3 September 1943, in the presence of the Red Army NII VVS representatives. The results were deemed satisfactory, and a decision was made to fit all the aircraft of the 213th Night Bomber Division with MAKF-4s before 1 October.

On a bombing mission with 300kg (661lb) of bombs, the U-2 'crawled' to the front line at a speed of approximately 90km/h (56mph).

Polikarpov U-2VS 'White 4'
2nd Polish Night Bomber Air Regiment 'Kraków', Lublin, summer 1944
ANDREY YURGENSON



ABOVE: The attachment of 50kg (110lb) bombs to a U-2's underwing racks.



ABOVE: A U-2VS carrying underwing ABPK-100 bomb dispensers, and sporting winter camouflage.

Not all of the aircraft were able to climb to the required altitude of more than 1,000m (3,281ft) above the most dangerous area of the route. From that moment on, the type's chief weapon and ally was its covert nature.

Many tactical techniques were employed when approaching the target and making an attack. Pilots resorted to group attacks, with the most daring crews drawing fire upon themselves. They bombed searchlights and anti-aircraft artillery units, and subjected them to machine gun fire. The main goal in every case was to leave the area under fire in good time. Battles with ground gunners were decidedly unequal. If hit, the aircraft could catch fire and burn out in just 40 seconds.

The particular tactics for operations in the German rear required the U-2s to fly from small, temporary landing sites along the front line. In the evening or as darkness fell, aircraft flew to these locations, to which bombs and fuel were brought in advance. By day, German reconnaissance and attack aircraft searched for the principal basing locations of the Soviet night raiders; at night, they tried to find the forward sites.

Utmost attention was paid to camouflaging the field units. Special care was taken to ensure an effective blackout; the use of powerful floodlights was reduced almost to zero. Sometimes, car headlights or small bonfires were used for short-term illumination, but more often kerosene lamps of a tubular lantern design were employed. Pilots used to say that one should be able to perform a landing approach at night "with the runway lit by the tip of the regiment commander's cigarette."

To protect the main airfields used by the U-2s, decoy airfields were sometimes set up near them, with intensive combat operations being simulated at these locations. The decoys were provided with clearly detectable night take-off lights; the actual bases, meanwhile, were lit with only two small lights indicating the take-off and landing direction. On returning from a combat sortie, U-2 crews approached the false airfield — sometimes with their navigation lights on — and simulated the landing procedure. They then switched off the lights and flew to the darkness-enveloped main airfield.

In most cases, such practice yielded good results. From 15-18 September 1942, German aircraft made 67 attacks against airfields of the 272nd Night Bomber Division; of those, only 31 raids actually targeted the operating airfields. Furthermore, from 21-31 October, the division's main bases were attacked by German bombers just twice.

Combat operations by the night bomber divisions enjoyed mixed success. One measure of the U-2s' efficiency can be ascertained by comparing the losses sustained by various aircraft types. In May 1944, the 5th Air Army had 1,105 aircraft, among them 72 U-2s in the 312th Night Bomber Division. That month, it lost 19 U-2s. Of those, three were shot down, 14 sent for repair, and two suffered accidents. Losses of all aircraft types in the 5th Air Army for that same period totalled 336 aircraft, of which 121 were shot down. Attrition among the U-2 night bombers was considerably lower than for other combat aircraft.

For pilots who flew U-2s, the number of combat sorties was the key indicator of their performance. Among the top scorers were two Heroes of the Soviet Union, Maj A. A. Dobkevich (with 1,037 combat sorties) and Maj A. P. Yerofeyevsky (1,034).

The number of U-2s in combat service on the most intensive segments of the Soviet-German front was impressive, too.

Gradually, as the war went on, the quantities grew. In January 1944, 49 night bomber regiments at the front had up to 1,000 U-2 bombers in operation. As the military situation changed, units were reassigned to other areas. As of January 1945, the number of combat U-2s amounted to 1,018 aircraft. A quite appreciable number operated with the 3rd Air Army of the 1st Baltic Front (116) and the 15th Air Army of the 2nd Baltic Front (153). Upon the war's end in May 1945, night light bomber regiments had at their disposal 991 U-2s.

Front-line U-2 disposition, 1 July 1943

6th Air Army of the North-western Front	31 active (1 unserviceable)
3rd Air Army of the Kalinin Front	4 (2)
1st Air Army of the Western Front	205 (1)
15th Air Army of the Bryansk Front	51 (1)
16th Air Army of the Central Front	75 (3)
2nd Air Army of the Voronezh Front	42 (8)
5th Air Army of the Steppe Front	20
17th Air Army of the South-western Front	71 (5)
8th Air Army of the Southern Front	67 (12)
4th Air Army of the North Caucasian Front	72
257th Separate Air Division of the Air Force	15
Total	**653 (38)**

THE 'NIGHT WITCHES'

The heroic Soviet comedy 'Nebesny Tikhokhod' ('The Slow-Pacer in the Sky') made the U-2 immensely popular with the general public. It also established a belief that, during the war, the aircraft was flown mostly by female crews. In fact, of more than 80 regiments and many squadrons that flew U-2s, only one female regiment operated at the front: the 46th Guards 'Taman' Regiment. Its history began on 8 October 1941 when Josef Stalin signed Order No 0099 to deploy three women's air regiments — the 586th Fighter Regiment, the 587th Bomber Regiment, and the 588th Night Light Bomber Regiment flying the U-2.

Formation of the 588th Night Light Bomber Regiment at Engels was basically completed on 6 February 1942. As soon as June, its crews began to fly combat sorties. This was a hard time for the Red Army's Southern Front. Against a rampant enemy and with heavy losses, Soviet troops were retreating from Voroshilovgrad and Rostov.

The women's regiment suffered casualties, too. Squadron leader Lyuba Olkhovskaya and navigator Vera Tarasova failed to return from their first combat sortie, which was flown by three crews led by regiment commander Yevdokia Bershanskaya.

Throughout summer 1942, the 588th kept up operations on the Southern Front. The night bombers attacked German crossings on the Mius and Severny Donets rivers, and carried out raids against vehicle columns in the steppes near Salsk.

ABOVE: 588th Night Light Bomber Regiment comrades-in-arms: pilot Marina Chechneva and navigator Yekaterina Ryabova.

Together with other units, the regiment suffered the hardship of retreating from the Donbass region to the Caucasian foothills.

On 13 August, it was redeployed to the village of Assinovskaya, where it remained for nearly five months. During a relative lull, a group was organised for the training of new navigators, the separate navigator squadron members being retrained as pilots. Replacement crew members also arrived, comprising women sent to the Army under mobilisation. Throughout the war, 150 new recruits joined the unit.

Before the end of 1942, the 588th took part in the defence of Vladikavkaz, the U-2s bombing German troops near Mozdok, Prokhladnaya and Digora. The following March, the regiment began to fly combat sorties to support offensive operations aimed at breaking through the 'Blue Line', a line of defences constructed by the Germans on the Taman Peninsula. On some nights, the crews flew as many as eight or 10 sorties.

Polikarpov U-2VS 'White 19'
46th Guards Night Bomber Regiment, 1945
ANDREY YURGENSON

In no way was the women's regiment treated any differently from its male counterparts, nor was it ever posted to 'quiet' parts of the front. The women fought on an equal basis, suffered the same difficulties and hardships, and incurred heavy casualties. From its formation until the termination of hostilities, 32 members of the 588th died in combat.

The night of 31 July 1943 was the most tragic. Twelve crews departed on a mission to bomb 'Blue Line' positions. German night fighters, interacting with searchlight units, shot down four U-2s. Eight women were killed. A burning U-2 typically took less than a minute to disintegrate in mid-air, while pilots carried no parachutes until 1944. It was believed that death was the best way out for a crew shot down over enemy territory. Navigators seldom had machine guns at their disposal. The regiment's aircraft were fully equipped with defensive machine guns only as late as summer 1944.

From November 1943 to May 1944, the 588th supported the landing of seaborne troops on the Kerch Peninsula, and took part in liberating the Crimea and Sevastopol. Bombing missions were flown every night in April 1944, by which time many pilots and navigators had flown 500 combat sorties.

For its especially meritorious combat achievements, the 588th Night Light Bomber Regiment was re-designated as the 46th Guards Night Bomber Regiment on 3 February 1943. It was awarded the title of 'Taman' Guards Night Bomber Regiment decorated with the Order of the Red Banner and the Order of Suvorov Third Class for its part in the liberation of the Taman Peninsula. After liberation of the Crimea, the 46th was redeployed to Byelorussia (today Belarus), and headed towards Berlin in 1945.

The regiment's women pilots flew 23,672 wartime missions, and dropped more than 3,000 tonnes of bombs on the enemy. At the war's end its strength numbered 230 personnel, among them 80 aircrew members. Twenty-three women, five of them posthumously, were awarded the title of Hero of the Soviet Union; another two were made Heroes of Russia in more modern times. Approximately 40 of the regiment's pilots and navigators flew in excess of 500 missions — those given the title of Hero had to have notched up 800.

Upon the end of hostilities in May 1945, many women were demobilised by the Soviet armed forces. The 46th Guards Night Bomber Regiment existed as a combat unit for a few months longer. It was disbanded on 15 October 1945.

ABOVE: Leaflets being dispensed from a U-2VS named *Avenger*, with tail number 19, from the 46th Guards Regiment. The fuselage bears the inscription, "We will take revenge for our comrades-in-arms Tanya Makarova and Vera Belik!" This aircraft is also depicted in the colour side view on this page.

SECOND-LINE ROLES

During the initial period of hostilities, when manufacturing of the U-2 for its new role had not yet been launched, aircraft were handed over to combat units from their second-line counterparts. Before mid-1942, 898 U-2s were thus provided to the Army, mostly from flying schools.

As of 1 July 1942, light bomber regiments had at their disposal 679 U-2s, 90 being unserviceable. The number operating on the front line had risen to 1,072 by 19 November, with 122 unserviceable. It should be noted that even if an aircraft was unserviceable on a certain day, it could have been mission-ready as soon as the next day or — in extreme cases — in two days.

U-2s were also taken from the Civil Air Fleet. This resulted at one time in a situation whereby almost all these small biplanes were operating on the front line, leaving just a few in second-line and training roles. In 1944, second-line units of the Civil Air Fleet had only 34 U-2s in service. The statistics testify to the extent of militarisation of the civil 'slow-pacers'. In 1944, U-2 combat losses in the Civil Air Fleet regiments totalled 50 aircraft; non-combat losses, 64. The corresponding figures for 1945 are, respectively, 26 and 25.

The quantity of U-2 air ambulances in service may seem far from significant, but there are many reports from combatants who attributed their survival to these aircraft. Numerically, the high point in the service of S-1, S-2 and S-3 aircraft in Army units was in

ABOVE: Moscow, 11 January 1944. A U-2SP of the 574th Separate Liaison Squadron is taxiing for take-off, carrying a cargo of freshly-printed metropolitan newspapers for troops of the 1st Baltic Front.

RIGHT: Nurses loading an injured soldier onto a U-2 fitted with Bakshayev ambulance containers in 1942.

May 1942, when 179 were noted in use. Factory No 387 in Kazan made 1,204 Bakshayev ambulance cabins prior to discontinuation of production in 1945.

In comparison with the night bombers' combat achievements, the U-2's role as a liaison aircraft receives very little attention. However, it is of no less significance. Given the shortage of radio equipment in Red Army units, U-2s formed the basis of the wartime communications system as established in 1942. Every frontal headquarters had 32 liaison aircraft assigned, and each army 12. Given the importance of this activity, liaison squadrons were manned by the most experienced pilots.

In Soviet Naval Aviation, U-2s were used for liaison purposes only, and were not numerous — summer 1942 saw a maximum of 56 on strength. The number of U-2s of all types in the Far East grew somewhat before the start of hostilities in Japan. In August 1945, 181 were in service with the Air Force of the Pacific Fleet and the Pacific Flotilla.

With the war in Europe having come to an end, there arose during the summer of 1945 the problem of finding further duties for this army of biplanes. Some of the military examples were handed over to the Civil Air Fleet, and converted into training, agricultural or passenger-carrying aircraft. However, a year later, more drastic measures were taken. A total of 11,937 obsolete and worn-out aircraft were officially written off, among them 1,959 Po-2s.

Aviation Factory No 387 in Kazan and No 168 in Rostov-on-Don continzed to build the latest Po-2 derivatives until the late 1940s, namely the Po-2S air ambulance, the Po-2A agricultural version, and the passenger-carrying Po-2L. These found a wide range of domestic applications, for instance in forest fire-fighting, geological exploration, aerial surveys and communication.

ABOVE: This U-2 is performing parachute-dropping training.

The Po-2 also remained in use with the Civil Air Fleet schools and the flying clubs of DOSAAF (the Voluntary Association for Assistance to Army, Aviation and Fleet) until the early 1950s for initial training and exercises and, sometimes, para-drop training. Some were in service with the Air Force in the 1950s as liaison aircraft and as trainers for blind or night flying.

Mass decommissioning of the Po-2s in the Soviet Union began in 1958-59. In remote areas of the country, they remained in operation for a year or two more — possibly, at some locations, for even longer. However, they disappeared from official reports and summaries.

The type continued in post-war service in many other Communist countries. Licence production was undertaken in Poland from 1948-56, the CSS-13 being built by the WSK-Mielec and WSK-Okęcie factories to the tune of some 500 examples. The Yugoslav Air Force used its Po-2s as late as 1959, and the type soldiered on with aero clubs in eastern and central Europe for longer still, not least as glider tugs.

'BED CHECK CHARLIES' OVER KOREA

Perhaps the most famous employment of the Po-2 after World War Two occurred during the 1950-53 Korean War. Its role harked back to the Great Patriotic War, as North Korea's Korean People's Air Force operated the biplane as a night intruder, taking advantage of its low noise levels and slow-flying capabilities. The first such raid against a United Nations base took place on 28 November 1950, when a single Po-2 attacked Pyongyang airfield and caused major damage to parked US Air Force F-51 Mustangs of the 8th Fighter Bomber Group.

Thereafter, the manner in which UN forces were roused from their slumbers by the Polikarpovs and other North Korean aircraft – the likes of Yakovlev Yak-18s, Lavochkin La-11s and, on one occasion, a Beriev MBR-2 seaplane among them – led to application of the 'Bed Check Charlie' nickname, first used by US troops to describe Japanese nuisance raiders during the Guadalcanal campaign. Their missions were sporadic, but highly irritating. On 17 June 1951 a pair of Po-2s bombed F-86 Sabres lined up at Suwon, destroying one 335th Fighter Interceptor Squadron aircraft and badly damaging four others. Not bad for a biplane designed in the 1920s.

Just as in World War Two, the slow-paced Po-2 was a difficult weapon to combat. Especially for the early Western jets active in Korea, decelerating sufficiently to get in a decent shot proved a risky business, while the Polikarpovs could use terrain to their advantage in making an escape. Illustrating the dangers, one USAF F-94 Starfire night fighter collided with its target Po-2 on 12 June 1952. But there were several successful shoot-downs. Notably, Po-2s were the subject of the sole air-to-air kills ever recorded by several types: the B-26 Invader (a USAF aircraft, with undercarriage and flaps extended to slow to 90kt, achieving the feat in June 1951), the F7F Tigercat (single examples falling victim to US Marine Corps F7F-3Ns of VMF(N)-513 on 30 June and 23 September 1951) and the AD-4 Skyraider (another Marine aircraft, of VMC-1, claiming the kill on 15 June 1953).

Ben Dunnell

Technical Details

ABOVE: Assembly of a Po-2 fuselage frame during a recent restoration in Russia. In the background is a rig for the wing assembly.

A restorer's perspective on the design and construction of the Polikarpov biplane

The author has been involved in the restoration of U-2s/Po-2s since 2002, and can thus provide insights both into the type's original construction and how it may be restored today.

Essentially, the U-2 was an ordinary two-seat biplane with an all-wooden structure and simple design. In its first incarnation it had a squared-off tail and wingtips and tail. This was brought about by the requirement to make manufacturing cheaper, and to ensure easy component swaps in case of repair. In particular, all the outer wing panels were identical, while ailerons could be used as elevators, and vice versa. The wing section utilized the thick Prandl 365 aerofoil section with a relative thickness of 14 per cent. On the second prototype, for the wing section a thinner OSS TsKB 2 aerofoil with relative thickness of eight per cent was used (later, it was referred to as the TsAGI 541 design). The tail and wingtips were also rounded off.

The wood used is mostly straight-grained pine with a specific density of 0.52kg/cubic cm; depending on the quality of the wood, two or three cubic metres of such material are required for one aircraft. Aircraft plywood is of critical importance; the required thicknesses are 1mm (eight to 10 sheets); 1.5mm (six or seven sheets); 2.0mm (five or six sheets); 3.0mm (one sheet); and 5.0mm (one sheet). The sheets are of standard type, measuring 1.5 by 1.5m (4.92 by 4.92ft).

To bond the materials in a U-2/Po-2 restoration, it is better to use modern synthetic adhesives — for example, the K-153 plasticated epoxy resin — rather than the historical casein glue. While this does involve a certain deviation from originality, the final bonding quality and the resulting reliability of the structure are worth it.

The Po-2 has a truss fuselage; the wooden components are secured together using assemblies made from 1mm, 1.5mm, 2mm and 3mm-thick steel sheets. Fragments of assemblies prepared according to pattern drawings are assembled into the required structural components using steel bolts and fixative welding. The workmanship will, as they say, "correspond to the professional level of a village blacksmith". OVS steel wires (of 2mm and 2.5mm thickness) are needed to assemble the fuselage.

To assemble the wing, steel rods are used to make the internal braces. The required rod diameters are 4mm (a length of approximately 20m will be needed), 5mm (about 30m), 6mm (2m) and 7mm (2m).

Other necessary items include materials for the engine mount, cowlings, and undercarriage; cables for control linkages; flying instruments and engine instruments. We will also need cotton cloth for the skin, a small amount of leather, glass for the windscreens, and approximately 100kg (220lb) of cellulose dope.

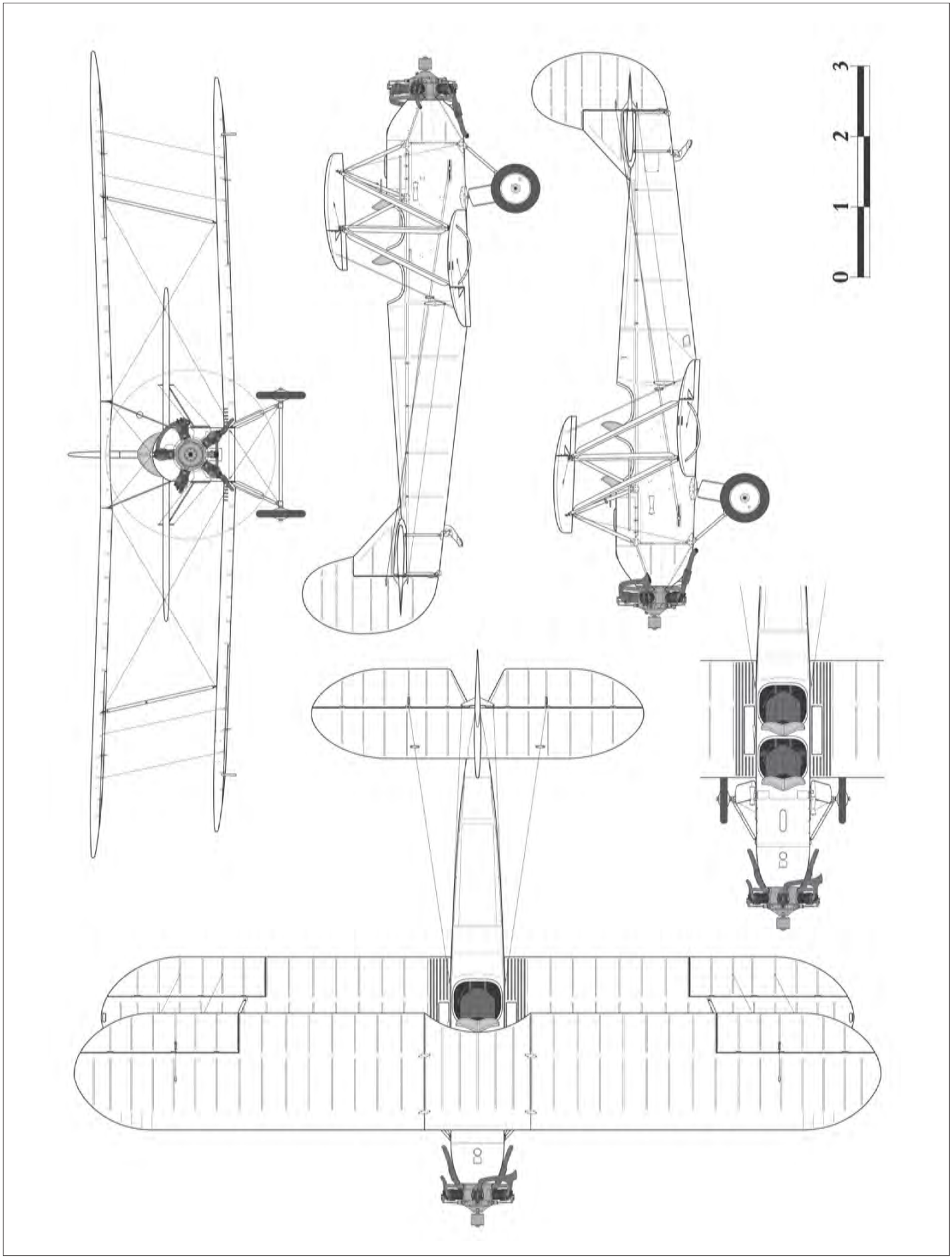
Most Po-2s were equipped with M-11G and M-11D engines, though during the post-war period the M-11K and M-11L were used. Today it is difficult to find such engines, which featured open-type pushrods and had no valve boxes. The M-11FR-1 and M-11FR, which were used on the Yak-18 trainer, are more widely available for U-2/Po-2 restorations in the modern era.

The standard fixed-pitch propeller is bonded from wood. Years ago, the prop was fabricated from ash boards, with outer plates made from oak or beech. Later, dense pine and oak were used. Depending on the aircraft's purpose, propellers with 2.35m diameter and a pitch of 1.49m, 1.67m or 1.73m were used.

U-2 specifications

	U-2 M-11	U-2VS	AP-1
Length	8.17m (26.8ft)	8.17m (26.8ft)	8.17m (26.8ft)
Upper wingspan	11.42m (37.5ft)	11.42m (37.5ft)	11.42m (37.5ft)
Empty weight	650kg (1,433lb)	684kg (1,508lb)	711kg (1,567lb)
Gross weight	907kg (2,000lb)	1,064kg (2,346lb)	1,053kg (2,321lb)
Maximum speed (ground level)	160km/h (99.4mph)	134km/h (83.3mph)	139km/h (86.4mph)
Maximum speed (3,000m/9,843ft)	140km/h (87mph)	132km/h (82mph)	-
Service ceiling	4,450m (14,600ft)	3,500m (11,483ft)	3,000m (9,843ft)

Note: data for U-2 as manufactured by Aviation Factory No 23 in 1935-36.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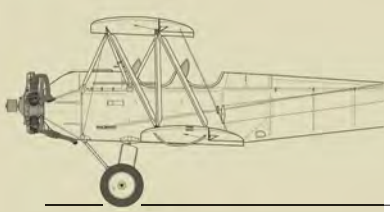
ABOVE: An unmarked U-2VS on a test flight.

Flying and preserving the Polikarpov veteran



In the words of a description of a 1939 flight evaluation, "The aircraft taxies steadily at 800-850rpm, allows unassisted taxiing at a wind of up to seven to eight metres per second, and performs turns easily. The take-off is normal. The tail lifts easily… speed at lift-off is 75-80km/h [46.6-49.7mph]. The best indicated rate of climb is 95km/h [59mph] at 1,550rpm. The aircraft climbs steadily…

"In level flight, the aircraft demonstrates good longitudinal and transverse stability, similar to aircraft of previous models. The best gliding speed is 90-95km/h [56-59mph] at 400-450rpm. The aircraft glides steadily, without any abnormal tendencies.

"The best turning airspeed is 108-115km/h [67.1-71.5mph] at 1,580rpm. The aircraft enters and exits turns at a bank of up to 45° easily; considerable effort is required for steep turns. The aircraft is stable while turning.

"The entry speed for a loop is 150-160km/h [93.2-99.4mph] at 1,750rpm. Altitude loss is up to 50m [165ft]. The aircraft behaves normally. The aircraft performs rolls normally at a speed of 105km/h [65.2mph] at 1,300rpm. Altitude loss is 80-100m [260-328ft]. With normal rudder and elevator deflection angles, the aircraft enters a spin… it spins and recovers from the spin normally.

"The landing is performed normally, and the aircraft lands easily on three points. The landing speed is 65-70km/h [40.4-43.5mph]. There are no abnormal tendencies during the approach and landing run."

STARTING THE 'SLOW-PACER'

This extract is from the instructions for manually starting the M-11 engine. "Upon taking his seat in the aircraft", it reads, "the pilot (technician) shall make sure that all instruments and control levers are in good order, and the ignition is off.

"After opening the gasoline valve, the pilot (technician) shall command: 'Turn the propeller', and shall confirm the command by extending his left arm horizontally to the side and performing, with it, a rotational motion at the shoulder level.

"The engine-man, upon receiving the command, shall ask: 'Is it off?' The question shall be confirmed by his arms being held upward and crossed. The pilot (technician) shall again make sure that the ignition in the cabin is off, and shall answer, 'It is off'. He shall also confirm the answer by holding his arms upward and crossed.

"Upon receiving the confirmation, the engine-man shall take the propeller blades in his hands and turn the propeller in the forward direction. Meanwhile, the pilot (technician) shall perform engine priming using the priming pump and making three to five pumping motions in the summer period or eight to 12 pumping motions in the winter period.

"The engine-man shall energetically rotate the propeller to reach compression. Simultaneously with the propeller snatch, the engine-man shall run off to the right, put up his right arm, and report loudly, 'Contact!'

"The pilot (technician) shall reply, 'Clear prop!' and start up the ignition by engaging the switch and turning the starting magneto handle. He shall also confirm the command by extending his left arm to the side.

"If the engine fails to be started, the pilot (technician) shall turn off the ignition and command, 'It is off'. Simultaneously, he shall confirm the command by lifting crossed arms above his head.

"After that, the propeller shall again be set to compression with the ignition off, and the starting procedure shall be repeated. The engine-man may come up to the propeller only after the affirmative answer by the pilot (technician), 'It is off' to the engine-man's question, 'Is it off?'"

THE Po-2 TODAY

ABOVE: The Shuttleworth Collection's Po-2 G-BSSY has been flying at Old Warden since 2011. It is marked as an aircraft of the 9th Guards Night Bomber Air Division, which supported Polish rebels in September 1944. DARREN HARBAR

Many U-2s/Po-2s have been preserved, several in Russia itself. Two are listed among the exhibits in the Air Force Museum at Monino. Another is kept in Kazan, and one is on display in the V. P. Chkalov Museum in Chkalovsk near Nizhny Novgorod. The latter (c/n 9589) was registered personally to famed test and long-distance pilot Valery Chkalov as USSR-Ch4. It is a unique aircraft, since it was one of just four private aeroplanes registered in the Soviet Union at that time.

Meanwhile, a significant number of 'Kukuruzniks' — the aircraft's nickname, derived from the Russian word for maize, and a reference to its early crop-dusting role — have reappeared in the sky. The veteran biplane has, indeed, become a symbol of the restoration of flying historic aircraft in Russia. Materials used in its construction are widely available, structural components can be made easily with minimum equipment, there is an abundance of technical documentation, and — most importantly — M-11 engines still exist. Simple maintenance and reliability provide good grounds to hope that the aircraft will carry on flying for many years to come.

It's not just in Russia and other former Warsaw Pact states that Po-2s can be found flying today. The Flying Heritage Collection at Everett, Washington, has a 1944-vintage Russian Front combat veteran Po-2 that also served in the Korean War. Kermit Weeks keeps a 1954-built example in his Fantasy of Flight museum in Polk City, Florida, and the Military Aviation Museum near Virginia Beach also has a Po-2 in its collection. The only one in the UK is the Shuttleworth Collection's machine, which dates from 1944, and flew in Yugoslavia in both military and civil hands post-war. The ex-Yugoslav Po-2W in the Salis family's La Ferté Alais, France-based Casques de Cuir fleet hasn't flown for a few years.

ABOVE: The Military Aviation Museum's Po-2 N3602 during a flight out of Virginia Beach. MAM