RED STAR VOLUME 22

Mil's Heavylift Helicopters

Mi-6/Mi-10/V-12/Mi-26

Yefim Gordon, Dmitriy and Sergey Komissarov

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MIDLAND
An imprint of
Ian Allan Publishing

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ISBN 1 85780 206 3
RAT
Published by Midland Publishing
4 Watling Drive, Hinckley, LE10 3EY, England
Tel: 01455 254 490 Fax: 01455 254 495
E-mail: midlandbooks@compuserve.com

Midland Publishing is an imprint of
Ian Allan Publishing Ltd

Worldwide distribution (except North America):
Midland Counties Publications
4 Watling Drive, Hinckley, LE10 3EY, England
Telephone: 01455 254 450 Fax: 01455 233 737
E-mail: midlandbooks@compuserve.com
www.midlandcountiessuperstore.com

North American trade distribution:
Specialty Press Publishers & Wholesalers Inc.
39966 Grand Avenue, North Branch, MN 55056, USA
Tel: 651 277 1400 Fax: 651 277 1203
Toll free telephone: 800 895 4585
www.specialtypress.com

Design concept and layout
by Polygon Press Ltd (Moscow,Russia)
Line drawings by Polygon-Press

This book is illustrated with photos by Yefim Gordon, Dmitriy Komissarov, Sergey Komissarov, Vladimir Drobyshevskiy, Alfred Matusevich, Sergey Sergeyev, Chris Lofting, Peter Davison, Marcus Fülber, Chris Knott, ITAR-TASS, as well as from the archives of the Mil' Moscow Helicopter Plant,' Rostvertol, Yefim Gordon, Sergey and Dmitriy Komissarov, *Air Forces Monthly*, *Air Progress*, *Flieger Revue* and *World Air Power Journal*, and the Russian Aviation Research Trust

Printed in England by
Ian Allan Printing Ltd
Riverdene Business Park, Molesey Road,
Hersham, Surrey, KT12 4RG

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Title page: CCCP-11287, an Aeroflot/Moscow Agricultural Aviation & Commuter Air Traffic Directorate Mi-6, carries a power line pylon.
This page: Part of the static display at the Moscow-Domodedovo airshow on 9th July 1967. Mi-6P CCCP-58647, Mi-10K CCCP-29115 and Mi-10 CCCP-04102 are in the foreground.

Front cover: Gleaming with fresh paint, this uncoded Russian Air Force Mi-26 makes a demonstration flight at the Hydro Aviation Show 2004 in Ghelendjik.
Rear cover, top: Two Russian Air Force Mi-6s display different shades of grey (Chris Lofting). Bottom: the second prototype V-12 at the Central Russian Air Force Museum (Marcus Fülber).

Introduction

When the OKB-329 design team led by Mikhail Leont'yevich Mil' acquired its own prototype manufacturing facility (plant No.329) and was bolstered by an influx of highly skilled cadre in the late 1940s, it was thus in a position to develop and build the GM-1 light utility helicopter. (OKB = ***o****p*ytno-*kon***strook**-*torskoye byu***ro** – experimental design bureau; the number is a code allocated for security reasons.) Redesignated Mi-1 in production form, the OKB's firstling proved highly successful and was built in a whole range of versions in the 1950s. Building on the experience gained with the Mi-1, the Mil' OKB created the larger Mi-4 multi-purpose helicopter, likewise powered by a radial engine. These machines were put into large-scale production in Kazan' and Rostov-on-Don, where branch offices of OKB-329 were set up; the branch offices were tasked with refining the basic design and creating new versions, and did so with success. The Mi-1 was also produced abroad (in Poland).

Later products of OKB-329 included such famous machines as the light twin-turbine Mi-2 and the ubiquitous and versatile Mi-8 twin-turbine medium helicopter, as well as the Mi-6 and Mi-10 'big lifters' – the world's largest rotary-wing machines in their day. Other noteworthy designs created by the company in the 1950s and 1960s included the V-7 experimental helicopter with a main rotor driven by tip-mounted turbojet engines.

The unique features of the rotorcraft created by the Mil' OKB often had no direct analogues in foreign aircraft design and called for the development of cutting-edge technology and specialised test methods. Yet, even though the OKB had made its mark and proved its ability to develop viable rotorcraft, it still had to make do with 'scraps from the table' in terms of research and development support within the framework of the Ministry of Aircraft Industry (MAP – *Mini***ster***stvo aviatsi***on***noy pro***mysh***lennosti*). The reason was that rotorcraft were always regarded as 'second-best'; MAP's research centres catered chiefly for the needs of the OKBs developing combat jets which enjoyed higher priority. Hence from the outset Mikhail L. Mil' and his team had to rely largely on their own resources when evolving and mastering the all-important R&D methods.

Mikhail Leont'yevich Mil', the founder of OKB-329.

Nevertheless, the OKB never ceased co-operating with the helicopter design departments of the Soviet Union's key aviation research establishments. These were the Central Aero- and Hydrodynamics Institute named after Nikolay Ye. Zhukovskiy (TsAGI – *Tsen***trahl***'nyy* ***a****ero- i* ***ghid****rodina***mich***eskiy insti***toot**), the Central Aero-Engine Research Institute (TsIAM – *Tsen***trahl***'nyy insti***toot** *avi-atsi***on***novo mo***toro***stro***yen***iya*), the All-Union Research Institute of Aviation Structural Materials (VIAM – *Vseso***yooz***nyy insti***toot** *aviat-si***on***nykh materi***ah***lov*), the Flight Research Institute named after Mikhail M. Gromov (LII – ***Lyot****no-is***sled***ovatel'skiy insti***toot**) and others. Close ties were also forged with the Ministry of Defence's own research establishments, as well as with engine and avionics manufacturers. As a result, in the 1950s the Mil' OKB formed the core of the Soviet Union's own school of helicopter design which soon earned worldwide recognition. Chief Designer Mikhail L. Mil' personally supervised research efforts in various areas of helicopter dynamics and aerodynamics. The OKB persistently refined its aerodynamic and flight performance calculation methods. The structural strength section achieved a notable success in calculating rotor loading, ensuring the required dynamic strength, eliminating rotor blade flutter, ground and aerial

Left: The GM-1 (the first prototype of the Mi-1 utility helicopter, the first product of OKB-329) in an early test flight.
Right: An Aeroflot Mi-2 utility helicopter flies an ice reconnaissance mission from the nuclear-powered icebreaker *Sibir'* (Siberia) somewhere in the Arctic Ocean.

resonance and other dangerous phenomena and reducing vibration levels.

The years of hard work have brought the Mil' OKB and its progeny worldwide renown; by the early 1960s the company had earned a place among the world leaders in the field of helicopter design. Mil' helicopters became the holders of numerous world records, testifying to the potential of their creators. Not only were these aircraft delivered in large numbers to numerous customers abroad (starting in 1965, when Mil' helicopters were first displayed outside the Soviet Union) but they also kicked off the helicopter design and manufacturing industry in several nations affiliated with the USSR (namely Poland and the People's Republic of China). The OKB rendered constant assistance both to aircraft manufacturing enterprises in its home country and to foreign operators of Mil' types; these were not limited to the traditional set of the Soviet Union's Warsaw Pact allies and 'third-world' countries but included such nations as the USA, the Netherlands and Japan.

The most important area, however, was the home market where the Mil' OKB had to cater for the needs of both the Armed Forces and the sole Soviet airline, Aeroflot. The Soviet Army had an ever-increasing need to airlift large quantities of personnel and bulky and heavy materiel during major airborne assault (or 'vertical envelopment') operations. This meant the choppers had to be bigger and haul ever bigger payloads. The national economy was an important customer for such rotary-wing giants as well due to the increasing industrial activity in the eastern regions of the USSR, which were rich in natural resources but had a sparse road and railway network.

The late 1950s and early 1960s were the time when the first of the huge helicopters created to address these needs were born. This book deals with the development and service history of the Mi-6, the Mi-10, the unique V-12 and finally the Mi-26.

In recognition of his work in creating these highly capable rotorcraft, Mikhail L. Mil' received high government awards – the Hero of Socialist Labour title, three Lenin Orders, the Great Patriotic War Order (2nd Degree), the Order of the Red Banner of Labour, the Red Star Order and numerous medals.

Above left: The Mi-8 utility helicopter is among the most famous products of the Mil' Design Bureau. This picture shows the second prototype, the V-8A.

Left: The Mi-26 is the latest of the Mil' heavylift types covered in this book – and the most powerful chopper currently in service anywhere. This example chartered by Scorpion Air is seen salvaging a US Army Aviation Boeing Vertol CH-47D Chinook which had been downed by the Taliban guerrillas in Afghanistan during Operation *Enduring Freedom*.

Chapter 1

Bigger is Better

The First Soviet Heavylift Helicopter

The success achieved in the early 1950s by the Moscow State Aircraft Plant No.329 in developing the Mi-4 transport and troop-carrying helicopter filled Chief Designer Mikhail L. Mil' and the members of his staff with confidence and prompted them to try their hand at new rotorcraft of considerably greater load-carrying capacity. The designers came to the conclusion that the next stage in heavylift helicopter construction should be represented by a rotorcraft capable of airlifting cargoes weighing some six tonnes (13,230 lb), such as heavy artillery pieces with their tractors, lorries and self-propelled guns for the airborne assault troops.

VM-6 heavy transport and assault helicopter (project)

The engineers of OKB-329 fully realised the complexity of the task facing them; they knew that all previous attempts both at home and abroad to build a helicopter with an all-up weight in excess of 14 tonnes (30,870 lb) had ended in failure. Nevertheless, the young team of designers confidently set about the work, and as early as the end of 1952 the General Arrangements Section of the OKB submitted the first projects of a machine featuring hitherto unseen dimensions. It was allocated the manufacturer's designation VM-6, which denoted '*vertolyot **Mil'a*** (Mil' helicopter) with a six-tonne payload'.

Despite the opinion of the most prominent Soviet and foreign specialists who expressly recommended a tandem twin-rotor layout for heavy machines, Mil' opted for a single-rotor helicopter. He took the bold decision to start projecting a five-blade main rotor of a hitherto unseen diameter in excess of 30 m (98 ft). At that time the rotors of the biggest helicopters had a diameter not exceeding 25 m (82 ft), and the only attempt to build a rotor of huge dimensions, undertaken by the Hughes Aircraft Company in the USA, had failed to bring the desired results. As for the mechanical reduction gearbox for such a heavy machine, no one had ever tried to tackle that task.

Furthermore, initial studies showed that the use of piston engines for machines of that class was inexpedient. In consequence, new turboshaft engines had to be mastered. The VM-6 was designed around a single TV-2F gas turbine engine developed by the Kuibyshev-based OKB-276 design bureau led by Nikolay Dmitriyevich Kuznetsov. In accordance with an agreement reached with Mikhail L. Mil', Chief Designer Pavel Alekseyevich Solov'yov at the Perm'-based OKB-19 undertook to modify this engine into a turboshaft version with a free turbine; this version was designated TV-2VM. This layout made it possible to adjust the main rotor RPM within a range that ensured maximum economic efficiency and the greatest possible operating radius. It was decided to place the engine above the cargo hold. Located forward of the main gearbox, it ensured the proper position of CG by providing a counterbalance to the long tailboom with the tail rotor.

While the work on the project was going on, the military posed a new requirement calling for the increase of the helicopter's load-carrying capacity by 50%. The OKB had to undertake a complete redesign. Now the dimensions of the machine were considerably increased and the powerplant came to comprise two TV-2VM turboshafts. In addition, the customer envisaged the use of the transport and troopship helicopter for certain missions calling for a speed of up to 400 km/h (249 mph). This prompted the designers at OKB-329 to study a version utilising the high-speed compound helicopter layout, which was in vogue at that time. In this version the machine was to feature detachable cantilever wings equipped with powerful high-lift devices and carrying two turboprop engines with tractor propellers mounted at mid-span for forward propulsion. The wings made it possible to off-load the main rotor in cruise flight and obtain speeds comparable to those of fixed-wing transport aircraft.

By the end of 1953 the preliminary design project of the VM-6 powered by two TV-2VMs was completed, but Mikhail L. Mil' still had to convince the customer of its feasibility. On 11th June 1954 the Soviet Council of Ministers issued a directive calling for the development of the giant helicopter, which was allocated the designation V-6. The machine was regarded as 'a new means of airlifting army units and almost all types of artillery pieces employed at the army division level' and was intended to transport a 6-tonne (13,230-lb) payload at the normal all-up weight, 8 tonnes (17,640 lb) in overload configuration and 11.5 tonnes (25,360 lb) in the event of flights over short-distances.

In accordance with the current practice of that period, concurrently the design bureau headed by Nikolay Il'yich Kamov was also allotted the task of designing a rotary-wing aircraft of approximately the same class. By that time the Kamov engineers had developed the project of the Ka-22 compound helicopter with side-by-side rotors of relatively small diameter and two propulsive tractor propellers, the engine/rotor/propeller packages being installed at the tips of the shoulder-mounted strut-braced wings. In contrast, the

A model of the VM-6 project as originally envisaged, showing the low-set wings carrying turboprops with tractor propellers. Note also the almost hemispherical nose with a machine-gun mount.

Above: The first prototype of the V-6 (Mi-6); the real thing was quite different from the original project. The main rotor head is wrapped in tarpaulins; note the ground power carts alongside.

Above: The Mi-6 prototype dwarfs its stablemate, a Mi-1TU trainer, at Zakharkovo airfield. Note the open cowlings serving as work platforms and the windowless forward entry door.

Another shot of the Mi-6 prototype at Zakharkovo with mainwheel spats and minus wings. The car is a 1945-model GAZ-M20 Pobeda (Victory) fastback.

engineers of the Mil' OKB rejected outright the economically inefficient compound rotorcraft layout, retaining only small wings intended to off-load the main rotor.

Mi-6 (V-6) heavy transport and troopship helicopter (*izdeliye* 50)

The helicopter was simultaneously designed in transport, assault and casualty evacuation (Casevac) versions. By the end of 1954 the Mil' OKB had completed the advanced development project (ADP) of the V-6, and by 1st June 1955 the Government commission gave its approval to the mock-up.

Shortly afterwards the Moscow-based Plant No.329 in the Moscow suburb of Panki (the seat of the Mil' OKB) and Plant No.23 situated in Fili (then also a suburb but now long since part of Moscow) began manufacturing the parts of the first prototype of the helicopter which was now officially designated Mi-6 and allocated the product code *izdeliye* 50. (*Izdeliye* (product) such-and-such was, and still is, a common term for coding Soviet/Russian military hardware items.) Its construction proceeded under the direction of chief project engineer M. N. Pivovarov, while N. G. Roosanovich was appointed Deputy Chief Designer in charge of the project.

The most difficult problem to be tackled during the development of the V-6 was the design of the main rotor blades. Projecting of the blades proceeded under the direction of A. E. Malakhovskiy, V. V. Grigor'yev and A. M. Grodzinskiy, while M. A. Leikand was responsible for the development of the rotor head which, for the first time in Soviet helicopter design practice, incorporated hydraulic dampers. The Mil' OKB engineers developed a radically new all-metal main rotor blade design which utilised a steel spar and a rib-and-stringer structure divided into separate sections called pockets. The latter were not rigidly interconnected; hence they were not subjected to stresses as the blades flexed, which relieved the blade structure of considerable variable loads. The blades were of trapezoidal planform. The high forward speed specified for the helicopter dictated the use of high-speed airfoils at the blade tips (subsequently the main rotor design was changed). The tail rotor had all-wooden blades.

The TV-2VM turboshafts powering the helicopter had a take-off rating of 5,500 eshp each and a nominal rating of 4,700 eshp. This power was distributed via the main gearbox to the main and tail rotors, the cooling fan, generators, hydraulic pumps and other auxiliary mechanisms. The torque imparted to the output shaft of the R-6 four-stage planetary main gearbox reached 60,000 kg·m (434,076 lb·ft); Western engineers did not succeed in developing a gearbox of comparable capacity until seven years later. Development work on the gearbox was conducted under the direction of A. K. Kotikov and V. T. Koretskiy.

The helicopter's streamlined fuselage was an all-metal riveted semi-monocoque structure. In its dimensions (12 x 2.65 x 2.5 m; 39 ft 4½ in x 8 ft 8⅜ in x 8 ft 2½ in) the V-6's cargo hold was close to those of the An-8 and An-12 military transports. Detachable tip-up seats could be installed along the walls and along the centreline; in the Casevac version the hold could accommodate 41 stretcher cases and two medical attendants. (This was not the limit of the machine's capacity: in emergency situations during the helicopter's operational service it could transport as many as 150 persons.) The stressed cargo hold floor equipped with tie-down cleats permitted the transportation of various types of hardware and heavy cargoes. For example, the helicopter could carry two ASU-57 self-propelled guns or a BTR-152 armoured personnel carrier, guns and howitzers of different types with their tractor vehicles, or materiel of appropriate weight for the engineer troops. A detachable external sling system ensured the carriage of slung loads weighing up to 8,000 kg (17,640 lb). The fuselage was designed under the direction of M. P. Andriashev.

The helicopter's flight control system incorporated powerful hydraulic actuators. Initially the V-6 was equipped with an AP-31V three-channel autopilot which had been tested on the Mi-4; from 1962 onwards it was replaced by the improved AP-34V on production machines. As distinct from its predecessor, the AP-34V was incorporated into the control circuit consecutively, rather than in parallel, which considerably eased the piloting. The autopilot for the V-6 was developed under the direction of S. Yu. Yesaulov, and the flight control system as a whole was designed under the direction of I. S. Dmitriyev.

Assembly of the first V-6 prototype, which by then had already been officially redesignated Mi-6, took place in the workshop at the Zakharkovo industrial airfield near Moscow. Concurrently with prototype construction the stressed units and assemblies of the airframe were subjected to fatigue tests. In October 1956 the machine was basically completed in the wingless version, with the exception of the main rotor, the manufacturing of which was lagging behind. For this reason the helicopter was equipped with an aerodynamic brake (moulinette, or 'club rotor') instead of the normal main rotor, and it was decided to conduct fatigue tests for the time being. Not until June of the following year was the rotor completed and installed on the prototype. Thus, the fatigue test article was turned into a flying prototype. The machine wore an overall silver colour scheme with no markings other than the Soviet Air Force's red star insignia on the fuselage; it was fitted with large mainwheel spats and airfoil-shaped fairings on the main gear oleo struts.

Above: This head-on shot of the prototype taxying at Zakharkovo shows the asymmetric arrangement of the navigator's station glazing panels.

On 5th June 1957 factory test pilot R. I. Kaprelyan lifted the Mi-6 off the ground for the first time; on 18th June he performed a circuit of the airfield. The flights went on in the summer and continued into the autumn. On 30th October 1957 the Mi-6 made its mark: a crew captained by Kaprelyan lifted a payload of 12,004 kg (26,469 lb) to an altitude of 2,432 m (7,979 ft). This achievement caused a sensation, since it amounted to twice the record figure attained previously by the Sikorsky S-56 heavy helicopter in the USA.

In February 1958 plant No.23 completed the second flying prototype of the Mi-6. It differed from the first prototype in being fitted with all the units and equipment stipulated by the project; accordingly, it had two-position variable-incidence wings (with incidence settings for cruise flight and autorotation mode), an external sling system, the AP-31 autopilot

The Mi-6 displays its impressive lines during an early test flight – still in wingless configuration.

Above: This view shows the unbroken window arrangement on the starboard side. The narrow horizontal window on the nose is in the navigator's entry door.
Below: The second prototype built at Moscow-Fili was the first Mi-6 to feature the characteristic wings.

Above: An early-production Mi-6 fitted with external tanks and bristling with aerials (compare with the photo on page 4). Note the soot-blackened wing roots.
Below: As this picture testifies, at least the first 120 Rostov-built Mi-6s (such as c/n 2681110V here) were delivered with mainwheel spats.

The second prototype shows off its wings. Unlike production examples, this machine did not carry the Soviet Air Force star insignia on the wings.

and so on. In the same year both helicopters took part in an air display in Tushino. In December 1958 manufacturer's tests of the Mi-6 powered by TV-2VM turboshafts were completed.

The commencement of the joint state acceptance trials was somewhat delayed due to the decision to re-engine the Mi-6 with the D-25V turboshafts which had been developed by the same Solov'yov OKB. While having the same power rating as the TV-2VM, the new engine, which was derived from the core of the D-20P turbofan powering the Tupolev Tu-124 short-haul airliner, was shorter and lighter. However, the new engine's free turbine had the opposite direction of rotation; therefore, the R-6 main gearbox had to be replaced with a new one designated R-7. This change was accompanied with a modification to the oil system. Plant No.23 delivered the first helicopter powered by the new engines in the spring of 1959. A decision was taken not to wait until the re-engined version had completed its manufacturer's tests and to start the state acceptance trials of the Mi-6 with the old TV-2VM engines. Flights in accordance with the programme of these trials began in the summer of 1959. While the military test pilots familiarised themselves with the new machine, the D-25V-powered helicopter joined the tests, and its predecessor was sent back to Zakharkovo for refitting with the new turboshafts.

Prior to the state acceptance trials and in the course of these, a number of new world records were established on the Mi-6. On 16th April 1959 a crew captained by S. G. Brovtsev lifted a payload of 5 tonnes (11,025 lb) to 5,584 m (18,321 ft), and R. I. Kaprelyan with his crew lifted 10 tonnes (22,050 lb) to 4,885 m (16,028 ft). In September 1962 the Mi-6 climbed to an altitude of 2,738 m (8,983 ft) with an unprecedented load of 20.1 tonnes (44,320 lb). Its all-up weight in the record flights reached 48 tonnes (105,840 lb). Twelve years later the Mi-6 ceded its title of the most powerful helicopter to another aerial giant designed by M. L. Mil', the V-12 twin-rotor helicopter (described later in this book) which was developed using powerplant/rotor packages and some other units tried and tested on the Mi-6.

The high power/weight ratio, coupled with excellent aerodynamics, enabled the Mi-6 to become the world's highest-performing helicopter with regard not only to payload but to speed as well. On 21st September 1961 a crew captained by N. V. Lyoshin attained on the Mi-6 a speed of 320 km/h (198.88 mph), which had long been regarded as unattainable for helicopters. For this achievement the American Helicopter Society awarded to the Mil' OKB the prestigious Sikorskiy Prize 'in recognition of an outstanding achievement in

Records established on the Mi-6 helicopters

Date	Description of the record	Record figure	Test pilot
30.10.1957	Altitude with a payload of 10,000 kg (22,050 lb)	2,432 m (7,979 ft)	R. I. Kaprelyan
30.10.1957	Maximum payload to 2,000 m (6,560 ft)	12,004 kg (26,428.8 lb)	R. I. Kaprelyan
16.4.1959	Altitude with a payload of 5,000 kg (11,025 lb)	5,584 m (18,321 ft)	S. G. Brovtsev
16.4.1959	Altitude with a payload of 10,000 kg (22,050 lb)	4,885 m (16,028)	R. I. Kaprelyan
21.9.1959	Speed on a 100-km (62-mile) course	268,92 km/h (167.13 mph)	B. V. Zemskov
21.9.1961	Speed on a 15-25-km (9.3-15.5 mile) course	320 km/h (198.88 mph)	N. V. Lyoshin
11.9.1962	Speed at 1,000 km (621 miles) with a load of 1,000 kg (2,205 lb)	284,534 km/h (176.84 mph)	V. P. Koloshenko
11.9.1962	Speed at 1,000 km (620 miles) with a load of 5,000 kg (11,025 lb)	284,534 km/h (176.84 mph)	V. P. Koloshenko
13.9.1962	Altitude with a payload of15,000 kg (33,075 lb)	2,738 m (8,983 ft)	R. I. Kaprelyan
13.9.1962	Altitude with a payload of20,000 kg (44,100 lb)	2,738 m (8,983 ft)	R. I. Kaprelyan
13.9.1962	Maximum payload to 2,000 m (6,560 ft)	20,117 kg (44,358 lb)	R. Kaprelyan
15.9.1962	Speed at 500 km (311 miles)	315.657 km/h (196.18 mph)	B. K. Galitskiy
15.9.1962	Speed at 1,000 km (621 miles)	300,377 km/h (186.68 mph)	B. K. Galitskiy
15.9.1962	Speed at 1,000 km (621 miles) with a load of 1,000 kg (2,205 lb)	300,377 km/h (186.68 mph)	B. K. Galitskiy
15.9.1962	Speed at 1,000 km (620 miles) with a load of 2,000 kg (4,410 lb)	300,377 km/h (186.68 mph)	B. K. Galitskiy
26.8.1964	Speed at 100 km (62 miles)	340 km/h (211 mph)	B. K. Galitskiy

Above: An uncoded Soviet Air Force Mi-6 undergoes ground checks (probably prior to delivery) with a ground power unit based on the ZiS-150 lorry. Note the tactical area navigation (TACAN) aerials on the sides of the nose and under it; the starboard aerial is mounted just aft of the navigator's entry door.

Mi-6 with the lower portions of the engine cowlings open. Moscow/Fili-built examples sometimes had the c/n stencilled on both sides. Note the different position of the engine cooling louvres; also, the starboard TACAN aerial is mounted directly on the navigator's station door on this example.

Above: Another aspect of Mi-6 (c/n 1030402V) as it taxies past the camera. The strong wing incidence is very much in evidence.

the development of the art of helicopter construction'. Two years later a crew captained by B. K. Galitskiy scored a still greater success; the Mi-6 covered a distance of 100 km (62 miles) with a speed of 340.15 km/h (211.4 mph). In all, 16 world records were established on machines of this type.

Mi-6 heavy transport/troopship helicopter

The Armed Forces were so much in need of heavy helicopters that a Government decision on putting the Mi-6 into series production was adopted nearly two years before the completion of the state acceptance trials. The latter were accompanied by a fair share of problems and took more than eighteen months.

Several well-known test pilots took part in the state acceptance trials and in the subsequent service introduction of the helicopter. These included G. V. Alfyorov, S. G. Brovtsev, B. V. Zemskov, R. I. Kaprelyan, G. R. Karapetyan, V. P. Koloshenko, N. V. Lyoshin, Ye. F. Milyutichev and others.

On 5th September 1960 a crew captained by test pilot N. V. Lyoshin, flying an early-production Mi-6, tested the helicopter in the autorotation mode. The construction number was quoted in abbreviated form as 0104V, making accurate identification impossible; the full c/n was either 9680104V or 0030104V – see note on c/n systems below. When the helicopter was making a shallow gliding descent with the engines throttled back, the port engine surged; it was immediately shut down. Lyoshin managed to reduce the excessive vertical speed and performed an emergency landing in 'aeroplane fashion' (a rolling landing). During the landing run the nosewheel leg hit a hummock and collapsed, after which the helicopter continued to 'eat dirt' for another 90 metres (300 feet) until it came to a standstill. At the moment of the collision, oil from the oil tank spilled on the engine and ignited, but ground personnel from the airfield was quick in reaching the site of the incident and managed to extinguish the fire. Fifteen days later Lyoshin, while flying another production Mi-6 (c/n 0205), performed the first pre-planned landing in autorotation mode. This time, too, it ended in an incident. The helicopter touched down in a nose-high attitude, impacting the ground with the tail bumper and the mainwheels. As the nose started coming down, three main rotor blades struck the tailboom, damaging it. After every

A model of the future Mi-6P passenger helicopter marked CCCP-30012. Note the wheel spats on all three landing gear units, the lack of wings and the window arrangement which did not match the real thing.

incident of this kind appropriate modifications were made to the helicopter or the necessary corrections were introduced into the flight manual.

Additional test flights were also performed. For example, in October, after the 5th September incident, the D-25V engine was subjected to testing with regard to the risk of surge and failures in flight. In November-December of that year the methods of determining the uniformity of the main rotor blades' conical rotation plane were tried. In January 1961 landings in the autorotation mode were practised at the Soviet Air Force State Research Institute named after Valeriy P. Chkalov (GK NII VVS – *Gosoo**dar**stvennyy **kra**snozna**myon**nyy na**ooch**no-is**sle**dovatel'skiy insti**toot** voyenno-vozdoosh**nykh** seel*) at Chkalovskaya airbase about 30 km (18.5 miles) east of Moscow. Before the end of November tests were completed of the external sling system, including emergency jettisoning of the cargo; they had been conducted at Zakharkovo and over the Medvezh'yi Ozyora (Bear Lakes) locality east of Moscow. In June-July 1962 tests were conducted of the D-25V engine with a new 9-stage compressor replacing the original 8-stage assembly.

In December 1962 the state acceptance trials were successfully completed. The report prepared by GK NII VVS stated, among other things: *'The prototype Mi-6 transport and troopship helicopter powered by two D-25V turboshafts is the biggest helicopter in the world and the first Soviet helicopter with turboshaft engines. It is superior to all Soviet helicopters in its performance and, above all, as regards the payload, dimensions of the cargo hold, the number of troops and the amount of combat materiel it can carry.'* In the following year the Mi-6 was officially included into the inventory of the Armed Forces.

In addition to plant No.23, manufacture of the new machine began at plant No.168 in Rostov-on-Don where the first four production machines were completed as early as 1959. A branch of the Mil' OKB was set up at plant No.168 for the purpose of perfecting the helicopter and developing new versions. The Mi-6 was produced by this plant until 1980 when it was supplanted by the Mi-26 new-generation helicopter. The production run at Rostov-on-Don totalled 874 Mi-6s of all versions. At times the production tempo reached 74 machines per year (that was the number of machines manufactured in 1974). As for the Moscow-based production, it did not last long and was terminated in 1962. After completing just 50 Mi-6s, plant No.23 was transferred to the Ministry of General Machinery (MOM – *Mini**sterstvo** **ob**shchevo **ma**shi**no**stroy**en**iya*, or Minobschchemash), the industry responsible for the Soviet space and missile programmes, and switched over to the manufacture of rocketry and spacecraft.

(Note: The Mi-6 utilised four distinct construction number systems. In all cases the c/n was usually suffixed by a B (the Cyrillic letter V) as a product code. Some sources claim it stood for *verto**lyot*** (helicopter), but this appears doubtful; at any rate, plant No.168 had built helicopters before, so there was no reason to single out the Mi-6 like this.

Moscow/Fili-built examples had seven-digit c/ns – for instance, Soviet Air Force '12 Red' (c/n 1030401V). The first digit denotes the year of manufacture (1961); the second is always a zero and remains unexplained, while the third (3) indicates plant No.23 (less the first digit in order to confuse hypothetical spies). The remaining two pairs of digits are the batch number and the number of the aircraft within the batch (up to ten per batch).

Over the years, plant No.168 used three systems for the Mi-6. The first one (used in 1959-69) was straightforward, again usually with seven digits. For example, Mi-6 CCCP-11329 No.1 manufactured on 22nd June 1964 (it was later re-registered CCCP-21861 and the original registration passed to An-12BK c/n 8346010) was c/n 4681705V – that is, year of manufacture 1964, plant No.[1]68, Batch 17, 05th aircraft in the batch. Examples built in 1960 had eight-digit c/ns, the year being indicated by a 10 (because it followed the '9' for 1959!); thus, Soviet Air Force '15 Red' was c/n 10680508V. Usually there were ten aircraft per batch, although Batch 21 built in December 1975 consisted of 15 helicopters.

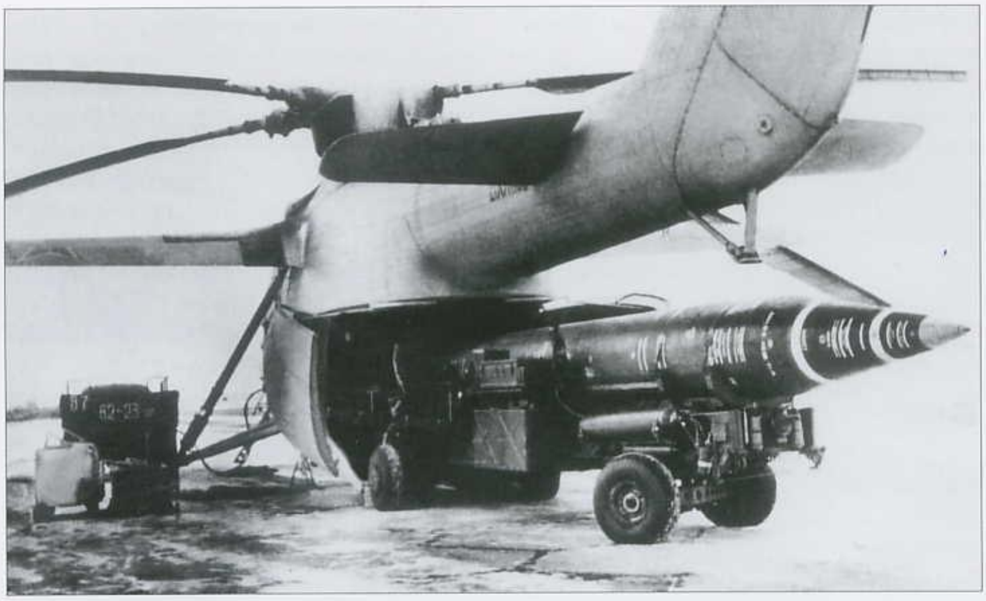
The second system, which was in use in 1970-74, had six digits. For instance, Mi-6A CCCP-21001 manufactured on 27th February 1974 was c/n 747308V – that is, year of manufacture 1974, Batch 73, 08th aircraft in the batch. Finally, the third system used until the end of production featured a four-digit number meaning nothing at all so as not to reveal the batch number and the number of the aircraft within the batch; these four-digit numbers apparently ran in sequence, but very probably there were gaps in the sequence to further confuse 'the enemy'. Thus, Mi-6A CCCP-21013 manufactured on 30th August 1974 is c/n 0437, Mi-6AYa '12 Red' is c/n 0699V, while Mi-6A CCCP-21075 manufactured on 7th June 1980 is c/n 0717.

On military Mi-6s the c/n was normally stencilled on the tailboom ahead of the port stabiliser in large characters. Grey-painted civil examples also carried it on the tailboom, but Mi-6As in 1973-standard Aeroflot livery did not display the c/n visibly.)

Production Mi-6s differed from the prototypes in several respects. For instance, soon after production entry the original blown dome glazing of the navigator's station located in the extreme nose gave way to an optically flat panel in order to eliminate annoying reflections and distortion. An NUV-1 gimballed mount for a 12.7-mm (.50 calibre) Afanas'yev A-12.7 machine-gun was added under the nose, allowing the navigator to 'sweep the landing pad clean' of enemy opposition prior to a landing assault. The wheel spats and main gear oleo fairings were discarded as impractical.

The Mil' OKB constantly worked on refining the Mi-6. In 1959-62 a new main rotor blade spar made of a one-piece tube with variable-thickness walls was introduced into production. Improved production methods in the manufacture of the spar tube helped make the process less labour-intensive and enhance the dynamic strength and service life of this unit. Improvements were also introduced into the design of the rotor blade as a

Mi-6 (c/n 1030302V) after conversion into the Mi-6PRTBV mobile missile system support base.



Above: The Mi-6RVK (c/n 2681110V) disgorges a towed mobile launcher with an R-17V intermediate-range ballistic missile.

The same launcher with the missile erected into position for launch.

whole. Metal foil honeycomb filler found use in the manufacture of the blade pockets. The blades' planform became rectangular; their service life was increased from 50 hours in 1957 to 1,500 hours in 1971. The tail rotor design underwent no radical changes in the course of the Mi-6's entire production run. The service life of the helicopter's main units and assemblies was constantly increased. In 1957 it amounted to 50 hours, increasing to 200 hours in 1961, 500 hours in 1965, 800 hours in 1969 and finally 1,500 hours in the 1970s.

Shortly after the commencement of the tests the Mi-6's main undercarriage units were fitted with two-chamber shock absorbers replacing the original single-chamber units and received a fluid by-pass system with a spring-loaded damper connecting the two chambers. This innovation developed under the direction of O. P. Bakhov and B. Yu. Kostin minimised the probability of ground resonance.

In 1962 the Mi-6 was adapted for the transportation of the BU-75 BrM dismountable drilling rig and other oil prospecting equipment. Modifications were concerned with the external sling suspension system and equipment inside the cargo hold. That same year an Ivchenko AI-8 turbine auxiliary power unit (APU) was installed on the port clamshell door of the cargo hatch to facilitate engine starting, easing the strain on the DC batteries; a trial installation was made of two 2,260-litre (497 Imp gal) auxiliary fuel tanks in the cargo hold, which increased the ferrying range to 1,450 km (900 miles). The variable-incidence wings gave place to fixed ones, which reduced weight and simplified the piloting of the helicopter. In 1963 the stabiliser structure was reinforced. In 1968 new main rotor blades with a steel spar and a glassfibre secondary structure were tested on the Mi-6; in 1972 this was followed by the testing of lighter-weight blades with a thinner spar web.

Four types of dust/debris extractors were tested on the Mi-6's engine air intakes for operation in dusty localities; from 1972 onwards production Mi-6s were fitted as standard with an inert gas pressurisation system protecting the fuel tanks against explosions if hit by enemy fire. The helicopter's avionics also underwent improvement. Following the introduction of a new autopilot in 1967, the helicopter was fitted with a main rotor speed governor. An external sling suspension system with a load-carrying capacity increased to 12 tonnes (26,460 lb) was tested repeatedly; studies were made of various methods of transporting exceptionally heavy loads by several helicopters on a single suspension device, and so on.

In 1965 the Mi-6 made its international debut at the 26th Paris Air Show where it was one of the show-stealers. Since then the helicopter represented the Soviet helicopter construction school on numerous occasions at major international air shows and exhibitions. After that, the NATO's Air Standards Co-ordinating Committee (ASCC) allocated the reporting name *Hook* (H for helicopter) to the Soviet 'big lifter'.

A large group of Plant No.329 employees received high Government awards for the development of the Mi-6 helicopter (and the Mi-10 derived from it several years later). The prestigious State Prize for 1969 was awarded to M. L. Mil', V. P. Lapisov, A. V. Nekrasov, M. A. Leikand, P. A. Solov'yov, M. N. Pivovarov, V. T. Matsitskiy, D. M. Choomachenko, L. N. Mar'yin, G. P. Kalashnikov, I. P. Ervich and O. V. Uspenskiy.

In the course of its 40-year history the Mi-6 spawned numerous and varied military and civil versions as detailed below.

Mi-6 production transport and passenger helicopter

The commercial transport and passenger version of the Mi-6 was developed in 1963 to meet a requirement placed by Aeroflot, which needed a heavylift chopper to support construction and oil/natural gas drilling work in the eastern regions of the USSR. The main differences from the basic military transport version were the deletion of the machine-gun mount and some changes in the equipment.

Wearing the 'MAP-style' registration CCCP-06174 No.1 and a smart green/white colour scheme, the prototype (c/n 5682010V) was converted from a regular transport helicopter; it was this machine that was unveiled at the 1965 Paris Air Show. This version was built in quantity. (Registrations in the 061xx block were set aside for assorted aircraft belonging to MAP divisions and were periodically re-used; thus, CCCP-06174 No.2 was Mi-8T c/n 8588.)

Mi-6PRTBV heliborne mobile missile maintenance base

Development of the Mi-6PRTBV, a heliborne mobile missile maintenance base intended for transportation of missiles and readying them for launch (PRTBV = ***po**dvizhnaya* ***r**aket**no-t**ekh**n**icheskaya **b**aza **v**erto**lyot**novo **tip**a*), was regarded by the Soviet Armed Forces command as part of a whole set of measures that were being evolved with a view to ensuring the mobility of missile forces. Bearing no tactical code, the Mi-6PRTBV prototype (c/n 1030302V) took to the air for the first time in 1960; two years later, after comprehensive tests, it was recommended for service introduction. This version differed in being provided with special cargo hold equipment and additional means of concealment; it could transport to the launch sites the

Above: A 9M21 Loona-MV theatre ballistic missile on a launcher is loaded into Mi-6RVK c/n 2681110V.


Above: The experimental Mi-6M anti-submarine warfare helicopter.


This head-on view of the Mi-6M shows the open doors in the large lateral weapons panniers.

Above: Smartly painted CCCP-06174 (c/n 5682010V) was the prototype of the commercial version of the Mi-6. Note the dark-coloured heat shields on the wing leading edges protecting these from the hot exhaust; the inner wings were painted to disguise the exhaust soot stains as much as possible.

Mi-6 CCCP-06174 makes a test flight prior to its participation in the 1965 Paris Air Show.

warheads of intercontinental ballistic missiles (ICBMs), or complete *izdeliye* 8K11 and 8K14 intermediate-range ballistic missiles (IRBMs), or R-9 and R-10 theatre ballistic missiles, but without their launchers. At the same time the designers developed a Mi-6 version intended for the transportation of missile fuel. The Mi-6PRTBV was not built in series.

Mi-6RVK prototype heliborne missile system

The Mi-6RVK (*raketno-vertolyotnyy kompleks*, heliborne missile system) was developed and built by OKB-329 jointly with enterprises of the Ministry of Medium Machinery (MSM – *Ministerstvo srednevo mashinostroyeniya*; this curious name was given to the ministry responsible for the Soviet atomic industry). In 1963 two such systems were submitted for testing; these were the *izdeliye* 9K53 and 9K73 ballistic missiles (alias R-17V, better known by its NATO codename SS-1 *Scud*). Two more systems comprised the Mi-6RVK helicopter and lightweight self-propelled launchers with missiles operated by ground forces – the short-range 9M21 *Loona-MV* (Moon) and the medium-range 8K114 respectively. These systems successfully passed testing in 1965 and were turned over to the armed forces for operational testing, but series manufacture never took place. The R-17, though built in quantity, used self-propelled launchers on a MAZ-543 eight-wheel drive chassis. Hence the Mi-6RVK (c/n 2681110V) remained a one-off.

Mi-6 ECM version (prototype)

In 1962 a Mi-6 version intended for counteracting the enemy's electronic intelligence (ELINT) activities made its appearance; it was the first Mi-6 version of this kind. Its mission was to protect the radars forming part of the country's Air Defence system from being detected by the enemy's ELINT means. The helicopter was fitted with appropriate mission equipment and could be identified by the additional aerials on the starboard side.

Mi-6PP ECM helicopter (prototype)

In the 1980s Mil' OKB developed the Mi-6PP electronic countermeasures helicopter (*postanovshchik pomekh* – ECM aircraft) which was intended for jamming the adversary's airborne early warning and control (AEW&C) assets and airborne ELINT systems. This version was not built in series.

Mi-6M ASW helicopter (first use of designation)

The Mi-6M (*morskoy* – maritime, or naval) was a shore-based anti-submarine warfare (ASW) helicopter which was under development from 1958 onwards. It was intended to carry potent armament comprising four PLAT

Above: The Mi-6P prototype, CCCP-58647, shares the hardstand with Mi-8P CCCP-11097 during a display for Soviet government officials. Note the Beriyev Be-12 Chaika ASW amphibians in the background.

Above: An uncoded Mi-6PZh2 fire-fighting helicopter seen during trials. Note the chin-mounted water cannon and the small cylindrical tank on the starboard side of the nose characteristic of this version.

Mi-6PZh2 '41 Yellow' (c/n 9683901V) 'fires' the water cannon in a test flight. The emergency exit doors are removed – just in case. Note the water replenishment pipes and the ATs-40-131 fire engine in the background.

Above: The ill-starred cannonless Mi-6PZh (CCCP-06174) dumps its load of water through the ventral nozzle. The hinged water replenishment pipes are lowered into position; note the pump unit at the end.

Another view of Mi-6PZh CCCP-06174 dropping water, this time with the water replenishment pipes stowed.

air-dropped ASW torpedoes (*protivo**lod**ochnaya aviatsi**on**naya tor**peda***) or Kondor (Condor) ASW missiles. The first version of this helicopter was built in 1963. It was fitted with two large panniers housing the armament and located on each side instead of the strap-on fuel tanks. The Mi-6M did not progress beyond the prototype stage and the designation was subsequently re-used (see below).

Mi-6 Boorlak ASW/MCM helicopter (prototypes)

In 1965 one more Mi-6 was converted under the *Boor**lak*** (barge hauler) programme into an ASW/mine countermeasures (MCM) helicopter – a tug for an experimental sonar or a mine clearing trawl. (In 19th-century Russia, the *boorla**ki*** were teams of strongmen whose job was to haul barges up rivers by means of ropes, hence the name.) The development of the ASW equipment took longer time than expected; for this reason the naval versions of the helicopter were not submitted for state acceptance trials, to say nothing of being put into production. The converted Mi-6s were used as testbeds for testing various items of ASW equipment.

Mi-6P passenger helicopter prototype

The Mi-6P (*passa**zheer**skiy* – passenger, used attributively) was a passenger version developed in 1965. A comfortable passenger cabin with rectangular windows was provided, featuring heat- and soundproofing, a coat closet and a toilet. It accommodated 70 or 80 passengers, depending on the seat pitch; the seats were located five-abreast, with an aisle offset to port. The number of cabin windows was increased from nine in the standard version to 11 (on the port side it was 3+door+4+door for the Mi-6 *sans suffixe* and 3+door+2+3+door+1 for the Mi-6P) The rear clamshell doors and cargo ramp were replaced by an identically shaped fairing which incorporated retractable airstairs on the centreline and the AI-8 APU on the port side. In case of need the passenger version could easily be converted into a transport or Casevac version.

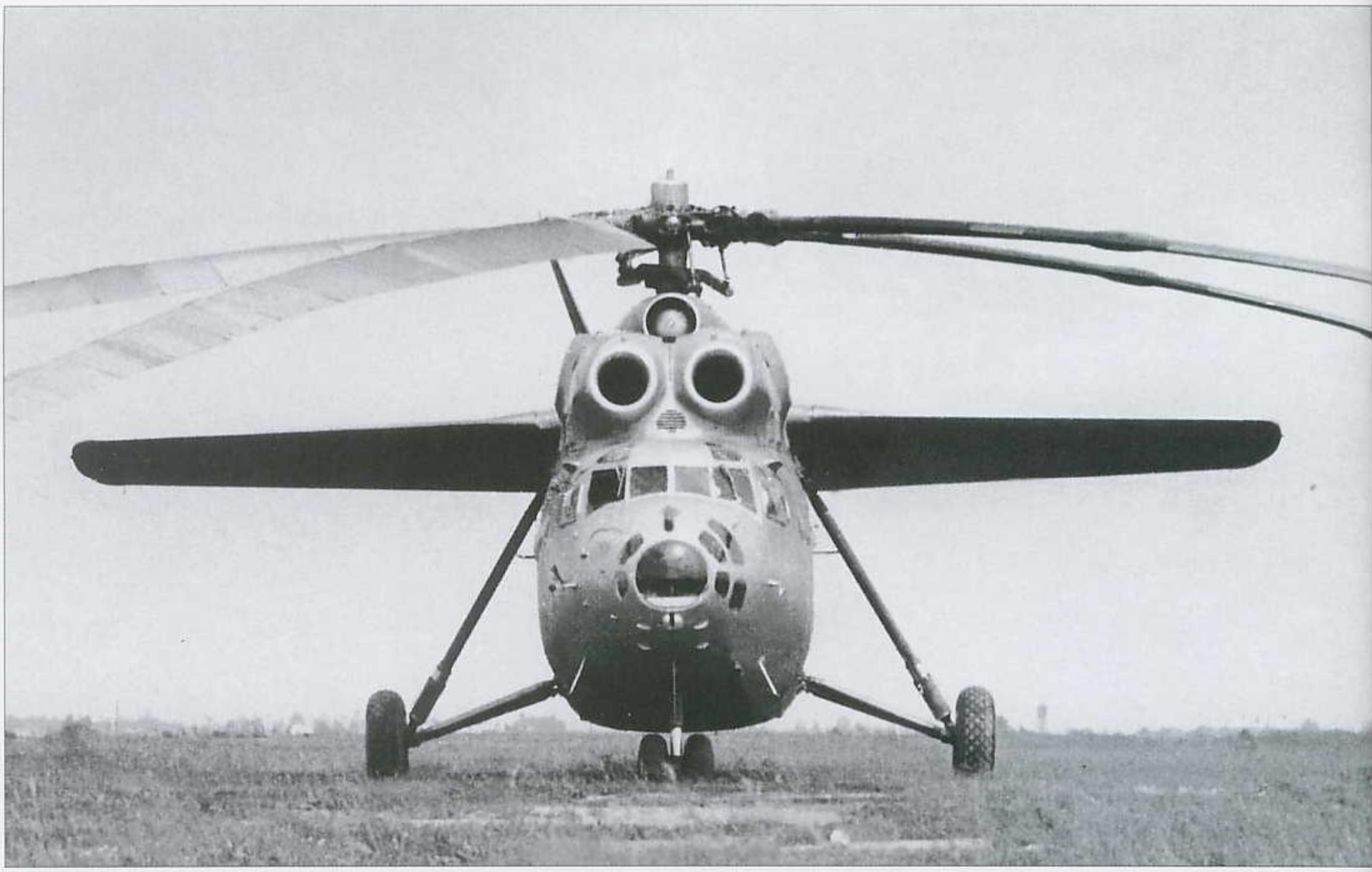
The Mi-6P prototype, wearing the same green/white livery as CCCP-06174 and the 'MAP-style' registration CCCP-58647 (c/n 6682905V), was converted from a regular transport helicopter and unveiled at the 1965 Paris Air Show. This version was not built in series either. The prototype was eventually transferred to the Soviet Air Force on 12th May 1970.

Mi-6PS SAR helicopter

Developed in 1966, the Mi-6PS (*pois**kovo**-spa**sah**tel'nyy* – search and rescue, used attributively) was intended for locating and rescuing the crews of *Vos**tok*** (East) and

Above: Two classic pieces of Soviet transport engineering of the 1950s – an early-production silver-painted Mi-6 with a domed forward transparency of the navigator's station and a ZiS-150 dropside lorry (with early 1960s yellow number plates, EI 32-74) converted into a ground power unit.

This production Mi-6 has the lateral TACAN aerials positioned well aft (compare with the example at the top).



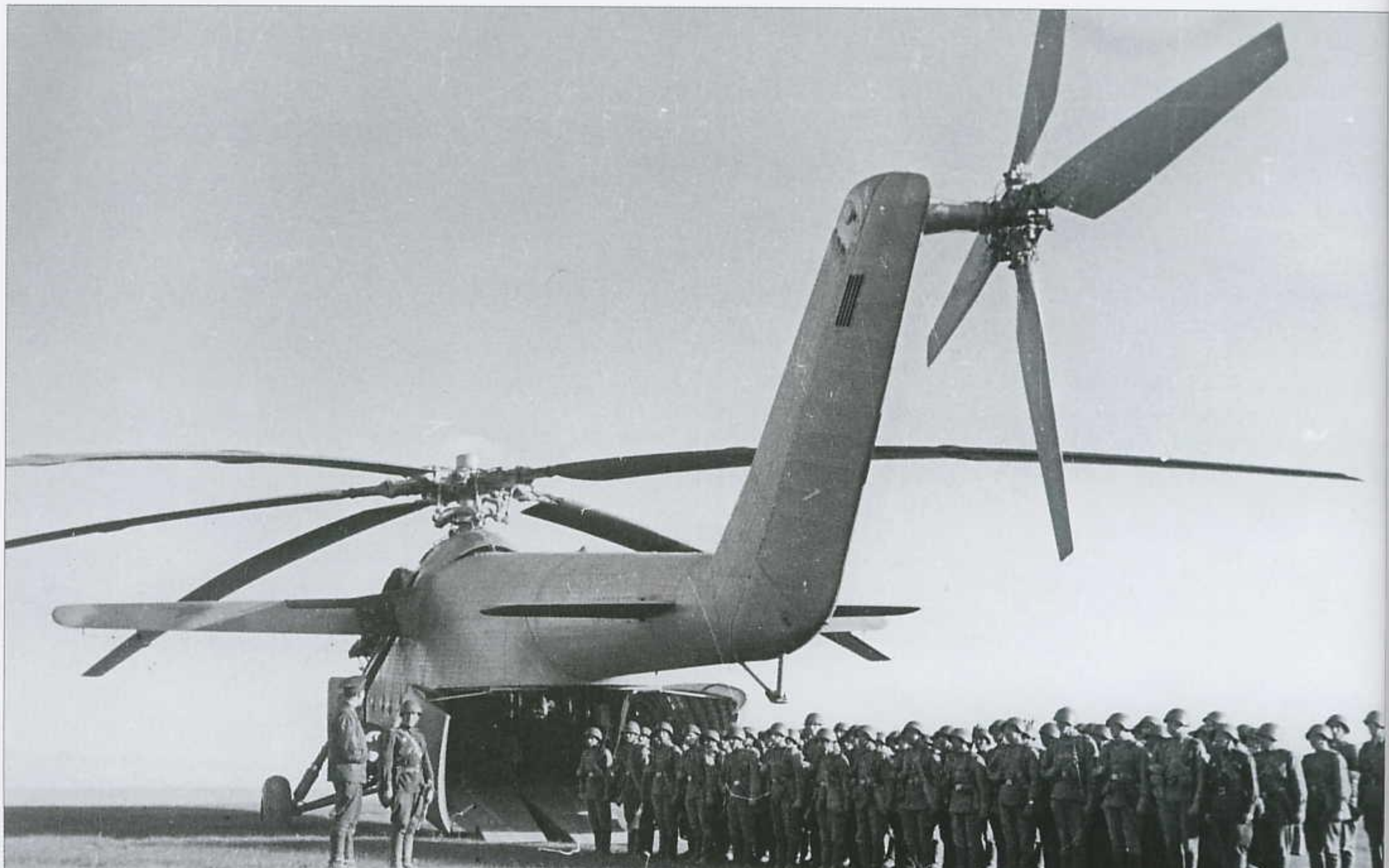
Above: Head-on view of an early-production Mi-6. Note the doors under the nose (with a bulge at the front) concealing the NUV-1M gimballed mount for an A-12.7 machine-gun.

Mi-6 (c/n 1030302V) lifts off, with at least five Mi-4s and a Vertol V-44 tandem-rotor helicopter in the background.

Above: A fine winter study of an uncoded Soviet Air Force Mi-6AYa (Mi-22) airborne command post in standard overall grey camouflage. Note the modified nose glazing, the windowless doors and the ventral bulge over mission equipment replacing the cargo suspension system hatch.

After checkout trials at GK NII VVS this Mi-6 coded '88 Red' was used for development work at LII in Zhukovskiy. Note the black 'anti-soot' bands on the wing roots.

Above: An ASU-57 self-propelled gun adorned with the Soviet Airborne Troops (VDV) badge rolls away from a Mi-6, with at least ten more Mi-6s in the background. All are early-production examples with the characteristic domed nose glazing.



Soviet Army personnel wearing steel helmets prepares to board a Mi-6. The type had an impressive capability as a 'people carrier'.

Soyooz (Union) series spaceships after their landings, as well as recovering the re-entry capsules. It had an additional avionics system helping the helicopter to navigate over water (in the event that the capsule should splash down somewhere in the ocean after an emergency de-orbiting instead of landing normally in a designated area of the Kazakhstan steppes), a cabin with medical equipment for the cosmonauts' recreation after returning to the conditions of normal gravity, a system for hooking up the re-entry capsule to be recovered and transporting it on a sling, a rescue hoist and containers with rubber dinghies and life rafts. The prototype (c/n 2681006V) was converted by the Air Force's aircraft overhaul plant (ARZ – *aviaremontnyy zavod*) No.535 in Konotop, the Ukraine, in January 1969.

Mi-6PZh fire-fighting helicopter

In 1967 the Mil' OKB developed a fire-fighting version of the Mi-6 designated Mi-6PZh (*pozharnyy* – fire-fighting). It differed from the baseline version in having the wings deleted to save weight and improve hovering performance. Installed in the cargo cabin was a tank holding 12 tonnes (26,460 lb) of water and equipped with an ejection nozzle placed in the hatch where the external sling hook used to be. It was supplemented with a tank for a foaming agent, pumps, and two tubular booms hinged to the forward fuselage, with transverse stiffening rods in between like the rungs of a ladder and a common 'mouthpiece' at the rear. The booms were lowered by means of cables and pulleys for taking on water in the hover; when stowed under the fuselage, the 'mouthpiece' rested in an aperture formed by the removal of the cargo ramp. The helicopter could also carry to the site of fire six bag-type tanks holding 1.5 tonnes (3,307 lb) of extinguishing agent each, packed into a special net on a sling.

The Mi-6PZh prototype was converted from the abovementioned commercial demonstrator (CCCP-06174 No.1), receiving a striking new red/white colour scheme (as befits a 'fire engine'!). After a series of test flights in which it scooped up water from the Khimki Reservoir north of Moscow, the helicopter was exhibited at the 27th Paris Air Show in June 1967. Soon after the show the Mi-6PZh was called upon to extinguish a forest fire near Marseilles in the south of France; unfortunately the helicopter crashed in so doing, killing the crew captained by the well-known test pilot Yuriy A. Garnayev.

Mi-6PZh2 fire-fighting helicopter

In 1971 a new fire-fighting variant of the Mi-6 was built. Designated Mi-6PZh2, it differed from its predecessor in having a steerable water cannon with a combined barrel (for delivering water and a foaming agent) on a flexible mount in the forward fuselage where the machine-gun mount used to be.

The helicopter successfully passed state acceptance tests and took part in fighting forest fires on numerous occasions. Several transport and troop-carrying machines were converted into this version. One Mi-6PZh2 coded '41 Yellow' (c/n 9683901V) was preserved at the Russian Air Force Museum in Monino.

Mi-6A heavy transport/troopship helicopter

The Mi-6A was a new baseline version of the helicopter, developed in 1971 as a result of numerous improvements incorporated in this machine in the course of the first ten years of its operational service. It differed from the original Mi-6 mainly in having an increased service life of the main units and new avionics. Furthermore, the cargo ramp was replaced by a one-piece triangular flap, with appropriate modifications to the clamshell doors; the vehicle loading ramps were hinged directly to the door sill. A single hydraulic unit was incorporated into the modified hydraulic system. The Mi-6A could transport 90 troops and up to 9 tonnes (19,845 lb) on a sling. The maximum AUW was increased to 44 tonnes (97,020 lb).

Mi-6A – commercial transport and passenger version

A civil version of the Mi-6A helicopter was developed in the 1970s. It differed in having the machine gun deleted and featured some changes in equipment. Civil Mi-6As were built in quantity.

Mi-6APS (Mi-6PSA) SAR helicopter

This version combined the features of the production Mi-6A and the Mi-6PS prototype. A limited number of Mi-6APS SAR helicopters (called Mi-6PSA in some sources) were introduced into operational service; they were produced by conversion at aircraft repair plants where they were fitted with a modest set of equipment, first of all with onboard winches and containers holding inflatable dinghies and other rescue equipment.

Prototype communications relay version of the Mi-6

A communications relay version of the Mi-6 was created in 1974 by installing a potent set of radio communications equipment in the cargo cabin, supplemented by additional antennas on the fuselage sides and on the tailboom. It was not built in series.

Mi-6VKP airborne command post

The Mi-6VKP (*vozdooshnyy komahndnyy poonkt*, airborne command post) was evolved from the production Mi-6 by the specially organised 'department for equipment control' (ORO – *otdel rookovodstva oboroodovaniyem*) at ARZ No.535 in Konotop. The work started in late 1972. ORO was headed by Major D. M. Mel'nikov, with Majors V. M. Morozov and V. F. Kosenkov and Captain Ye. I. Marfenkov as leading specialists.

The Mi-6VKP was intended for controlling the troops of a ground forces army or an air army. The helicopter's cargo hold housed a secure radio communications suite and a 'war room' for headquarters officers. In reality this airborne command post belied its name, since it could perform its functions only after landing and deploying its equipment on the ground.

The Konotop plant converted a total of 36 Rostov-built Mi-6As to Mi-6VKP standard. This version was readily identifiable by the three large blade aerials on the tailboom immediately ahead of the stabilisers, the large 'towel rail' aerial under the tailboom and the vertical rod aerials mounted on brackets on the centre fuselage in line with the engine exhausts. Two telescopic aerials were carried on the main gear units, to be removed and erected outside the helicopter after landing.

Mi-22 (Mi-6AYa, Mi-6VzPU) airborne command post

Due to the *modus operandi* described above the capabilities of the Mi-6VKP were rather limited. Therefore, somewhat later OKB-329 developed its own ABCP version of the Mi-6A – a true airborne command post capable of performing its functions in flight as well as on the ground. The machine was designated Mi-6AYa, that is, Mi-6A modified under the *Yakhont* (Sapphire) programme, albeit the military chose to call it Mi-6VzPU (*vozdooshnyy poonkt oopravleniya* – airborne control post).

As distinct from the Mi-6VKP, the Mi-6AYa had a single large blade aerial above the root of the tailboom and a string of smaller blade aerials along the fuselage underside. Telescopic aerials were still carried on the main gear units to permit ground deployment. This version was built in series and entered squadron service in 1975 under the designation Mi-22.

Mi-6TZ-SV refuelling helicopter

The designation Mi-6TZ (*toplivozapravshchik* – fuel tanker) was allocated to a version intended for providing refuelling facilities to Army and Air Force units. This version was envisaged already at the initial stage of the Mi-6's development, but series manufacture of the fuel tankers did not start until the late 1960s. The first to enter squadron service were the Mi-6TZ-SV (the SV stands for *sookhoputnyye voyska* – ground forces), but in actual fact these machines were used for refuelling Tactical Aviation aircraft and Army Aviation helicopters on the ground. Generally

Above: This artist's impression of the modernised Mi-6M (the second helicopter to bear this designation) shows the retractable landing gear and the faired main rotor head. This was an early step towards the Mi-26.

speaking, any production Mi-6 could be converted into such a machine. The freight hold housed two fuel tanks with a total capacity of 7,400 litres (1,628 Imp gal; in fact, these were standard external tanks from the Mi-10 helicopter), an NS-30 pump unit, two reels with refuelling hoses and nozzles and other necessary equipment. Special canisters were provided for the carriage of lubricants and alcohol.

In the first half of the 1960s military test pilots conducted experiments with in-flight refuelling (IFR) of the Mi-4 utility helicopter, using the Mi-6 as an IFR tanker, but this work did not proceed further than the experimental stage.

Mi-6M heavy transport helicopter (project, second use of designation)

The Mi-6M (the second version to have this suffix letter, in this case denoting *modifitseerovannyy*, modified) was developed by OKB-329 as a thorough redesign of the Mi-6. On 26th November 1967 the Council of Ministers issued a directive tasking the OKB with developing a helicopter capable of transporting 11 to 20 tonnes (22,255-44,100 lb) over a distance of 800-1,200 km (496-745 miles). However, more profound studies conducted at the OKB revealed that the scope for increasing the helicopter's load-carrying capacity would be very limited if the five-blade main rotor were to be retained. Therefore in 1970 the development of the Mi-6M was discontinued. The OKB-329 design bureau, which was renamed MVZ (Moskovskiy vertolyotnyy zavod – Moscow Helicopter Plant) after Mikhail L. Mil's demise, embarked on the projecting of a new third-generation heavy helicopter which was subsequently designated Mi-26 (described separately in this book).

Mi-6 engine testbed with D-25VF engines

In 1969 a Mi-6 was converted into a flying testbed for the uprated D-25VF engines with a take-off rating of 6,500 eshp. This engine had been developed for the V-12 heavylift helicopter. The testbed was also used for studying ways and means of improving the performance of the basic Mi-6.

Mi-6 rotor system testbed for the Mi-26

One more testbed produced by converting a Mi-6 was used in 1975 as part of the development effort to create the Mi-26 helicopter (see Chapter 4). It was an aerodynamics testbed

'12 Red', a Mi-6AYa (Mi-22) airborne command post, awaits repairs, hence the lack of the tail rotor. Note the large blade aerial atop the root of the tailboom which is the Mi-22's main identification feature.

intended for testing the Mi-26's eight-blade main rotor and five-blade tail rotor, as well as a number of other systems and units of the new machine.

Mi-6VR Vodoley water-spraying testbed

The year of 1976 saw the commencement of flights of the Mi-6VR *Vodoley* (Aquarius) water-spraying testbed which was intended for testing the de-icing systems of other helicopters in the conditions of artificially produced icing. The cargo cabin housed a water tank and the water was fed to ventral spraybars installed immediately ahead of the cargo door threshold; the spraybars were forward-swept and were attached to the wing undersurface by long struts.

Above: Another aspect of Mi-22 '12 Red', showing the ventral antenna farm. Note that this example has windows in the port side doors; the absence of star insignia on the wings is also noteworthy.

Structural description of the Mi-6A

Type: Military and commercial multi-purpose helicopter designed for day/night operation in visual meteorological conditions (VMC). The helicopter's crew comprises five persons: captain, co-pilot, navigator (doubling as the gunner on military versions), flight engineer (F/E) and radio operator (R/O).

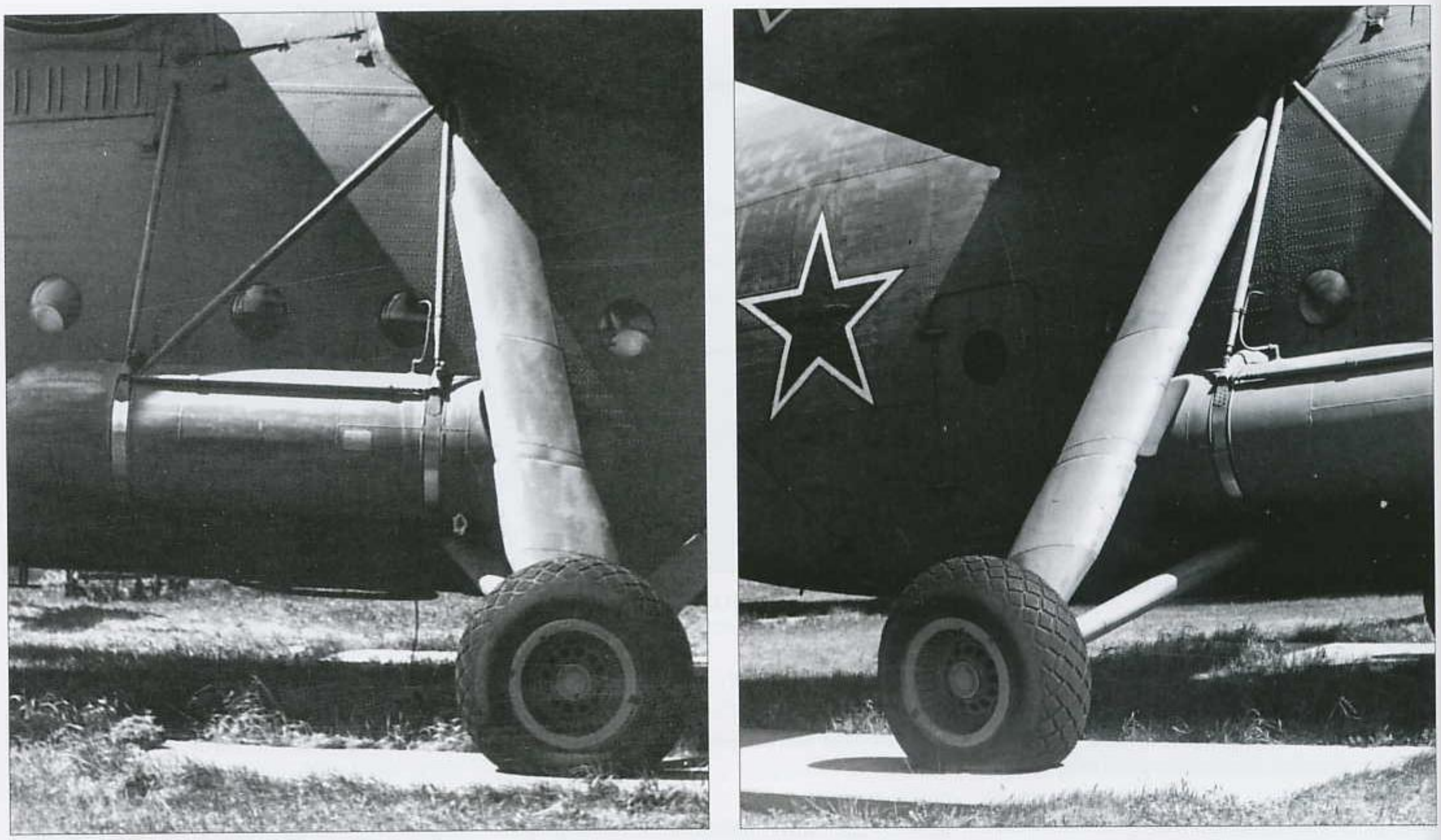
The airframe is of riveted all-metal construction, with lentil-shaped rivets used throughout (except for a few roundhead rivets which serve as levelling marks), and is mostly made of D16T duralumin and V95T aluminium alloy. Some structural elements are made of AK-6 and AL-9 aluminium alloys, ML5, VM65-1 and MA-8 magnesium alloys, VT1-1 high-strength titanium alloy and 30KhGSA, 18KhNMA, 1Kh18N9T, 40KhNMA, OKhN3MFA, 45, 25 and 20 grade steel.

Fuselage: Conventional semi-monocoque structure with frames, longerons and stringers; the skin thickness varies from 0.8 mm (1/32 in) to 2.5 mm (3/32 in). The basic cross-section is oval with the larger axis vertical. Structurally the fuselage consists of four sections: forward fuselage, centre fuselage, tailboom and tail rotor pylon (fin). Each section has its own numbering of frames

The *forward fuselage* has 12 frames (Nos 1-12) and 141 stringers (Nos 0 and 1R/1L through 70R/70L). It houses the crew section, the helicopter's controls, flight and navigation avionics, instruments and radio communication equipment and most of the auxiliary equipment items. Its cross-section changes from circular at the front to quasi-oval with flattened sides and top. The forward extremity of the stepped nose houses an extensively glazed navigator's station (Frames 1-6). The glazing comprises a one-piece forward dome on the prototypes and initial production aircraft (replaced by an optically flat panel and a two-piece crescent-shaped window immediately aft on later machines), three small windows above one another on each side in the first row and two larger windows above one another on the port side, plus one dorsal pane, in the second row. On the starboard side of the nose (opposite these two windows) there is an aft-opening jettisonable entry door with a window (Frames 2-4). The glazing is made of Perspex 3 mm (7/64 in) think, except for the forward panel, which is made of boron-silicate triplex glass. On military versions the underside of the extreme nose features hydraulically-powered clamshell doors (Frames 1-3) for the NUV-1M machine-gun installation.

The rest of the crew is seated in a spacious flightdeck, the captain on the left and the co-pilot on the right, the F/E on the left and the R/O on the right behind them; a bulkhead with a doorway 700 mm (2 ft 3½ in) wide is located aft of the pilots' seats at Frame 9. The flightdeck glazing features four optically flat windshield panes (the inner two are 4-mm (5/32 in) Perspex and the outer two triplex glass), two triangular eyebrow windows and four side windows. The foremost pair of side

The forward fuselage (crew section) of an early Mi-6 modified by riveting additional armour plates to the sides of the navigator's station and the flightdeck escape doors. Note the open direct vision window.



Left: The centre fuselage and the port external tank with its retaining straps and N-strut. Right: The starboard main landing gear unit with a faired shock strut.

windows is built into jettisonable emergency escape doors for the pilots (Frames 5-8); they are sliding direct vision windows having a trapezoidal shape and are bulged for better downward visibility. The second pair of side windows is circular, and the port side window is again built into a jettisonable emergency escape door for the F/E and the R/O (Frames 9-12); on late-production Mi-6s and Mi-6As this door features a sliding rectangular window. The flightdeck floor is made of plywood reinforced with duralumin sheet.

The flightdeck roof incorporates a forward-hinged hatch (Frames 8-9) opening outwards for access to the engines and main rotor head on the ground; steps are fitted above the rear side windows to permit safe access. Two downward-hinged battery compartment access doors with three latches each are located low on the port side of the forward fuselage. The forward fuselage terminates in a bulkhead (Frame 12) with a two-leaf door 700 mm wide giving access to the freight hold.

The *centre fuselage* has 42 frames; Nos 1, 5, 8, 10, 14, 18, 22, 26, 31, 38 and 42 are I-section mainframes absorbing the principal loads and the others are ordinary Z-section rolled frames. The troop/cargo cabin with a suitably stressed floor 11,725 mm (38 ft $5\frac{5}{8}$ in) long is located between Frames 1-26; it has a maximum width of 2,720 mm (8 ft 11 in) at Frame 26 and a maximum height of 2,595 mm (8 ft $6\frac{1}{8}$ in) at Frame 18. The cabin floor is made of duralumin sheet with anti-slip ribbing and rests on the lower portions of Frames 1-26 and two longerons; it is stiffened by twelve Z-section lengthwise profiles. It incorporates a central hatch for the external sling system (Frames 14-18) measuring 1.44 x 1.93 m (4 ft $8\frac{11}{16}$ in x 6 ft $3\frac{63}{64}$ in) which is closed by twin upward-opening doors in the floor and twin doors in the fuselage underside; the upper and lower doors are linked by rods. Bays for eight fuel tanks are located under the floor between Frames 2-4, 4-6, 6-8, 8-10, 10-12, 12-14, 14-16, 16-18, 18-20 and 20-22; these bays have double walls with stiffeners in between to absorb the pressure in the tanks.

Positioned above the centre fuselage are the engine bay (Frames 1-14) and the main gearbox bay (Frames 14-18), aft of which are three more fuel tank bays (one between Frames 19-22 and two side by side between Frames 22-26). Detachable panels protecting piping and cable runs from damage are fitted to the cabin walls and ceiling.

At the aft of the cabin end is a cargo hatch measuring 2.65 x 2.7 m (8 ft $8\frac{11}{32}$ in x 8 ft $2\frac{27}{64}$ in) closed by large hydraulically actuated clamshell doors featuring a sharply sloping hinge line. Their lower forward portions are cut away to avoid encroaching on the cabin width when open; the resulting aperture is closed by a triangular flap hinged to the cargo hatch sill. The port clamshell door carries a housing for the APU. Three detachable vehicle loading ramps can be hooked up to the sill to create a full-width ramp; the centre ramp is wider than the outer ones. The clamshell doors and lower flap form the rear part of the fuselage when closed; each door has 15 frames and 15 stringers.

Personnel access to the troop/cargo cabin and the crew section is via a rectangular entry door to port (Frames 8-10) measuring 1,635 x 805 mm (5 ft $4\frac{3}{8}$ in x 2 ft $7\frac{45}{64}$ in) with detachable boarding steps. Two more doors of identical dimensions are located on both sides between Frames 22-24 (immediately ahead of the cargo door threshold); these serve basically as emergency exits. All doors are aft-hinged and open outwards. As standard there are nine circular cabin windows to port (3+door+4+door) and ten to starboard (9+door), although the entry doors were windowless on some early-production Mi-6s and most Mi-6AYa (Mi-22) ABCPs. All windows except those built into the doors are slightly bulged; the Perspex glazing is 3 mm thick. Two of the windows open, permitting air hoses from an air heater to be inserted for preheating the engines and the main gearbox in the winter.

The tapered circular-section *tailboom* is a stressed-skin structure with 18 frames and 28 channel-section extruded stringers; the skin thickness is 1.2 and 1.5 mm ($\frac{3}{64}$ in and $\frac{1}{16}$ in). The tailboom is joined to the centre fuselage by bolts at the end frame No.42. Its diameter is 1.76 m (5 ft $9\frac{19}{64}$ in) at the front and 1.2 m (3 ft $11\frac{1}{4}$ in) at the rear. The tailboom houses the tail rotor transmission shaft, pedal control cables, stabiliser attachment fittings and some avionics and equipment items.

The *tail rotor pylon (fin)* is built integrally with a circular-section structure with seven frames mating with the tailboom; its axis is 'kinked' 45°40' upwards relative to the axis of the tailboom. It comprises a fin (featuring 14 ribs), a fixed rudder and a detachable fairing which covers the opening giving access to the intermediate gearbox and the attachment point of the tail bumper shock strut. The tail rotor pylon houses the intermediate gearbox, the final drive gearbox and the transmission shaft between the two. Rib 14 carries the final drive gearbox, while Rib 8 incorporates a support for the transmission shaft. The fixed rudder has a riveted construction. Its structure comprises ribs, longitudinal members made of metal angles, metal bands placed crosswise and the skin. The skin is metal on the starboard side (where the tail rotor is) and AM-100 linen fabric on the port side. The fixed rudder has an asymmetrical airfoil which serves to off-load the tail rotor as the forward speed increases.

Wings and stabilisers: Cantilever shoulder-mounted *wings* of trapezoidal planform creating lift which off-loads the main rotor in cruise flight, absorbing up to 25% of the all-up weight. Incidence 14°15' for the port wing and 15°45' for the starboard wing; no sweepback, no dihedral. The wings utilise a TsAGI P35 high-speed airfoil; thickness/chord ratio 15% at root and 12% at tip.

The wings are of riveted construction and comprise a centre section beam and two detachable wing panels. The central beam is mounted in pivoting attachment fittings placed between Frames 18-19 and is fixed in the preset position with the help of a rigid rod. Each wing panel comprises a torsion-box type spar, ribs (Nos 5-32 on each side), stringers, leading-edge and trailing-edge sections and a rounded wingtip fairing. The skin is made of duralumin 0.6 to 4 mm (approx 0$\frac{1}{32}$ to 0$\frac{5}{32}$ in) thick. 20-kg (44-lb) anti-flutter weights are installed at the wingtips. The wing root sections between ribs 8-14 subjected to heating by engine exhaust gases are protected by special heat shields made of 0.8-mm ($\frac{1}{32}$ in) stainless steel; these are cooled by ram air via gaps between the shield and the wing skin. The wing/fuselage joint is covered by fairings.

The all-moving *stabilisers* of trapezoidal planform ensure stability and controllability in forward flight. Each stabiliser features a spar, nine duralumin ribs, a trailing-edge stringer and a rounded tip fairing; the skin is metal ahead of the spar and AM-100 fabric aft of it. The stabilisers are connected by a beam set in roller bearings; the incidence is +5° to −13°, adjusted by means of a rod connected to a worm-and-roller control mechanism installed between tailboom frames 14-15, depending on the collective pitch setting.

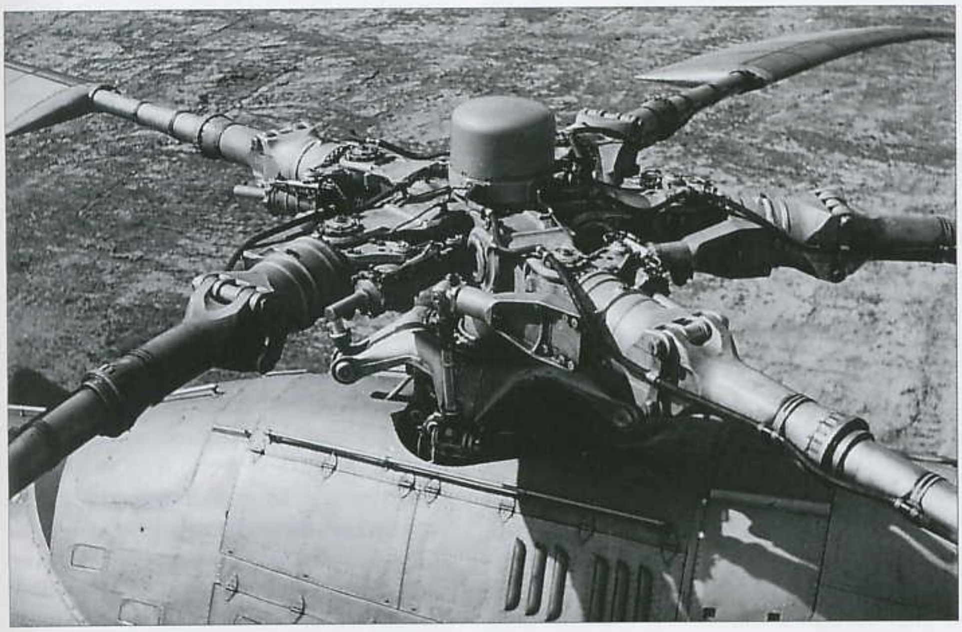
Landing gear: Non-retractable tricycle type, with oleo-nitrogen shock absorption. The fully castoring nose unit attached to centre fuselage Frame 1 has twin K3-27/2 non-braking wheels measuring 720 x 310 mm (28.35 x 12.2 in); they are mounted on a common axle, which precludes the possibility of self-induced 'shimmy' oscillations. Tyre pressure is 6 kg/cm² (85.35 psi).

The main units are of the three-strut pyramid type and comprise half-axles and two-chamber shock absorbers; the upper ends of the shock absorbers and the tubular forward lower rods integral with the half-axles are attached to centre fuselage Frame 18, while the tubular rear braces are attached to Frame 22. The high-pressure chambers of the struts are connected by piping to a spring-loaded damper at Frame 14 to prevent ground resonance. The main units feature KT-67 brake-equipped wheels measuring 1,325 x 480 mm (52.2 x 18.9 in) with low-pressure tyres; tyre pressure is 7 kg/cm² (99.58 psi). The wheels are fitted with pneumatic expander-tube brakes.

A non-retractable tail bumper is provided to protect the tailboom and tail rotor in a tail-down landing. It consists of a shock absorber, two tubular struts and a tailskid made of cast magnesium. The shock absorbers and the damper are filled with AMG-10 hydraulic fluid; its total amount in the system is approximately 64 litres (14 Imp gal).

Powerplant: Two Solov'yov D-25V turboshaft engines rated at 5,500 eshp for take-off and 3,100 eshp in cruise mode at 3,100 m (10,170 ft) and 250 km/h (155 mph). The D-25V is a single-shaft engine with a fixed-area intake assembly (front casing), a nine-stage axial compressor, a can-annular combustion chamber with 12 flame tubes, a single-stage axial power turbine and a two-stage axial free turbine. Air bleed valves are provided at the third and fourth compressor stages.

Two accessory gearboxes are mounted on the front casing. The dorsal gearbox carries the STG-12GM starter-generator, the NR-23A primary fuel regulator pump, the Model 889A delivery pump, the TsR-23A centrifugal fuel flow regulator, the AK-50T air compressor (port engine only) and the DTE-12 engine rpm sensor. The ventral gearbox carries the MN-23S primary oil pump, the MFS-35 oil filter, the TsVO-23 centrifugal air separator, the oil emptying cock and the magnetic chip trap. The MNO-23G oil scavenging pump is located on the rear casing.



Left: Close-up of the main rotor head; right: the AV-63 tail rotor.

Engine pressure ratio at take-off power 5.6; power turbine speed at take-off power 10,530 rpm; mass flow at take-off power 26 kg/sec (57 lb/sec); turbine temperature 1,160°K. Specific fuel consumption 0.287 kg/hp·hr (0.632 lb/hp·hr) at take-off power and 0.343 kg/hp·hr (0.756 lb/hp·hr) at cruise power. Length overall 2,737 mm (8 ft 11¾ in), width 1,086 mm (3 ft 6¾ in), height 1,158 mm (3 ft 9 19/32 in), dry weight 1,243 kg (2,241 lb). The designated service life is 6,000 hours.

The engines are installed side by side on top of the centre fuselage between Frames 2-14 (ahead of the main gearbox), symmetrically relative to the fuselage axis. Each engine is attached to the fuselage with the help of brackets and adjustable rods connected to three mounting lugs on the intermediate casing (two lateral, one ventral) and two more on the rear casing sides immediately ahead of the jetpipe. Three engine attachment brackets (port, starboard and centre) are provided in the engine bay at Frame 5 and three more between Frames 7 and 11.

The port and starboard engines are interchangeable, except for the handed exhaust pipes made of welded Kh18N10T stainless steel; each pipe has a tunnel for the free turbine shaft connected to the main gearbox. To ensure cooling of the exhaust pipe, it is enclosed in a casing with structural sections welded to its inner surfaces; these structural sections form spiral-shaped ducts directing the cooling air flow.

The D-25V has a recirculation-type pressure lubrication system comprising two subsystems. The oil system of the engine's power section transformer oil or MK-8 grade mineral oil; it features a tank, an oil cooler and piping. The free turbine and engine transmission (the power take-off shaft) are serviced with a 50/50 mixture of MK-22 or MS-20 oil and transformer oil or MK-8 in the winter, or a 75/25 mixture of the same grades of oil in the summer.

The powerplant also features a free turbine overspeed protection system and an IV-200G vibration monitoring system.

The engines are started electrically by STG-12GM starter-generators. On most Mi-6s, except early production batches, engine starting and ground power supply is ensured by an Ivchenko AI-8 APU mounted in a housing on the port clamshell door of the cargo hatch, with intake and exhaust orifices. The Mi-22 ABCP has a more powerful Stoopino Machinery Design Bureau TA-6 APU.

The engines, together with the main gearbox and the cooling fan assembly, are enclosed by a large fairing incorporating an air intake assembly and multi-section cowlings with cooling air exit louvres. The upper cowling panels open upwards, while the lower panels on both engines, the cooling fan section and the main gearbox fold down to serve as work platforms during maintenance; there are fixed portions of the cowling between the upper and lower panels. The work platforms are opened and closed by hydraulic rams which also actuate their locks. Grab rails are provided along the top of the fairing.

The fairing incorporates longitudinal and transverse firewalls made of OT4-0 titanium alloy. The transverse firewall, which serves as an attachment point for the first and second cowling panels and work platforms on each side, consists of three parts (the upper parts are detachable to permit engine removal).

Powertrain: Engine torque is fed via overrunning clutches into the R-7 main gearbox mounted on a truss-type bearer between Frames 14-18; the eight bearer struts (four main and four auxiliary) are attached to these fuselage mainframes. The main rotor shaft is inclined 5° forward. The overrunning clutches enable the helicopter to continue flight even if one of the free turbine shafts jams or one of the engines seizes; they also enable the helicopter to land in autorotation mode after a dual engine failure.

The R-7 is a four-stage gearbox. The first stage has bevel gears and two torque equalising mechanisms, the second stage has four cylindrical gears transmitting torque to a large central gear; the planetary third stage and the fourth stage form a differential mechanism. There are two accessories gearboxes driving the MNR-23 main oil pump, the MN-7P transmission oil pump and the MNO-7 scavenging oil pump. The R-7 also mounts the rotor brake, whose drum is connected to the flange of the tail rotor drive shaft, and the autopilot servos. There are four drives for hydraulic pumps, two drives for AC generators, two drives to tachometer sensors for measuring the RPM of the free turbine shafts, and two reserve drives.

The main gearbox reduces the engine transmission shafts' rotation speed and conveys torque to the main rotor, tail rotor drive shaft and the fan serving the engine oil coolers and main gearbox oil cooler. The overall reduction ratio is 0.01445 for the main rotor drive shaft, 0.2484 for the tail rotor drive shaft and 0.366 for the fan. Like the engines' free turbines, the R-7 uses a 50/50 mixture of MK-22 (MS-20) and MK-8 or transformer oil in the winter and a 75/25 mixture of the same grades of oil in the summer. The total amount of oil is about 235 litres (51.7 Imp gal).

The space between the handed canted sections of the exhaust pipes is occupied by the cooling fan installation driven by the main gearbox; its air intake and short sloping air duct are located ahead of the main rotor head. The air supplied by the fan is fed into the oil coolers; a part of this airflow is routed to cool the exhaust pipes, main gearbox and engines and to ventilate the crew section and cargo hold. The heated air is fed into an air/air heat exchanger and heats the air that goes into the cargo hold. The cooling air outlet is located at the rear of the engine/main gearbox fairing.

A long drive shaft passing inside the tailboom connects the main gearbox with a V1525-000 intermediate gearbox at the base of the tail rotor pylon turning the axis of the shaft up through 47° and thence with the V1537-000 final drive gearbox which turns the shaft through 90° to starboard. The tail rotor drive shaft comprises eleven sections, nine of which are mounted on eight intermediate bearings up to the intermediate gearbox. The final two sections of the shaft between this and the final drive gearbox are mounted on one intermediate bearing. The final drive gearbox incorporates the tail rotor pitch control mechanism.

Mi-6s were used for massive vertical envelopment operations, as this view testifies. Note the Mi-10 standing rightmost in the third row and the group of 21 Mi-8s in the background.

Rotor system: Five-bladed *main rotor*, turning clockwise when seen from above. The fully articulated rotor head mounted on the main gearbox output shaft has axial, flapping and drag hinges with adjustable stops and is equipped with hydraulic dampers. To enhance the stability of the blades' movement and improve the helicopter's performance, the main rotor head is provided with 'flapping movement compensator' which reduces the blades' angle of attack when they start their upward movement.

The interchangeable blades have a rectangular planform with a constant chord of 1,000 mm (39⅜ in). They feature geometrical camber changing in accordance with a linear rule. The principal structural member of the blade is a tubular steel spar. It carries 21 blade pockets (separate sections with limiting ribs) loosely connected with each other; the trailing-edge parts of the pockets feature a honeycomb filler. The blades utilise two main airfoils: between the innermost pocket (No.0) and the No.18 pocket it is NACA 230M, followed by a transitional airfoil and then by a high-speed TsAGI airfoil on the Nos 19-21 pockets. The blades are provided with balance tabs on the trailing edge of Nos 14-16 pockets and have electric de-icing. A compressed-air spar failure warning system is provided.

Blade incidence angles range from 1° to 13°30' ±30'. The blade droop angle when at rest is 7°; the maximum flapping angle (vertical travel) is 25° ±30'.

The four-bladed AV-63B reversible pusher-type *tail rotor* located on the starboard side likewise turns clockwise when seen from the hub. The interchangeable L63-Kh6BP blades of trapezoidal planform are attached to the rotor head by hinges permitting a flapping movement. The blades are of all-wooden construction and have an alcohol de-icing system. Blade incidence with the pedals set neutral is 4° ±30', varying from 23°30' ±30' ('hard a-starboard' position) to –9°30' ±30' ('hard a-port' position).

Top and above: Mi-6s were often used for transporting aircraft (not necessarily disabled) on a sling. Here, the 'victims' are two UTI-MiG-15 trainers and a single-seat MiG-15. Note the open machine-gun bay doors.

Control system: The Mi-6 has full dual controls. Flight control is effected by changing the size and direction of the main rotor thrust and by changing the tail rotor thrust. Pitch and roll control is effected with the help of the cyclic pitch control sticks; its deflection by the pilots causes, via the swashplate, a change in the direction of the main rotor's resultant thrust. Swashplate travel limits are 7°30' ±12' forward, 5°54' ±18' aft, 4°42' ±12' to starboard and 5°48' ±12' to port.

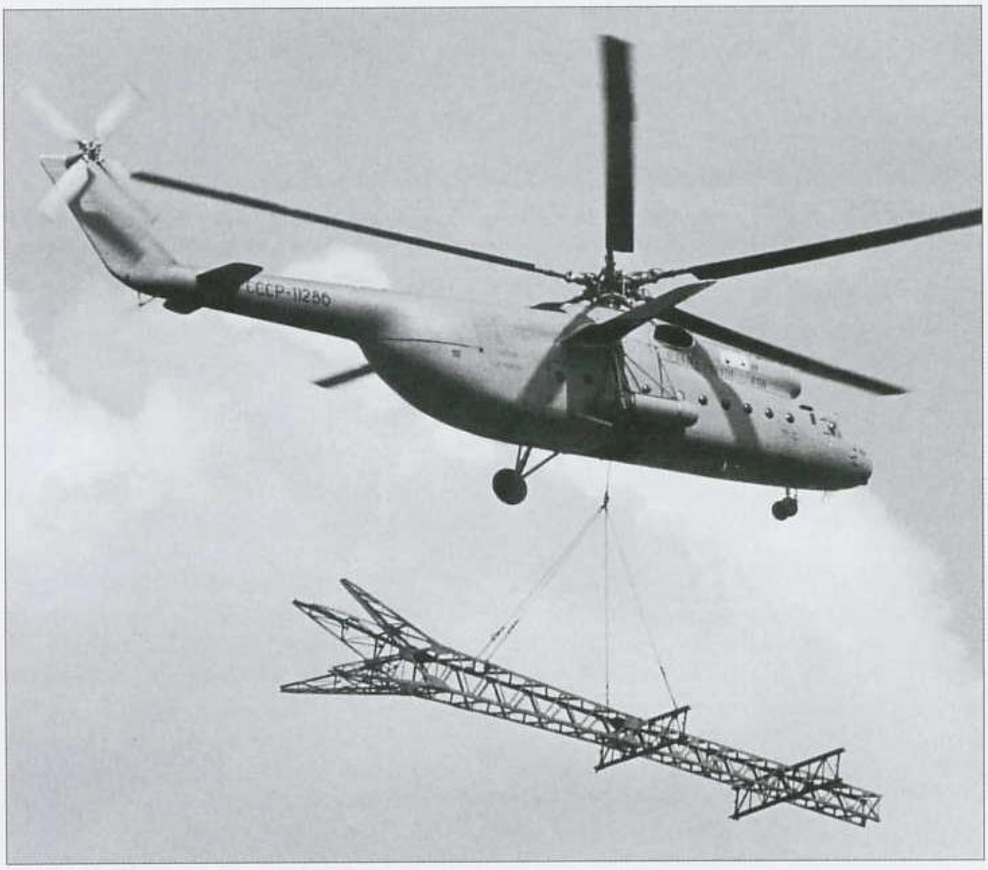
Directional control is effected by pedals which change the collective pitch of the tail rotor and, in consequence, its thrust. The control system is of a mechanical mixed type, with mainly rigid linkages. Cables are used for the tail rotor and stabiliser control at the following stretches: aft end of centre fuselage, tailboom and tail rotor pylon.

The AP-34B Srs 2 four-channel autopilot ensures the helicopter's stabilisation in yaw, roll, pitch and altitude. Control is effected by RP-28 combined two-chamber servos (*roole**voy** pri**vod***) doubling as hydraulic control actuators. An SDV-5000-OA hydraulic damper is installed in the yaw control channel. The system of main rotor collective pitch control incorporates a spring loading device with an ENT-2M electromagnetic brake to warn the pilot that an excessive increase of the collective pitch with the engines at take-off power causes a reduction of the main rotor's RPM. To maintain automatically the preset main rotor speed, an RPM stabiliser with a KAU-30B actuator (*kombi**nee**rovannyy agre**gaht** oopravleniya* – combined control unit) is included into the engine control system.

Fuel system: Internal fuel is carried in 11 bag-type tanks (Nos 1-8 under the cargo cabin floor and Nos 9-11 above the cabin, see Centre fuselage). Tank No.1 is a reserve tank; the rest are divided into five groups connected by piping (Group I, Nos 2 and 3; Group II, Nos 4-6; Group III, Nos 7 and 8; Group IV, Nos 9 and 10; Group V, No.11). Electric pumps are installed in each group of tanks and the reserve tank; they ensure the transfer of fuel and build up of the necessary pressure before the engines' delivery pumps. To increase the range, the helicopter can be fitted with two 2,250-litre (495 Imp gal) cylindrical external tanks attached to the fuselage sides by locks and N-struts, as well as with additional ferry tanks of identical capacity in the cargo hold.

The internal tanks hold a total of 8,250 litres (1,815 Imp gal); this increases to 12,750 litres (2,805 Imp gal) with external tanks and

Above: A Soviet Air Force Mi-6 *sans suffixe* carries a mock-up of the Vostok first-generation space capsule during an air event in the late 1960s.



At first, Aeroflot Mi-6s wore an Air Force-style grey colour scheme and registrations in the 11xxx block. Here, CCCP-11286 transports a power line pylon.

to 17,250 litres (3,795 Imp gal) with long-range tanks installed in the cargo hold. The fuel feed to the engines can be controlled automatically or manually. The latter option makes it possible to switch on or switch off any fuel pump and to change the order of fuel consumption from the tanks. Fuel grades used are Russian T-1, T-2, TS-1 or TS-1G kerosene, or Western equivalents; grade 'I' special fluid is added in winter to prevent ice formation. A refuelling connector is located on the starboard side of the forward fuselage.

The helicopter is equipped with an inert gas pressurisation system. For this purpose three 8-litre (1.76 Imp gal) carbon dioxide bottles are mounted above the cargo hold.

Hydraulics: The hydraulic system comprises main, backup and auxiliary systems. Hydraulic power is supplied by NSh-2S cog-type pumps driven off the main gearbox.

The main and backup systems work the RP-28 servos and the KAU-30B combined control unit. When using the main hydraulic system, two modes of controlling the helicopter are possible: manual control by the pilot and combined control by the pilot with corrections introduced by the autopilot. When using the backup hydraulic system, only manual control is possible. The auxiliary system works the windshield wipers, opens and closes of the doors of the machine-gun installation, unlocks the collective pitch lever, adjusts the pilots' seats in height and seat back angle and actuates the external sling locks. In addition, on the ground it operates the clamshell doors of the cargo hold, the vehicle loading ramps and the engine cowling sections/work platforms.

The hydraulic system utilises the AMG-10 oil-type hydraulic fluid (*aviatsionnoye mahslo ghidravlicheskoye*); nominal pressure is 120-150 kg/cm² (1,714-2,142 psi). The main and backup systems are fed separately from two tanks mounted on the GB-1 hydraulic unit (*ghidro**blok***). The AMG-10 is fed to the auxiliary system from the upper section of the backup system tank. The hydraulic tanks of both systems have a capacity of 67 litres (14.74 Imp gal) each.

Pneumatic system: The pneumatic system actuates the wheel brakes, the engine air bleed control bands (valves), the shutters in the cabin heating hot air duct and the machine-gun cocking mechanism. Compressed air is stored in the upper parts of main undercarriage shock struts doubling as air bottles charged to 50 kg/cm² (714 psi). Replenishment of these bottles with a capacity of 32 litres (7.04 Imp gal) each is effected by an AK-50T compressor driven by the port engine.

Electrics: The electrical system caters for the functioning of the flight instruments and navigation equipment, engine monitoring instruments, radio equipment, lighting, engine start-up system, de-icing system and some other mechanisms and equipment items.

Primary 27V DC is supplied by two STG-12TM starter-generators, with four 12SAM-55 storage batteries located in bays on the port side of the nose as a back-up. 360V AC is supplied by two SGS-90/360 three-phase generators with a capacity of 90 kW (for feeding the main rotor de-icing system), PT-500Ts, PAG-1FP and PO-1500 converters (supplying 400 Hz AC to the navigation and radio equipment). A ShRAP-500 DC ground power receptacle and a ShRA-200LK AC ground power receptacle are provided on the port side of the centre fuselage.

De-icing system: The engine air intakes, main rotor blades, flightdeck/navigator's station windshields and pitot heads are electrically de-iced. The tail rotor blades are de-iced by a system using an ethyl alcohol/glycerine mixture from a 28-litre (6.16 Imp gal) tank.

Fire suppression system: Fire protection in the engine bays, the main gearbox bay and fuel tank bays, as well as inside the engines, is ensured by a fire extinguishing system. The six OS-8MF fire extinguisher bottles (*ognetooshitel' statsionarnyy* – stationary fire extinguisher) are charged with $114V_2$ grade chlorofluorocarbon. The first shot is fired automatically, triggered by DPS-1AG flame sensors forming part of the SSP-2A fire warning system (*sistema signalizahtsii pozhara*); the second one is activated manually when the contents of the automatically-operated bottles have been exhausted.

Avionics and equipment:

Flight and navigation equipment includes a GMK-1A compass system which can work in magnetic correction mode or in gyro compass mode, a DAK-DB-5VK celestial compass, an MRP-56P marker receiver; ARK-9 and ARK-UD automatic direction finders and an RV-3 radio altimeter.

The *flight instrumentation* includes a US-35 airspeed indicator, a VD-10 altimeter, an AGK-47VK gyro horizon and an AChS-1 clock.

Communications equipment includes a two-way communications radio with an R-807 transmitter and a US-9 receiver; an R-802 command link radio; a 1-RSB-70 (Yadro-1A) HF communications radio; and an SPU-7U intercom

Data recording equipment comprises an MSRP-12 flight data recorder capturing 12 analogue parameters, including barometric

Above: The Mi-6 was often used as a 'flying crane', as exemplified by CCCP-21192 (c/n 9684205V) of the Komi CAD installing a ventilation outlet at an industrial construction site in 1969.

Mi-6 CCCP-11325 (c/n 3681406V) of the Moscow Agricultural Work & Commuter Air Traffic Directorate lifts a ZiL-157K 6 x 6 lorry on a sling.

Above: The Egyptian Air Force took delivery of a number of Mi-6s, including this example with the late-standard nose glazing design.

altitude, indicated airspeed, roll rate, vertical and lateral G forces and throttle settings, and an MS-61 cockpit voice recorder.

Lighting and signalling equipment includes internal lighting, external lighting (navigation lights on the tailboom and at the wingtips, red revolving anti-collision lights above and below the centre fuselage, formation lights and blade tip lights to avoid collisions during massive night-time assault operations), landing/taxi light, floodlights and two EKSP-46 four-round signal flare launchers on the port side of the nose.

Oxygen equipment: The oxygen equipment is intended to ensure the crew's efficiency during high-altitude flights. The helicopter can be equipped with five KKO-LS sets each of which comprises a KP-21 breathing apparatus, a KM-16N oxygen mask, a KP-58 breathing apparatus and an R-58 connector. The flight engineer and troops transported in the cargo cabin can use portable KP-21 breathing apparatus. Three 4-litre (0.88 Imp gal) stationary oxygen bottles are fitted as standard; in Casevac configuration 26 additional bottles holding 7.6 litres (1.672 Imp gal) each are fitted.

Cargo and troop-carrying equipment: An external sling device for the transportation of bulky loads can be installed in case of necessity. In this case a barrier is erected in the cargo hold around the central hatch; above it a special truss carrying a swivelling lock is attached to centre fuselage mainframes 14 and 18. On the outside beneath the fuselage a circular barrier was installed to prevent the sling touching and damaging the edges of the cargo floor hatch. Provision is made for automatically hooking up the sling by the cable of the LPG-3 onboard winch which is mounted near Frame 1 of the centre fuselage.

Armament: Military versions feature an NUV-1M gimballed mount under the navigator's station featuring a 12.7-mm (.50 calibre) Afanas'yev A-12.7 (TKB-481) machine-gun. The normal ammunition complement is 200 rounds, the full complement is 270 rounds. The field of fire is ±30° to port and starboard and 55° downwards.

Mi-6 in action

In the Soviet Union the majority of the Mi-6s were delivered to the Armed Forces where the process of forming independent helicopter regiments (OVP – *ot**del'**nyy verto**lyot**nyy polk*) reporting to various mechanised infantry or tank armies started in the early 1960s. With the advent of the Mi-6 these units came to have a mixed inventory: two squadrons flying Mi-6s (12 to 15 machines each) and two squadrons equipped with Mi-4s, and later Mi-8s.

As production of the Mi-6 built up, one such regiment was included into each Defence District and each group of Soviet forces stationed abroad. For example, the Group of Soviet Forces in Germany (renamed Western Group of Forces in 1989) included the 239th Independent Guards Helicopter Regiment (OGVP – *ot**del'**nyy Gvar**dey**skiy verto**lyot**nyy polk*) based at Brandis AB; there were also the 340th OVP at Kalinov (L'vov Region) in the Carpathian Defence District, the 51st OGVP at Aleksandriya AB (Kirovograd Region) in the Kiev DD, the 320th OVP at Kherson (Crimea Region) in the Red Banner Odessa DD, the 280th OVP at Kagan (Turkmenistan) in the Central Asian DD and the 181st OVP at Dzhambul (southern Kazakhstan) in the Turkestan DD.

There is an interesting aspect of the helicopter units' order of battle in the Defence Districts. Repeated attempts were made to transfer these helicopter regiments from Air Force control to the Ground Forces (after all, they had been set up precisely for catering to the interests of the Ground Forces). However, it was not until late 1991 that this organisational structure took its final shape.

The Mi-6 was also put on the strength of independent squadrons and composite air regiments which ensured the functioning of headquarters of Defence Districts, Groups of Forces and Air Armies. Such units had in their inventory transport and special-purpose aircraft and helicopters of assorted types. As a rule, their complement included one or two Mi-6VKPs or Mi-22s, sometimes supplemented by an equal number of the transport version of the Mil' heavylifters. For example, the 456th Independent Guards Composite Air Regiment (GvOSAP – *Gvar**dey**skiy ot**del'**nyy* ***smesh**annyy **avia**polk*) at Gavryshevka airfield near Vinnitsa had a Mi-22, and the 296th OVE (*ot**del'**naya verto**lyot**naya eska**dril'**ya* – Independent Helicopter Squadron) at Mahlwinkel AB, Germany, had two Mi-6VKPs at its disposal. The big Mil' machines were also operated by search and rescue units stationed in the areas where recoverable spaceships made their landings: an air detachment in Aral'sk, squadrons in Cheben'ki (near Orenburg) and Karaganda, a regiment in Troitsk (near Kustanai).

The first crews composed of service pilots mastered the new machine with the assistance from factory specialists. Later, conversion to the Mi-6 was conducted in a special centre at Loogansk, the Ukraine, and a regiment stationed at Torzhok became the lead regiment for the service introduction of the Mi-6 (subsequently the 344th Combat and Conversion Training Centre (TsBP i PLS – *Tsentr boye**voy** podgo**tov**ki i pere**oo**chivaniya* ***lyot**novo sos**ta**va*) of the Army Aviation was set up on the basis of this regiment). After the delivery of the Mi-6s, Soviet helicopter pilots finally entered the era of gas turbine engines as the last among military airmen. The machine's capabilities caused admiration on the part of the flight crews, and this served as an additional morale incentive for those mastering the helicopter.

The Mi-6 proved to be very stable, and it was a pleasure to fly it in cruise mode. However, at slow speeds the helicopter suffered considerable vibrations; besides, when flying with a high all-up weight (in excess of 42.5 tonnes/93,700 lb) the helicopter was clearly underpowered. Therefore rolling take-offs and roll-on landings became standard operational procedure for the Mi-6. This not only permitted to increase the take-off weight, but also made it possible to overcome vibrations quicker. The new helicopter differed appreciably from the Mi-4 in its piloting techniques; in particular, it was much more sluggish. While in its performance the Mi-6 was superior not only to the Mi-4 but to all other helicopters in the world, on many other counts the machines of the first production batches could scarcely lay claim to being new-generation rotorcraft. The service life before the first overhaul was initially 300 hours, later raised to 600 hours. Many complaints were caused by the AP-31V autopilot and the main hydraulic system; the helicopter lacked an APU. Virtually all early-production Mi-6s up to and including the 20th Rostov-built batch were sent for overhauls to the Konotop aircraft repair plant. Here the helicopters did not just receive a new lease of life; they were endowed with new qualities and became more convenient in operation. Here are a few examples. It was at ARZ No.535 in Konotop that all early-production Mi-6s were retrofitted with the AI-8 APU and the MSRP-12 FDR monitoring 12 flight parameters. A complete replacement of the onboard electric circuitry was also made. Later the Mi-6s operated east of the Urals started undergoing overhauls at an aircraft repair plant in Khabarovsk.

Very many complaints were associated with the early-production D-25V engines which were prone to surging. The most dangerous phenomenon, however, was the overspeeding of the free turbine. This process developed very swiftly; it led to the disintegration of the turbine with the red-hot blades and discs flying in all directions with a savage force and destroying everything in their path. The majority of such uncontained failures occurred in the air and ended in crashes. After one of these crashes the machines were fitted with a system (SZTV – *sistema zashchity toorbiny vinta*) for the protection of the main rotor which measured the free turbine shaft's RPM and automatically shut the engine down, should the free turbine speed exceed the admissible limit.

Improvements introduced over the years on the Mi-6 and later on the Mi-6A as well were accompanied by an increase of the AUW, yet they achieved their purpose. The helicopter became a reliable combat machine well liked by its crews and capable of fulfilling its missions successfully. The most important of these was probably the delivery of nuclear warheads from depots to ballistic missile launch sites and airfields where the missile strike aircraft were deployed. Each regiment had several specially selected crews which received an appropriate security rating. Furthermore, introduction of the Mi-6s into service held the promise of endowing the Ground Forces with a hitherto unseen level of mobility.

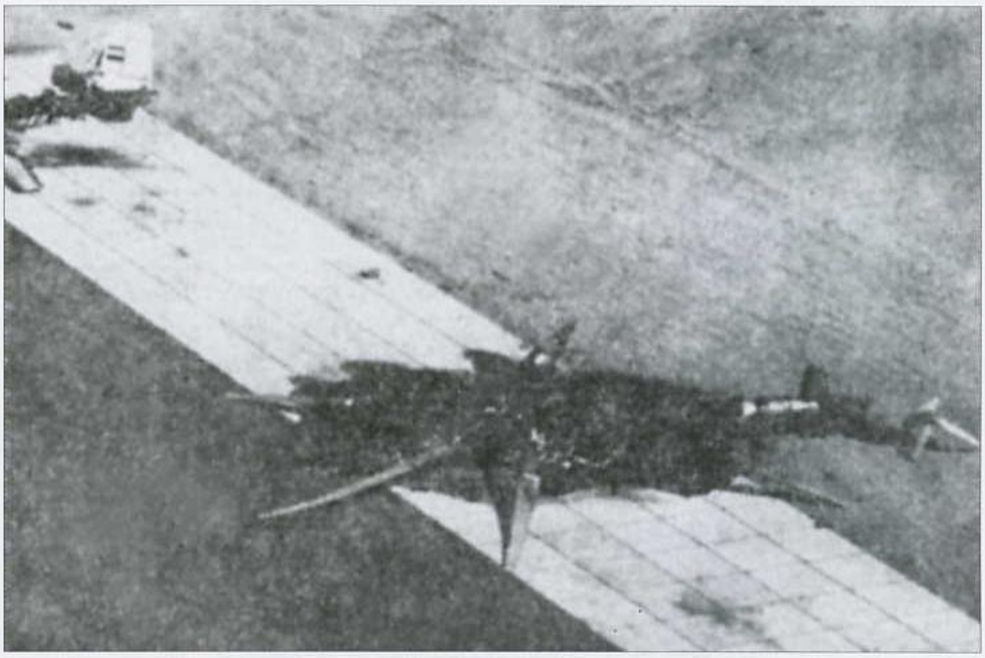
One may regard the invasion of Czechoslovakia by Warsaw Pact forces as the first combat operation in which the Soviet Air Force Mi-6s took part. During the night of 21st August 1968, several Mi-4s and Mi-6s from a helicopter regiment of the Northern Group of Forces landed on the tarmac of Prague's Ruzyne airport; deploying from the Polish town of Legnica, they delivered the first wave of the airborne assault. A helicopter regiment from the Southern Group of Forces also took part in the events in Czechoslovakia, leaving its base at the Hungarian airfield of Kolocsa to take up temporary residence at Bratislava. Both regiments stayed in Czechoslovakia for more than a year. During this period the Mi-6s were used very actively for delivering various kinds of military materiel, ammunition, foodstuffs and sometimes even armoured personnel carriers.

Already during the first weeks after the invasion cases were recorded when Soviet Mi-4s came under heavy machine-gun fire, which led to the loss of at least two helicopters. In consequence, the Mi-6s started performing their flights at an altitude of 4,000 m (13,100 ft). Climb to this altitude and descent from it was performed in a steep spiral in the airfield area.

Approximately the same techniques were used also during the Afghan War which marked the culmination of the Mi-6's combat career in the Soviet Armed Forces. The helicopters made an excellent showing during flights high up in the mountains, displaying their ability to maintain confidently an altitude in excess of 6,000 m (19,690 ft) which was unattainable for the smaller Mi-8s. The main missions flown by the Mi-6s during that war were transportation flights. Only very rarely were they involved in assault operations – above all, due to the risk of high personnel losses in the event of the helicopter being shot down. Transportation of underslung loads was performed in exceptional cases, mainly for the purpose of evacuating damaged helicopters of other types.

To cater for the needs of the relatively small 40th Army (the Soviet contingent in Afghanistan), it proved necessary to build up a very large helicopter task force which included Mi-6s operated by the 181st and 280th Regiments; the number of these machines in squadrons reached 20. One more squadron of Mi-6s staffed with Soviet specialists operated in support of the government troops of the Democratic Republic of Afghanistan.

When the catastrophe at the Chernobyl atomic power station occurred on 26th April 1986, the 51st OGVP was sent to the disaster area. Initially the Mi-6s performed transportation flights; when the disaster relief teams started burying the disabled reactor of the power station's Unit 4, the Mi-6s were used for carrying externally slung loads of sand and



Above: Most of the Egyptian Air Force's original Mi-6 fleet was destroyed on the ground by Israeli air strikes during the Six-Day War of 1967. A destroyed EAF Il'yushin IL-14 transport is visible beyond.

lead slabs and dropping them on the reactor building demolished by the blast. When the radiation doses accumulated by the crews reached 25 Roentgen, the MoD started sending crews from all over the Soviet Union to Chernobyl to relieve the crews from Aleksandriya. After the completion of the work the machines, which defied decontamination, had to be struck off charge and buried on site.

Export deliveries of the Mi-6 started in 1956. Over the years these helicopters were purchased by Indonesia, the United Arab Republic (later Egypt when the UAR split up), North Vietnam, Pakistan, India, Iraq, Algeria, Ethiopia, Bulgaria and Poland. In all, more than 60 machines were delivered to foreign customers. In addition, Soviet civil crews undertook tours abroad on their helicopters. For example, pilots from Ukhta worked in Norway and Austria. Conversion training of flight and ground crews from the countries which had acquired these machines was conducted in the Kremenchug Civil Aviation Flying School. The Mi-6s delivered to foreign customers had their designated time between overhauls understated.

The combat career of the Mi-6 abroad started in 1967 in the course of conflicts in Indo-China and in the Middle East. Their participation in the Six-Day War turned out to be more than deplorable: on the morning of 5th June the UAR Air Force was in possession of 12 helicopters of this type, based at Bir Tamada and Bir Gafgafa, and by nightfall ten of them had been destroyed on the ground by Israeli air strikes. Soviet aid allowed these losses to be made good, and by the time the Yom Kippur War broke out in October 1973 the Egyptians had a combat-ready squadron of Mi-6s. As distinct from the Egyptian Air Force's Mi-8s, these helicopters were not used over the battlefield and in the enemy's immediate rear because, in view of their big dimensions, they were considered to be too vulnerable. They were used mainly for airlifting various loads in the interests of the units of the second echelon.

On the other hand, in Indo-China the Mi-6 displayed its best qualities to advantage. The heavy helicopters were on the strength of the 919th regiment of the North Vietnamese Air Force. At first, as reported by different sources, they were flown by Aeroflot crews; later the new hardware was fully mastered by the local airmen. Initially the Mi-6s operated within the territory of North Vietnam, carrying cargoes, small army units and repair teams which were engaged in the restoration of bridges and road stretches destroyed destroyed by USAF raids. The Mi-6 played a key role in the so-called programme for enhancing the stability (survivability) of the North Vietnamese Air Force's fighter element. The huge helicopters lifted MiG-17 or MiG-21 fighters and evacuated them to splendidly camouflaged small reserve airstrips or to shelters in the mountains at a distance of 10-30 km (6.2-18.6 miles) from the main airfields, or even to the territory of neutral China where they were safe from American air strikes. When the raids of the US aviation were over, the aircraft returned to their bases from which they continued to fly combat sorties. For example, in November 1967, shortly before a USAF raid on Noi Bai AB, the Vietnamese (who had been alerted in a timely fashion) succeeded in evacuating the fighters. Apart from aircraft, surface-to-air missile (SAM) systems were also redeployed over short distances. The Mi-6s also performed airlift missions in the interests of the troops on the offensive; they took part in the Vietnamese Army's blitzkrieg against the Khmer Rouge in Kampuchea in 1979.

The Mi-6 enhanced its good reputation in the course of the war between Somalia and Ethiopia in Ogaden. The Addis Ababa regime had at its disposal a squadron of helicopters of this type which carried out a large scope of work during the preparation and execution of a counteroffensive. Mi-6s were used fairly widely in Iraq which had 14 such helicopters at its disposal in September 1980, before the beginning of the Iran-Iraq War. In the course of the eight-year war they were used both for landing tactical assault groups and for transport missions. Several machines were reported lost due to enemy action, including attacks by Bell AH-1 Huey Cobra combat helicopters. In August 1990 the Mi-6s took part in Saddam Hussein's invasion of Kuwait. There is no reliable information as to how they fared in Operation Desert Storm (that is, whether they survived the Allied air strikes).

During the post-Soviet period the Mi-6 had a chance to smell gunpowder in several hot spots of the country that used to pride itself as the 'fraternity of all peoples'. In early March 1992 helicopters of this type took part in evacuating the personnel and combat materiel of the 366th Mechanised Infantry Regiment from Stepanakert, the capital of the Nagornyy Karabakh enclave that was the bone of contention between Armenia and Azerbaijan. At that time the crews of these machines made about 30 sorties, coming under fire from both belligerents in so doing

Specifications of the Mi-6A

Length:	
minimum, rotors stopped	37.49 m (122 ft 11 63/64 in)
rotors turning	41.739 m (136 ft 11 9/32 in)
Fuselage length	33.165 m (108 ft 9 45/64 in)
Fuselage width	3.2 m (10 ft 5 63/64 in)
Height on ground with normal take-off weight, rotors stopped	9.156 m (30 ft 0 31/64 in)
Ground clearance with normal take-off weight	0.596 m (1 ft 11 15/32 in)
Ground angle	2°
Main rotor diameter	35.0 m (114 ft 10 in)
Main rotor disc area, m^2 (sq ft)	962 (10,344)
Main rotor disc loading, kg/m^2 (lb/sq ft)	42.1 (8.63)
Tail rotor diameter	6.3 m (20 ft 8 in)
Wing span	15.3 m (50 ft 2 23/64 in)
Wing area, m^2 (sq ft)	35.0 (376.34)
Stabiliser span	5.082 m (16 ft 8 13/64 in)
Stabiliser area, m^2 (sq ft)	4.87 (52.36)
Landing gear track	7.502 m (24 ft 7 23/64 in)
Landing gear wheelbase	9.175 m (30 ft 1 7/32 in)
Maximum indicated airspeed, km/h (mph)	300 (186)
Normal take-off weight, kg (lb)	40,500 (89,285)
Maximum take-off weight, kg (lb)	44,000 (97,000)
Payload, kg (lb):	
with a 40,500-kg (89,285-lb) TOW	5,516 (12,160)
with a 42,500-kg (93,690-lb) TOW	7,516 (16,570)
with a 44,000-kg (97,000-lb) TOW	9,016 (19,880)
Maximum payload with a 42,500 to 44,000-kg TOW and reduced fuel, kg (lb)	12,000 (26,455)
Maximum slung load, kg (lb)	8,000 (17,640)
Service ceiling, m (ft):	
with a 40,500-kg TOW	4,500 (14,760)
with a TOW in excess of 40,500 kg	3,000 (9,840)
Climb time with a 40,500-kg TOW, minutes:	
to 3,000 m	9.7
to 4,500 m	20.7
Effective range at 1,000 m (3,280 ft) with a 40,500-kg TOW, km (miles)	970 (602)
Endurance at 1,000 m and 140-160 km/h (87-99 mph) with a 40,500-kg TOW	2.85 hours

but suffering no losses. When the former Soviet Air Force assets were up for grabs, Georgia was among the new proprietors of the Mi-6; judging by the scant information carried by the mass media, the Georgian machines were occasionally used for airlift missions in support of its troops engaged in the civil war in Abkhazia (1992-93).

Radical organisational changes took place in the regiments stationed in the Ukraine. In 1992 the Aleksandriya-based 51st OGVP was transformed into an Independent Helicopter Brigade of the National Guard. In September 1997 two Mi-6s from the Ukrainian Army Aviation were committed to action and used for dropping paratroopers during Exercise *Kazatskaya step'* (Cossack Steppe) which was conducted at the Shiroki Dan test range near Nikolayev with the participation of Ukrainian, British and Polish troops.

Several Mi-6s were delivered to the Indonesian Air Force in the days when Indonesia was still on good terms with the Soviet Union.

A notable chapter in the biography of the Soviet Air Force's Mi-6s was their employment in the national economy of the Soviet Union and their participation in space programmes. These helicopters were engaged in SAR operations conducted after the landing of recoverable modules of Soviet manned and automatic space vehicles. Along with special aviation units assigned to the Cosmonaut Detachment, crews from the 181st OVP took an active part in these operations; when this regiment was despatched to Afghanistan, they were replaced by crews from the 157th OVP. The main task of the Mi-6 was to deliver the recoverable module to an airfield from where it was transported further by an An-12 turboprop. The crews fulfilled their missions day and night regardless of weather.

The civil career of the Mi-6 began almost at the same time with the type's introduction into army service. Its capabilities, which were regarded as fantastic by the standards of that time, proved to be a great boon for the national economy: that was the time of rapid development of new oil and gas regions, primarily in Siberia and in the North where transport network was practically non-existent. The table on page 36 lists Aeroflot enterprises which operated the Mi-6 in Soviet times.

At first, Aeroflot Mi-6s wore an Air Force-style grey livery and were registered in the CCCP-112xx and -113xx blocks. Later they were to be re-registered *en masse* in the CCCP-210xx and -218xx blocks, the original registrations passing to An-12 transports. The drab colour scheme gave way to Aeroflot's blue/white fleetwide standard livery; helicopters operated in the northern areas had an orange/blue colour scheme for high definition against white backgrounds.

As early as 1963-64 the airmen of the Tyumen' Civil Aviation Directorate logged about 600 hours and transported nearly 3,500 tonnes (7,875,000 lb) of cargoes.

It should be noted that the mastering of the new helicopter by Aeroflot proceeded at a quicker pace as compared to the Air Force. This was due to the greater experience characteristic of Aeroflot pilots who logged considerably more flight hours per year than their military colleagues.

Nearly all civil Mi-6s were assigned to flight detachments stationed east of the Urals or in the North. Crews from virtually all detachments worked in the regions characterised by the development of new oil and gas deposits and other epoch-making industrial projects; for instance, Mi-6s belonging to the Turkmen CAD saw a lot of action in the oil-rich Tyumen' Region. This made it possible, for example, to concentrate up to 40 or 50 Mi-6s in the north of the Tyumen' Region; it is no exaggeration to say that without their participation the USSR would have received oil from that region much later.

In 1963-1965, during the construction of the Shaim-Tyumen' and Igrim-Urals main oil pipelines – the first of the kind in Siberia, the Mi-6s were engaged in trial transportation of large-diameter steel pipes measuring more

FAP 679, one of the Mi-6s delivered to the Peruvian Air Force, at Lima. The forward fuselage is painted dayglo orange.

than 30 metres (100 ft) in length and weighing nearly 7 tonnes (about 15,400 lb). This work was largely experimental. In the following decades not a single major oil or gas pipeline was built without the participation of the Mi-6. The use of helicopters made it possible to achieve an appreciably higher tempo of the on-site preparations and commission the pipelines into operation on schedule.

Civil crews flew the Mi-6s with slung loads much more often than military crews. This was due not so much to the large number of outsize cargoes, but rather to the low efficiency of the Mi-6 when transporting cargoes in the cargo cabin. The onboard loading and unloading devices were limited to a winch which permitted only to haul the pipes into the cabin through the rear loading hatch; for this reason the winch was used very rarely. Therefore it took much time and arduous work to fill the spacious cabin.

Civil Mi-6s were overhauled by ARZ No.402 at Moscow's Bykovo airport. The first example refurbished there was CCCP-11320 No.1 (c/n 2680908V) of the Komi CAD.

Unfortunately the Mi-6's civil operations were not without their fair share of accidents – for widely varying causes. Sometimes Mother Nature was to blame; for instance, on 12th June 1976 Mi-6 *sans suffixe* CCCP-21875 (c/n 6682502V) of the Komi CAD/Ukhta UFD/302nd Flight came down in a forest 19 km (11.8 miles) from Kedva settlement, Ukhta District/Tyumen' Region, after losing control in severe turbulence; the damage was so severe that the machine was a write-off.

On other occasions the tell-tale human factor was the cause. On 26th August 1974 Mi-6A CCCP-21157 (c/n 737110V) of the Arkhangel'sk CAD/2nd Arkhangel'sk UFD/68th Flight crashed 110 km (68 miles) south-east of Vorkuta. Investigation showed that poor crew discipline was the cause; the helicopter had hit a hillside after deviating from the designated air route below minimum safe altitude (such cases are called CFIT – controlled flight into terrain). In another instance of human error, Mi-6A CCCP-21019 (c/n 0539) belonging to the Komi CAD/Ukhta UFD/ 302nd Flight force-landed on rough ground in autorotation mode near Kharasavey airport on 12th July 1986 when both engines flamed out due to incorrect operation of the fuel system. Again, the helicopter was damaged beyond repair.

Sometimes, however, it was hardware failure that caused the accidents; no doubt, this was due partly to the wear and tear the helicopters were subjected to. For instance, on 1st July 1994 Mi-6A RA-21040 (c/n 0604) operated by the Salekhard division of Tyumen'AviaTrans (the airline is now rebranded UTair) suffered an in-flight fire in the port engine and was destroyed by fire after the ensuing off-field forced landing 38 km (23.6 miles) from Nadym airport. By then the helicopter, which was manufactured by the Rostov plant on 28th September 1976, had logged 14,151 hours 41 minutes total time and 18,398 cycles and had undergone 14 overhauls. (Actually the latter figure is not so exorbitant as it may seem; helicopters generally have shorter prescribed times between overhauls than fixed-wing aircraft.)

It was an accident caused by hardware failure that eventually led the type to be withdrawn altogether. On 21st July 2002 Mi-6A RA-21074 (c/n 0716) operated by Noril'sk Avia went missing during a mission above the Taimyr Peninsula. The wreckage was not discovered until several days later; there were no survivors among the crew and passengers. The investigating panel quickly established that the main gearbox had disintegrated in flight, causing a massive fire. After that, the CIS Interstate Aviation Committee cancelled the Mi-6's type certificate. At present there are no flying Mi-6s in the Air Force, nor in the numerous airlines that have been set up in the post-Soviet times – they have been superseded by the Mi-26.

Confirmed Aeroflot units operating the Mi-6

Civil Aviation Directorate	United Air Detachment & constituent Flight	Home base	New operator name
Arkhangel'sk CAD	2nd Arkhangel'sk UAD/68th Flight	Arkhangel'sk-Vas'kovo	2nd Arkhangel'sk Air Enterprise
Far Eastern CAD	2nd Khabarovsk UAD/249th Flight/?? Sqn	Khabarovsk-MVL	Vostok Aircompany
Komi CAD	Pechora UAD/338th Flight	Pechora	Komiavia (now Komiaviatrans)
	Ukhta UAD/302nd Flight	Ukhta	Komiavia (now Komiaviatrans)
Krasnoyarsk CAD	2nd Krasnoyarsk UAD	Krasnoyarsk	
	Noril'sk UAD/329th Flight	Noril'sk-Alykel' (?)	Noril'sk Avia
Magadan CAD	Chaunskoye UAD/151st Flight	Chaunskoye	
Moscow Agricultural Work & Commuter Air Traffic Directorate; *	Myachkovo UAD/?? UAD	Moscow-Myachkovo	
Central Regions CAD			
Northern CAD †		Arkhangel'sk?	
Polar CAD ‡			
Turkmen CAD	Ashkhabad UAD/166th Flight/3rd Sqn	Ashkhabad	
Tyumen' CAD	Nizhnevartovsk UAD/441st Flight	Nizhnevartovsk	Tyumen'AviaTrans
	Salekhard UAD/388th Flight	Salekhard	Tyumen'AviaTrans
	Surgut UAD/121st Flight	Surgut-Pobedit	Tyumen'AviaTrans
	1st Tyumen' UAD/438th Flight	Tyumen'-Plekhanovo	Tyumen'AviaTrans
Urals CAD			
Volga CAD			
Yakutian CAD	Nyurba UAD/270th Flight	Nyurba	Nyurba Airlines
Training Establishments Directorate (UUZ)	Kremenchug Civil Aviation Flying School	Kremenchug-Bol'shaya Kokhnovka	
State Civil Aviation Research Institute (GosNII GA)		Moscow/Sheremet'yevo-1	

* The Moscow Agricultural Work & Commuter Air Traffic Directorate was expanded and renamed in 1971 to include the regions of central Russia's bread belt.
† The Northern CAD was divided into the Leningrad and Arkhangel'sk CADs. ‡ Disbanded

Chapter 2

The Flying Cranes

The idea of using helicopters as 'flying cranes' for heavy construction work came up soon after the operational use of helicopters had assumed a large scale. The first dedicated crane helicopters were built in the USA in the 1950s. The Sikorsky Corporation took the lead in this field; its projects proved to be much more successful than those of its predecessors. For starters, the firm created the S-60 experimental helicopter whose design was optimised for achieving the highest possible payload/weight ratio: a thin boom replaced the traditional fuselage and a lightweight tricycle undercarriage was used. The S-64 Skycrane brought out in 1962 carried this concept further: to save weight the engines were not even fitted with cowlings. The flightdeck was designed in such a way that the pilots could face either forward for conventional flight or aft, enjoying an excellent view of the cargo during 'flying crane' operations. The helicopter could transport a load of 9 tonnes (19,850 lb) – either on a sling or as a pod attached to the fuselage between the stalky inverted-U shaped main landing gear units – over a distance of 85 km (53 miles); later versions of the S-64 (known in US Air Force service as the CH-54 Tarhe) had their load-lifting capacity increased to 12 tonnes (26,460 lb). These machines were in production until 1973; the S-64 'flying crane' ranks among the best designs evolved by the Sikorsky Corporation.

In the Soviet Union, too, the idea of using helicopters as 'flying cranes' aroused considerable interest. After the advent of the Mi-6 heavy airlifter in 1957 this helicopter soon gained wide use in various operations. The use of the Mi-6 made it possible to reduce dramatically the time required for various construction and installation jobs and produced impressive economic results. A decision to create a dedicated crane helicopter based on the Mi-6 held promise of still greater advantages. Additionally, such a machine could be brought out quickly and relatively cheaply; the use of proven components would increase reliability, simplify the industry's task in launching production of this machine and ease its introduction into service.

The work on the new machine, tentatively designated V-10, was started pursuant to a Council of Ministers directive dated 20th February 1958. This document tasked OKB-329 with creating a dedicated crane helicopter capable of transporting externally slung loads whose dimensions did not permit their carriage inside the cargo hold of the Mi-6. The helicopter was intended to transport a 12-tonne (19,850-lb) payload over a distance of 250 km (155 miles) and a 15-tonne (33,000-lb) payload over shorter distances.

Development of the V-10 proceeded under the direction of Deputy Chief Designer N. G. Roosanovich. At first M. N. Pivovarov was appointed chief project engineer; he performed these duties in parallel with his work on the Mi-6. When the scope of work on the V-10 increased, the OKB decided that this project merited the appointment of its 'own' chief project engineer; this role was entrusted to L. N. Babushkin. The design work was accompanied by various research studies, including wind tunnel testing of scale models.

The machine was intended for use both in the national economy and in the Armed Forces. Requirements posed by the military influenced the machine's configuration to a considerable extent. Above all, it was necessary to provide a fuselage with a sufficiently spacious cargo hold which was to be used for accommodating a group of cargo attendants and a system for heating 'special cargoes' transported externally. As a result, the cabin was to accommodate either 28 persons or a payload of 3 tonnes (6,615 lb) which could be loaded through a side door in the aft fuselage with the help of a winch and a boom. To ensure simultaneous lift-off of all wheels of the undercarriage and eliminate the possibility of bank and side-slip during take-off and landing, the centre fuselage together with the powerplant and the main gearbox (and, consequently, the rotor axis) was inclined 1°30' to starboard relative to the vertical plane of the flightdeck. The cockpit was upturned by 4°15' relative to the fuselage waterline, which ensured the flightdeck's horizontal position in cruise flight.

Design work on the V-10 was already in progress when a new requirement came, stipulating that the helicopter should be able to transport cruise missiles and ballistic missiles. The V-10 was to be able to 'straddle' the 'special cargo' by rolling on to it; there should also be provisions for the cargo to take its place under the helicopter by moving under its own power or be pulled there by a tractor (self-propelled vehicles and trailers respectively). This resulted in the emergence of a unique 'long-legged' quad undercarriage emulating the layout of the timber-hauler trucks used at sawmills or the container haulers found in large seaports. With the shock absorber struts fully compressed the helicopter's ground clearance was 3.75 m (12 ft 3⅝ in); the wheel track was in excess of 6 m (19 ft 8¼ in) and the wheelbase was more than 8 m (26 ft 3 in). To preserve a horizontal position of the flightdeck when parked, the starboard undercarriage legs were made 300 mm (11 13/16 in) shorter than those on the port side.

The use of the dynamic system and powerplant from the Mi-6 on the V-10 was not an optimum solution from the standpoint of achieving the maximum payload/weight ratio. The provision of a bulky and heavy 'real' fuselage and the heavy undercarriage considerably aggravated this situation. While the US designers succeeded in increasing the S-60's load-carrying capacity by 25% as compared to the baseline S-56, the Mil' OKB engineers hoped to obtain an increase of 20% at best.

The peculiarities of the V-10's design created the risk of so-called ground resonance cropping up. However, the huge experience accumulated by the designers in the process of designing the preceding machines, notably the Mi-6, enabled them to tackle this extremely complicated task successfully.

Initially provision was made for hooking up the cargo placed under the helicopter, lifting it up to the fuselage with the help of a winch and fixing it in position between the undercarriage legs by bracing wires. For this purpose a truss carrying an LPG-7 winch and an eight-fold pulley was affixed to the fuselage mainframes inside the cabin near the main gearbox bay; the winch and the pulley catered for the lifting and lowering of the cargoes. The hydraulic grips securing the cargo could be controlled from the crew cockpit and from the ground with the help of a portable control panel. When the requirement stipulating the transportation of missiles appeared, the designers decided to augment the winch, with a set of remote-controlled hydraulic jacks which made it possible to lift off the ground containers and materiel items weighing up to

Above and below: The first prototype V-10 (Mi-10), c/n 04101, as originally built with single wheels on all four landing gear units and outward-canted main gear struts. Note the deployed escape chute and the suspended cargo platform; it is loaded with a Yaroslavl'-built YaAZ-210 6 x 4 dropside lorry.

Above: The first prototype in an interim configuration with new main gear units featuring vertical struts and twin wheels. The nose units have been modified to incorporate boarding steps. The ramps used for loading vehicles onto the suspended platform are visible here, as are the bulged flightdeck windows.

12 tonnes and equipped with four attachment points matching the hydraulic grips.

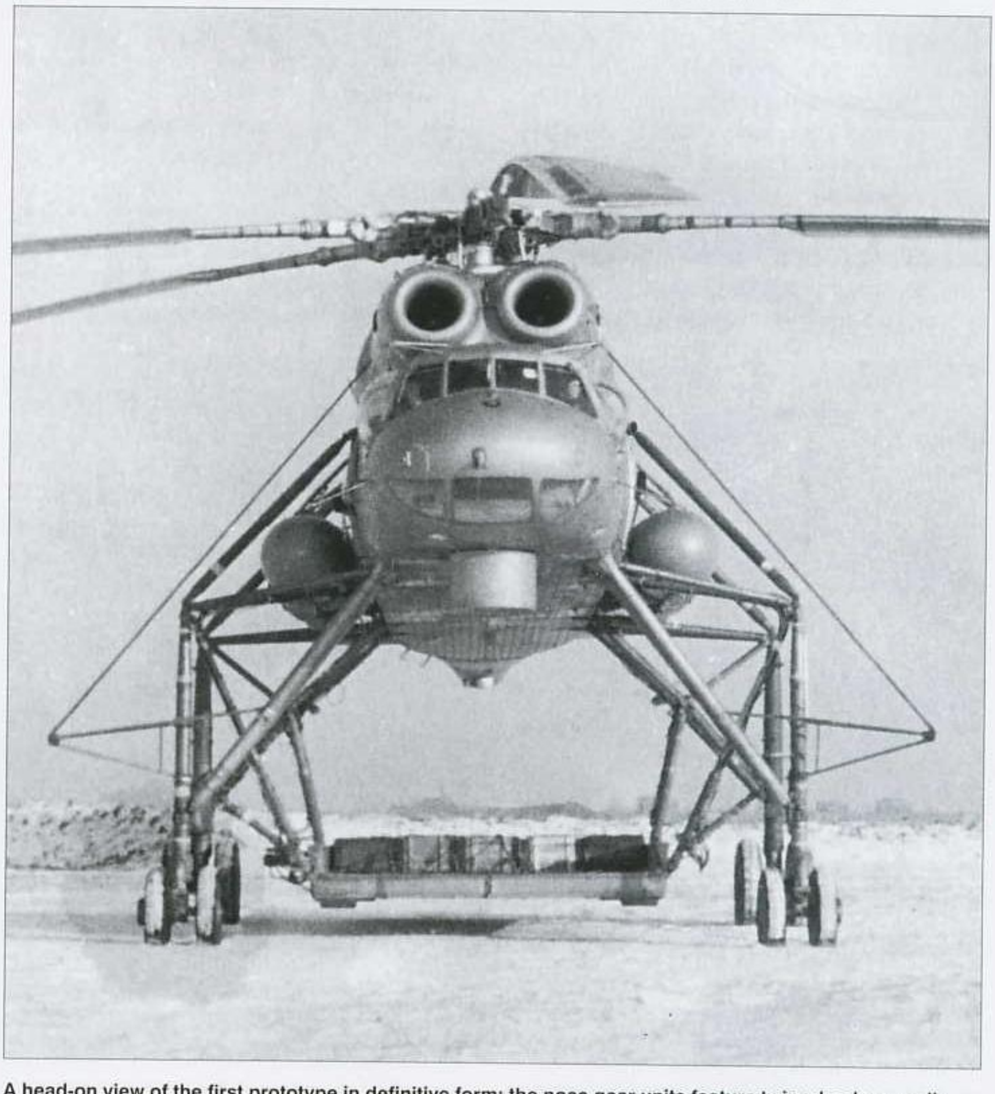
To cater for the transportation of loads and materiel not fitted with such attachment points provision was made for a special versatile platform measuring 8.5 x 3.6 m (27 ft 10⅝ in x 11 ft 9¾ in) and weighing 1,340 kg (2,955 lb); it was to be suspended on hydraulic grips between the undercarriage legs. The platform was equipped with an LPG-3 winch and detachable ramps for rolling wheeled and tracked vehicles on and off; when carrying no load the platform could be moved about on the airfield on its own wheels.

To ensure emergency escape from the helicopter during a flight with the platform attached, a telescopic chute was installed under the flightdeck; this chute would drop, extending to full length ahead of the cargo platform and permitting the crew to bail out safely without striking the slung load.

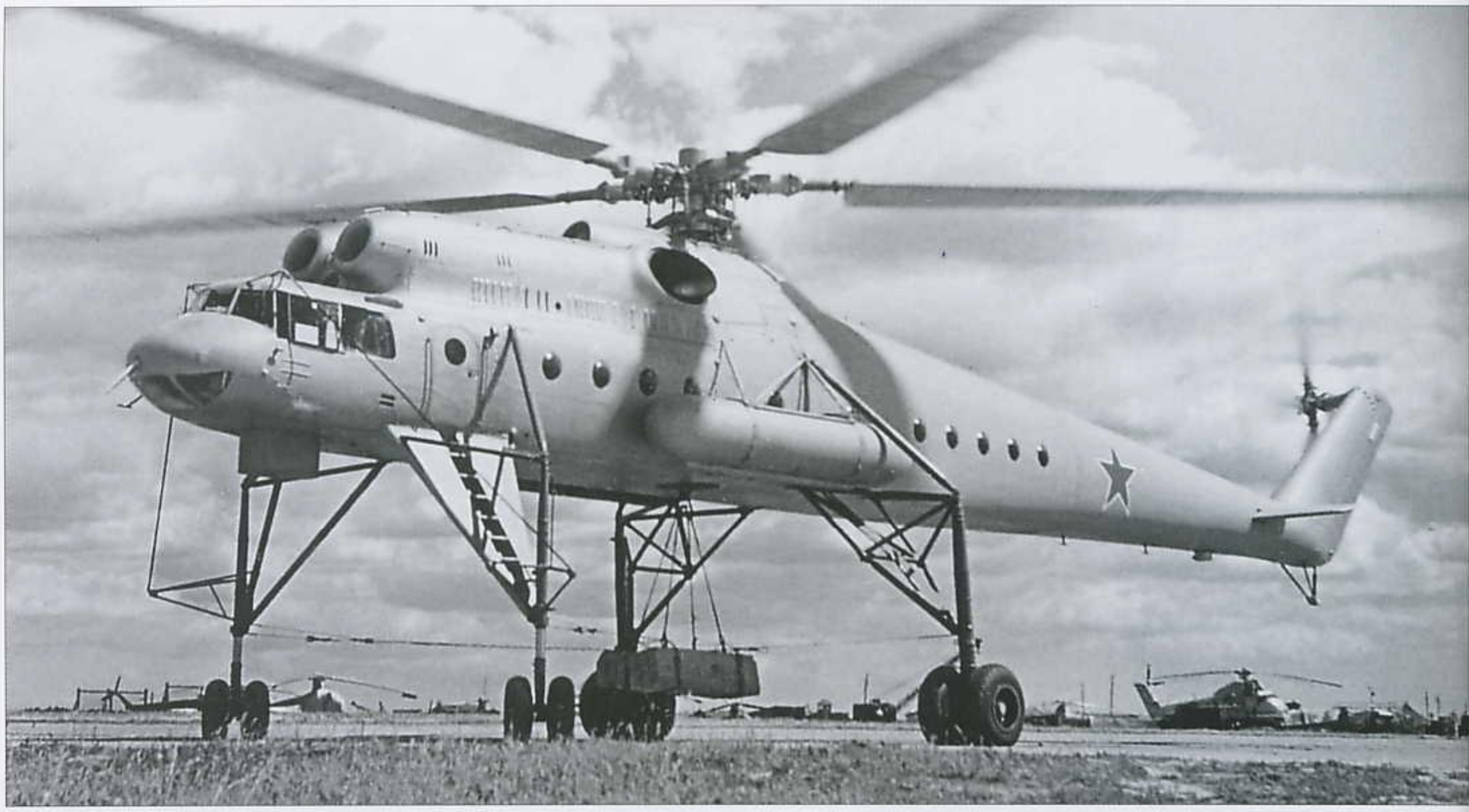
The V-10 also featured the external sling system that had been used on the Mi-6; it could handle cargoes with a weight of 8 tonnes (17,640 lb). The pilots could monitor the underslung cargo from their workstations via a closed-circuit TV system; its camera was placed under the fuselage and the display sat on top of the pilots' instrument panel.

V-10 (Mi-10) prototype helicopters

Thanks to the use of units from the Mi-6 the design work proceeded rapidly and was completed in 1959. Construction of the first proto-



A head-on view of the first prototype in definitive form; the nose gear units feature twin wheels as well. Note the cables stretched between special struts to facilitate emergency egress from the flightdeck.



Above: The Mi-10 prototype in definitive form with twin wheels on all four landing gear units. Two concrete blocks are suspended under the fuselage for test purposes. Note the Sikorsky S-58 in the background on the right; this helicopter was purchased for evaluation purposes.

type V-10 (c/n 04101; 04 is apparently some kind of product code, while 101 means Batch 1, 01st aircraft in the batch) was finished by the summer of the following year. Even before the beginning of the flight tests, however, the machine was allocated the service designation Mi-10. The first prototype lacked the escape chute, and all undercarriage legs were fitted with single wheels, those of the front units being of the castoring type.

On 15th June 1960 the Mi-10 took to the air for the first time at the hands of R. I. Kaprelyan, the OKB's chief test pilot. Subsequently in the course of manufacturer's tests the helicopter was piloted mainly by G. V. Alfyorov and B. V. Zemskov.

The testing proceeded smoothly. Already in its fourth flight the Mi-10 embarked on a flight over a distance of 3,000 km (1,865 miles) which it successfully accomplished, making several refuelling stops en route. Test pilots of the Mil' firm explored the helicopter's capabilities with regard to transporting various kinds of materiel. To determine its performance when carrying outsize cargoes on a platform, they performed flights with a special container. Concurrently, static tests were conducted in TsAGI on the third prototype Mi-10, CCCP-04103 (c/n 04103). Generally Soviet civil registrations in the CCCP-04xxx block

The first prototype Mi-10 lifts off in unloaded condition during trials, showing the ventral hatch for the cargo sling. The escape chute is retracted and its bottom closed by a jettisonable cover. Note how the rear ends of the external tanks fit in between the rods of the main gear trusses.

were reserved for assorted Polar Aviation aircraft, but in this case the registration was obviously derived from the construction number.

Sadly, in May 1961 the first prototype crashed during a positioning flight from Kazan' to Moscow. When the helicopter was flying in the vicinity of the town of Sasovo, the crew noticed a drop in the main gearbox oil pressure, and the crew captain, test pilot P. A. Anoofriyev, opted for a precautionary landing. Having spotted a small meadow at the edge of a swamp, he hovered above it and ordered navigator/radio operator S. Klepikov to disembark and check the site. Klepikov saw that the helicopter's port undercarriage legs were above the swamp, and forbade the touch-down. The crew had to seek another site for the emergency landing. During the transition to horizontal flight the oil pressure dropped to zero. The crew barely succeeded in clearing an earthen embankment that ran across the helicopter's flight path; the terrain further ahead was a rye field with a bumpy surface, and it was there that the helicopter was forced to land. The machine touched down at a high horizontal speed; after a rolling run of more than 300 m (1,000 ft) the helicopter hit a hummock, rolled over and burst into flames. Only Klepikov survived, sustaining minor injuries. Co-pilot V. P. Mikhailyuk, flight engineer T. M. Aruin and technician A. A. Myslovskiy were killed outright; the captain died on the following morning in a local hospital.

In an hour Mikhail L. Mil' was informed of the crash. Soon he arrived at the site of the tragedy in a Mi-4 helicopter, accompanied by A. M. Zagordan, an engineer from GK NII VVS, and G. P. Chernyshov, the Air Force representative at OKB-329. The ensuing investigation traced the cause of the crash to a failure of the main gearbox oil pump actuator.

Shortly thereafter the second Mi-10 prototype (c/n 04102) joined the test programme. In addition to the improved main gearbox oil system, the helicopter was fitted with twin wheels on all four landing gear units; the machine was equipped with cables with a soft coating mounted outside the fuselage in the flightdeck area so as to facilitate emergency escape of the crew with the helicopter on the ground. Subsequently these modifications became standard on production Mi-10s.

On 9th July 1961 the second prototype was shown to the public for the first time during the traditional Aviation Day air parade at Moscow-Tushino. The helicopter transported to the VIP spectator area of the airfield a prefabricated hut for geological survey teams, and this was immediately converted into a sales kiosk. After this event the Mi-10 received the NATO reporting name *Harke*.

On 23rd September a crew captained by B. V. Zemskov set an absolute world payload-to-altitude record on the second prototype Mi-10 by lifting a payload of 15,103 kg (33,302 lb) to an altitude of 2,200 m (7,218 ft). That same day a crew captained by G. V. Alfyorov lifted 15 tonnes to 2,326 m (7,632 ft).

This view shows clearly how the cargo platform is secured to the landing gear struts by a set of struts. Note also the small wheels used for towing the empty platform around the apron.

In December 1961 the helicopter was submitted for joint state acceptance trials. However, it was not admitted to these because the customer presented new requirements stipulating an increase in the designated service life of the engines and the main gearbox, the installation of new undercarriage legs fitted with fairings and installation of new main rotor blades. (Initially the main rotor blades of the Mi-6 – borrowed in as-was condition for the Mi-10 – featured a tubular steel spar consisting of three sections joined together. Later the Mil' OKB developed a blade with a spar having only one joint and supplemented by pockets with AST metal foil honeycomb filler, which made it possible to enhance reliability considerably and increase the blades' service life.) Introduction of these changes necessitated a new round of factory testing of he Mi-10, and the first stage (Stage A) of the state acceptance tests could commence only with a full year's delay. The helicopter was transferred to GK NII VVS, where a team headed by chief project engineer S. Kh. Atabekyan was assigned to the machine for conducting the tests. The team also included project test pilot A. G. Solodovnikov, flight engineer V. D. Pirogov, second pilot N. V. Razomazov and chief project engineer's assistant V. A. Yermolayev.

In the course of the state acceptance trials experiments were made with transporting various cargoes, involving the use of the whole range of special devices with which the Mi-10 was provided. For example, the helicopter airlifted various automobiles (including coaches and tanker lorries) on a platform onto which they were driven under their own power. The cargoes transported by the Mi-10 also included railroad containers and other non-self-propelled cargo items which were hauled onto the platform by the onboard winch. Outsize cargoes created a considerable drag

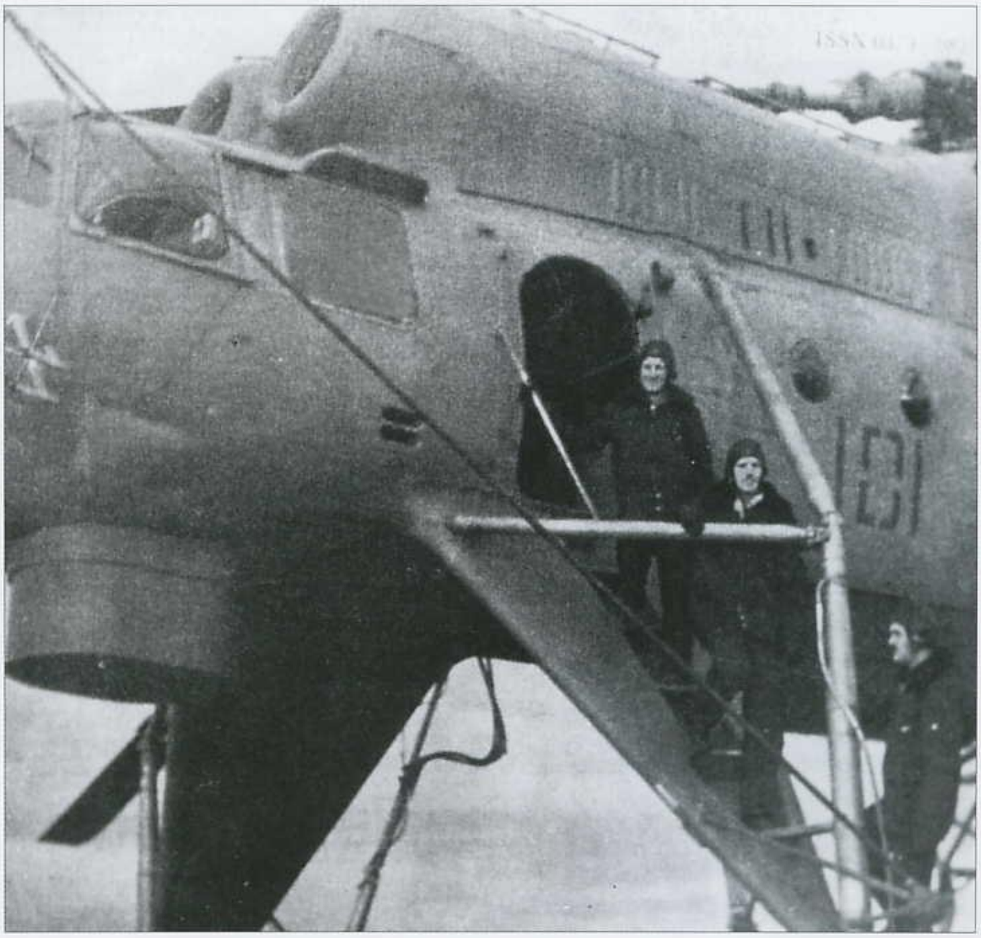
Above: The second prototype Mi-10 (c/n 04102) in its original military guise during the air event at Moscow-Tushino on 9th July 1967. The helicopter has just delivered a prefabricated hut marked 'Geological prospecting party No.17' to the airfield and lowered it to the ground, using the internal winch.

The scene a few minutes later as the helicopter taxies away. Note the braces attached to the hut's roof to stop it from swaying.

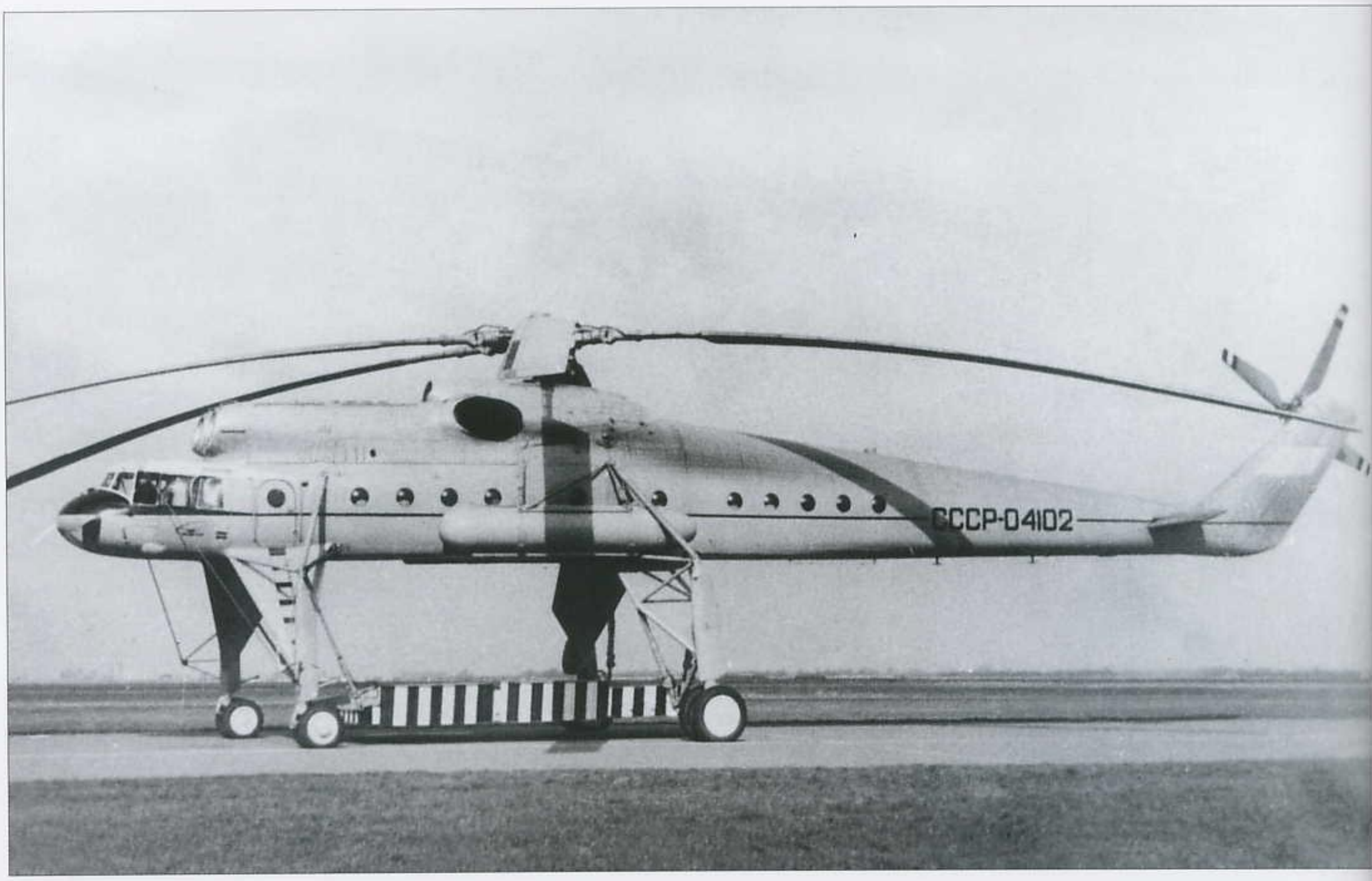
Above: Mi-10 c/n 04102 a few moments before touching down at Tushino with the prefabricated hut firmly pressed to the flat fuselage underside. The shape of the landing gear trusses obviously accounts for the shape of the hut's roof! Note the APU air intake and exhaust just aft of the flightdeck.

in flight. This was especially the case with the prefabricated hut for geological teams, which was fitted with attachment points matching the helicopter's hydraulic grips and was transported without the platform. During the concluding stage of the state acceptance trials landings were performed in autorotation mode. The testing proceeded at a very high tempo and was basically completed in early 1964, ahead of schedule.

Generally, on the basis of the test results the Mi-10 received a positive appraisal. The tests confirmed the helicopter's ability to transport cargoes weighing up to 15 tonnes (33,000 lb) and measuring 20 x 3.5 x 5 m (65 ft 7½ in x 11 ft 5¾ in x 16 ft 4¾ in) both on hydraulic grips and on a platform; a cruciform cargo could have a width of up to 10 m/32 ft 9¾ in. However, the testers also revealed certain shortcomings. The main problem proved to be the high level of vibrations, which were especially pronounced at low speeds. There were also other complaints. In particular, it turned out that the CCTV system installed in the flightdeck was suitable only for observing the swinging of the load during its transportation on a sling. The system proved of little use during operations with the cargoes in the hover and on the ground; therefore, if the pilot wished to catch just a glimpse of what was going on under the helicopter he was forced



A test crew disembarks from one of the Mi-10 prototypes wearing Soviet Air Force markings and the tactical code '101 Red'.



Above: The second prototype received a grey/yellow colour scheme and the registration CCCP-04102 (based on the c/n) for its international debut at the 1965 Paris Air Show. Note that all four landing gear trusses are now enclosed by fairings, not just the port forward one.

Mi-10 CCCP-04102 undergoes routine maintenance with the engine and main gearbox cowling panels open for inspection. A ground power unit on a ZiS-150 chassis is parked alongside, while a fuel bowser based on a MAZ-200 diesel lorry tops up the helicopter's fuel tanks. The nosewheels are of a new type.

Above: Mi-10 CCCP-04102 makes a tight taxying turn, carrying a L'vov-built LAZ-695 *sans suffixe* bus. Note the extreme negative incidence of the stabilisers, the cargo hoist arm above the starboard-side cargo door and the Tupolev Tu-124 airliner taxying in the background.

CCCP-04102 a few moments after becoming airborne, with the delightful LAZ-695 *sans suffixe* (identifiable by the rounded rear end with that characteristic split window and dorsal air scoop) on the platform.

Above: CCCP-04102 (this time with a TZA-7.5-500A refuelling bowser based on a MAZ-500A on the platform) in the static park of the 9th July 1967 airshow at Moscow-Domodedovo in company with other Mil' choppers.

Above: Mi-10 CCCP-04102 was briefly displayed at the Economic Achievements Exhibition (VDNKh) in Moscow. An SPT-114 electrically powered mobile gangway provided access to the interior.

Above and below: Wearing the registration in unusually large digits, the third prototype (CCCP-04103, c/n 04103) carries a ZiL-158 bus. The windows in the latter's four-leaf doors are obscured for some reason.

to open a flightdeck window and lean out nearly up to his waist. Thanks to the tall undercarriage the flightdeck was elevated to second floor level, thus affording an excellent view. However, during a rolling take-off or a roll-on landing the helicopter displayed a tendency to sway alarmingly from side to side on its stalky undercarriage. Attaching the cargoes to hydraulic grips proved to be a very awkward and time-consuming procedure. The military customers were also unhappy about the need to provide a wide range of combat materiel, special containers and so on with attachment points matching the helicopter's hydraulic grips.

In the summer of 1965 a meeting was held at the Mil' OKB with the participation of the design bureau staff and representatives of GK NII VVS; they discussed the test results and the possibilities for refining the Mi-10. The measures agreed upon became the basis of a programme for the helicopter's development; its implementation dragged on as long as until 1967. Within that period many of the problems found their solution. In particular, it was found inexpedient to have both a winch and the hydraulic lifting devices on board the helicopter; elimination of the winch made it possible to improve the Mi-10's payload-to-weight ratio. However, attempts to eradicate completely the helicopter's main defect, the high level of vibrations, were to no avail, and this deficiency persisted throughout the machine's service career.

Mi-10 production helicopter (*izdeliye* 60)

A decision on putting the Mi-10 into series production was taken as far back as 1961, but its implementation was constantly delayed, and not for technical reasons alone. To a large extent this was due to a gradual waning of interest towards heliborne missile systems. Yet, on 5th March 1964 the Rostov-based plant No.168 which was building Mi-6 helicopters (it was renamed Rostvertol later to reflect its new specialisation in rotary-wing aircraft) started the manufacture of the Mi-10 which received the factory code '*izdeliye* 60'. The enterprise was headed by D. M. Choomachenko at that time.

It took half a year to build the first production helicopter (c/n 4680101K – that is, year of production 1964, plant No.[1]68, Batch 01, 01st aircraft in the batch; the K suffix, apparently meaning *krahn* (crane), was used to distinguish the Mi-10 from the Mi-6 in order to ease the work with documents at an enterprise which was simultaneously producing both models). On 10th September 1964 the machine took to the air with R. I. Kaprelyan at the controls. Gradually the production tempo was built up, albeit it remained generally rather low. In 1965 two machines were rolled out of the assembly shop; these were examples from the second production batch, c/ns 5680201K and 5680202K. They were followed by a further two machines from the third batch (0301K and 0302K) and the first three machines of Batch 4 (0401K, 6680402K and 0403K). In 1967 the plant completed the fourth batch by building Mi-10s c/ns 7680404K and 7680405K and started the manufacture of the fifth batch. In 1968 the plant turned out the sixth batch; the seventh batch, built in 1969, was the biggest of all.

Virtually every batch featured some minor design changes and improvements. For example, starting with c/n 6680402K, jettisonable cockpit doors replacing the original sliding blister windows were introduced to ease crew escape in an emergency.

In 1966 a single Mi-10 crane helicopter was purchased by a Dutch company for resale to the USA. Registered N16556, the helicopter was operated by the Bolivian division of Petroleum Helicopters, Inc. (PHI), an air enterprise which specialises in the support of oil and natural gas drilling. This was the sole foreign operator of the Mi-10.

A total of 40 'long-legged' Mi-10 *sans suffixe* helicopters were manufactured. These included several special-mission versions as described below.

Above: An operational Soviet Air Force Mi-10 with the cargo platform attached. Most of the Mi-10s were later converted for ECM duties.

This production Mi-10 (c/n 8680604K) built in 1968 was donated to the Soviet Air Force Museum in Monino. Note the flightdeck escape door rep[lacing the earlier sliding blister window.

Mi-10R record-breaking helicopter

On 14th January 1965 a very special version of the Mi-10 made its first flight. Designated Mi-10R, this machine coded '81 Red' was a specially prepared for setting world records, hence the R for *rekordnyy*. Its weight was brought down to the barest minimum; the quad undercarriage was replaced by a tricycle undercarriage taken wholesale from the Mi-6, with additional fairings and spats on the main struts, plus a tail bumper with twin wheels. Hence some Western sources erroneously referred to this machine as the Mi-10K (*korotkonogiy* – short-legged); in reality the Mi-10K is a totally different version – a dedicated 'flying crane'.

On 26th May 1965 a crew captained by V. P. Koloshenko established the first record on this helicopter by lifting a payload of 5 tonnes (11,025 lb) to an altitude of 7,151 m (23,462 ft). Two days later a crew captained by G. V. Alfyorov used the Mi-10R to set a sensational world record by lifting 25,105 kg (55,356.5 lb) to 2,840 m (9,318 ft). A specially manufactured metal slab attached under the fuselage was used as the main load. In all, eight absolute world records were set on the Mi-10 and Mi-10R (see table below).

Mi-10RVK heliborne missile system

In 1965 flight testing was conducted of the Mi-10RVK (*raketno-vertolyotnyy kompleks*, heliborne missile system) which became the only heliborne missile system based on the Mi-10 helicopter to reach the flight test stage. Of the numerous variants of heliborne missile systems and mobile missile maintenance bases using the Mi-10 as the delivery vehicle, only the 9K74 (alias S-5V) system including the 9P116 launcher and the 4K95 cruise missile was developed to the flight test stage. The launcher was a large trailer that would be towed to the actual launch pad by a cross-country vehicle after landing.

Records established by the Mi-10

Date	Version	Description of the record	Record figure	Crew captain
23.9.1961	Mi-10	Altitude with a payload of 15,000 kg (33,075 lb)	2,326 m (7,632 ft)	G. V. Alfyorov
	Mi-10	Maximum payload to 2,000 m (6,560 ft)	15,103 kg (33,302 lb)	G. V. Alfyorov
26.5.1965	Mi-10R	Altitude with a payload of 2,000 kg (4,410 lb)	7,151 m (23,462 ft)	V. P. Koloshenko
26.5.1965	Mi-10R	Altitude with a payload of 5,000/5,175 kg (11,025/11,411 lb)	7,151 m (23,462 ft)	V. P. Koloshenko
28.5.1965	Mi-10R	Altitude with a payload of 15,000 kg (33,075 lb)	2,840 m (9,318 ft)	G. V. Alfyorov
28.5.1965	Mi-10R	Altitude with a payload of 20,000 kg (44,100 lb)	2,840 m (9,318 ft)	G. V. Alfyorov
28.5.1965	Mi-10R	Altitude with a payload of 25,000 kg (55,125 lb)	2,840 m (9,318 ft)	G. V. Alfyorov
28.5.1965	Mi-10R	Maximum payload to 2,000 m (6,560 ft)	25,105 kg (55,356 lb)	G. V. Alfyorov

The photos on this page show the one-off, record-breaking tricycle-gear Mi-10R; note the design of the nose gear unit, the flat side windows of the flightdeck and the lack of the APU. The helicopter wore dayglo orange stripes along the fuselage and a Soviet flag on the fin to complement the Air Force star insignia.

The trials took place in 1965. The Mi-10RVK's take-off weight reached 44.6 tonnes (98,340 lb), the weight of the launcher being 12 tonnes (26,460 lb); this required the helicopter to be fitted with low-pressure tyres. After landing it took five minutes to prepare the system for a launch. The maximum launch range was 200 km (124 miles). The work on the Mi-10RVK was terminated in the same year because the 4K95 missiles were being phased out.

Mi-10P (Mi-10PP) ECM and direction-finding helicopter

The year of 1970 saw the completion of development work on the Mi-10P ECM helicopter (the military preferred to call it Mi-10PP; PP stands for *postanovshchik pomekh*, jammer). It was intended for assisting the combat activities of tactical aviation by jamming the enemy's radar systems.

The machine was fitted with the huge slab-sided ST-9000 Step' (Steppe) ECM pod weighing 7,125 kg (15,710 lb) which was suspended on hydraulic grips. The pod housed three *Booket* (Bouquet) jammers which disrupted the operation of air defence and missile guidance radars by blanking their screens, and eight *Fasol'* (Kidney bean) response transmitters intended for creating false radar returns (their work produced several false target 'blips' at a time on the enemy radar screens). The front end of the pod incorporated a large radiator dissipating the heat generated by the mission equipment. The helicopter's cargo hold housed the ECM operators' workstations, as well as the electric power supply system for the equipment accommodated in the pod.

In the 1970s and 1980s most of the Mi-10s that were on strength with the Armed Forces were converted into the ECM versions at the aircraft repair plants in Rostov and Konotop. The price of the upgraded helicopter was seven million roubles, nearly six times the price of the baseline version.

The Mi-10PP was operated by the 825th OVP (Independent Helicopter Regiment) which was redeployed from the town of Sredne-Belaya to Garovka-2 airfield situated in the vicinity of Khabarovsk, as well as by Soviet Air Force helicopter regiments stationed in Nerchinsk (Russian Federation), Kobrin (Belorussia) and at Brandis AB (16th Air Army, Group of Soviet Forces in Germany). By the mid-1980s the 825th OVP included a squadron of the Mi-10PP ECM helicopters; this sub-unit became a gathering place for machines of this type which had previously been on the strength of air regiments deployed in the western defence districts and army groups. Apparently, by that time all the serviceable Mi-10PPs were concentrated near the Chinese border.

Above: A Mi-10RVK missile carrier with the 9P116 wheeled launcher attached. Note the fat low-pressure tyres on all four landing gear units.

Above: The Mi-10P (alias Mi-10PP; c/n 7680502K?) with the huge ST-9000 Step' ECM pod under the fuselage. Note the forward-mounted radiator and the wheels for towing the pod.

Mi-10 CCCP-04102 after outfitting as a Mi-10UPL. The automotive trailer suspended under the fuselage is a mobile ore analysis laboratory.

Above: The prototype of the Mi-10K 'flying crane' helicopter during initial flight tests. An external sling cable is attached to the helicopter

Above: This view shows the Mi-10K's shorter external fuel tanks. As originally flown the prototype wore a grey/yellow colour scheme similar to that of Mi-10 CCCP-04102 and no registration.

Close-up of the Mi-10K prototype's forward fuselage, showing the nose gear units, the ventral cockpit and the entry door with a boarding ladder.

Mi-10GR direction-finding helicopter prototype

Starting in 1966, the Mi-10 was used as a basis for developing a direction-finding helicopter intended to spot the location of enemy transmitters. That year a single production Mi-10 was converted into the prototype of an ELINT (direction-finding) helicopter designated Mi-10GR; the suffix was derived from the codename of the ELINT system, *Grebe**shok*** (Comb). It was intended for pinpointing the location of radio frequency (RF) transmitters; for this purpose it was equipped with a special pod underslung beneath the fuselage and fitted with antennas that could be lowered in the operating mode.

Mi-10UPL versatile field laboratory

In addition to the versions described above, in 1966 the OKB produced the prototype Mi-10UPL intended to carry a mobile versatile field laboratory for ore analysis (*ooniver**sahl'**-naya pole**va**ya labora**to**riya*, hence the UPL). The helicopter (the original second prototype, CCCP-04102) carried a heavy-duty two-axle van trailer outfitted with special equipment; on arrival at the airfield nearest to the geological prospecting site it would be disengaged and towed to the actual location by a lorry.

Modified Mi-10 'flying crane' helicopter prototype

Four years later, in 1970, one of the Mi-10 *sans suffixe* helicopters was re-engined for trial purposes with uprated D-25VF turboshafts delivering 6,500 eshp for take-off; the powertrain had to be reinforced accordingly. Additionally, the helicopter featured various new equipment items.

Mi-10K 'flying crane' helicopter

The Mil' OKB designers were aware of the fact that the Mi-10's design configuration was not ideally suitable for a 'flying crane', being intended primarily for operation by Aeroflot. Taking into account the requirements issued by GosNII GA (State Research Institute of Civil Aviation), in 1964 the OKB started the development of a 'short-legged' version – not in terms of range but quite literally. This held the promise of improving the machine's economic efficiency at modest development costs. The designers put to good use the experience of using the Mi-4 and Mi-6 for construction and installation jobs. These machines had a major drawback: their pilots could not see the underslung load and the place of its installation from their seats. Therefore one of the crewmembers acted as operator: taking up a position near the entry door or the central hatch, he gave signals to the crew captain (later some Mi-4s used as 'flying cranes' were retrofitted with a closed-circuit TV system). After the installation of a major structure the cable on which it had been suspended had to be jettisoned. This entailed the risk of inflicting damage both to the cable and to the structure that was being erected. Recovering the jettisoned cable and hooking it up to the helicopter again also involved much time-consuming work. The Mil' engineers carefully studied the design features incorporated by US designers on the S-64A. The payload/weight ratio of this machine was close to 50%, and its cockpit accommodated an operator/pilot workstation which afforded an excellent view downward and aft.

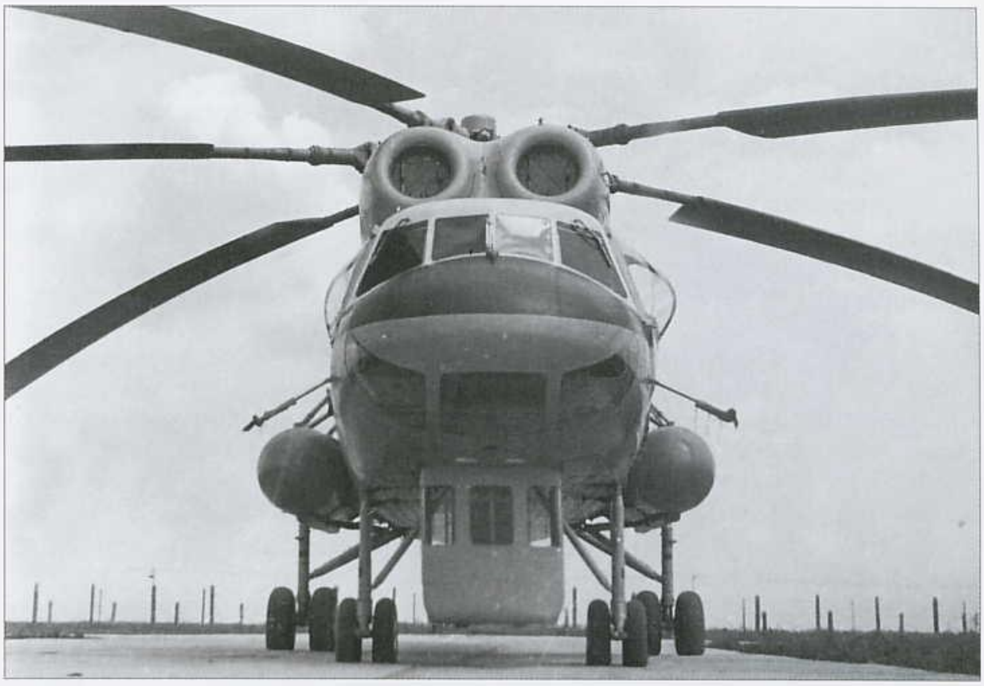
The first prototype Mi-10K (*korotko**nogiy*** – short-legged) was produced at the Mil' firm's experimental production facility in Panki by converting the third production Mi-10, c/n 5680202K. Chief project designer A. Kh. Serman was in charge of this work. The machine was equipped with a new quad undercarriage featuring shorter struts (the track of the nose units was greatly reduced, since there was no longer a need to straddle external loads) and new avionics; shorter external fuel tanks were installed and some additional measures were taken to cut the airframe weight. As a result, the Mi-10K's empty weight was reduced by more than 1,500 kg (3,307 lb) as compared to the 'long-legged' Mi-10 *sans suffixe*. However, the new helicopter's lifting capacity became somewhat lower; its upgraded external cable suspension system was designed for a maximum load of 11.8 tonnes (26,020 lb). Structural strength considerations did not permit the machine to operate with greater concentrated loads.

An extensively glazed additional cockpit with an aft-facing operator's seat and an extra set of controls was mounted under the Mi-10K's forward fuselage at the location previously occupied by the emergency exit chute. When performing construction and installation jobs, the operator pilot descended into this cockpit and controlled the helicopter, enjoying an excellent view of the load and of the place where it was to be installed.

The unregistered Mi-10K prototype made its first flight on 6th September 1966. Shortly thereafter it was submitted for the state acceptance trials at GosNII GA which were conducted by a team headed by engineer V. I. Maslov. During that period the machine was used for installation jobs in Leningrad and the Dagestan Autonomous SSR. In Moscow the helicopter piloted by F. I. Belooshkin lifted a radio tower to free the site for the construction of a 10-storey apartment building and transported the radio tower to the *Stroitel'* (Construction Worker) stadium. Without the use of a 'flying crane' this operation would have taken some six weeks.

In 1967 the Mi-10K, now registered CCCP-29115, made its successful international debut, being demonstrated at the 27th Paris Air Show. During the show the helicopter demonstrated its capabilities by dismantling a factory gantry crane incorporating 11-tonne (24,255-lb) trusses.

State acceptance trials of the Mi-10K lasted until 1968. Their results led to the conclusion that for certain jobs the use of this helicopter was 50% cheaper than the use of a column crane, required 70% less workforce and made it possible to tackle the job 70% quicker. Nevertheless, the machine was not put into series production immediately. The military heritage incorporated in the machine now displayed to the full extent its negative influence. The baseline Mi-10 *sans suffixe* could compensate for the insufficient engine power by performing a rolling take-off with the load on a platform, but the 'crane' was deprived of this possibility. As a result, its normal take-off weight had to be reduced to 37 tonnes (61,590 lb), and the payload/weight ratio was diminished as compared to the baseline version, going down to 31%. The high level of vibrations remained a serious problem. There were also some other complaints – for example, work conditions of the operator pilot had to be improved. Perfecting the helicopter dragged on for several years, whereupon a decision was taken to start quantity production.



Above and below: Front and rear views of the Mi-10K prototype (c/n 5680202K). Note the bulged blister windows of unequal size (the captain's blister is bigger).

The Mi-10 prototype shows off its lean profile in a test flight.

Series manufacture of the Mi-10K started in Rostov on 23rd March 1974. In the course of preparations for it the helicopter's control system was modified and dimensions of the underslung cockpit were increased. In the following year the Mi-10K was equipped with a system for damping the vibrations and oscillations of the underslung load. Once again, production Mi-10Ks were registered in the 04xxx block, although the registrations no longer coincided with the c/ns. Machines from CCCP-04121 up to and including CCCP-04135 had the trailing edge section of the tail rotor pylon deleted; some of them were equipped with a KO-50 kerosene heater installed in a fairing on the starboard side of the fuselage, as on the Mi-8 utility helicopter.

In the course of the 'flying crane's' operational service the Mil' OKB invested much effort into reducing the level of vibrations. Later, in 1975, a Mi-10K, equipped with a special system for damping vibrations and a system for damping the oscillations of the slung load was flight-tested.

The Mi-10K flying cranes rendered useful operational service until recently; at least one example was operational as late as 2004. They performed many unique construction and installation jobs which made it possible to put new industrial enterprises into operation within a considerably shorter time frame and to reduce the costs of their construction.

All in all, 55 Mi-10 helicopters of different versions were built in Rostov. According to Rostvertol documents, the Mi-10K's production run amounted to 17 machines (seven of them were delivered in 1976 and the other ten in 1977); this total included two 'long-legged' Mi-10s converted into Mi-10Ks by the Rostov plant. It is also known that three or four Mi-10s were transferred to the Moscow Helicopter Plant (the Mil' OKB) for conversion into experimental variants and 20 machines were converted into ECM helicopters.

In 1968 a group of members of the Mil' OKB design staff was awarded a State Prize for the development of the Mi-6 and Mi-10 helicopters.

Structural description of the Mi-10 and Mi-10K helicopters

Type: Heavylift helicopter (Mi-10) or dedicated 'flying crane' helicopter (Mi-10K) designed for daytime operation in VMC. The crew of the Mi-10 *sans suffixe* comprises three persons: the captain (in the left-hand seat), the co-pilot/navigator and the flight engineer. The Mi-10K has a crew of four: two pilots, an operator pilot (when performing the installation work) and flight engineer.

Fuselage: The fuselage is an all-metal semi-monocoque variable cross-section structure with a flat undersurface. Structurally the fuselage consists of four sections: the forward and centre sections, the tailboom and the tail rotor pylon.

The *forward fuselage* houses the flightdeck. On the Mi-10 *sans suffixe* its floor incorporates an emergency escape hatch closed by doors and panels; these can be jettisoned with the help of a lever and a special mechanism, allowing the crew to bail out via a telescopic chute. On the Mi-10K this emergency hatch is replaced by a special hatch giving access to the underslung additional cockpit. The flightdeck glazing features four optically flat windshield panels, three windows in the lower row to provide a measure of downward view for taxying and landing (the two outer segments are curved) and two side windows on each side. The side windows are sliding direct vision windows; the forward ones (at the pilots' seats) are bulged for better downward visibility; late-production Mi-10s have jettisonable flightdeck doors. All four side windows can be jettisoned for emergency evacuation; the Mi-10 *sans suffixe* is provided with special cables running from struts above the outer windshield panels to the nose gear units to assist evacuation on the ground. Late-production Mi-10s have jettisonable flightdeck doors.

The flightdeck roof incorporates a forward-hinged hatch opening outwards for access to the engines and main rotor head on the ground. The flightdeck is separated from the main cabin by a bulkhead with a door.

The *centre fuselage* is inclined 1°30' to starboard relative to the vertical reference line and houses the entry vestibule and the cargo cabin. Located on the port side between Frames 2 and 4 is a quasi-oval entry door (the aperture is 'flattened' at the bottom to provide an even threshold) opening inward and forward; on most helicopters a bay housing the APU is located opposite. The forward bulkhead of the cargo cabin (Frame 5) incorporates a door giving access from the entry vestibule. Placed on the starboard side between Frames 22 and 25 is a rectangular cargo door comprising two sections (the forward one is larger); the cabin terminates in a bulkhead at Frame 35, which incorporates a door giving access to the tail boom. There are 12 circular windows to port (door+4+1+1+5) and 11 to starboard (1+3+1+1+door+4), although the first window to starboard is usually transformed into the APU air intake.

The stressed floor of the cargo cabin is provided with a circular hatch located between Frames 15 and 17; it measures 1,000 mm (3 ft 3⅜ in) in diameter and is intended for attaching cargoes carried externally on a sling. The cargo cabin is 14.04 m (46 ft 0¾ in) long. Provision is made for installing detachable tip-up seats for 28 persons along the cabin walls between Frames 6 and 28. The seats are arranged as follows: three 3-seat blocks and four single seats to starboard, four 3-seat blocks and three single seats to port.

Placed above the centre fuselage are engine and main gearbox bays and a service fuel tank container. Two hatches are provided in the cabin ceiling for inspecting the engines and the main gearbox.

The *tailboom* is a stressed-skin structure featuring frames and stringers. Inside, along its upper part, the boom accommodates the tail shaft of the powertrain and cable linkages for the stabiliser and tail rotor control. Mounted between Frames 15 and 16 are attachment fittings for the stabiliser; cutouts are made in that area for the stabiliser spar.

A floor made of aluminium sheets is provided for passage inside the tailboom. The tailboom is joined to the centre fuselage by frames with joining flanges and the help of 71 steel bolts.

The *tail rotor pylon (fin)* comprises three parts: a fin, a fixed rudder and a detachable fairing. Frame 7 of the tail rotor pylon carries the intermediate gearbox of the tail rotor drive. Access to it is possible via an oval opening in the spar web of the tail rotor pylon. The fixed rudder features an asymmetrical profile and has a duralumin skin on the side of the tail rotor (starboard) and fabric covering on the opposite side. In the upper part on the port side there are louvres to let in the air for cooling the intermediate gearbox.

Landing gear: The Mi-10 *sans suffixe* has a quad undercarriage which enables it to perform take-offs and landings on grass airstrips, as well as on paved airstrips or other prepared pads. The undercarriage provides a ground clearance of 3.75 m (12 ft 3⅝ in). It comprises two levered-suspension nose legs and two main legs with oleo-pneumatic shock absorbers. The starboard units are 300 mm (11$^{13}/_{16}$ in) shorter than the port ones.

Each castoring nose gear unit comprises a shock strut, five bracing struts forming a truss, and twin K2-112 non-braking wheels measuring 950 x 250 mm (37.4 x 9.84 in). Tyre pressure in the nosewheels is 4.7 kg/cm² (66.86 psi). The space between the two innermost bracing struts of each forward leg is faired over, and the port nose gear unit incorporates boarding steps.

Each main undercarriage unit consists of a pyramid-shaped welded truss, an upper bracing strut and a lower V-shaped bracing strut, a shock strut and twin KT-115 braking wheels measuring 1,230 x 260 mm (48.42 x 10.24 in). Mainwheel tyre pressure is 6.5 kg/cm² (92.47 psi).

The quad undercarriage of the Mi-10K has a ground clearance of 1.65 m (5 ft 5 in) in the area of the main units. Each levered-suspension nose unit comprises a shock strut, two bracing struts (inboard and rear) and twin K2-116 wheels measuring 595 x 185 mm (23.42 x 7.28 in). Each main unit comprises a shock strut, a truss formed by five struts, and twin KT-54 braking wheels measuring 950 x 350 mm (37.4 x 13.78 in). Unlike the Mi-10 *sans suffixe*, the Mi-10K has a tail bumper comprising a shock absorber, two tubular bracing struts and a skid made of cast magnesium.

Powerplant: Two D-25V turboshaft engines (see Mi-6 for description). The engines are installed above the cargo cabin symmetrically relative to the longitudinal axis and have an inclination of 0°44'28" forward and downward relative to the fuselage waterline. The engines and main gearbox are enclosed by a common fairing with hinged cowlings and powered work platforms, as on the Mi-6.

An AI-8 APU is installed on the starboard side of the entry vestibule, with the air intake and the exhaust located in tandem.

Powertrain and rotor system: As for the Mi-6, except that an AV-63B-Kh65 or AV-63B tail rotor is fitted.

Control system: Generally similar to that of the Mi-6. The helicopter has dual controls (on the Mi-10K a third set of controls is installed in the ventral cockpit; it can be disconnected by a switch on a special panel in the flightdeck). Control linkages are of a mixed type, mostly rigid. Cables are used for controls dealing with the rotor brake and fuel shut-off cocks, as well as for the stabiliser and tail rotor control in that part of the control linkages which runs through the centre fuselage and the tailboom.

The helicopter is equipped with an AP-31V three-channel autopilot which stabilises the machine in pitch, roll and yaw (the Mi-10K is equipped with the AP-34B Srs 2 differential four-channel autopilot which ensures stabilisation in roll, yaw, pitch and altitude). The control system incorporates BU-32A and BU-32A (RP-28) two-chamber hydraulic actuators which double as the autopilot servos. The manual control system incorporates spring-loading devices intended to create the necessary stick forces and to eliminate them when a stable flight mode has been achieved.

Fuel system: The fuel system comprises five tanks: a service tank, two strap-on tanks and two additional tanks (four additional tanks on the Mi-10K). The additional tanks are mounted on the cargo cabin floor on special

The Mi-10K prototype in its later green/white colour scheme as CCCP-29115.

Another view of CCCP-29115. Note the rain gutter above the APU air intake window.

supports. The total amount of fuel is 8,230 kg (18,150 lb), or 10,620 litres (2,336.4 Imp gal) for the Mi-10 *sans suffixe* (11,600 litres/2,552 Imp gal on the Mi-10K). Refuelling is performed through the fillers of the tanks or via a single-point refuelling connector.

Hydraulics: The hydraulic system comprises three systems: main, backup and auxiliary. The main and backup systems work all hydraulic actuators. The auxiliary system works the windshield wipers, pilot seat adjustment jacks, the cylinder controlling of the cooling fan's adjustable guide vanes, disconnects the friction coupling of the collective pitch lever, works the hydraulic grip system (on the Mi-10 *sans suffixe*), ensures the opening and closing of the powerplant cowling panels doubling as work platforms, operates the lock of the sling system (on the Mi-10K it additionally operates the rear door of the ventral cockpit, works the hydraulic damper in the pedal control circuit and feeds the hydraulic coupling which switches on the controls in the ventral cockpit).

The main units of the hydraulic system, together with the hydraulic accumulators and hydraulic tanks, are grouped into the GB-1 hydraulic unit. Each hydraulic system comprises the NShS-2S pump, a hydraulic accumulator (two accumulators in the main system), an automatic device for reducing the load affecting the pump, with the non-return valve and pressure relief valve, filters for course and fine purification, the DIM-240 (240K) electric manometer, electric hydraulic valve and so on. Switching from the main system to the backup system is effected automatically and is triggered by a drop of pressure in the main system. To check up the hydraulic system on the ground, a panel for connecting the airport servicing hydraulic unit is provided on the port side of the fuselage (on the Mi-10K the main system is provided with a Model 465MTV electric pump which is actuated by an external power source, the AI-8 APU or, under exceptional circumstances, the DC batteries). The total capacity of the hydraulic system is 150 litres (33 Imp gal) of AMG-10 oil. The working pressure is 120-150 kg/cm^2 (1,714-2,142 psi).

Pneumatic system: The pneumatic systems actuates the wheel brakes and feeds compressed air into electromagnetic valves for controlling the bands which regulate the air bleed from the engine compressors. Compressed air with a pressure of 50 kg/cm^2 (711.29 psi) is stored in two bottles; the role of these bottles is played by the internal volume of the upper bracing struts of the main undercarriage legs. The air is replenished by the AK-50T compressor installed on the port engine. The system's capacity is 75 litres (16.5 Imp gal).

De-icing system: As for the Mi-6, except that the AV-63B Srs 2 tail rotor has electric de-icing; the alternative AV-63B tail rotor has alcohol de-icing.

Electrics: Generally as for the Mi-6. DC power is supplied by two STG-12TM starter-generators, two 12SAM-55 storage batteries and the AI-8 APU. AC power is supplied by two SGS-90/360 generators, PO-3000 (PO-750A) and PT-500Ts converters.

Avionics and equipment: The radio equipment comprises communications and radio navigation equipment. The *communications equipment* caters for air-to-ground and air-to-air communication, as well as for intercom. Mi-10s *sans suffixe* up to c/n 6680202K had an Argon-S short-wave communications radio, replaced by the Neon radio on subsequent machines and by the Karat-M radio on the Mi-10K. Helicopters up to c/n 7680501K are fitted with an RSIU-4B (R-801B) command radio, later machines have an RSIU-5B (R-802B) radio, the Mi-10K is fitted with an R-860-2 radio. All Mi-10s are equipped with the SPU-7 intercom. The Argon-S radio has a wire aerial mounted on the starboard side between the forward and main undercarriage legs (on the Mi-10K the antenna runs along the tailboom). Machines equipped with the R-802B are fitted with AShS blade aerials mounted on port upper side of the fuselage between Frames 28 and 29.

The *radio navigation equipment* serves for piloting the helicopter with recourse to locator beacons, broadcasting radio stations and radio beacons. It comprises the ARK-10 or

ARK-9 automatic direction finders, RV-UM or RV-3 radio altimeters. The fixed direction aerial of the ARK-10 is located above the fuselage between Frames 33-34, its omnidirectional aerial is located beneath the fuselage between Frames 30 and 35.

The *flight instrumentation* includes a set of flight and navigation instruments and a set of instruments intended to monitor the functioning of the engines, powertrain and other systems of the helicopter. The instruments are placed on the pilots' and flight engineer's instrument panels.

Cargo handling equipment: The cargo handling equipment comprises a cargo platform, hydraulic grips, an external sling attachment device etc. The cargo platform's useful area measures 8,530 x 3,542 mm (27 ft 11⁵³⁄₆₄ in x 11 ft 7²⁹⁄₆₄ in); the platform is fitted with three wheels, four supporting struts for resting on the ground during loading, and three detachable ramps for the loading of vehicles. In flight configuration the ramps are attached to the sides of the platform on special brackets. The platform is provided with 92 tie-down cleats and four attachment fittings with ball-ends to match the locks of the hydraulic grips. Mounted on port side is an attachment point for the LPG-3 winch utilised for hauling the cargo onto the platform. The platform's tie-down equipment includes a five-fold pulley, tie-down cables and nets, shackles (with or without rollers for cables), wheel chocks and hydraulic jacks which are housed in special containers.

Hydraulic grips are provided for attaching outsize cargoes or the platform to the helicopter. They constitute a suspension system comprising eight hydraulic jacks which prevent the cargo from being displaced in any direction. Placed on the trusses of the main undercarriage units are two pyramids of the rear hydraulic grips formed by three struts each. The forward hydraulic grips, depending on the cargo type, are attached either to fittings on centre fuselage Frame 5 or to fittings in the upper part of the nose gear struts. The locks gripping the cargo have a shape of tongs with spherical hollows on the inner sides of the cheeks to fit the spherical tips of the fittings attached to the cargo or to the platform. The hydraulic grips and hydraulic cylinders have tips of adjustable length to suit various kinds of cargoes to be attached. The hydraulic grips are controlled by electric and hydraulic devices by means of switches on a portable control panel. The hydraulic system of the hydraulic grips constitutes a part of the auxiliary hydraulic system of the helicopter. During flights without cargoes the hydraulic grips are fixed in place by a special device. Provision is made for an emergency jettisoning of the cargo in flight.

Basic specifications of the Mi-10 and Mi-10K helicopters

	Mi-10	Mi-10K
Length		
ignoring rotors	32.86 m (107 ft 9¾ in)	32.4 m (106 ft 3⅝ in)
rotors turning	41m (134 ft 6¼ in) *	39 m (127 ft 11½ in)
Main rotor diameter	35.0 m (114 ft 10 in)	35.0 m (114 ft 10 in)
Weights, kg (lb):		
empty	27,100 (59,755)	25,450 (56,117)
normal AUW	43,550 (96,028)	37,000 (81,585)
maximum AUW	43,700 (96,358)	38,000 (83,790)
Cargo weight, kg (lb):		
normal	12,000 (26,460)	3,000 (6,615)
maximum	15,000 (33,075)	11,800 (26,019)
on a sling	8,000 (17,640)	
Speed, km/h (mph):		
maximum	335 (208)	350 (217.5)
cruising	180 (112)	228 (141.7)
Service ceiling, m (ft)		
hovering ceiling out of ground effect	3,000 (9,840)	1,000 (3,280)
hovering ceiling in ground effect		3,000 (9,840)
dynamic ceiling		4,750 (15,585)
Practical range, km (miles)	430 (267)	500 (311)

* Some sources state the length as 41.89 m (137 ft 5¼ in)

Above: Mi-10K CCCP-29115 in the static park at the 1967 Paris Air Show. Note the exhibit code H-241 on the fuselage.

Another view of the Mi-10K at Le Bourget.

Above: Mi-10K CCCP-04121 (c/n 2163) of the Tyumen' CAD in 1973-standard Aeroflot livery. Note the KO-50 cabin heater ahead of the external fuel tank.

The Mil' OKB's Mi-10K CCCP-29115, now painted in almost-standard blue/white Aeroflot livery, prepares to lift a section of an oil refinery installation.

A device for the sling suspension and external carriage of outsize cargoes weighing up to 8,000 kg (17,640 lb) is located under the ceiling of the cargo cabin; it is attached to Frames 14 and 18. It comprises a stressed frame, a swivel lock, a cargo cable with a snap hook for slings and a tip matching the gripping pincers of the lock. The MPT-2 mechanism caters for proper tension of the cable. The swivel lock is provided with electric and hydraulic control which is effected with the help of buttons on the left-hand 'pitch-throttle' lever, or manually in case of need.

The onboard boom with the LPG-2 electric winch permits to lift and load into the cargo cabin cargoes weighing up to 200 kg (441 lb). The boom is installed near the rear door on starboard side between Frames 22 and 25; it can rotate around a vertical axis.

On the Mi-10K the external sling device permits hooking up cargoes weighing up to 11.8 tonnes (26,000 lb), their airlifting and quick unhooking at the place of destination. The main elements of this device are: a lock with a hydraulic cylinder, the LPG-3 electric winch, a set of cargo slings with a hook or the DG-65 electric lock, a lock for hooking-up and other things. A pyrotechnic cable-cutting device caters for the emergency jettisoning.

The Mi-10 and Mi-10K in service

The crane helicopter was put into service already at the prototype stage when it performed a series of demonstration flights in Europe. In 1965 the Soviet Government decided to show Soviet helicopters for the first time at the 26th Paris Aerospace Show; until then, only fixed-wing aircraft had represented the Soviet aircraft industry at Le Bourget. In the course of preparation for the international debut the second prototype had its tail bumper deleted, the space between the main bracing struts on all four undercarriage legs was faired over, their shock struts were provided with fairings, and the machine itself received a new coat of paint.

On 1st June a group of helicopters comprising a Mi-6, a Mi-8 and the second prototype Mi-10, set off from an airfield near Moscow on a long-range flight spanning over 7,000 km (4,350 miles) and crossing the territories of six European countries (the crew of the Mi-10 was captained by test pilot B. Zemskov). One more helicopter piloted by G. V. Alfyorov accompanied this group as far as the Soviet border. Refuelling stops were made at Smolensk, Vitebsk-Vorony, Warsaw-Okęcie, Berlin-Schönefeld, Copenhagen-Kastrup and Brussels-Zaventem. Since West Germany had denied the Soviet group permission to overfly its territory, the route had to pass over Denmark and the Netherlands. This was the first time when such large helicopters flew over the sea. For this they used a 20-km (12.4-mile) corridor situated close to a target practice range of the West German Air Defence troops. A Soviet ship, M/S *Ivan Polzoonov*, performed radar monitoring of this flight until the helicopters were safely over dry land again.

During that year's show in Le Bourget the Mi-10, together with the Mi-6 and the An-22 *Antey* (Antheus) airlifter, became the stars of the show. The Mi-10 demonstrated the transportation of a LAZ-695 *sans suffixe* bus on the cargo platform, while the US visitor, the Sikorsky S-64A, failed to demonstrate its capabilities. During the static show the Mi-10's platform was used for setting up a miniature movie theatre in which documentary films about Soviet helicopters were shown.

Since the Soviet Government took a decision to start selling the new helicopters to foreign customers, Mikhail L. Mil' was authorised to show 'everything' and answer all sorts of questions. US representatives were amazed by the unexpected openness on the Soviet side; their pilots were permitted to perform a flight on the Mi-6. In return, pilots from the Mil' firm were given the opportunity to pilot the Bell 47 and one of the Sikorsky helicopters.

In the following year an invitation was received from Western Europe for the Mi-6 and the Mi-10 to undertake a demonstration tour to a number of countries. On 7th March 1966 the two helicopters (the Mi-10 was piloted by Zemskov) set off from Sheremet'yevo on one more journey. After intermediate landings in Vitebsk, Vilnius, Warsaw, Berlin, Copenhagen and Billund (the latter city is also in Denmark) the group arrived in Rotterdam where a demonstration flight took place on 12th March. On 14th March the helicopter flew to Amsterdam where the Mi-10 made several spectacular flights with a 12-tonne (2,460-lb) Caterpillar bulldozer tied down on its cargo platform. As a result, customers from Netherlands bought one Mi-10 helicopter through the Aviaexport foreign trade agency; shortly thereafter they resold it to the USA. In the USA the helicopter passed tests, logging 170 flight hours and receiving a high appraisal.

As for the of the practical operation of the Mi-10 by its main customer, the Soviet Air Force, the type's service career was on the whole not quite successful. As series production of the Mi-10 went on, several examples of the machine (and sometimes single examples) were distributed to Independent Helicopter Regiments which already had the Mi-6 in their inventory. The crews from the helicopter centre in Lugansk, where the Mi-6 had also started its service, were the first to get acquainted with the new machine. Among the service units notable progress in mastering the heavylift helicopters was scored by a regiment stationed at Torzhok which later formed the basis for the 344th TsBP i PLS of the Army Aviation. The 'westernmost' regiment to receive the Mi-10 was the 239th GvOVP stationed at Brandis AB, East Germany. In the first half of the 1970s it had up to four Mi-10s on strength. Helicopters of this type were delivered to the 51st OGVP stationed at Aleksandriya AB (Kirovograd Region, the Ukraine), the 181st OVP (Dzhambul, Kazakhstan), the 280th OVP (Kagan, Tajikistan), the 112nd OVP (Nerchinsk, Chita Region), the 825th OVP (Sredne-Belaya AB, Amur Region) and to regiments stationed in Legnica (Poland), Kobrin (Belorussia) and to some other units.

The unorthodox machine differed from the Mi-6 in some respects as regards handling and maintenance (primarily due to the taller undercarriage); moreover, it had some unpleasant peculiarities. The standard operational procedure was that a loaded helicopter would perform a rolling take-off, and the machine behaved decently enough even when operating from an unpaved airstrip. However, training flights were often performed with no payload, and in such cases the Mi-10 swayed quite noticeably. During rolling landings the front wheels occasionally suffered a shimmy. Therefore service pilots, when flying unloaded Mi-10s, tried to perform take-offs and landings vertically, which had some negative effect on the crews' proficiency for actions in combat conditions. In cruising flight the Mi-10 was less stable than the Mi-6. A cargo tied down on the platform not only created considerable drag but was also prone to icing up if the machine entered clouds, which was fraught with the danger of the helicopter simply dropping to the ground. The crews were instructed in such cases to leave the dangerous zone as quickly as possible and, should the situation become critical, resort to emergency jettisoning of the platform.

Transportation of cargoes too bulky for the cargo hold of the Mi-6 was regarded as the Mi-10's main task. In the course of combat training, including major military exercises, the crews perfected their skill in transporting various kinds of materiel on the platform: lorries, armoured scout vehicles, armoured personnel carriers, mobile radio stations and so on. Sometimes the Mi-10s were involved in rendering assistance to local civil authorities. For example, crews of the 112th OVP under-

Unspeakably dirty and weathered, RA-04130 (c/n 2294) of Komiavia was one of the Mi-10Ks operated by the successors of Aeroflot.

N16556 operated by the American company Petroleum Helicopters, Inc. was the sole Mi-10 to be exported.

took transportation of high-voltage power line pylons.

The Mi-10s of the 181st OVP took part in the Afghan War. In January 1980 the regiment was redeployed from Dzhambul to Afghanistan where it was stationed at Kunduz as its main base. In the summer of the same year a Mi-10 performing a flight from Kunduz to Maimane suffered a crash when transporting a TZA-7.5-500A refuelling bowser (based on the MAZ-500A cabover), the driver sitting in the helicopter's cargo cabin. When one of the engines cut unexpectedly, the crew jettisoned the platform and tried to perform a rolling emergency landing at a site which they spotted ahead of them. However, it turned out to be covered with large stones and potholes; as a result, the nose gear units collapsed, the helicopter nosed over, disintegrated and burned out. Another Mi-10 arrived from Dzhambul to replace it.

Unlike the Mi-6, the Mi-10 proved to be virtually unneeded in the Soviet Air Force. Its main mission, which had exerted so much influence on its design features, was forgotten virtually from the outset. However, soon a new and worthy task was found for this machine: it came to be used as an ECM helicopter. The Step' pod carried by the new Mi-10P version housed standard Soviet airborne ECM equipment. The crane helicopters were sent one by one to aircraft repair plants in Rostov and Konotop where they were converted into Mi-10Ps (Mi-10PPs) and then sent back, often to quite different helicopter regiments.

The Mi-10 was operated by the Soviet Air Force until 1989, whereupon the helicopters were progressively phased out and scrapped. Some of their units and systems were saved, though, and served as spare parts for other types of military hardware. For example, the Step' ECM pods of the 112th OVP were transferred to the 36th OSAP (Independent Composite Air Regiment) where their contents were used for the maintenance of ECM equipment on the An-12PP ECM aircraft. Two helicopters were donated to museums in Monino and Torzhok, and one machine was placed on a plinth in Garovka.

Deliveries of the 'short-legged' Mi-10K crane helicopters to Aeroflot began in the mid-1970s. Initially they were operated by three Flights: the 223rd Flight of the Komi CAD/Ukhta United Air Detachment (Komi Autonomous SSR), the 255th Flight of the Tyumen' CAD/1st Tyumen' UAD based at Tyumen'-Plekhanovo, and by a detachment based at Myachkovo near Moscow. The greater part of the Mi-10Ks (seven or eight machines in each case) found their way into the first two of the mentioned detachments. Later, in the course of reorganisations, the machines of the 223rd Flight were transferred to the Ukhta UAD/302nd Flight, while those operated by the 255th Flight passed to the 1st Tyumen' UAD/438th Flight. In addition, at least one such helicopter was turned over to VNII PANKh (All-Union Scientific Research Institute for Employment of Aviation in National Economy) in Krasnodar.

Between 1975 and 1979 the crews of Ukhta-based machines performed more than 50 complex installation jobs. Among the operations performed by them especially worthy of note is the installation of a 70-metre (230-ft) TV relay mast on the route of the Nadym – Ukhta gas pipeline and of high-voltage power line pylons during the construction of a power transmission line over the Volga River near Kostroma. Some of the feats accomplished by the Mi-10 crews were truly unique. In 1980 the Ukhta UAD operating the 'flying cranes' (it was led by T. Mal'tsev, a well-known pilot who had been awarded a State Prize) for the first time in the world used two helicopters simultaneously for the installation of heavy metal trusses. A TV relay mast 100 m (330 ft) high and weighing 40 tonnes (88,000 lb) was assembled on the ground and fitted with pivoting attachment points; then it was erected into the vertical position by two Mi-10 helicopters. In the following year a similar job was performed in the Tyumen' region.

According to assessments made by GosNII GA, the cost of installation jobs performed by the Mi-10K 'flying crane' helicopter proved to be 1.5 times lower than when the Mi-6 was used. The early 1980s saw the introduction of several additional devices designed to make operations with an underslung load more efficient. These included a 'self-gripping hook' which made it possible to hook up a cargo without assistance from ground personnel, and a 'seeker' for performing installation jobs, likewise, without assistance from construction workers. One more such device was the system permitting the slung cargo to be oriented in the required direction.

The relatively small number of production Mi-10Ks succeeded admirably in tackling all the numerous jobs on the vast territory of the Soviet Union. The Mi-10K's sufficient ferrying range and good navigation equipment made it possible to transfer the machines quickly from one construction site to another, performing ferrying flights around the clock.

Only one Mi-10K has been lost in an accident, and then it was a non-fatal one. On 21st December 1992 the port engine of CCCP-04120 (c/n 2162) operated by the Tyumen' CAD/1st Tyumen' UAD/438th Flight cut during long-line operations in the vicinity of Noyabr'sk, Tyumen' Region, followed two seconds later by the starboard one. The crew jettisoned the slung load and attempted an emergency landing in autorotation mode, but the helicopter came down in a swamp, suffering heavy damage. It was later salvaged but declared a write-off.

The break-up of the Soviet Union was accompanied by collapse of Aeroflot as the biggest air carrier in the world; its regional branches started turning into independent enterprises. The Mi-10Ks became the property of new owners. For example, in 1992 an Mi-10K previously operated by a Tyumen branch of Aeroflot was placed at the disposal of the Skytech company with headquarters in Brussels. This company used the Mi-10 with much success for the installation of radio relay masts in the Alps. However, on the whole the intensity of the Mi-10's operational use diminished considerably after the demise of the Soviet Union. The reason for this was not so much the general worsening of the economic situation as the need to extend the machines' service life, which was coming to an end.

Chapter 3

The Twin-Rotor Giant

V-12 heavy transport helicopter (*izdeliye* 65)

The V-12 helicopter, of which two prototypes were built, became the last-ever helicopter to feature the side-by-side twin-rotor layout. One may presume that it marked the final chapter in the development of giant helicopters.

The capabilities displayed by the Mi-6, which then reigned supreme as the world's largest transport helicopter, were by no means the utmost that could be obtained. The designers were convinced that the dimensions and payload of transport helicopters could be further increased. To reinforce the point, there was a need for a VTOL aircraft capable of lifting commercial and military single cargoes weighing more than 20 tonnes (44,000 lb).

In 1959 the Mil' OKB started its first project studies of an ultra-heavylift helicopter which was designated V-12, or *izdeliye* 65. In 1961 Pyotr V. Dement'yev, Chairman of the State Committee for Aviation Hardware (GKAT – *Gosoo**darstvennyy** komi**tet** po aviatsi**on**noy **tekh**nike*) officially endorsed a document tasking the OKB with developing a project of a helicopter capable of lifting 20 to 25 tonnes (44,000-55,000 lb); it was followed by an official directive issued by the Council of Ministers calling for the development of the V-12 transport helicopter with cargo hold dimensions similar to those of the giant An-22 airlifter that was under development in the Antonov OKB. The helicopter was intended for airlifting various items of combat materiel weighing up to 25 tonnes (55,000 lb), including the *izdeliye* 8K67, 8K75 and 8K82 intercontinental ballistic missiles.

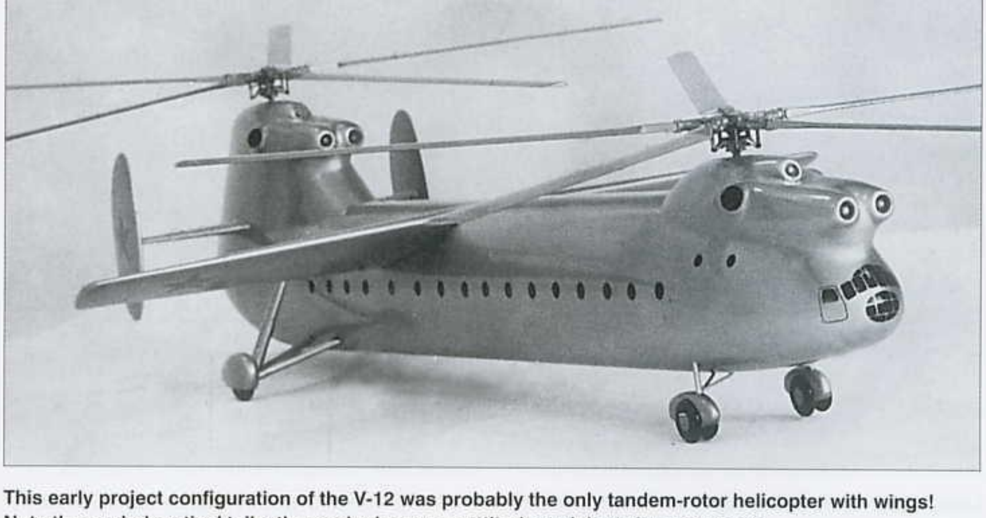
N. T. Roosanovich was directly responsible for this project as Deputy Chief Designer; in 1968 he was succeeded by Marat N. Tishchenko in this capacity. G. V. Remezov became the V-12's chief project engineer, while D. T. Matsitskiy and V. A. Izakson-Yelizarov were appointed chief engineers in charge of the flight tests.

During that period the biggest US helicopter manufacturing companies were also engaged in design studies on heavylift helicopters, but they did not proceed as far as the construction of prototypes. On the other hand, research conducted by the Mil' team made it possible to convince the country's leaders that building an ultra-heavylift helicopter was quite feasible.

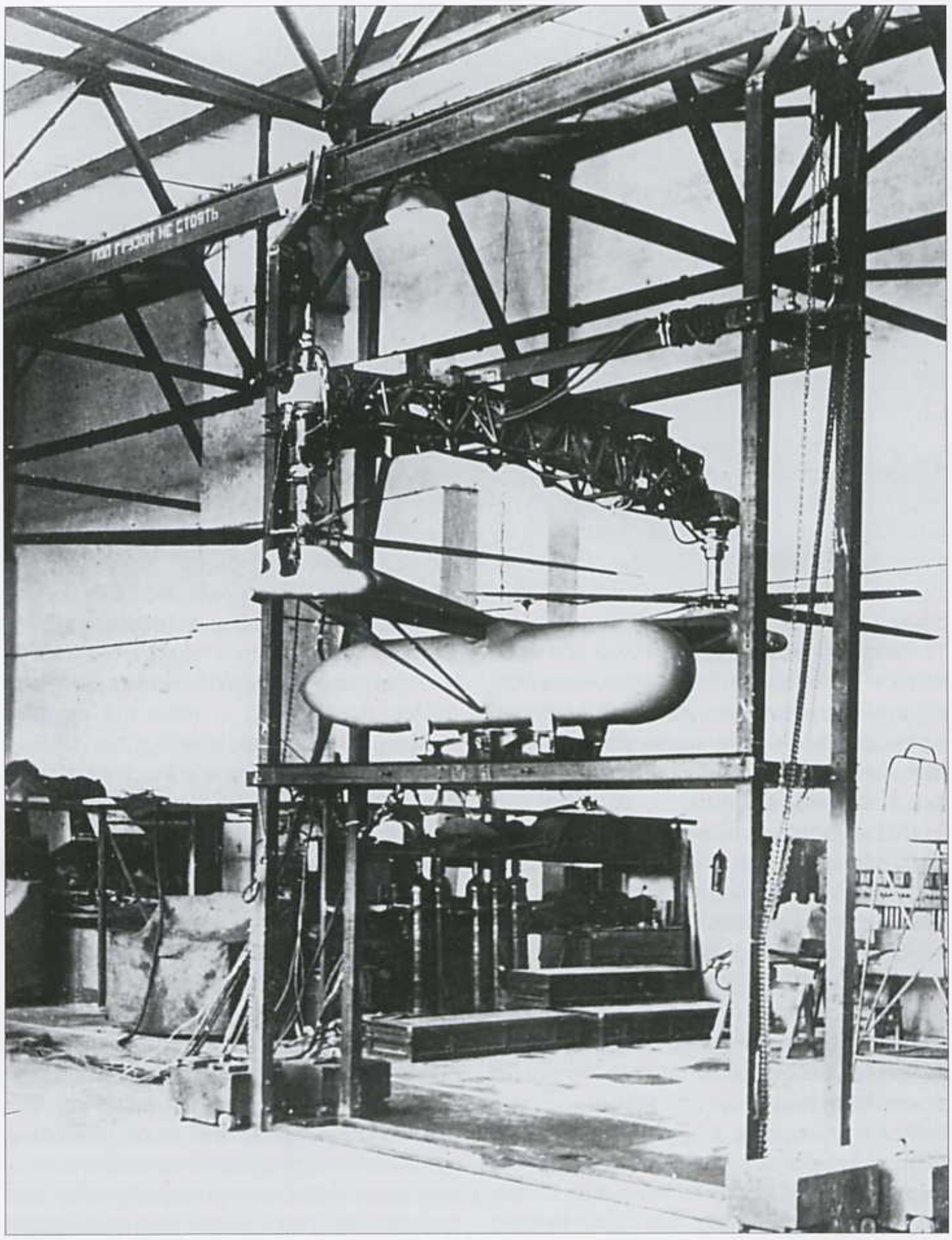
Initially the Soviet designers, just like their US colleagues, stuck to the opinion that a heavylift helicopter could be created only using the tandem twin-rotor layout. To study the specific properties of this layout, the flight test facility of Plant No.329 procured a production Yakovlev Yak-24 helicopter from an army unit, as well as an example of the Boeing Vertol V-44 helicopter that had been purchased in the USA for evaluation purposes. These machines were used to study the interference of the tandem rotors, the distribution of power between them, the required engine power in different flight modes; the problems associated with side-slip and many other things were also assessed.

At the same time work went ahead on the first V-12 project. Two main rotor/powerplant packages from the Mi-6 were arranged in tandem and cross-shafted, the disc areas of the five-blade rotors overlapping; the gearboxes were different, of course, since the rotors turned in opposite directions. The overlapping was kept to a minimum because of the danger of the blades colliding in flight; this made the fuselage considerably longer and bulkier than stipulated by the specification. Furthermore, the air intakes of the aft pair of engines were placed in the wake of the exhaust gases coming from the forward engines; ingestion of these gases could cause the rear engines to surge. At the same time, research into the properties of the tandem twin-rotor layout showed that this layout could not ensure a high dynamic ceiling, high speed and a high rate of climb. A failure of two engines would make the continuation of flight impossible; a flight at the dynamic ceiling and in high ambient temperatures would be accompanied by a drastic deterioration of performance. As a result, the tandem layout was dropped and a study into alternative layouts had to be undertaken.

The single-rotor layout would appear to be the simplest option. Initially there were plans to make use of a jet-powered rotor of the type used on the V-7 experimental helicopter, but, bearing in mind the negative experience of the latter's testing, this idea had to be given up. Opting for a mechanical drive from the engines to the rotor, the designers sought to enhance the torque imparted to the shaft of the main gearbox; this was to be achieved by arranging two R-7 main gearboxes borrowed from the Mi-6 above one another to drive a common output shaft. The main rotor was to have a diameter of 38 m (124 ft 8 in) and feature eight stock blades from the Mi-6; the 1-m (3 ft 3⅜ in) increase in diameter would be achieved by attaching the blades to longer shank extensions. However, this configuration of the main gearboxes required thorough prior research and lengthy testing, while the had to meet a specific flight test deadline. Therefore the idea arose of utilising a low-speed large-diameter free turbine with a vertical shaft which would be placed under the main gearbox on the same vertical axis; each engine's core would be connected to the turbine by a gas duct – the so-called



This early project configuration of the V-12 was probably the only tandem-rotor helicopter with wings! Note the angled vertical tails, the marked nose-up attitude and the twin nosewheels.



Above: A schematic model of the V-12 in its ultimate side-by-side twin-rotor configuration. The model served for verifying the powerplant/powertrain layout.

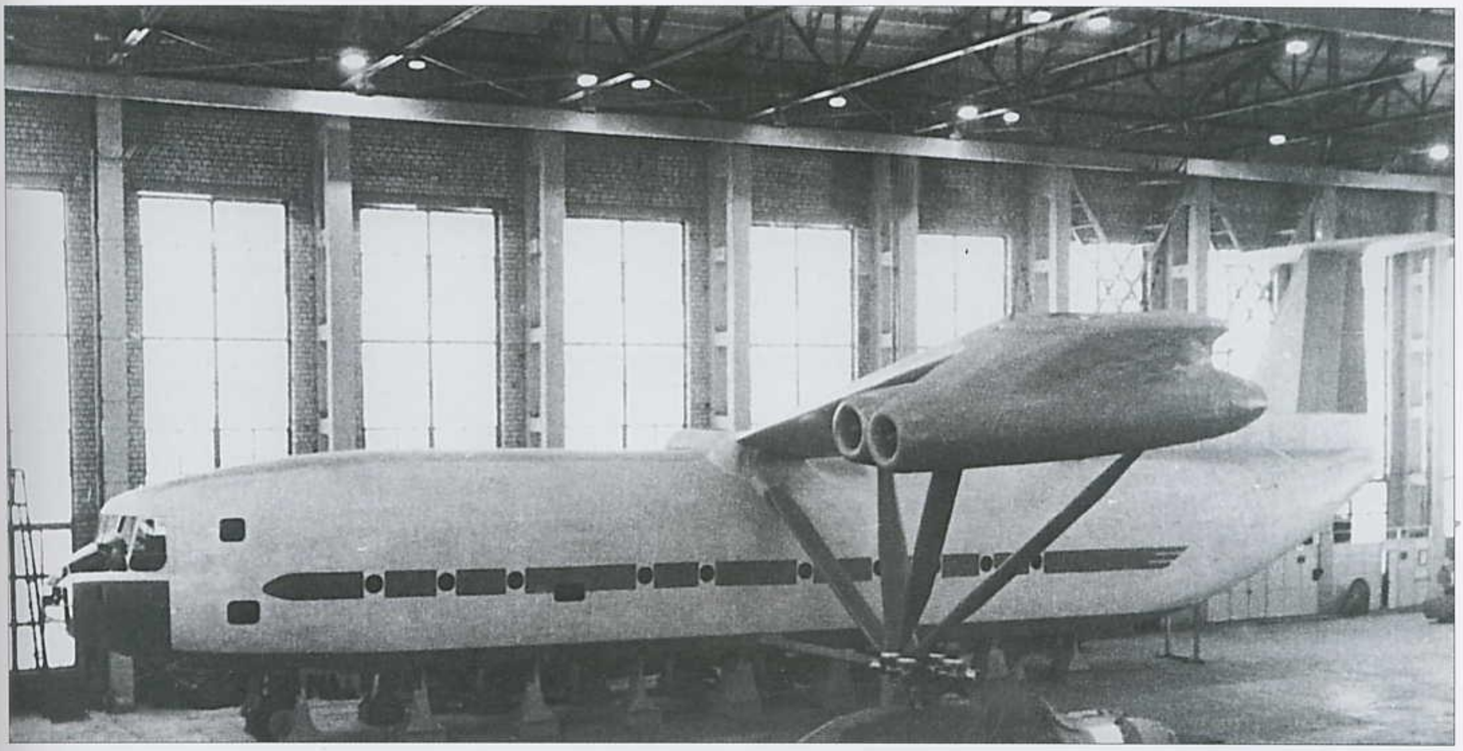
Looking like a railway carriage with wings, this full-scale test rig at Panki was used for testing the actual engine/rotor packages and transmission. Only the starboard pair of engines is fitted here.

'snail' (reflecting the likeness to a snail's spiral-shaped shell). In this case the main gearbox design would be much simpler thanks to the absence of bevel gears, but developing a low-speed turbine with a diameter of 4.5 m (14 ft 9 in) was also a time-consuming task. Hence in 1962 the designers of the Mil' OKB decided to revert to the idea of 'duplicating' the powerplant/main rotor assembly from the Mi-6, but this time the machine was to feature a transverse layout.

In developing an ultra-heavylift side-by-side twin-rotor helicopter, the Mil' OKB had to tackle a number of extremely difficult problems associated with this layout – problems that had not been solved by any helicopter-manufacturing company in the West. These problems were aggravated by the sheer size of the machine under development.

When projecting the V-12, its designers sought to make the fullest possible use of the experience accumulated in the development and construction of prototype helicopters created by Ivan P. Bratukhin's OKB in the 1950s. The worst problem posed by the side-by-side twin-rotor layout was the design of the transverse supporting structures carrying the powerplant/rotor packages; the objective was to make these structures sufficiently lightweight and minimise their resistance to the rotor downwash, and yet make them sturdy and rigid. Strut-braced aeroplane-style wings had to be rejected from the outset because of their excessive weight and considerable loss of main rotor thrust in hovering flight. On the other hand, the use of rigid and streamlined trusses (stub wings) might provoke 'aerial resonance' of rotors mounted on an elastic base. The risk of this resonance cropping up on a helicopter featuring a side-by-side twin-rotor layout was increased by the presence of heavy engine nacelles mounted at the tips of the stub wings.

Nevertheless, by mid-1963 the designers succeeded in evolving a structure intended for mounting the two powerplant/rotor packages that would have sufficient bending and torsional stiffness while minimising the thrust losses resulting from the structure's resistance to the rotor downwash. Having carefully studied several structural arrangement options, the designers selected an unorthodox solution: the powerplant/rotor packages were to be placed at the outer ends of three-dimensional trusses, some elements of which were shaped like wings with reverse taper. Using wings with this planform solved to a considerable extent the problem of minimising the losses arising from the wings' resistance to the rotor downwash: the airflow created by the rotors had the highest speed in the area where the wing chord was at its narrowest. At the same time the wings' maximum chord was in the area close to the rotor blade



Above and below: The full-scale mock-up of the V-12 in the assembly shop of plant No.329 in Panki. Note the stepped nose and the T-tail; both features changed before the real thing was built. The engine nacelles were also reshaped later on.

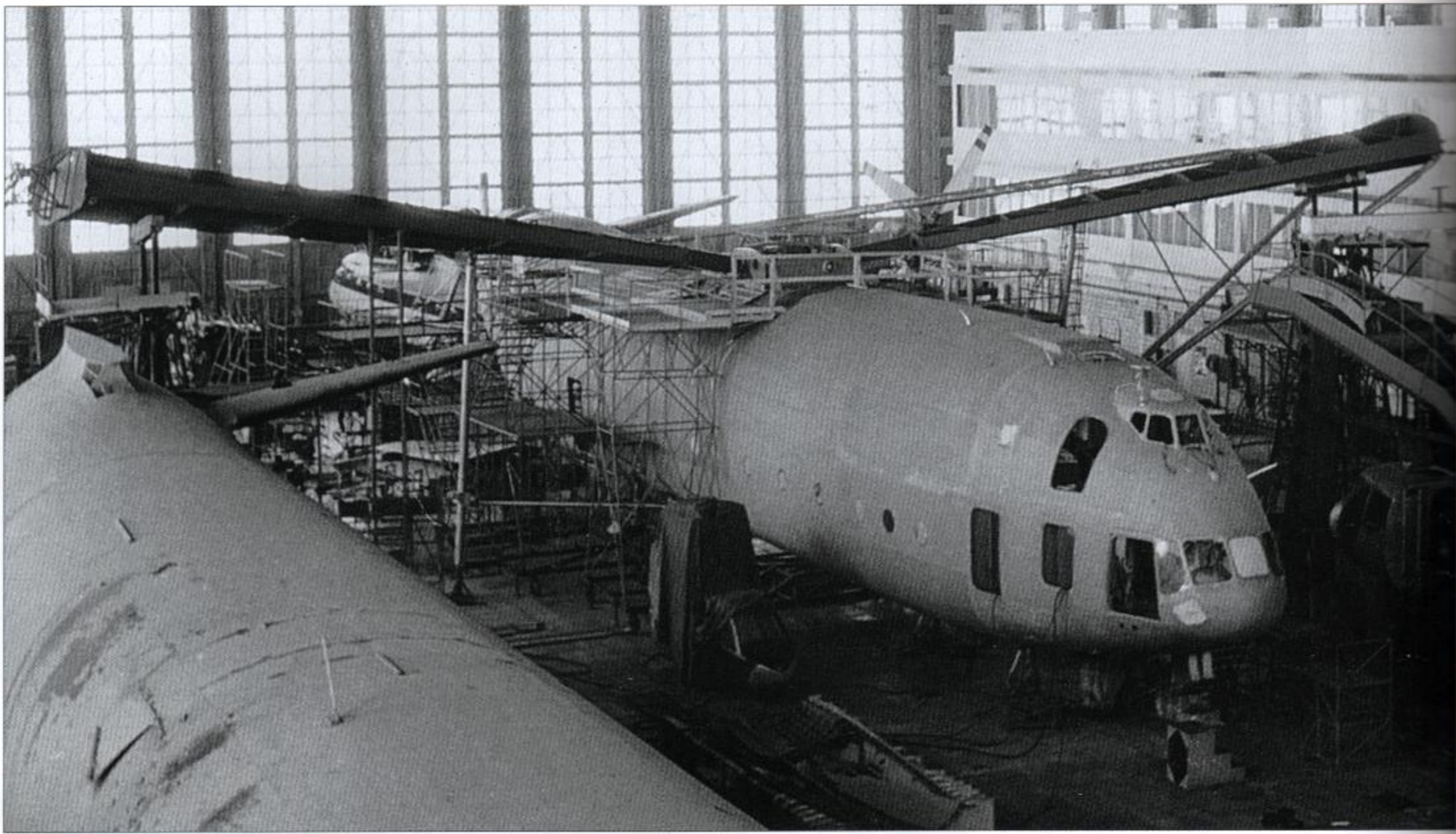
shanks; this prevented the emergence of reverse airflow in the area characterised by negative induced speeds.

The giant helicopter was to be powered by four 6,500-eshp D-25VF turboshafts developed by OKB-19 led by Chief Designer Pavel A. Solov'yov; each of the two pairs would drive its own main gearbox. Mounted on the main gearbox output shafts were two five-blade rotors measuring 35 m (114 ft 10 in) in diameter. The engines, main gearboxes, rotor heads and swashplates were slightly modified versions of the same units that had been used earlier on the proven Mi-6 and Mi-10 production helicopters. However, this was the only thing the new ultra-heavy airlifter had in common with its predecessors. The basic differences in the design of its main components were dictated by the special features of the side-by-side twin-rotor layout (the need for precise synchronisation of the two rotors' rotation speed and the altered principle of controlling the machine in the roll channel).

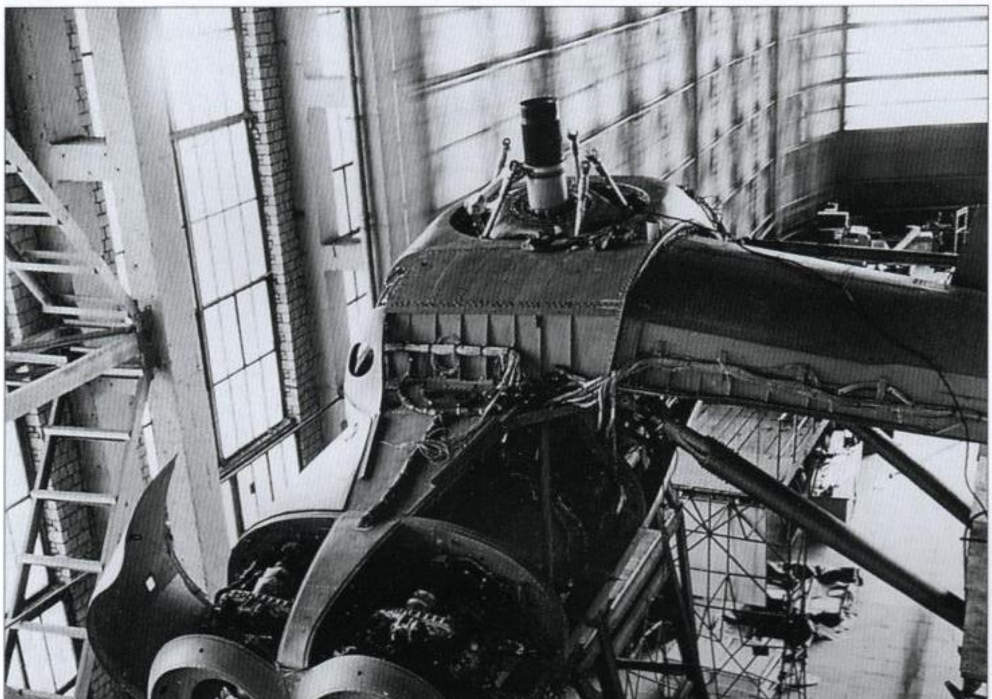
The speed of the rotors, whose disc areas had a 3-m (9 ft 10 in) overlap, was synchronised via a cross-shaft connecting the two main gearboxes. To cater for the 'kink' of the cross-shaft between the dihedral wings, a special intermediate gearbox was installed in a bay above the fuselage where the wing roots joined each other. In addition, the cross-shaft served for transmitting the power from one main gearbox to the other. The need for such power transmission on a side-by-side twin-rotor helicopter was constantly present due to the fact that roll control was effected by differentially changing the collective pitch on the port and starboard rotors while retaining the same power setting of the port and starboard powerplants. The cross-shaft could also perform the function of transmitting power from one powerplant to the other in situations when their power output was unequal (for example, when one or even both engines on one side became inoperative).

Choosing the rotors' direction of rotation correctly was equally important. Research results showed that roll and yaw control could best be harmonised if the advancing rotor blades passed above the fuselage (that is, the port rotor turned anti-clockwise and the starboard rotor clockwise when seen from above).

The helicopter's fuselage comprised the crew section situated in the nose and a cargo hold of impressive dimensions: it measured 28.15 x 4.4 x 4.4 m (92 ft 4 17/64 in x 14 ft 5 7/32 in x



Above: The first prototype V-12 nearing completion at Panki, seen over the fuselage of the second prototype. The different nose design is obvious; note the curious 'penthouse' for the navigator which was one of the V-12's trademark features.



Close-up of the first prototype's starboard engine nacelle, showing the main gearbox.

14 ft 5⅞₂ in). The crew section was a 'two-storey' structure, which resulted in a very distinctive nose profile. The rear fuselage incorporated a suitably stressed cargo ramp and clamshell doors which opened to provide access for wheeled vehicles, as well as for the loading of various single cargoes weighing up to 5 tonnes (11,025 lb) with the help of powerful electric winches and overhead hoists. Mounted above the cargo hold in its rearmost part was a conventional aircraft-type tail unit.

The unique control system of the V-12 was designed with due regard to the substantial length of the linkages, the possible deformations of the airframe, the high all-up weight and the considerable friction forces arising in the control linkages during their operation. The system incorporated two stages and included main and intermediate hydraulic actuators, as well as automatic devices which ensured an acceptable level of control forces and synchronised the deflection of control surfaces. The intermediate actuators, as well as the special hydraulic actuators of the rudder and elevators, were powered by a hydraulic system which was housed in the intermediate shaft gearbox bay (in the wing centre section). The main hydraulic actuators were powered by hydraulic systems housed in the port and starboard engine packages. All the three systems were completely independent; each of the three systems, in their turn, comprised a main system and a back-up system.

To check the airframe's fundamental resonance oscillation frequencies and to ensure the predetermined stiffness and resonance characteristics of the helicopter's structure, studies and development work were conducted on scaled-strength models built to 1/10th scale. A full-scale test rig looking like a boxcar with wings was built to test the rotors, transmission and powerplant. Scale models of the helicopter were subjected to wind tunnel tests at TsAGI.

A steadily growing number of subcontractor organisations were involved in the development of the giant helicopter; gradually the development of the V-12 began to assume the character of a national programme. In April 1965 the Council of Ministers issued one more directive on the construction of the first prototype of the V-12, which enabled the Moscow Helicopter Plant (Mil' OKB) to improve its production and research facilities considerably. Concurrently, the Saratov aircraft plant No.292 started tooling up for manufacturing a service test batch of five Mi-12 helicopters (as the machine was to be designated in production form). In late 1965 representatives of the Air Force conducted tests on a full-size mock-up in order to check the possibilities of accommodating 36 items of combat hardware in the helicopter's cargo hold. After that, in April 1966, the mock-up review commission gave its final approval to the mock-up and endorsed the construction of the first flying prototype.

Upon completion of its assembly the first prototype was subjected to frequency testing. Right in the assembly workshop the prototype was suspended on elastic cables to special pillars, and the rotor heads were fitted with imitation blades and vibrators. The tests confirmed that the airframe was sufficiently rigid and resistant to aerial resonance. By the early summer of 1967 the first flying prototype of the giant rotorcraft was ready for flight testing.

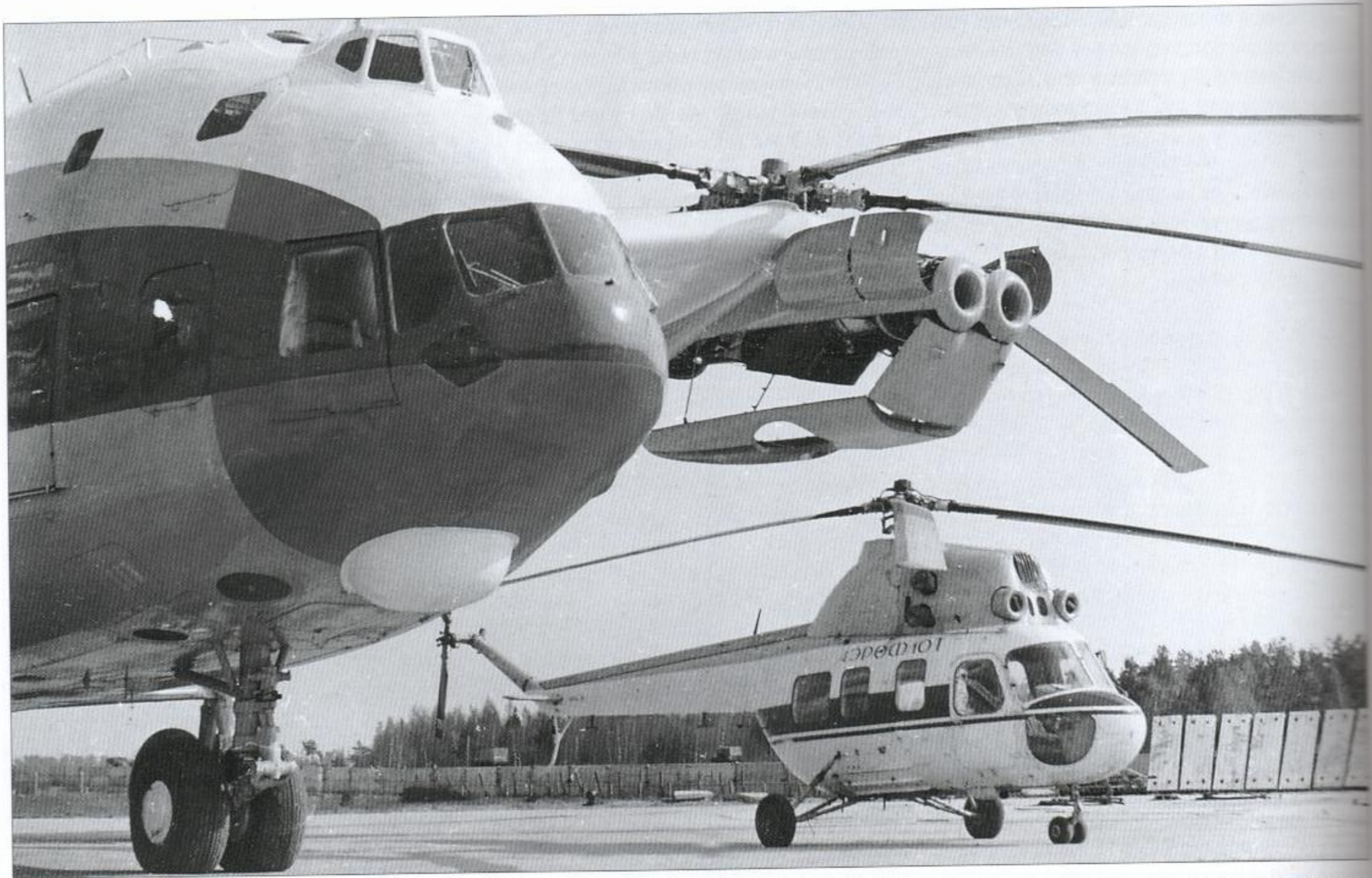
The as-yet unregistered V-12 prototype performed its first lift-off from the factory pad in Panki on 27th June 1967, piloted by test pilot V. P. Koloshenko. In full view of the numerous spectators and the General Designer the helicopter, after a few oscillations in close proximity of the ground, made a rough touchdown on one wheel. The damage was insignificant (a burst tyre and a bent wheel disc), but a mishap during the very first flight had a depressing effect on the morale of the Design Bureau staff. Moreover, the Western press carried reports alleging that the helicopter had been severely damaged.

It turned out that the first lift-off of the giant helicopter had been accompanied by a new type of self-induced vibrations of the 'control system – airframe' type. Deflections of the control stick to the sides proved to be kinematically linked with the vibrations of the cockpit floor through the pilot's hand and arm under the conditions when the frequency of self-induced vibrations of the control system coincided with that of the helicopter's airframe. This dynamic phenomenon was very quickly eliminated after some minor modifications designed to increase the rigidity of the control system. Endplate fins were added to the tips of the horizontal tail.

In December 1967, after modifications which had improved the effectiveness of the control system, the V-12 started performing small hops as a matter of routine, and on 10th July 1968 the helicopter (now wearing the 'MAP-style' registration CCCP-21142) made a positioning flight from the factory pad to the flight test facility of the Mil' OKB in Lyubertsy just outside Moscow. The manufacturer's flight test programme was completed within a month without any mishaps. This was due not least to the very thorough experimental checking of the project, but also to the use of the powerplant and main rotor assemblies of the Mi-6 helicopter which had been perfected in the course of series production.

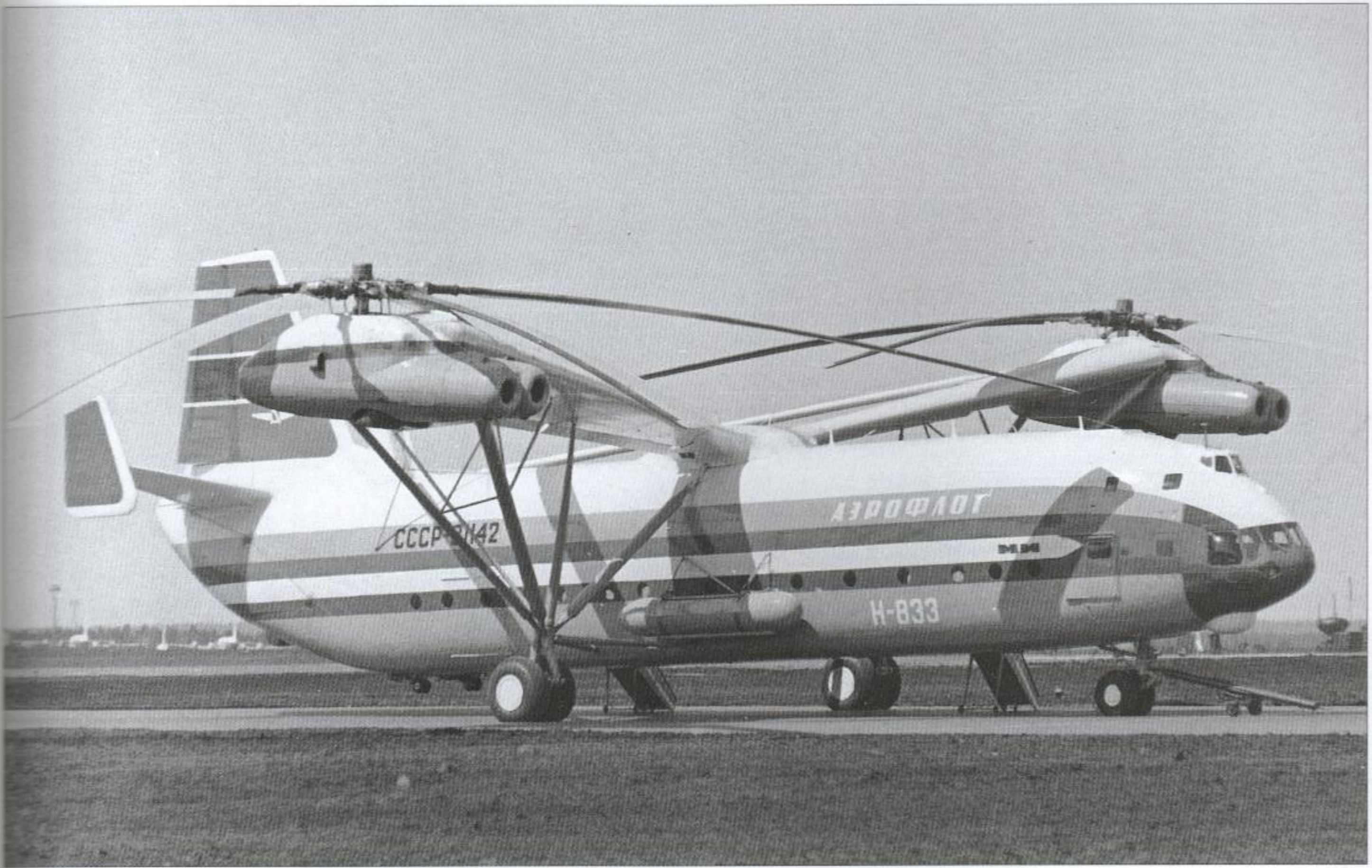
In the autumn of 1968 the first flying prototype of the V-12 was transferred to the Flight Test Institute (LII) in Zhukovskiy for Stage A of the joint state acceptance trials. No special problems were noted; development work was concerned mainly with the helicopter's equipment. In addition to the specially designed AP-44 autopilot, the V-12 received the experimental VUAP-2 autopilot; later it was replaced by the AP-34B1. The machine was also fitted with an ROZ-1 ***Lot****siya* (Navigational directions) weather/navigation radar (the chin radome intended for it was empty at first) and

The ceremonial rollout of the first prototype of the V-12. The rotor blades and the flightdeck emergency doors have yet to be fitted.



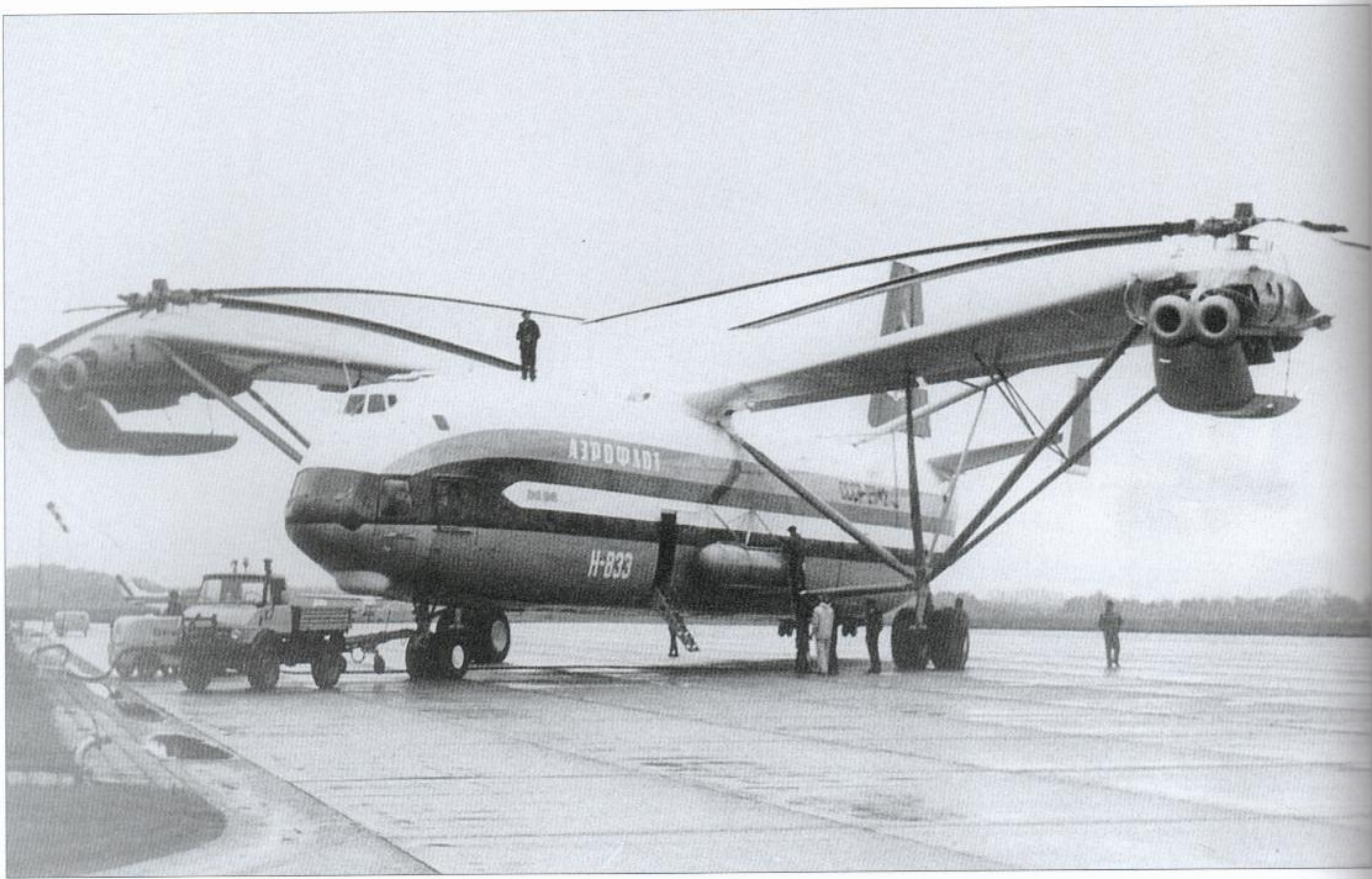
Above: The biggest and the smallest of the Mil' OKB's turbine-engined progeny – the first prototype V-12 and an early-production Mi-2 utility helicopter which is dwarfed by the giant airlifter. Note the undernose air intake and exhaust ports for the APU aft of the as-yet empty radome.

Another view of the Mi-2 and the V-12. The latter's huge engine cowlings give virtually unrestricted access to the engines and the main gearboxes. Note the small twin-wheel tail bumpers and the supports on which the cargo ramp rests.

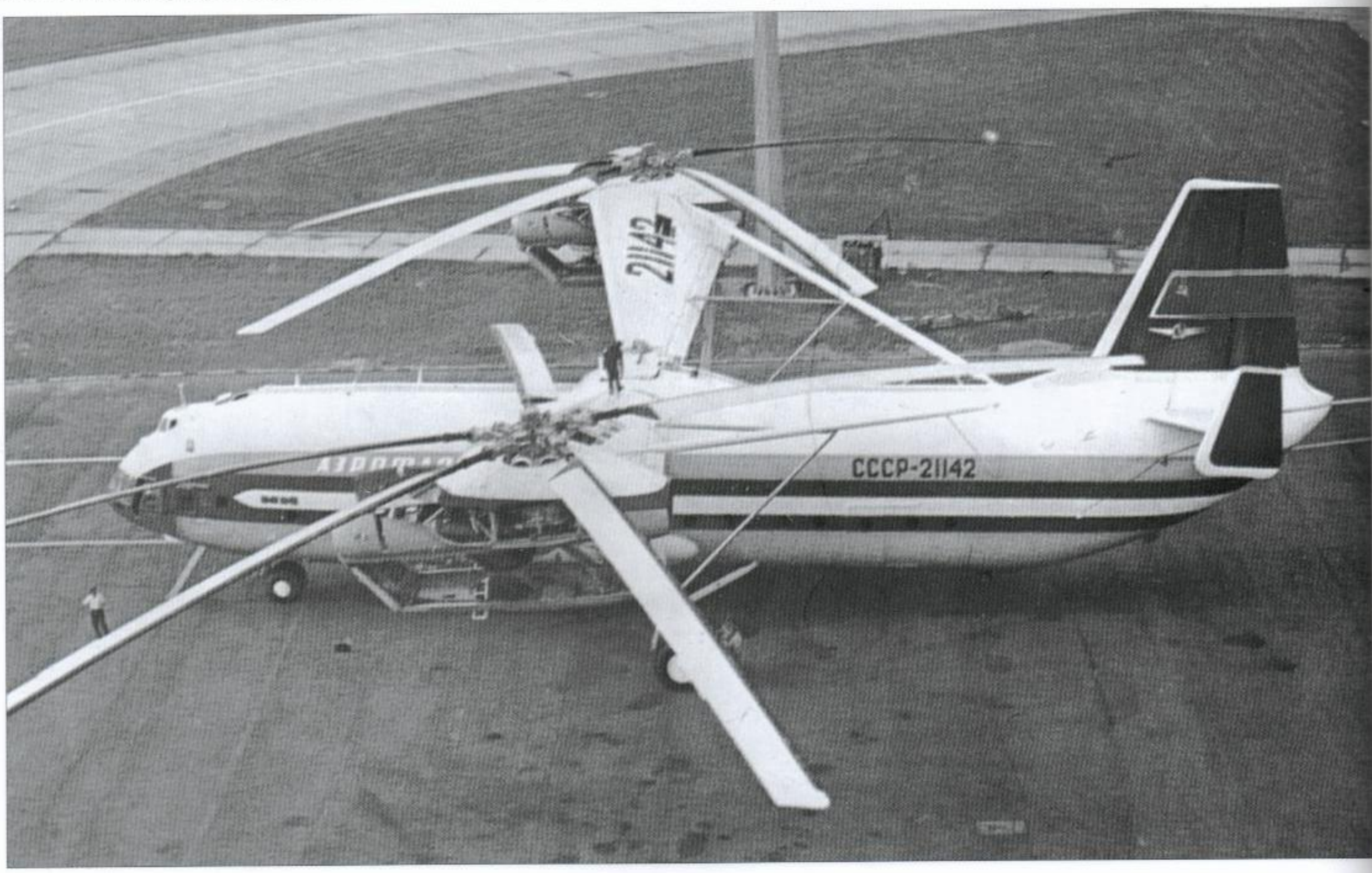


Above: Wearing the Le Bourget exhibit code H-833, the V-12 prototype sits on a taxiway on the north side of Moscow-Sheremet'yevo airport (the present Sheremet'yevo-1) before departure to the Paris Air Show. Tall gangways were required for boarding.

Another view of CCCP-21142 as it taxies at Moscow-Sheremet'yevo.



Above: The V-12 during a refuelling stop en route to Paris. Of course the Mercedes-Benz Unimog U600 was not used to tow the giant helicopter, only the trailer-mounted Shell fuel pump working with the centralised refuelling system. Note the boarding ladder.



An aerial view of the V-12 at Le Bourget. The registration was carried across the top of the wings but not on the wing undersurface.

Above: The V-12 was impressive enough on the ground, but in flight it was a truly awesome sight. Note the oil cooler air outlets at the rear ends of the engine nacelles; the oil cooler air intake scoops are located on the outer faces of the nacelles in line with the rotor heads.

Another in-flight photo of the V-12, showing the complex wing support/undercarriage trusses. Note the partially open entry door.

Above: The V-12 in the static park at Le Bourget in company with another giant aircraft, a Lockheed C-5A.

The V-12 stole the show at Le Bourget '71. The visitors queued for hours to come aboard.

external strap-on fuel tanks. The original all-metal rotor blades taken from the Mi-6 were replaced for trial purposes by new blades featuring a composite construction; they had a steel spar in combination with glassfibre leading-edge and trailing-edge sections, the latter with a metal foil honeycomb filler.

On 22nd February 1969, in the course of flight testing, a Mil' OKB crew captained by V. P. Koloshenko established a new absolute world payload-to-altitude record by lifting a load of 31 tonnes (68,355 lb) to an altitude of 2,350 m (7,708 ft). Half a year later, on 6th August, Koloshenko and his crew lifted on the V-12 prototype a payload of 40.2 tonnes (88,641 lb) to an altitude of 2,250 m (7,380 ft); this record remains unsurpassed to this day! In all, seven world records were established on the V-12. For the development of the V-12 ultra-heavy lifter the Mil' OKB received its second Sikorsky Prize which was awarded by the American Helicopter Society for outstanding achievements in helicopter technology.

Thus, prior thorough theoretical studies and the chosen layout of the ultra-heavylift helicopter fully proved their worth. The helicopter successfully passed the entire pre-planned test programme, making 122 flights and 77 hovers; the testing fully corroborated the design performance characteristics and demonstrated the machine's reliability. The V-12 displayed fine handling qualities both with the autopilot engaged and in the manual control mode, good handling in the autorotation mode and low noise and vibration levels; it had a comfortable flightdeck; furthermore, it could continue flight with two of its engines inoperative.

The helicopter's payload could be increased by using the rolling take-off technique. The volume of the cargo hold surpassed that of the Mi-6 by a factor of 7.2, yet the specific weight characteristics of the giant machine proved to be comparable to those of its predecessor. In 1970 the completion of Stage A of the V-12's joint state acceptance trials was marked by a long-range flight from the Moscow region to the GK NII VVS facility at Vladimirovka AB in Akhtoobinsk, Saratov Region. In October of the same year the state commission recommended the helicopter for series production, providing appropriate modifications were made to its systems and the defects noted during tests were rectified.

During stage 'A' of the state acceptance trials the leaders of the country took a decision to show the giant helicopter at the 29th Paris Air Show and thus demonstrate the potential of the Soviet aircraft industry. In May-June 1971, wearing the Paris Air Show exhibit code H-833, V-12 CCCP-21142 started a series of glorious flights over Europe. At Le Bourget the brand-new supersonic airliners – the Soviet Tu-144 and the Anglo-French

World helicopter records established by the V-12 helicopter

Date	Record description	Record figure	Test pilot
22.2.1969	Altitude with a load of 15,000 kg (33,075 lb)	2,951 m (9,682 ft)	V. Koloshenko
22.2.1969	Altitude with a load of 20,000 kg (44,100 lb)	2,951 m (9,682 ft)	V. Koloshenko
22.2.1969	Altitude with a load of 25,000 kg (55,125 lb)	2,951 m (9,682 ft)	V. Koloshenko
22.2.1969	Altitude with a load of 30,000 kg (66,150lb)	2,951 m (9,682 ft)	V. Koloshenko
22.2.1969	Maximum load to 2,000 m (6,560 ft)	31,030 kg (69,016.5 lb)	V. Koloshenko
6.8.1969	Altitude with a load of 35,000 kg (77,175 lb),	2,250 m (7,382 ft)	V. Koloshenko
6.8.1969	Altitude with a load of 40,000 kg (88,200 lb)	2,250 m (7,382 ft)	V. Koloshenko
6.8.1969	Maximum load to 2,000 m (6,560 ft)	40,204 kg (88,699.8 lb)	V. Koloshenko

Above: In a demonstration of the V-12's capacities, two PMZ-13 fire engines based on the ZiL-157 are wheeled into the first prototype. The letters on the pre-1983 black number plate of the rear vehicle (89-11 YuASh) indicate it is registered in the Moscow Region. The cargo ramp/door design is clearly visible.

Concorde – happened to be parked alongside the V-12 and were accommodated virtually under its engine nacelles. The American transport and cargo helicopters also shown in Paris – the tandem-rotor Boeing Vertol CH-47 Chinook and the conventional Sikorsky CH-53 Stallion – had much smaller dimensions and were dwarfed by the V-12 ultra-heavy lifter. Sergey Sikorsky, vice-president of the Sikorsky Corporation and the son of Igor' V. Sikor-sky, the great Russian aircraft designer who had emigrated to the USA (he had come to Paris to present the CH-53 helicopter to the public) took a good look at the V-12 and expressed his admiration, saying that 'one could only bow in deference' to such technological achievements.

Aviation specialists were amazed not only by the helicopter's outstanding performance of the but also by the unorthodox design features associated with the powerplant layout and the special gearboxes and transmission to the rotors arranged side-by-side. Thus, the Soviet leaders' 'demonstration plan' was completely fulfilled and the giant helicopter became the star of the show at Le Bourget. That event was followed by demonstration flights in Paris, Copenhagen and Berlin. Reports published abroad spoke of the new

Here, a TZ-22 articulated refuelling bowser on a KrAZ-258 6 x 4 tractor unit is backed into the cargo cabin of V-12 CCCP-21142.

Above: The nose of the second prototype V-12, which is preserved at the Central Russian Air Force Museum in Monino.

machine with admiration. The NATO assigned the reporting name *Homer* to the V-12.

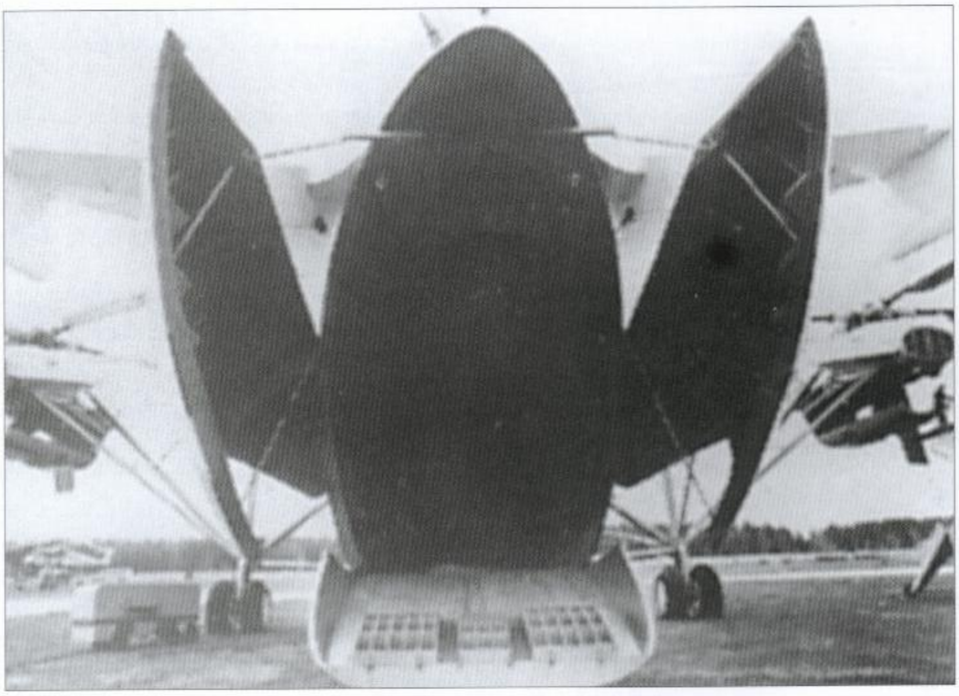
Yet, despite the successful completion of the first stage of the state acceptance trials and the triumph achieved by the machine in Europe, development of the V-12 was running behind schedule. The second flying prototype, which had been assembled at the Mil' experimental production facility in Panki, sat idle in the workshop for a full year, waiting for the engines to be delivered; not before March 1973 could it be flown to the flight test facility for participation in Stage B of the state acceptance trials. The second machine differed from the first prototype (which at that time was undergoing an overhaul for the purpose of pinpointing defective parts and units) in having more rigid control linkage rods and slightly altered rear fuselage support struts. A crew captained by test pilot G. V. Alfyorov was assigned to the second machine. The helicopter performed successful flights, but then suddenly the Air Force refused to accept the machine for the state acceptance trials, citing a number of reasons. The chief reason was that the task for which the V-12 was developed (rapid deployment of strategic ballistic missiles) was no longer on the agenda by the end of the 1960s. The General Staff altered the missiles' deployment concept; in addition, some of the missile systems which were to be served by the V-12 proved disappointing and were phased out. For the same reason the An-22 transport aircraft was manufactured in smaller numbers than originally planned. Other types of military and civil cargoes did not need so acutely such a costly vehicle as the huge V-12 helicopter.

There were other reasons which also had a negative influence on the V-12's production entry. For example, the Saratov aircraft plant, which had been preparing to manufacture the type, had its hands full producing other types of hardware by the time the state commission recommended the V-12 for production. Also, by then the Mil' OKB was already projecting a new-generation helicopter, the Mi-26. Despite being somewhat inferior to the V-12 in payload, the future Mi-26 was considerably superior in terms of technology and economic efficiency. Placing the Mi-12 into production could hamper the progress of the more modern Mi-26. Furthermore, the young Chief Designer Marat N. Tishchenko, who became head of OKB-329 after its founder's death in January 1970, did not yet command sufficient authority to insist on granting production status to a helicopter as unorthodox as the V-12. Thus, the designation 'Mi-12' bestowed upon the machine by some Western journalists turned out to be wishful thinking…

In 1974 all development work on the V-12 helicopter was suspended. The first prototype remained at the OKB's production facility in Panki, while the second prototype was donated to the Soviet Air Force Museum in Monino. Curiously, prior to this the same registration CCCP-21142 was applied to this machine as well.

Nevertheless, the construction and testing of a super-heavy helicopter with side-by-side twin rotors provided much valuable information, and Soviet aircraft constructors were not the only ones who benefited from it. The design staff of the Moscow Helicopter Plant named after M. L. Mil' succeeded in demonstrating the advantages of helicopters featuring a side-by-side twin-rotor layout and proved the viability of the method of 'duplicating' the powerplant/rotor packages for the purpose of increasing their lifting capacity.

General Designer, Doctor of Technical Sciences Mikhail L. Mil' received due recognition for his achievements in the creation of the V-12 and other helicopters. He was awarded the country's highest prizes (the State Prize in 1958 and the Lenin Prize in 1968) and the prestigious Hero of Socialist



This view illustrates the V-12's cargo ramp design, the three hinged vehicle-loading ramps and the clamshell doors with hinged actuating arms and internal stiffening braces.

Above: The cargo cabin of the V-12, sowing the rear pair of entry doors and the cabin heating air ducts running along the walls above the window level. Note the bottom of the cross-shaft's intermediate gearbox casing at the top of the picture.

Labour title (the civil equivalent of the Hero of the Soviet Union title). Many other members of the design team received high government awards. The V-12's design was recognised as an invention for which patents were issued in the USA, Great Britain and other countries.

Structural description of the V-12

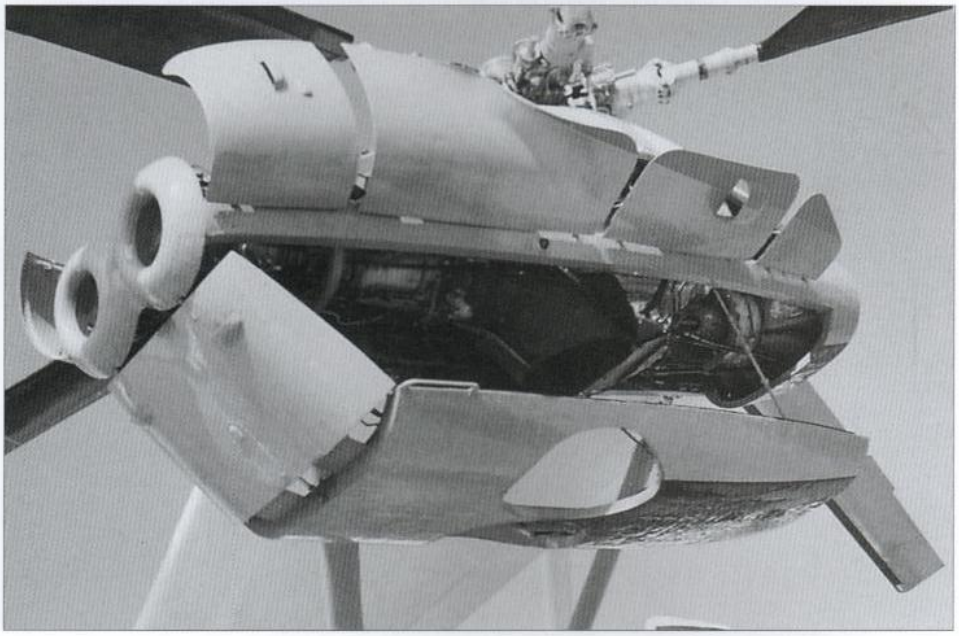
Type: Heavy military transport helicopter designed for day/night operation. The airframe is of riveted all-metal construction.

Fuselage: Conventional semi-monocoque structure; the basic cross-section is oval with the larger axis vertical. Structurally the fuselage consists of three sections.

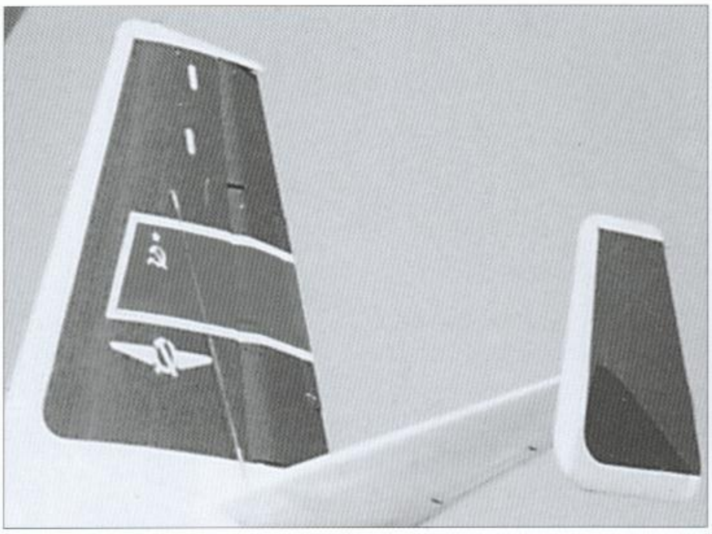
The *forward fuselage* comprises the crew section and the front end of the cargo hold. The crew section comprises two cockpits placed at different levels. The lower level (flightdeck) provides accommodation for two pilots, the flight engineer and the electrics engineer; it features five windshield panels made of optically flat glass, two jettisonable emergency escape doors with bulged windows for the pilots, plus two side windows (the port side one is a sliding direct vision window) and two more escape doors. The upper level is occupied by the navigator (sitting in a domed structure with three windshield panels and two side windows) and the radio operator; there are two small windows to starboard and one to port at his station.

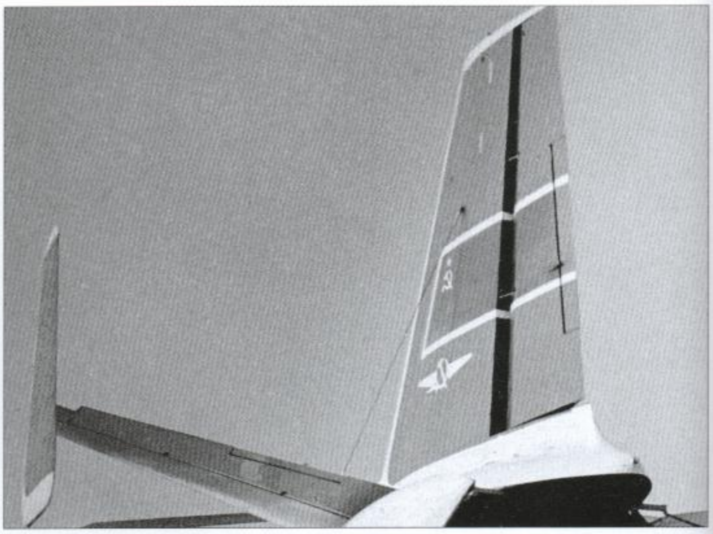
Underneath the flightdeck there is an unpressurised bay for the radar antenna enclosed by a detachable teardrop-shaped glassfibre radome. Further aft, offset to starboard, is the APU bay with ventral air intake and exhaust ports located in tandem.

The constant-section *centre fuselage* accommodates most of the cargo hold measuring 28.15 x 4.4 x 4.4 m (92 ft $4\frac{17}{64}$ in x 14 ft $5\frac{7}{32}$ in x 14 ft $5\frac{7}{32}$ in). The hold has 15 circular windows and two aft-sliding jettisonable doors



Close-up of the port engine nacelle with all cowling panels open for inspection. Note the black 'anti-soot' stripe along the underside of the lower cowling panel aft of the apertures for the jetpipes.





Above, left and right: Two views of the tail unit, showing the rudder and elevators with large trim tabs and the short-range radio navigation system antennas built into the fin.

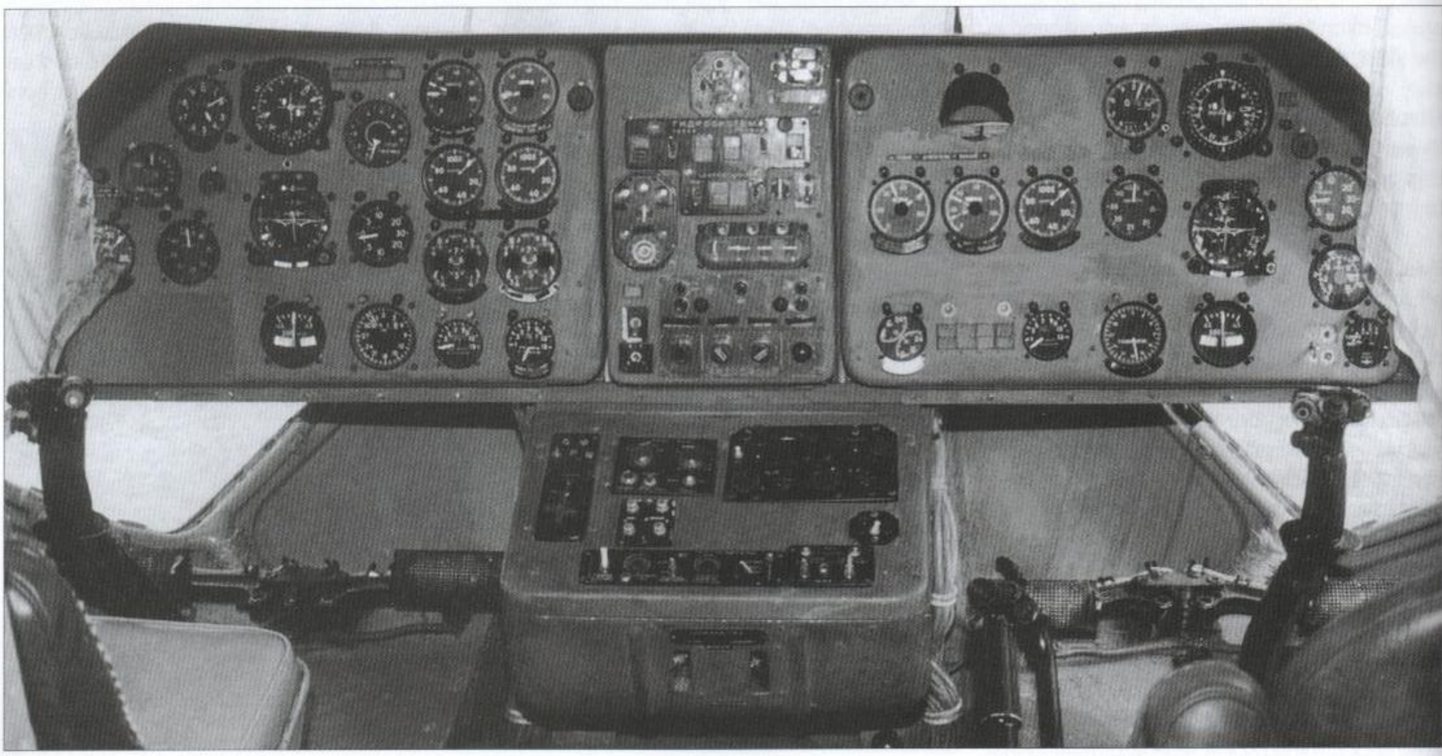
on each side (the window arrangement is 3+1+door+1+2+2+2+door+2). The rear end serves as an attachment point for the hinged cargo ramp; two telescopic supports are provided under the rear end to stop the helicopter from falling over on its tail during loading and unloading. The centre fuselage carries the wings and the complex wing/landing gear trusses. Two KO-50 kerosene heaters are mounted in external fairings ahead of the forward entry doors.

The tapered rear fuselage is cut away from below; the cutout is closed by the hydraulically actuated cargo ramp and two large hydraulically actuated clamshell doors featuring a sharply sloping hinge line. The ramp has two bumpers on which it rests when lowered; detachable vehicle loading ramps can be hooked up to its trailing edge.

Wings: Strut-braced shoulder-mounted monoplane wings of trapezoidal planform with reverse taper, mounted above the fuselage to leave the interior unobstructed. No sweepback at quarter-chord, forward sweep on leading edges, trailing-edge sweepback, marked dihedral and camber from roots.

The wings are supported by highly complex bracing structures (trusses) which include the main landing gear units. There are front and rear horizontal braces and a single strut sloping down from the wing root to form a pyramid inboard of each main gear unit, a V-strut outboard between the main gear unit and the wingtip, and finally a large drag strut running from the wingtip to the centre/rear fuselage joint. Additionally, there are small N-struts between the outboard V-struts and the wing underside, large V-struts linking the drag struts to the wings and smaller V-struts linking the drag struts to the fuselage.

The wingtips carry the engine/rotor packages and house the cross-shaft between them. The wing/fuselage joint is covered by a teardrop fairing housing the intermediate gearbox; the fairing incorporates hinged panels for access to this gearbox. The wing trailing edge is almost entirely occupied by two-section flaps deflecting 90° at low speed and in hovering flight to reduce the wing area impeding the rotor downwash.



The pilots' instrument panels and centre control pedestal of the V-12. Note the different arrangement of the instruments on the captain's and co-pilot's panels.

Tail unit: Conventional tail surfaces of all-metal stressed-skin construction attached to the rear fuselage. The cantilever trapezoidal horizontal tail featuring strong dihedral consists of two stabilisers and one-piece elevators The trapezoidal vertical tail consists of a fin with a prominent fillet and a one-piece rudder, augmented by two trapezoidal vertical endplates at the stabiliser tips. The rudder and elevators feature trim tabs.

Landing gear: Non-retractable tricycle type, with twin wheels on each unit. The levered-suspension castoring nose unit with twin rear jury struts is mounted under the forward fuselage; the main units are mounted on vertical struts forming part of the wing support trusses. All units have oleo-pneumatic shock absorbers; those on the main units are of the two-chamber type. Additionally, two tail bumpers with small twin wheels are mounted side by side ahead of the cargo ramp to protect the fuselage in a tail-down landing. The mainwheels are equipped with pneumatic brakes; steering on the ground is by differential braking.

Powerplant: Four Solov'yov D-25VF turboshafts rated at 6,500 eshp apiece. The D-25VF is an uprated version of the 5,500-eshp D-25V, as described in Chapter 1.

The engines are mounted in pairs in large nacelles mounted at the wingtips. Each engine has its individual air intake and a downward-angled exhaust pipe located about halfway along the nacelle's length. The space aft of the engines is occupied by the main gearbox for each respective pair, with the oil coolers further aft; air enters the oil coolers through scoops on the nacelle's sides and exits via an oval outlet at the rear. The nacelles feature numerous lateral and ventral cowling panels doubling as work platforms for engine/gearbox/oil cooler maintenance.

Engine starting is catered for by a TA-6 APU housed in the forward fuselage.

Powertrain: Each pair of engines drives its own main gearbox based on the R-7 used on the Mi-6/Mi-10; the design of the port and starboard gearboxes is similar but the output shafts are counter-rotating. The two gearboxes are linked by a multi-section cross-shaft passing through the wings to synchronise propeller rotation. A special intermediate gearbox is installed in a fairing above the fuselage (at the wing/fuselage joint) to cater for the 'kink' of the cross-shaft caused by the wing dihedral.

Rotor system: Two five-blade rotors measuring 35 m (114 ft 10 in) in diameter; the port rotor turns anti-clockwise and the starboard rotor clockwise when seen from above. The rotor heads and swashplates are slightly modified versions of similar units used on the Mi-6 and Mi-10. The rotors overlap (the overlap area is 3 m (9 ft 10 in) wide), requiring their rotation speed to be constantly synchronised.

Flight control system: The flight control system is designed in accordance with the following basic principles of helicopter control:

- a change in the propulsive force is effected by simultaneous longitudinal tilting of the swashplates;
- a turn around the vertical axis is effected by a differential change in the longitudinal inclination of the swashplates;
- lift is controlled by changing simultaneously the collective pitch of both rotors;
- roll control is effected by a differential change in the collective pitch of the port and starboard rotors.

Furthermore, the control system is designed with due regard to other special features of the helicopter, such as the considerable length of control linkages, possible deformations of the airframe, the high AUW and considerable friction forces arising in the control linkages during their operation.

The helicopter features a two-stage control system. The first stage consists of the usual helicopter controls: cyclic pitch control sticks, collective pitch levers and directional control pedals, rigid linkages and five intermediate hydraulic actuators of relatively low power. Four hydraulic actuators are incorporated in the control channels, one each for pitch, roll, yaw and collective pitch control, the fifth actuator is connected with the throttle grip and moves the engine control levers simultaneously.

Specifications of the V-12 helicopter

Crew	6
Number of passengers	196
Main rotor diameter	35 m (114 ft 10 in)
Empty weight, kg (lb)	69,100 (152,365)
Weights, kg (lb):	
normal take-off weight	97,000 (213,885)
maximum take-off weight	105,000 (231,525)
Payload, kg (lb):	
normal	20,000 (44,100)
maximum	40,000 (88,200)*
Speed, km/h (mph):	
maximum speed	260 (162)
cruising speed	240 (149)
Hovering ceiling, m (ft):	
out of ground effect	10 (33)
in ground effect	600 (1,968)
Service ceiling, m (ft)	3,500 (11,480)
Operational range, km (miles)	500 (311)
Ferry range, km (miles)	1,000 (622)

*Achieved in a record-breaking flight

Flanked by a Mikoyan MiG-29 fighter (left) and a Sukhoi Su-27M fighter, the second prototype sits in the outdoor display area of the Central Russian Air Force Museum. It wears a different colour scheme from the first prototype, but it was probably repainted on site.

Above: An artist's impression of the V-16 – basically a V-12 with new engines featuring large-diameter low-speed free turbines driving six-blade rotors.

The intermediate hydraulic actuators are installed in the fuselage on a special unit intended for transforming the separate movement of the controls in each control channel into combined inputs addressed to the actuators: the powerful hydraulic actuators for cyclic and collective pitch control which are placed in two pairs on the main gearboxes of the port and starboard powerplants. Simultaneously with the summating of the control inputs by the summating unit the inputs are transferred from rigid push-pull rods to cable linkages whose travel is several times greater than that of the rigid linkages.

In the engine nacelles, in the immediate vicinity of the hydraulic actuators, rigid linkages are again used; this is accompanied by a reduction of the gear ratio.

To enhance effectiveness of directional control at medium and high forward speeds, the vertical tail incorporates a rudder controlled by a special hydraulic actuator for directional control in unison with the movement of pedals. The same principle applies to the elevators which function in unison with the collective pitch changes.

The intermediate hydraulic actuators and special hydraulic actuators for the rudder and elevator are powered by a hydraulic system accommodated in the intermediate gearbox bay; the main hydraulic actuators are powered by hydraulic systems accommodated in the port and starboard engine nacelles.

All three systems are completely independent; each of them comprises a main system and a back-up system. The principles of redundancy and transition from the main systems to the back-up systems are basically similar to the corresponding systems of the Mi-6 helicopter (hydraulic actuator systems) and the Mi-8 (intermediate hydraulic actuator system).

Fuel system: Fuel is carried in wing tanks and external strap-on tanks. Fuel consumption is controlled automatically.

Avionics and equipment: The helicopter is equipped for day/night operations in good and adverse weather conditions. The four-channel autopilot installed in the helicopter and a system automatically maintaining the preset rotor RPM substantially ease the pilot's workload. An ROZ-1 Lotsiya panoramic weather/navigation radar featuring an LTs-1 revolving antenna in a chin radome is fitted.

Cargo and troop-carrying equipment: The rear fuselage incorporates a loading ramp and clamshell doors allowing self-propelled vehicles to be loaded/unloaded under their own power. Wheeled vehicles without engines can be hauled in with the help of powerful electric winches; various other single cargoes weighing up to 5 tonnes (11,000 lb) can be loaded by overhead gantry cranes.

V-16 (Mi-16) heavy transport helicopter (project)

Concurrently with the construction of the V-12 the Mil' OKB was working on the project of the 'ultra-heavy' V-16 helicopter with a lifting capacity of 40-50 tonnes (88,200-110,250 lb) which was regarded as a further development of the V-12. The V-16 was intended for the transportation of large single cargoes, engineer troops materiel and main battle tanks; it was also expected to serve as a logistic base for a mobile intercontinental missile system.

Originally the V-16 project envisaged a three-rotor layout with six D-25VF engines (!). However, it was superseded by a project representing basically a V-12 powered by two high-output gas-turbine engines featuring low-speed free turbines with vertical shafts. The work on the project was discontinued before it reached the detail design stage.

Mi-12M heavy transport helicopter (project)

In 1966 the Mil' OKB used the project of the V-16 helicopter as a basis for preparing a proposal envisaging a further upgrading of the V-12; the new version was designated Mi-12M. In accordance with this project the four D-25VF engine installed on the V-12 were to be replaced by two 20,000-eshp Solov'yov D-30V turboshafts (based on the D-30 turbofan; V stands for *vertolyotnyy* – helicopter, used attributively). The number of blades in each rotor was increased to six. The Mi-12M was intended to transport a load of 25 tonnes (55,125 lb) over a distance of 500 km (311 miles) and a load of 40 tonnes (88,200 lb) over a distance of 200 km (124 miles). This proposal received support from the Government, but the cancellation of the V-12 programme caused the work on the Mi-12M to be discontinued when it had reached the full-size mock-up stage.

A model of the projected Mi-12M. Note the large-diameter jetpipes of the D-30V engines and the six-blade rotors.

Chapter 4

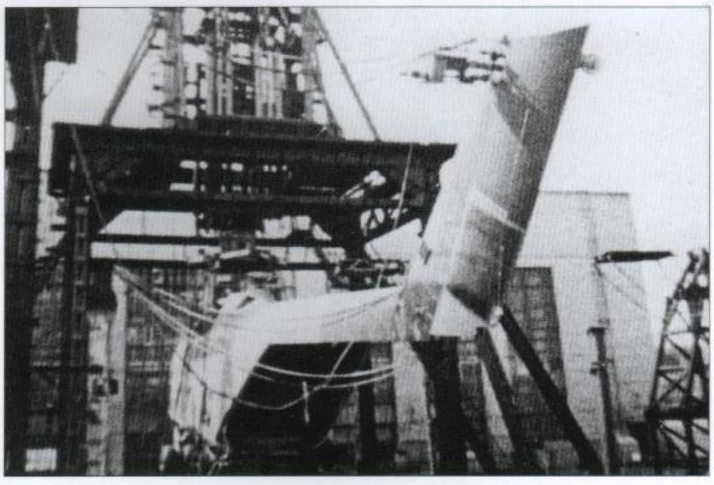
The New Generation

Mi-26 heavy transport helicopter

Since the early 1960s the Mi-6 remained the main heavylift transport and assault helicopter of the USSR for a decade. By the early 1970s, however, the complexity and scope of the tasks to be tackled by the country's helicopter fleet grew considerably, and the machines currently operated proved incapable of meeting them to the full extent. Studies undertaken at that time revealed an increasing need for the transportation of bulky cargoes weighing up to 20 tonnes (44,000 lb) over distances of up to 800 km (500 miles). These cargoes were primarily the new prospective types of armament for mechanised infantry divisions; importantly, the localities of eventual operations could be placed as high as 1,500 m (4,900 ft) above the sea level. Therefore the Mil' Moscow Helicopter Plant (headed by Chief Designer Marat N. Tishchenko since 1970) embarked on projecting heavylift helicopters of a new generation. At the same time the programme of the development of the V-12 ultra-heavy transport helicopter was wound up.

Above: 'The Partially Invisible Helicopter' – the Mi-26's full-scale powerplant/dynamic components test rig.

Chief Designer G. P. Smirnov and his deputy A. G. Samoosenko were directly responsible for managing the work on the new programme. The creation of the new heavylift transport and assault helicopter started with selecting the machine's layout and determining its basic characteristics. At first the designers tried to utilise as much as possible the production units and assemblies that had been used on the Mi-6 and V-12, as well as a number of technical features evolved earlier. Several layouts were considered for the future machine; they included a single-rotor layout, a side-by-side twin rotor layout and a tandem twin-rotor layout. The tandem twin-rotor layout appeared to be the best option (incidentally, it was this layout that was chosen by the designers of the XCH-62 in the USA). This layout promised some advantages, such as the reduction of the main rotor diameter and of the power transmitted by the main gearboxes, allowing the rotors and gearboxes to be made smaller and lighter; in addition, this would obviate the need for a large tail rotor, development of which could be a problem. However, studies revealed that in the long run a tandem-rotor helicopter would be a considerably heavier and more complex machine, among other things, due to the presence of cross-shafts between the two main gearboxes. Preliminary calculations showed that the intention to utilise units and assemblies from earlier helicopters in the new machine, as well as to resort to the previously tried design methods, would hardly be conducive to success, whichever layout was chosen. The take-off weight of the new helicopter could come close to 70 tonnes (some 154,000 lb), and it was necessary to reduce this figure to approximately 50 tonnes (110,000 lb).



Left and right: The static test airframe of the Mi-26 suspended under a gantry-type test rig which was used for testing the landing gear for crashworthiness.

Above: The full-scale mock-up of the Mi-26 nearing completion at Plant No.329 in Panki, with the tail rotor of a Mi-6 in the foreground.

Above: The rollout of the Mi-26 prototype, CCCP-06141 in October 1977. Cloth covers are fitted over the engine air intake filters, cooling fan intake and jetpipes. Note that the helicopter lacks Aeroflot titles.

A crane is used to install the Mi-26 prototype's main rotor blades. The vehicle in the background is an AGP series 'cherry picker' servicing platform based on a petrol-engined Ural-375D 6 x 6 army lorry.

Research undertaken by the Moscow Helicopter Plant (MVZ) together with TsAGI and the Central Aero Engine Institute (TsIAM – *Tsen***trahl'***nyy insti***toot** *aviatsi***on***novo mo***to***rostro***yen***iya*) prompted the designers to opt for the classical single-rotor layout. The new-generation heavylift helicopter was allocated the designation Mi-26 (product code '*izdeliye* 90'). Its PD project was approved by the Scientific and Technical Council of the Ministry of Aircraft Industry (MAP) in December 1971, and in the following year the MVZ received positive assessments from several institutes subordinated to MAP and the Ministry of Defence. In accordance with the Customer's requirements, the helicopter was intended to transport cargoes weighing up to 20 tonnes (44,000 lb) over a distance of 400 km (250 miles), while having a static ceiling in excess of 1,500 m (4,900 ft).

To attain these performance characteristics, a powerplant was needed with a total output of at least 20,000 eshp. It was envisaged that the powerplant would comprise two 11,400-eshp D-136 turboshaft engines. Development of this engine had just begun at the Zaporozhye-based 'Progress' Engine Design Bureau (ZMKB 'Progress' – '*Zapo***rozh***skoye mo***tor***no-kon***strook***torskoye byu***ro**, formerly OKB-478) headed by General Designer V. A. Lotarev. The new turboshaft was based on the core of the D-36 turbofan, Chief Designer F. M. Muravchenko being directly responsible for the design. The engine featured a modular design incorporating a system for early detection of failures, which held a promise of considerably easing engine repair and maintenance. The powerplant was expected to incorporate as standard an integral system for automatically maintaining the pre-set main rotor RPM and harmonising the power of the engines; in the event of an engine failure the system would automatically set the live engine to contingency mode. In this case the power of one engine should be sufficient to enable the helicopter to continue climbing and to hover in ground effect, providing the all-up weight did not exceed 40 tonnes (88,200 lb).

Certain difficulties were posed by the problem of transmitting the enormous output of the powerplant to the main rotor; this problem was successfully tackled by developing the VR-26 main gearbox. It was developed in-house by MVZ (previously the main gearboxes had been developed by engine design bureaux). In the design of the VR-26 the heavy planetary layout was relinquished in favour of a radically new three-cascade layout. This innovation, coupled with some other new features, made it possible to transmit to the main rotor twice the power and 50% greater torque compared to the Mi-6 at the cost of an insignificant increase of the gearbox's weight.

Above and below: The first prototype Mi-26 during initial flight tests. Note the asymmetrical door/window arrangement, the port side maintenance access steps, the air data boom attached to the nose radome and the strakes on the clamshell cargo doors. These strakes were later deleted as unnecessary.

Above: A head-on view of Mi-26 CCCP-06141 with the air data boom in place.

The MVZ specialists paid much attention to selecting the optimum parameters of the main rotor. Following research work conducted together with TsAGI, they developed rotor blades of metal and glassfibre construction which increase the main rotor efficiency considerably. The rotor had eight blades and measured 28 m (91 ft 10½ in) in diameter. It proved to be 40% lighter than the five-blade rotor of the Mi-6. For the first time the rotor head was made of a titanium alloy which ensured great fatigue strength and a 15% weight reduction as compared to the Mi-6's rotor head. No less innovative was the design of the tail rotor whose blades featured an all-glassfibre construction (as the reader remembers, they were wooden on the Mi-6). As a result, the five-blade tail rotor of the Mi-26 developed twice the thrust and had a 1.4 m (4 ft 7⅛ in) greater diameter while retaining the same weigh as the Mi-6's tail rotor.

When projecting the Mi-26, its designers sought to make the fullest use of the experience gained in the course of its predecessor's service career. For example, the engine air intakes were provided with vortex-type dust/debris filters separating 65-70% of the dust; subsequently this enabled the helicopter to operate in dusty localities virtually with no detriment to the engines' service life and at the cost of a minimum derating. To obviate the need for external electric power and compressed air sources, the helicopter was provided with an APU; to make the machine independent of ground ladders and work platforms for maintenance, the hinged engine cowling panels doubled as work platforms; a crawlway to the tail rotor was arranged inside the tailboom and the tail rotor pylon.

Furthermore, improvements were made concerning the mechanisation of cargo handling procedures: the Mi-26 featured two electric winches and an overhead gantry crane with a lifting capacity of up to 5 tonnes (11,025 lb). The hydraulically-operated cargo ramp could now be controlled not only from the flight engineer's workstation or from the cargo hold, but also from outside the fuselage. It could be fixed in a horizontal position, enabling the helicopter to carry items of outsize length. On the ground the cargo ramp could be fixed in a position level with a truck bed or a ground loader. The design of the main undercarriage units made it possible to change the ground clearance of the parked helicopter by slightly raising the aft fuselage, making it possible to align the load with the cargo ramp. To provide unrestricted access of vehicles to the loading hatch, the tail bumper was retracted to lie flush with the tailboom's undersurface. The external suspension system enabled the helicopter to carry outsize cargoes weighing up to 20 tonnes (44,100 lb). The helicopter could be outfitted for Casevac duties within a few hours; in this case it was equipped with 60 stretchers and three seats for medical attendants.

The new helicopter's navigation avionics suite included a weather radar which permitted the machine to operate around the clock in visual and instrument weather conditions. The Mi-26's flight control system incorporated a three-channel autopilot, systems for trajectory and flight director control; there was also a state-of-the-art flight data recorder system and a voice warning system informing the crew of emergency situations in flight.

During the development of the Mi-26 much attention was paid to experimenting with full-size assemblies and units of the helicopter for the purpose of perfecting their design. For example, a unique testbed was built for testing the powerplant and the main rotor; it remains unmatched to this day. Very interesting experiments were conducted on another test rig where a full-size fuselage of the machine was dropped to test its impact survivability. Valuable information was obtained during the flights of a Mi-6 converted into a testbed for the purpose of testing the Mi-26's main rotor.

Mi-26 (*izdeliye* 90) heavy transport helicopter prototypes

Construction of the full-size mock-up of the Mi-26 started in 1972, and its approval by the mock-up review commission took place three years later. By then the work on projecting the machine was largely completed. Two more years of intensive work passed, and in October 1977 the first flying prototype, registered CCCP-06141, was rolled out of the assembly shop of the MVZ experimental production facility in Panki. On 14th December, after six weeks of ground development work, the Mi-26 took to the air for the first time for a

Mi-26 CCCP-06141 hovers for the first time on 14th December 1977. No air data boom is fitted yet. Note that the black anti-soot panels near the engine jetpipes were considerably enlarged later.

Above: Mi-26 CCCP-06141, now with Aeroflot titles, a red radome and the Le Bourget exhibit code H-351, swallows an ATs-40-131 fire engine, with a KrAZ-255B1 heavy-duty 6 x 6 lorry waiting its turn. Note the entry door design.

three-minute hover. The machine was flown by a crew captained by project test pilot Gourguen R. Karapetyan. In February 1978 the helicopter was ferried to the flight-test facility of the Mil' firm in Lyubertsy where the main part of the manufacturer's tests was conducted.

The Mi-26 passed joint state acceptance trials at GNIKI VVS (State Research Institute of the Air Force) between May 1979 and August 1980. The first prototype was soon joined by the second prototype which was also built by the MVZ. During the state tests the two helicopters performed a total of 150 flights, logging 104 flight hours between them; they did not pose any problems worthy of note to the crews. As a result the Mi-26 was recommended for series production and for introduction into the inventory of the Soviet army.

Mi-26 heavy transport and assault helicopter

The Rostov helicopter plant No.168 (renamed RVPP Rostvertol in 1992) began tooling up for the manufacture of the Mi-26 as early as 1976, when the state acceptance trials were still in progress. Officially the helicopter entered series production on 4th October 1977. Concurrently the Motorostroitel' (Engine Constructor) Production Association (formerly plant No.478; now called Motor-Sich Joint-Stock Co.) in Zaporozhye, the Ukraine, started series manufacture of the D-136 turboshaft. The engine proved to be very successful; in addition to a very high power rating, it featured a low SFC of only 9.206 kg/hp (20.29 lb/hp). Coupled with the very good aerodynamics of the helicopter with its beautifully streamlined fuselage, this made it possible to obtain an unprecedentedly low fuel burn per tonne of payload. The D-136's Chief Designer F. M. Muravchenko received the State Prize for his contribution to the development of the new helicopter. The same kind of prize was awarded to a number of employees of MVZ, including O. P. Bakhov, while M. N. Tishcheko, who was promoted to the rank of General Designer, received the Hero of Socialist Labour title.

In the evening of 4th October 1980 the first production Mi-26 (possibly c/n 34001212002; fuselage number 0101 – that is, batch 01, 01st aircraft in the batch) was rolled out from the final assembly shop in Rostov-on-Don and towed to the flight test facility for ground development. The first hover flight took place at noon on 25th October; it was followed by a circuit flight on the following day. In both cases the helicopter was piloted by an MVZ test crew comprising pilots G. R. Karapetyan and A. P. Grooshin, navigator B. I. Meshkov and flight engineer A. F. Denisov. Further tests of the first production Mi-26 were conducted jointly by crews from the plant and the customer (that is, the Air Force).

(Note: Mi-26s intended for the home market have 11-digit construction numbers. The first eight digits are invariably 34001212 and remain unexplained; the remaining three are individual and appear to run in sequence – though there were very probably gaps in the sequence in order to confuse would-be spies. Additionally, Mi-26s have *fuselage numbers* showing the batch number and the number of the machine within the batch. So far it has not

The first prototype (already with the red radome but still without titles) during a test flight.

Above: Mi-26T CCCP-06197 (c/n 34001212030) owned by the Mil' Moscow Helicopter Plant displays traces of the Le Bourget '89 exhibit code H-380 on the rear fuselage.

This Mi-26 wearing a dark camouflage scheme is probably intended for the Indian Air Force. It is seen here undergoing pre-delivery checks at the factory airfield in Rostov. Note the folding work platforms underneath the engine jetpipes; these are usually obscured by the 'anti-soot' panels.

been possible to match the two systems; the only exception is a Soviet Air Force Mi-26 manufactured on 27th December 1982, which was c/n 34001212013 and f/n 0303. The first batch included three machines (f/ns 0101 through 0103), the second batch included five (f/ns 0201 through 0205). Further production proceeded in batches of ten. Batch 4 is an exception comprising eleven airframes; the last of these, f/n 0410A, was delivered to TsAGI for static tests in 1985.

Export examples, as well as some Mi-26s intended for export but not delivered, have six-digit c/ns under what may be called the 'Aviaexport system'. This, too, does not indicate the batch number or number of the aircraft in the batch – for exactly the same security reasons. The first three digits are a country code, the first one indicating the region; for instance, 226 equals Iraq (1 = Europe, 2 = Asia and the Middle East, 3 = Africa, 4 = Central America and the Caribbean, 5 = South America). The fourth digit is apparently always a 2 and the other two digits are the sequence number of the Mi-26 built for export. Thus, Mi-26T LZ-MOA (c/n 226206) manufactured on 31st January 1990 is the sixth example built for export and was intended for the Iraqi Air Force.

The c/n is embossed on small metal plates found on the left-hand side of all three cabin doors (that is, the leading edge of the port side doors and the trailing edge of the starboard door), as well as on the forward bulkhead of the cargo hold (near the roof access hatch on the port side), the rear end of the cargo ramp, the two vehicle loading ramps hinged to the latter and on some equipment items on the walls of the cargo hold. It pays to check several of these plates, as there are cases when Mi-26s swap doors and other items with the c/n on them in the course of an overhaul! The c/n is also stencilled on the port wall of the flightdeck and on the right-hand side of the tunnel for the external sling lock in the freight hold floor.)

The testing of production machines did not always proceed smoothly. For example, the aforementioned Mi-26 c/n 34001212013 operated by the Flight Research Institute (LII) crashed at an industrial airfield known by the callsign Kazbek on 8th July 1987. A landing approach with an excessively nose-high attitude after a test flight ended in a tailstrike, whereupon the tailboom broke off, the helicopter spun to the left, rolled over on its starboard side and burst into flames. Luckily the crew survived. On another occasion a test flight with the objective of developing the technique of a single-engine rolling landing on a small landing site in a fully fuelled helicopter ended in a crash. After the touchdown the Mi-26 bounced and then crashed on its starboard side, snapping off the tailboom.

Above: This Mi-26T (RA-06089, c/n 34001212499) wears the smart red/blue/white colours of Rostvertol.

Again the machine was destroyed by the ensuing fire but the crew of six, which included Merited Test Pilot V. P. Somov as co-pilot, succeeded in escaping from the blaze. After this accident recommendations were evolved for improving the landing gear shock absorbers and reinforcing the tailboom. Possibly the aircraft in question was Mi-26T CCCP-06003 (c/n 34001212106) of the Tyumen' CAD/1st Tyumen' UAD, which was damaged beyond repair at Labytnangi airport, Tyumen' Region, on 14th May 1989 during a single-engine training session.

Production Mi-26s were intended primarily for equipping the helicopter regiments of the Air Force; deliveries to the Aeroflot ranked second in importance. The military version differed from the civil configuration in being equipped with chaff/flare dispensers in prominent fairings on the fuselage sides and mounts for hand-held weapons at the cargo cabin windows. Soviet Air Force Mi-26s were delivered in a two-tone green camouflage scheme.

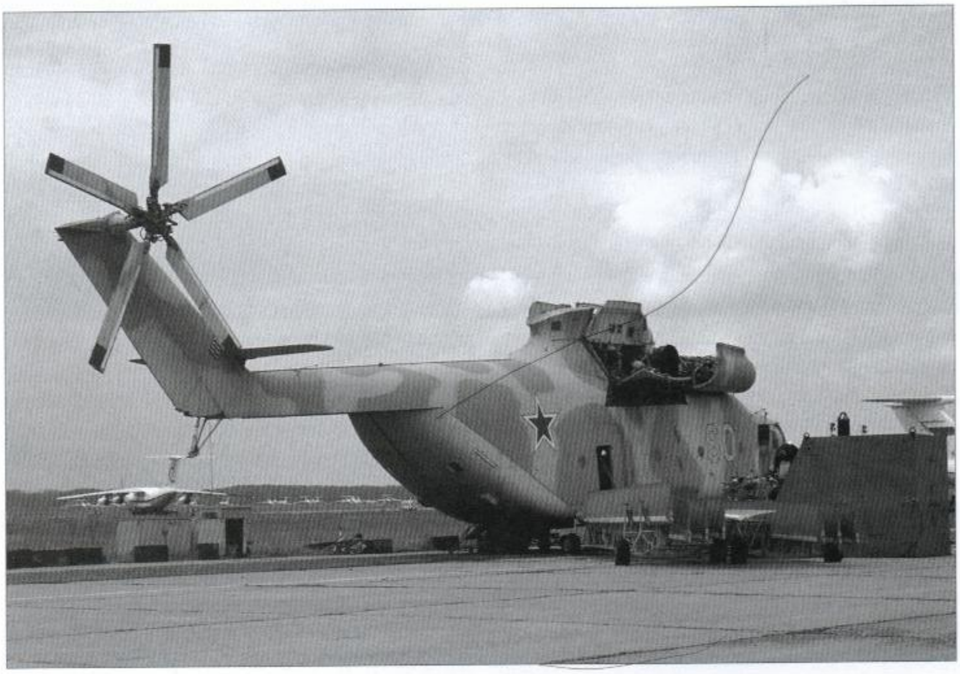
Mass deliveries of the Mi-26 to the Armed Forces and to Aeroflot had not yet started when this helicopter set a series of world records. For example, on 4th February 1982 a crew captained by test pilot G. V. Alfyorov performed a flight in which a payload of 25 tonnes (55,125 lb) was lifted to an altitude of 4,060 m (13,320 ft); in this flight the helicopter climbed to 2,000 m (6,560 ft) at an all-up weight of 56,768.8 kg (125,151.6 lb), which was also a world record. In the same year a Mi-26 crew captained by woman pilot Inna Kopets set nine world records for women. When the machine was already in widespread service, military test pilots beat one more world record that had been set by the Mi-8 back in 1967. Preparation for this flight was conducted at GNIKI VVS under the direction of project engineer Yu. Krylov. On 7th August 1988 a crew comprising Test Pilots 1st Class A. Razbegayev and A. Lavrent'yev, Merited Test Navigator L. Danilov and flight engineer A. Boorlakov passed the Moscow-Voronezh-Kuibyshev-Moscow closed-circuit route spanning over 2,000 km (1,242 miles) at an average speed of 279 km/h (173 mph). It is worth noting that the final stretch of the route was compounded by an atmospheric front accompanied by severe turbulence and a rain shower.

Along with the pilots of the Mil' Moscow Helicopter Plant and GNIKI VVS, a notable contribution to the Mi-26 development history was made by LII test pilots. For example, in 1986 this institute was engaged in evolving the techniques of transporting an outsize cargo weighing 37 tonnes (81,570 lb) by two helicopters. During one of the flights a faulty bar of a suspension unit on the helicopter piloted by A. Makarov caused a disengagement of the sling. This was fraught with the danger of a crash for the second helicopter captained by A. Grishchenko. The tragedy was averted thanks to the instantaneous reaction of co-pilot V. Somov who jettisoned the cargo. That marked the end of the unique experimental job.

By 1998 LII had completed comprehensive flight testing of the Mi-26 for the purpose of assessing the special features of the airframe stressing within the range of admissible flight speeds, determining the longitudinal stability and controllability characteristics and studying the machine's behaviour during landings in autorotation mode. This research was intended to enhance the operational capabilities of the helicopter.

The Mi-26 was shown to the general public for the first time in June 1981 at the 34th Paris Air Show where it became the star of the show. It was allocated the NATO reporting name *Halo*.

Above: Mi-26 '04 Yellow' in company with Mi-6A '16 Yellow' and a Mi-24P at Kubinka AB. Note the characteristic chaff/flare dispensers above the main gear units fitted to most Soviet/CIS military examples.



Above: A Russian Air Force Mi-26 coded '80 Yellow' sits with the main gearbox removed for repairs. The main rotor blades are placed on a special trolley beside the helicopter.

The same Mi-26 transitions to forward flight after take-off.

Mi-26T heavy commercial transport helicopter

On 12th January 1985 a civil version of the helicopter designated Mi-26T (***trahns***_portnyy_ – transport, used attributively) was put into series production. The commercial version differed from its military stablemate primarily in the navigation avionics suite; it lacked the chaff/flare dispensers and the mounts for assault rifles. The complement of equipment designed to enhance the machine's capabilities for operating with slung cargoes was considerably increased. For example, the load azimuth orientation system ensures its optimum position during cruise flight and external load orientation in the hover. A system for damping oscillations through the autopilot counteracts the possible swinging of the load. An electronic weight-measuring system determines the weight of the load in the hover with an error margin of 1%; the machine features DG-65 or VTDG-20 electrically operated locks making it possible to disengage the load without assistance from the cargo handling personnel. An external suspension system fitted with a special spreader bar permits the transportation of standard marine containers without assistance from cargo handling personnel. The versatile stabilising platform (USP – _ooniver_***sahl'***_naya stabili_***zee***_ruyushchaya plat_***for***_ma_) makes it possible to increase the flight speed with bulky elongated items (such as a prefabricated hut, a container or a pipe) on a sling to 200 km/h (124 mph) and reduces the fuel consumption by up to 50%. In addition, the range of devices utilised by the Mi-26 was supplemented by an automatic grip for handling large-diameter oil and gas pipes and a grip for logging operations in mountainous areas.

Mi-26TS (Mi-26TC) heavy commercial transport helicopter

The next stage in the helicopter's improvement was to incorporate measures enhancing operational reliability and survivability in emergency situations. For instance, the aluminium push-pull rods in the control system were replaced by steel ones to reduce the risk of their melting in the event of an in-flight fire, with an ensuing loss of control.

In this guise the machine was certified by the Air Register of the CIS Interstate Aviation Committee (AR MAK – _Aviatsi_***on***_nyy re_***ghistr*** _Mezhduna_***rod***_novo aviatsi_***on***_novo komi_***teta***) in accordance with the Russian NLGV-2 Airworthiness Regulations for Civil Helicopters harmonised with the American FAR-29 regulations. The new version received the designation Mi-26TS (_sertifi_***tsee***_rovannyy_ – certified) on 27th September 1995. In advertising materials for the export market, however, the helicopter is referred to as the Mi-26TC.

Mi-26T2 heavy transport helicopter

Currently MVZ and Rostvertol are jointly considering equipping the Mi-26 with state-of-the-art avionics, including a 'glass cockpit' (an electronic flight instrumentation system) and an undernose electro-optical survey system. These measures appear certain to make the helicopter more attractive for potential customers. The introduction of a system for monitoring the technical condition and service life of airframe units will reduce the maintenance man-hours by some 20%. Fitting the helicopter with an advanced navigation system, flight and navigation instruments, a moving-map display, a new radar, powerplant monitoring instruments, a precision system for flight control in the hover, night-vision goggles and so on will allow the flight crew to be reduced to two pilots, automating away the navigator and the flight engineer.

Designated Mi-26T2, the proposed upgrade was unveiled at the Farnborough International 2002 airshow in the form of a working flightdeck mock-up; the same mock-up was later demonstrated at the MAKS-2003 (19th-24th August 2003). According to the estimates of Western experts, 'the upgraded Mi-26T2 could fetch between $15 million and $18 million on the world market, whereas the standard Mi-26 costs from $11 million to $13 million'.

Mi-26TM heavy transport and 'flying crane' helicopter

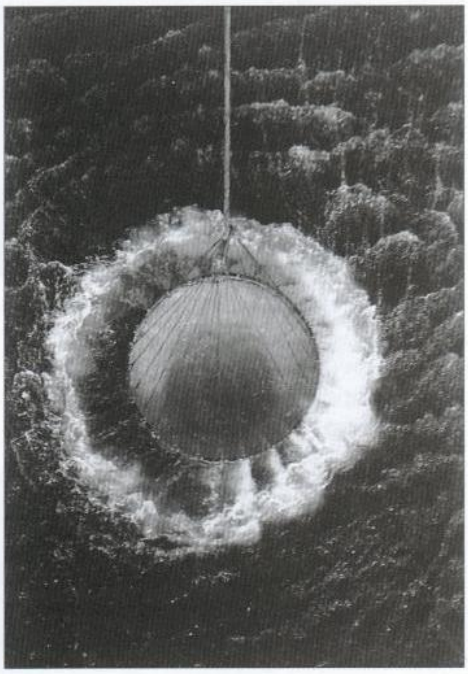
A natural direction of work in modifying the helicopter was the enhancement of its potential for performing construction and installation jobs. The Rostvertol Joint-Stock Co. developed a version designated Mi-26TM (*modifitseerovannyy* – modified) and fitted with an additional cockpit for the pilot/operator.

Two alternative upgrade versions are offered. In one of them, a rear cockpit with fly-by-wire controls is fitted in place of the loading ramp and clamshell doors which are removed, in a similar manner to the smaller Mi-8MTV-1K 'flying crane'. In the other version a cockpit with a set of controls mechanically linked to the existing ones can be suspended under the centre fuselage between Frames 3-5. The additional cockpit is provided with an instrument panel, a fan, window wipers, a seat with an adjustable back and jettisonable side blisters allowing rapid escape in an emergency. This cockpit was publicly unveiled in mock-up form at the MosAeroShow '92 – Russia's first real international airshow held at Zhukovskiy on 11th-16th August 1992.

The Mi-26TM prototype with the ventral cockpit (RA-06089, c/n 34001212499) owned by Rostvertol made its first flight on 13th November 1992; at that point the machine was still in Aeroflot livery with additional 'Rostvertol – Russia – Rostov-on-Don' titles. From

Above: Unregistered Mi-26TS c/n 34001212511 in red/white Moscow Fire Department colours at the MAKS-2001 airshow. This helicopter was later registered RA-06285.

Above: Mi-26TS (c/n 34001212511) with a VSU-15 'Bambi Bucket' shows its firefighting capabilities.



The VSU-15 is replenished from a body of water.

30th August to 5th September 1993 the same machine was displayed at the MAKS-93 airshow in Zhukovskiy in a new all-white colour scheme with huge 'MI-26TM' titles (the M was later deleted) and the code '059'.

The prototype of the version with the rear cockpit (-06088, c/n unknown) followed on 15th October 1993. Apparently no more Mi-26s were thus modified.

Mi-26PK heavy transport and 'flying crane' helicopter

In Moscow the initiative of the Rostov factory's designers did not find support – obviously because the head office had a competing project of its own. In 1997 MVZ offered its own 'flying crane' modification designated Mi-26PK (*podvesnaya kabina* – suspended cockpit). As the name suggested, a lateral pilot/operator cockpit accessible from inside the cargo hold was installed in place of the port forward entry door; it was fitted with a set of controls connected to the existing ones by mechanical linkages.

The Mi-26PK prototype was converted from the abovementioned Mi-26T RA-06089, which still had the characteristic ventral cockpit. Apart from the addition of the port side

Mi-26TP RA-06183 (c/n 34001212477 belonging to Rostvertol drops a load of water at Ghelendjik.

cockpit, the machine had a device looking like a cathode-ray tube (CRT) display in a boxy housing installed on the port side of the nose immediately ahead of the captain's windscreen. In this guise the helicopter was displayed statically at the MAKS-97 airshow (19th-24th August 1997). Four years later a Russian Air Force example coded '80 Yellow' (c/n 34001212081) was in the static park at the MAKS-2001 airshow (14th-19th August 2001). This Mi-26 boasted an identical external cockpit (except for the addition of an extra navigation light above the windows) but lacked the device on the nose seen earlier on RA-06089; the external cockpit was painted to match the helicopter's camouflage scheme and sported the logo of the *Vzlyot* (Take-off) specialised air services enterprise which operated the helicopter.

Mi-26K heavy 'flying crane' helicopter (project)

For quite a few years MVZ has been working on a project of a radical redesign of the *Halo* – the Mi-26K heavy crane helicopter with a crew of six. Making use of the idea that had proved its worth on the Mi-10 and mating it with the design features used by Sikorsky on the S-64 (CH-54), the Mil' OKB's decided to mate the existing crew section with a new thinner fuselage and new main undercarriage units closely resembling those of the Skycrane. The machine was to have a maximum take-of weight of 54 tonnes (119,000 lb), a maximum payload of 25 tonnes (55,125 lb), a cruising speed of 200 km/h (124 mph) with a slung load, a range of 520 km (323 miles) with a payload of 17 tonnes (37,500 lb) and a hovering ceiling of 1,800 m (5,900 ft). There were plans to put the Mi-26K into production in 1996, yet not even a prototype has been built up to now due to funding difficulties.

Mi-26TP fire-fighting helicopter

On 16th August 1994 the Mi-26TP experimental fire-fighting helicopter took to the air for the first time in Rostov. It is intended for putting out fires, including fires at industrial sites, in all geographical types of localities and for delivering various items of special equipment and fire-fighting teams. The helicopter's fire-fighting equipment comprises an operator's workstation, four water tanks with a total capacity of 15 m³ (529.7 cu ft), two reservoirs for chemical agents (fire retardant or foaming agent) with a volume of 0.9 m³ (31.78 cu ft), a system for pressurising these tanks to a level of 1.4 kg/cm² (20 psi), a system for ejecting the fire extinguishing liquid through a manifold passing through the standard external sling hatch and a system for dosing the chemical agents fed to the water tanks.

The helicopter is also equipped with a thermal imaging device, a satellite navigation system, means of individual protection for the crew when operating in smoky environments and means of communication with the fire-fighting teams operating on the ground.

The engineers responsible for the modification claim that any standard Mi-26 can be outfitted as a Mi-26TP firebomber in just one hour. The discharge of water takes 35-45 seconds and the replenishment of the water tanks on the ground takes not more than two minutes.

Mi-26 fire-fighting versions with external tanks

A different fire-fighting system based on the Mi-26 has been tested by Rostvertol; the helicopter is equipped with an external suspension system with a 60-m (197-ft) centrally attached sling carrying a block of modules comprising two EP-8000 tanks. However, this version does not seem to hold much promise because a mobile refilling station is required for filling the tanks with water.

Much more attractive is the option envisaging the use of the Mi-26 with the so-called Bambi Bucket flexible tanks which have proved their worth in 72 countries in the course of 25 years of operation. In this fashion the Mil' helicopter can deliver 19,600 litres (4,312 Imp gal) of water to the fire site in one pass. Electric remote control makes it possible to discharge the water from the tanks in a 'salvo' or one by one. Provided that one turnaround during the fire-fighting operation is accomplished within five minutes, the cost of delivery per litre of water is a mere 0.05 cents (as compared to 0.33-0.55 cents for fixed-wing aircraft, according to US estimates).

Tests involving a Mi-26TS belonging to Krasnodar-based NII PANKh (*Naoochno-issledovatel'skiy institoot primeneniya aviahtsiï v narodnom khozyaistve* – Research Institute for the Use of Aviation in the National Economy) and equipped with Twin Bambi Buckets holding in all 15 tonnes (33,000 lb) of water were conducted near *stanitsa* (Cossack village) Lazarevskaya, Krasnodar Territory, in 1997. They showed that the helicopter was stable with this load at speeds up to 227 km/h (141 mph). After that the machine made a good showing in Turkey, whereupon a contract was signed for fire-fighting operations in Italy and Spain. During the operations on the Apennine Peninsula the airmen from Krasnodar started their working day at 7.00am and finished it after sunset; they were warned that if the helicopter was not airborne within 15 minutes after the scramble order, the crew would be faced with a fine exceeding the cost of one hour's operation of the helicopter.

On 13th September 1997 Rostvertol officially handed over one Mi-26TM (HL9261, c/n 071217) to Samsung Aerospace Ltd. of South Korea. Between January and April 1998 this helicopter was engaged in fighting forest fires in Ulsan Province, making use of the Twin Bambi system. Thanks to the Mil' heavylifter, the damage caused by the fire was reduced by 83-85% as compared to the previous year when only light helicopters were used.

On 17th September 1997 yet another fire-fighting version of the Mi-26 performed its first flight, also in Rostov. It was equipped with the indigenous VSU-15 'Bambi Bucket' (*vodoslivnoye oostroystvo* – water discharge device) with a capacity of 15 m³ carried by the helicopter on a sling. This device was designed, manufactured and tested by the Technoex company of St. Petersburg jointly with NPK PANKh (ex-NII PANKh; NPK = Naoochno-proizvodstvennyy kompleks – Science & Production Complex). It can be transported over big distances in the cargo hold of the Mi-26. The VSU-15 can be filled with water from any open water reservoir in the hover in a matter of 10 seconds. The discharge of the water takes 15 seconds.

In 1998 the VSU-15 was put into series production, and four Mi-26Ts equipped with these devices have already been delivered to detachments of the Russian Ministry for Civil Aid and Protection (EMERCOM of Russia). On 19th August 1999 one such machine (c/n 34001212511) was officially handed over to the Fire Department of the Moscow City Police Department in the course of the MAKS-99 airshow (this machine was based on the Mi-26TS and wore appropriate nose titles). Originally bearing only the Russian nationality prefix, the helicopter was later registered RA-06285.

Mi-27 airborne command post

The Mi-26 served as the basis for several special-mission military versions. In the mid-1980s MVZ was engaged in developing an airborne command post designated Mi-27 which was envisaged as a successor to the obsolescent Mi-22. The helicopter's cargo cabin was divided by transverse partitions into a 'war room' for the HQ staff, an equipment bay and a utility compartment. The 'war room' compartment accommodated six staff work stations. The adjoining section provided accommodation for a team responsible for operating the mission equipment and maintaining communications; in case of need this section could be used for setting up an extra rest area. The equipment bay housed the radio communications and encoding/decoding suite. The utility section comprised a running water system, a galley, a rest area for two persons and a toilet.

Two production Mi-26s were converted into Mi-27 prototypes and subjected to testing in Leningrad and Yevpatoriya on the Black Sea. One of them (CCCP-06098) eventually found its way to the Khar'kov Institute of the Air Force where it remains to this day as a ground instruction airframe.

Mi-26S decontamination helicopter

In 1986, when a reactor meltdown occurred at the Chernobyl' nuclear power station, a production Mi-26 was hastily converted into a machine intended for decontamination work. Designated Mi-26S, it carried a tank for a special decontaminant fluid inside the cargo hold; a spraybar was fitted beneath the fuselage. The machine took part in the decontamination of the areas which had been affected by the radioactive fallout after the Chernobyl' disaster.

Mi-26TZ tanker helicopter

In 1988 a tanker version of the Mi-26 designated Mi-26TZ (***top**livoza**prav**shchik* – tanker) was developed at MVZ. The production version of this machine incorporating some modifications effected at the Rostov plant did not take to the air until 1st February 1996. It is intended for urgent delivery of fuel and for the ground refuelling of various types of materiel, including aircraft. The cargo hold houses a complement of modular refuelling equipment which comprises two trolleys with fuel tanks, pump units and control panels, trolleys with four distribution hoses for aviation fuel, ten hoses for diesel fuel and fuel transfer meters.

The volume of the fuel transported is 14,000 litres (3,080 Imp gal), the volume of lubricants is 1,040 litres (228,8 Imp gal) – that is, fifty-two 20-litre (4.4 Imp gal) jerrycans. Conversion time from a regular Mi-26 is 1 hour 25 minutes; the time required for deployment of the equipment and the reverse procedure is 10 to 25 minutes. The tanks intended for the refuelling mission can also be used for extending the helicopter's ferrying range. A small batch of such machines (up to four) was built at Rostvertol.

Mi-26NEF-M ASW helicopter

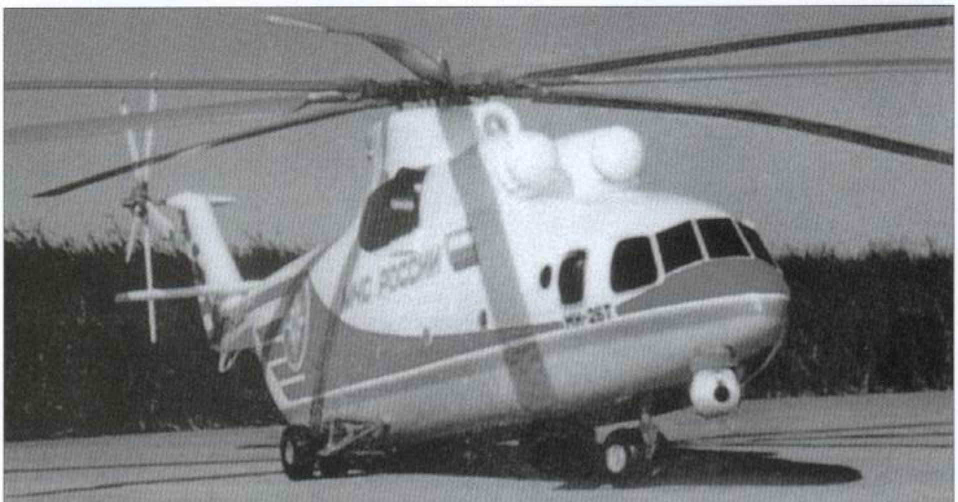
In 1990 a production Mi-26 (CCCP-06146, c/n 34001212317) was converted into the prototype of the Mi-26NEF-M shore-based ASW helicopter equipped with a dunking sonar. *Nef* (Russian for 'nave') was probably the name of the mission equipment suite. The machine's main external distinguishing feature was the curiously drooping 'tapir snout' housing a 360° search radar instead of the usual weather radar. A towed magnetic anomaly detector (MAD) 'bird' was located under the non-functional rear clamshell doors; also, two bulges over as-yet unidentified equipment were positioned on the fuselage sides above the chaff/flare dispensers. Apparently the mission equipment was developed by the Leningrad-based LNPO Leninets (Leninist), which was one of the Soviet Union's leading avionics houses. (LNPO = *Lenin**grahd**skoye na**ooch**no-proiz**vod**stvennoye obyedi**nen**iye* – Leningrad Scientific & Production Association. It is now known as the Leninets Holding Company.)

The work did not proceed beyond the experimental stage. On 18th August 1991 the

Mi-26T RA-06273 (c/n 34001212501) in the markings of Uralaviatrans.

Above: CCCP-06098, one of the two Mi-27 airborne command posts, showing the ventral antenna farm and the closely-spaced raised windows.

Above: A model of the 'flying hospital' version of the Mi-26 developed for the Russian Ministry for Civil Aid and Protection (EMERCOM), showing the stretcher arrays and the operating room.



This model depicts another configuration proposed for EMERCOM of Russia with a Urals Optomechanical Plant (UOMZ) GOES-320 gyro-stabilised opto-electronic system under the nose.

Mi-26NEF-M was unveiled to the public at the open doors day at Pushkin near St. Petersburg, LNPO Leninets's flight test facility, during the annual Aviation Day air fest. Later the helicopter was fully reconverted to standard configuration, serving with the New Zealand-based airline Heli Harvest as RA-06146.

Mi-26PP ECM helicopter prototype

A prototype was built and tested of the Mi-26PP (*posta**nov**shchik **po**mekh* – ECM aircraft). The machine remained a prototype.

Mi-26A heavy transport helicopter

Tests were conducted of the Mi-26A equipped with a new flight and navigation avionics suite. This version did not go into production either.

Mi-26P heavy transport helicopter for border guard troops (prototype)

Among the one-offs was also the Mi-26P (*pogra**nich**nyy* = Border Guard version). It was intended to be used by the KGB's Border Guard troops in the High North and was fitted with special communications equipment.

Mi-26M heavy transport helicopter (project)

In 1992 a PD project of the Mi-26M (*moderni**zee**rovannyy* – upgraded) was prepared at MVZ. This helicopter was to have improved performance as compared to the baseline version. This was to be achieved through re-engining the helicopter with advanced ZMKB Progress (Muravchenko) D-127 turboshafts rated at 14,000 eshp. There were plans for putting this machine into production in 1998.

Passenger version of the Mi-26TS helicopter (project)

Studies were made at Rostvertol of a 70-seat passenger version of the Mi-26TS, as well as of a tourist version with a first-class cabin for 12 passengers and an economy-class cabin for 24 passengers. The designers took into account not only the Russian NLGV-2 airworthiness standards but also the US FAR-29 and the European JAR-29 regulations, which made realistic the hopes of obtaining the Russian and foreign type certificates.

To achieve this, a number of complicated problems had to be solved, which called for various modifications to the basic helicopter and entailed an increase of the all-up weight. For example, it was necessary to ensure the possibility of an emergency ditching and ensure passenger evacuation within a strictly specified time limit. It was also necessary to conduct certification tests. All this called for considerable financial outlays. Therefore, to this day the project has not come to fruition.

A model of the Mi-26 in a passenger configuration was demonstrated at the MAKS-93 airshow; it sported rectangular cabin windows and the designation Mi-26P (*pas-sazheerskiy* – passenger, used attributively). This version was intended to carry 63 passengers over a distance of 750 km (466 miles) at a cruising speed of 250 km/h (155 mph) with a normal AUW of 49,600 kg (109,400 lb).

Above: CCCP-06146, the Mi-26NEF-M ASW helicopter, at Pushkin in 1992. The 'droopsnoot' radome housing a search radar is clearly visible, but the cutout for the dunking sonar in the ramp is not. Before...

Mi-26TS 'Flying hospital'/Casevac helicopter (first use of designation); Mi-26MS (project)

Rostvertol engineers also developed a 'Flying hospital' version of the Mi-26TS helicopter. It catered for the delivery of medical personnel, diagnostics, medical treatment of patients on board and their evacuation. The special design features of this version included the installation of various functional modules in the cargo hold to provide intensive therapy en route while retaining the capability to transport equipment for a field hospital (electric power units and the like) on a sling.

An early project of a similar kind designated Mi-26MS (*modifi**tsee**rovannyy, sani**tar**nyy* – modified, medical) was demonstrated in model form at the MAKS-93 air show; its modules included a surgery compartment.

Mi-26L235 geological survey helicopter

In 1987 the Mi-26L235 was built at MVZ. Described as 'flying laboratory', it was intended for geological prospecting work . No further details have been released.

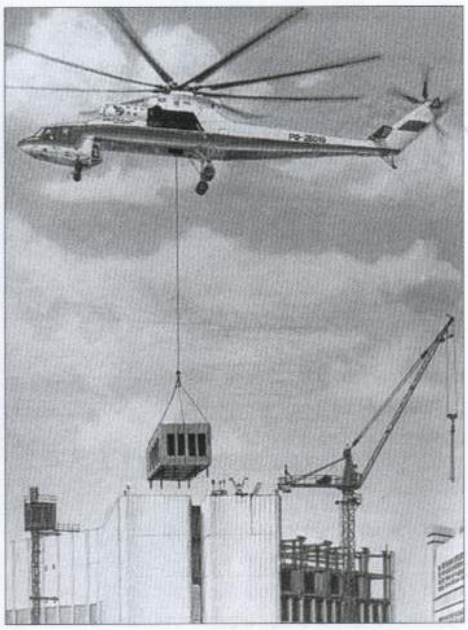
Mi-26TS 'Gheolog' survey helicopter (project)

Rostvertol engineers also developed a project of a similar version of the Mi-26; it was designated Mi-26TS '*Gheo**lo**g*' (Geologist). The helicopter, also classed as a 'flying laboratory', was intended for seismic prospecting of oil and gas deposits in offshore areas; it was to deliver to the prospecting site a special platform carried on a sling. The Mi-26TS 'Gheolog' featured flotation bags in case of ditching, special cargo hatch doors, an SLG-1500 winch, a PSN-6AK inflatable life raft and other necessary devices.

Structural description of the Mi-26

Type: Military and commercial multi-purpose heavy helicopter designed for day/night operation in VMC and IMC. The airframe is of all-metal construction and is mostly made of

...and after. Mi-26T RA-06146 operated by Aerinn/Heli Harvest and named *Vova* was fitted with a custom-made external cab with extra controls attached to a flightdeck escape window for 'flying crane' work.



An artist's impression of the Mi-26K 'flying crane' helicopter, showing the new fuselage

Above: Mi-26T RA-06089, seen here at the MAKS-97 airshow, featured two extra control cockpits (aft of the nose gear and in place of the port forward door) and an external TV display for 'flying crane' work.

The Russian Ministry of the Interior operated several quasi-Aeroflot Mi-26Ts, including RA-06091 which is seen here disgorging a BTR70 armoured personnel carrier in Mozdok, Ingushetia.

aluminium alloys. The helicopter has a crew of five: captain, co-pilot, navigator, flight engineer and flight technician.

Fuselage: The fuselage is an all-metal semi-monocoque structure with a variable cross-section. It comprises four sections: forward fuselage, centre fuselage, tailboom and tail rotor pylon (fin). The joint between the forward and centre fuselage allows the forward fuselage to be detached.

The *forward fuselage* houses the crew section (the flightdeck and a compartment for cargo attendants). It incorporates a dielectric radome hinged to starboard which is attached to a flat bulkhead mounting the radar scanner. The flightdeck glazing comprises three optically flat windshield panes and four sliding direct-vision windows which are bulged for better downward visibility and can be jettisoned in an emergency. The forward pair of windows have a trapezoidal shape and the rear ones are rectangular. The compartment for cargo attendants features two rectangular emergency exits incorporating circular windows. The flightdeck and the compartment for cargo attendants are divided by a metal bulkhead with a sliding door. The perimeters of the windows, emergency exits and the crew section door are sealed by inflatable rubber hoses.

The space beneath the flightdeck floor houses avionics and equipment bays. Units of the cargo hold's air conditioning, heating and ventilation system are located on the port side; the APU bay is located symmetrically to starboard.

Provision is made for protecting the crew section with detachable armour plates reaching the shoulder level attached to the rear bulkhead and the sidewalls; a detachable set of breathing apparatus for individual use is installed.

The *centre fuselage* is the main load-bearing part of the airframe to which forward fuselage and tailboom are attached. The fuselage underside features numerous reinforcement ribs. Placed between Frames 1F and 24F is the troop/cargo cabin; its floor length is 12.08 m (39 ft $7\frac{19}{32}$ in), increasing to 15.0 m (49 ft $2\frac{33}{64}$ in) with the loading ramp included. The cabin's maximum height is 3.16 m (10 ft $4\frac{13}{32}$ in) as measured at frame 17 and 2.95 m (9 ft) at frame 4; the width is 3.20 m (10 ft $5\frac{63}{64}$ in). Cabin volume is 121 m^3 (4,273 cu ft).

The aft end of the cabin is provided with a loading hatch closed by a hydraulically powered cargo ramp and clamshell doors which form the streamlined contours of the fuselage when closed. The doors are opened and closed by a common actuator driving a rotating crank which is linked to the doors by push-pull rods. Each clamshell door has a hatch with a square window inset into it; the hatches are intended for emergency escape on the ground. Up to four vehicle loading ramps can be hooked up to the trailing edge of the cargo ramp.

Personnel access to the troop/cargo cabin and the crew section is via a rectangular entry door to port at the front and two doors of identical dimensions on both sides at the rear; the rear pair is regarded as emergency exits. All doors are downward-hinged and function as airstairs; they are held in the open position by chains acting as handrails and as handles for closing the doors from within. There are three circular cabin windows to port (door+1+1+door+1) and four to starboard (1+1+1+door+1); the windows open inwards, allowing troopers to use their firearms. An upward-opening hatch offset to port and accessed via steps on the forward bulkhead of the cabin provides access to the upper surface for maintenance.

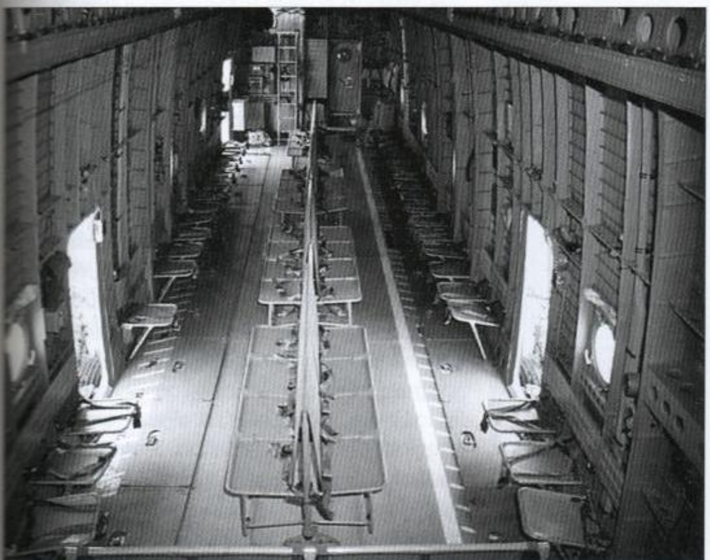
Placed dorsally aft of the cargo cabin, between Frames 24F and 41F, is the rear compartment whose contours merge into those of the tailboom. On top of the outside skin of this compartment there is a walkway used during the servicing of the helicopter; this lane goes further along the top of the tailboom.

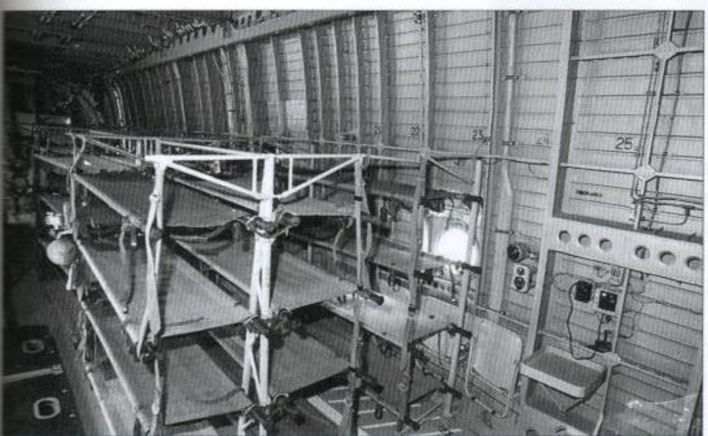
Placed on top of the ceiling panel (between Frames 3 and 24) are attachment fittings and brackets for mounting the engines, dust filters, main gearbox mount, hatch covers and cowling panels, bellcranks and rocker levers of the control linkages, hydraulic unit and rods supporting the engines.

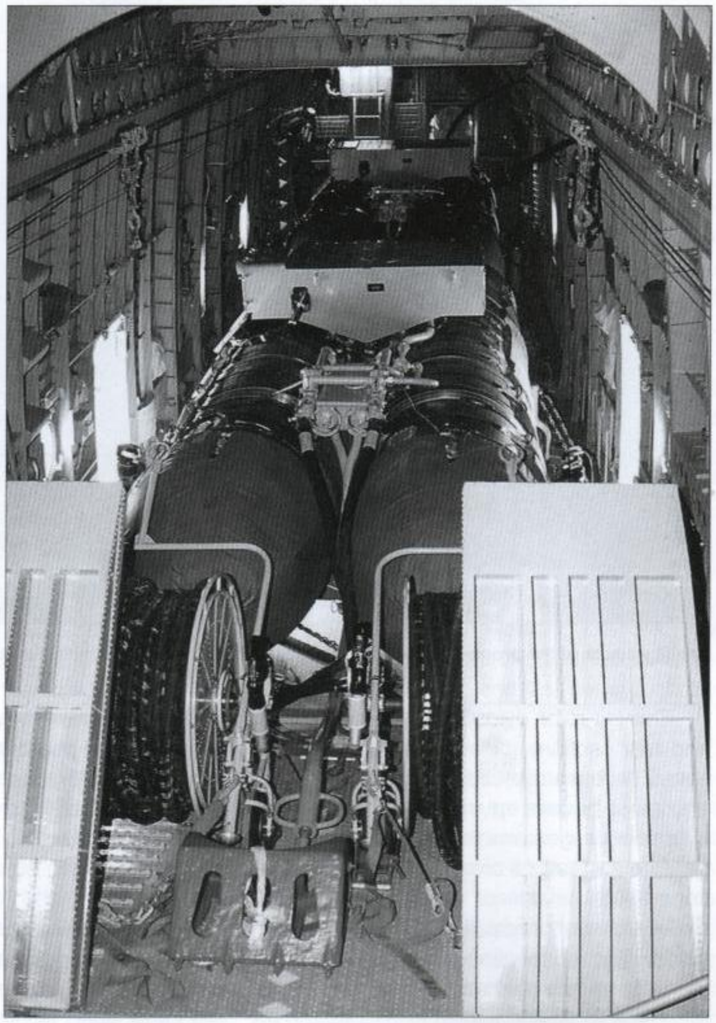
The space above the upward-sloping rear portion of the ceiling panel (between Frames 18 and 21) houses the upper container for service fuel tanks (Nos 9 and 10); these are enclosed by an aerodynamic fairing. On the outside, steps with casings and handrails are mounted on the port side (frames No.23 and No.24) for ground servicing.

The cargo cabin floor can be used for mounting trooper seats or uprights for stretchers (in Casevac configuration); it features tie-down facilities for the hardware to be carried and provides place for two winches. There are removable access panels in the anti-slip floor decking for the installation and servicing of the fuel system and other systems. A large hatch in the cargo cabin floor closed by an internal door is provided for the external load suspension system, the rigid part of which is mounted in the cargo floor structure and does not affect the helicopter's aerodynamics. Light guardrails are erected around it when the system is in use.

The *tailboom* is joined integrally to the rear part of centre fuselage at frame 41; it has a semi-circular cross-section with a flat undersurface. Mounted inside the tailboom are the tail transmission shaft supports, hydraulics piping and fittings for the attachment of the tail bumper. Both inside the tailboom and on its upper surface there are walkways for reaching the working platform intended to ease maintenance; it is accessed via a special manhole. A lower panel (frames 7-8) incorporates a hatch for the first of the three TV cameras making up the BTU-1B CCTV system.







The cargo cabin configured for different missions. Pictured above left is the troop carrier version with collapsible seats along the walls and removable seats on the centreline. The Casevac version is pictured on the left. On the right is the Mi-26TP with four water tanks; note the tip-up vehicle loading ramps.

Above: The flightdeck of a standard Mi-26, with the flight engineer's station on the left and the navigator's station on the right behind the captain and the co-pilot respectively.

The flightdeck of the proposed Mi-26T2 configured for a crew of two, with five large liquid-crystal displays.

The *tail rotor pylon (fin)* comprises front and rear sections joined together along the spar. The forward section mounts the stabilisers; it also houses the transmission shaft, the intermediate gearbox and the final drive tail gearbox, a gearbox oil cooler, attachment fittings for the stabiliser and the tail bumper struts, tail rotor control linkages and a built-in ladder. The rear section is a fixed rudder featuring an asymmetrical airfoil intended to create a side force and serves to off-load the tail rotor as the forward speed increases. Attached to the rear part of the fin is the fairing of the of the final drive gearbox; in the lower part there is a fairing with recesses for the tail bumper struts and a cut-out for its shock absorber.

The *stabilisers* have variable incidence which can be adjusted on the ground between +12° and –5°. The stabiliser structure comprises a spar, ribs, a trailing-edge stringer, skin and attachment fittings.

Landing gear: Non-retractable tricycle type, with oleo-nitrogen shock absorption and twin wheels on each unit. The castoring nose unit with a semi-levered suspension shock strut is fitted with non-braking K292/1U wheels measuring 900 x 200 mm (35.43 x 7.87 in), with a tyre pressure of 4.5+0.5 kg/cm² (64.2+7.14 psi). The strut is attached to centre fuselage Frame 1.

Each of the levered suspension main units is attached to the fittings of Frames 15 and 17. It has one KT140D-3 braking wheel outboard and one KT140D-070 non-braking wheel inboard measuring 1,120 x 450 mm (44 x 17.7 in); the tyre pressure is 6.0+0.5 kg/cm² (85.7+7.14 psi). The design of the main landing gear units makes it possible to change the helicopter's ground clearance.

A tail bumper is provided to protect the tailboom and tail rotor in a tail-down landing. It consists of a shock absorber, two tubular struts and a tailskid. To facilitate vehicle access to the cargo hatch the tail bumper retracts aft to lie flush with the underside of the tailboom when the cargo doors are opened.

Powerplant: Two Lotarev (ZMKB Progress) D-136 turboshaft engines rated at 10,000 eshp for take-off, with a contingency rating of 11,400 eshp (8,500 kW) and a maximum sustained power rating of 8,500 eshp (6,338 kW). The engine has a modular design, five of the nine modules (in the core) are identical to those of the D-36 three-spool turbofan, which facilitates production and repair.

The D-136 is an axial-flow engine with a two-spool core comprising a six-stage transonic low-pressure (LP) axial compressor featuring fixed inlet guide vanes, titanium discs/rotor blades and steel stator vanes; a seven-stage subsonic high-pressure (HP) axial compressor with variable inlet guide vanes, bleed valves at the 3rd and 4th stages, titanium blades on the first five stages and steel blades elsewhere; a low-smoke annular combustion chamber with 24 fuel nozzles and two igniters, and single-stage HP and LP turbines with cooled blades. Located further downstream are a two-stage free turbine with cooled discs and a handed exhaust pipe with an output shaft passing through it. An accessory gearbox is mounted on the intermediate case; unlike the D-36, it is located dorsally, not ventrally. Starting is by means of an SV-36 air turbine starter (*star**tyor** voz**doosh**nyy*) using compressed air from the APU, ground supply or cross-feed from the other engine.

Engine pressure ratio at take-off power 18.3, mass flow at take-off power 36 kg/sec (79 lb/sec); turbine temperature at take-off power 1,478°K, maximum turbine temperature 1,516°K. LP spool speed 10,950 rpm, HP spool speed 14,170 rpm, free turbine speed 8,300 rpm; the free turbine speed can be adjusted by the pilots within ±300 rpm.

Specific fuel consumption at take-off power 0.198 kg/hp·hr (0.436 lb/hp·hr), cruise SFC 0.206 kg/hp·hr (0.454 lb/hp·hr). Length overall 3,964 mm (13 ft 0 in), width 1,670 mm (5 ft 5¾ in), height 1,160 mm (3 ft 9⅝ in); dry weight 1,050 kg (2,315 lb).

The D-136 has a self-contained pressure-feed lubrication system, as well as a fuel flow control system and an electronic engine control system ensuring automatic starting and stable operation in all modes. The fuel flow control system maintains constant engine speed in accordance with the throttle settings. The powerplant is provided with a system automatically maintaining the pre-set main rotor speed. In the event of a single-engine failure (shut-down) the system automatically increases the power setting of the surviving engine to the contingency level, while still maintaining a constant main rotor speed (132 rpm).

The Mi-26 is equipped with a Stoopino Machinery Design Bureau TA-8V auxiliary power unit for self-contained engine starting, ground power supply and air conditioning; the APU also serves as a back-up electric power source in the event of a failure of the main generators. The TA-8V has a single-stage centrifugal compressor, a single-stage peripheral turbine, a 12-kW GS-12TO DC starter/generator and a GT40PCh6 AC generator. Dimensions, 1.368 x 0.701 x 0.717 m (4 ft 5⅞ in x 2 ft 3 19/32 in x 2 ft 4 15/64 in), dry weight with generator 216 kg (476 lb). Bleed air pressure 3.3 bars (47 psi), delivery rate 0.75 kg/sec (1.65 lb/sec), equivalent power 107 kW, fuel consumption 145 kg/h (320 lb/h). The APU can be started at altitudes up to 5,000 m (16,400 ft).

The engines, together with the main gearbox and the cooling fan assembly, are enclosed by a large fairing incorporating multi-section cowlings with cooling air exit louvres. The air intakes feature vortex-type dust/debris extractors with an extraction rate of 70-75%; these are attached to the air intake leading edges by three radial struts each. All cowling panels fold down to act as work platforms during maintenance. The fairing incorporates longitudinal and transverse firewalls made of OT4-0 titanium alloy.

Powertrain: Engine torque is fed via overrunning clutches into the VR-26 main gearbox which summates the torque from the two engines, reduces the engine transmission shafts' rotation speed and conveys torque to the main rotor, tail rotor drive shaft and the fan serving the engine oil coolers and main gearbox oil cooler. It has a modular three-stage design; length 2.5 m (8 ft 2⅜ in), width 1.95 m (6 ft 5 in), height 3.02 m (9 ft 11 in), dry weight 3,640 kg (8,026 lb). The main gearbox mounts a rotor brake intended to accelerate the stopping of the rotors after engine shutdown; it also serves as a parking brake for the powertrain.

The main gearbox has a pressure lubrication system using B-3V grade oil, with a capacity of 250 litres (55 Imp gal). The oil is cooled in four air/oil heat exchangers.

The space between the handed canted sections of the exhaust pipes is occupied by the axial-type cooling fan driven off the main gearbox; its air intake and air duct are located ahead of the main rotor head.

The tail shaft housed inside the tailboom transmits the torque from the main gearbox to the tail rotor via the intermediate and final drive tail gearboxes. The shaft comprises nine sections and seven supports with shielded ball bearings and splined couplings. The intermediate gearbox serves for changing the direction of the tail shaft axis by 44°. The final drive gearbox turns the shaft through 90° to starboard; it incorporates the mechanism for controlling the tail rotor pitch.

The fan serves the air/oil heat exchangers of the engines, the main gearbox and the hydraulic system, as well as the air/air heat exchanger of the AK-50T1 air compressor; it cools the casings of the engine free turbines, of the rotor speed governor and the 2-16-5-type fire extinguishers.

Rotor system: The *main rotor,* turning clockwise when seen from above, has eight hinged blades of rectangular planform weighing 375 kg (827 lb) each. The blades feature an improved airfoil with a thickness/chord ratio of 12% at the shank and 9% at the tip; they have a steel spar, a glassfibre structure and a special paper filler. The blades are electrically de-iced and feature a compressed-air spar failure warning system. Each blade is divided into 28 theoretical airfoil sections and comprises the spar/leading-edge section, 26 trailing-edge pockets, a shank fairing and a tip fairing. Pockets Nos 17-19 feature balance tabs used for adjusting the main rotor.

The blade's leading edge is protected by a titanium corrosion-resistant covering. The blade has a chord of 0.835 m (34 in), the blade tip speed is 220 m/sec (722 ft/sec).

The main rotor head, manufactured of VTZ-1 grade titanium, features a classic layout with feathering, flapping and drag hinges; the flapping and drag hinges are separated from each other, the flapping hinges being turned 6°58'. It incorporates centrifugal blade droop stops.

The five-blade variable-pitch pusher-type *tail rotor* is mounted on the starboard side of the fin and turns anti-clockwise when seen from the hub so that the forward blades go against the main rotor downwash, increasing the relative speed. The tail rotor head has separate flapping and feathering hinges; the blades are attached by two bolts to eye-lugs of the hinges. The blade comprises a glassfibre spar, an integral trailing-edge section and a tip fairing. The blade has a rectangular planform and features a NACA-230M airfoil, with a chord of 0.47 m (18½ in); it weighs 35.6 kg (78.5 lb).

The blades are equipped with an electric de-icing system; its heating elements are made of stainless steel grid enclosed between two layers of glassfibre insulation.

Control system: The Mi-26 has full powered dual controls. The helicopter is controlled by changing the amount and direction of the main rotor thrust and by changing the tail rotor thrust.

Pitch and roll control is effected with the help of the cyclic pitch control sticks, which causes a change in the inclination of the swashplate; this, in turn, causes a cyclic change of the blade pitch in different azimuth positions an, in consequence, a change in the amount and direction of the resultant main rotor thrust.

The main units of the control system are: the left and right control columns, two mechanical linkage lines, two spring-loading devices with EMT-2MP electromagnetic brakes, two KAU-140 combined control units and the swashplate mounted on the main gearbox.

Yaw control is effected by pedals by means of changing the amount of the tail rotor thrust due to the change of its collective pitch.

Collective pitch control produces a simultaneous and equal change of the main rotor blades' pitch which results in the change of the amount of the main rotor's thrust. Increase of the collective pitch causes the engines automatically to choose a higher power setting.

The main units include the left and right collective pitch levers, a control linkage and the KAU-140-01 combined control unit.

Combined control units are incorporated into the control system on the basis of a differential layout and function independently. Stick forces at control sticks and collective pitch levers, proportionate to their deflection, are created by spring-loading devices. The KAU combined control units double as hydraulic actuators and as servos of the VUAP-1 Srs 2 autopilot.

Fuel system: The helicopter's fuel system comprises ten bag-type tanks, two boost pumps, four transfer pumps, two units of jet pumps, shut-off valves, float valves and piping. The tanks are made of 203B grade kerosene-resistant rubber 0.7 mm (0.027 in) thick and have an external protective layer of 11KShZOO rubberised fabric 0.6 mm (0.023 in) thick. The Nos 4, 5, 9, 10 fuel tanks have a layer of R-29 grade foam rubber protecting the tanks against damage by small-arms fire. All tanks are housed in special containers forming an integral part of the fuselage structure; each tank is installed through its own hatch.

Provision is made for installing two or four additional fuel tanks in the cargo hold in the ferrying configuration. Additional tanks of cylindrical shape are welded from AMTsAP aluminium alloy sheet metal 2 mm (5⁄64 in) thick. The total capacity of the fuel system is 26,662 litres (5,866 Imp gal); of this amount, 9,650 litres (2,123 Imp gal) is housed in eight main tanks, 2,246 litres (494 Imp gal) in two service tanks and up to 14,736 litres (3,242 Imp gal) in the additional tanks.

Hydraulics: Three hydraulic systems (main, backup and auxiliary). The main and the backup systems work the KAU combined control units of the control system. In addition, the backup system serves for checking the helicopter's controls on the ground with the engines shut down and with no airfield hydraulic unit available. In flight the backup system works the hydraulic damper in the yaw control circuit, the upper lock of the external load suspension system, ensures the emergency closing of the cooling fan's guide vanes, the retraction and extension of the tail bumper, operates the mainwheel brakes and the helicopter weight measuring system.

AMG-10 hydraulic fluid is used. The hydraulic tank of the main system holds 41 litres (9.02 Imp gal); the backup and auxiliary systems have a common hydraulic tank holding 53 litres (11.66 Imp gal). The working pressure of 160-220 kg/cm² (2,285-3,142 psi)

Specifications of the Mi-26

Powerplant type	D-136
Take-off power, eshp	2 x 11,400
Main rotor diameter, m (ft)	32 (105)
Empty weight, kg (lb)	28,150 (62,071)
Take-off weighs, kg (lb):	
normal	49,500 (109,147)
maximum	56,000 (123,480)
Payload, kg (lb):	
normal internal	15,000 (33,075)
maximum internal	20,000 (44,100)
on a sling	20,000 (44,100)
Speed, km/h (mph):	
maximum speed	295 (183)
cruising speed	255 (158)
Hovering ceiling, m (ft):	
out of ground effect	1,800 (5,904)
in ground effect	2,900 (9,512)
Service ceiling, m (ft)	4,600 (15,090)
Operational range, km (miles)	490 (305)
Ferry range, km (miles)	1,800 (1,119)
Crew	5
Number of passengers	82

is built up by four NP-92A plunger-type pumps driven off the main gearbox. With the engines shut down, hydraulic pressure is provided by two NS46-2 pump units in the main and the backup systems and an NP01/1 manually operated pump in the auxiliary system. The hydraulic system's units are remote-controlled electrically by switches on the central control pedestal and the instrument panels of the pilots and the flight technician.

Pneumatic system: The pneumatic system works the mainwheel brakes, the sealing of the windows and the emergency exits in the crew section for protection against nuclear, biological and chemical (NBC) contaminants. It also feeds the windshield washer system.

The AK-50T1 Srs 3 compressor caters for building up the pressure and for charging two UBSh-4 air bottles with a total capacity of 8 litres (1.76 Imp gal). The working pressure is 40-50+4 kg/cm² (714+57 psi).

Electrics: The electric power supply system comprises a primary system, three secondary systems and an auxiliary system, as well as ground AC/DC power receptacles.

The primary system includes two engine-driven GT-90S46 three-phase AC generators with a capacity of 120 kVA, producing a 200/115 V, 400 Hz current. A PO-750A single-phase AC converter (*preobrazo**vah**tel' odno**fahz**nyy*) serves as an emergency source. The secondary systems comprise 36 V single- and three-phase AC systems, 400 Hz, with a PT-200P three-phase AC converter (*preobrazo**vah**tel' tryokh**fahz**nyy*) as a back-up source.

The auxiliary system includes the GT-40P46 AC generator driven by the APU.

The electric power supply system provides the power for the lighting equipment which comprises internal and external lighting and internal and external warning and indication systems.

De-icing system: The engine air intakes, rotor blades, flightdeck windshields, pitot heads and static ports are electrically de-iced.

Avionics and equipment:
The helicopter's *flight and navigation system* comprises a 7A813 weather radar, ARK-22 and ARK-UD automatic direction finders, a Veyer-M (Fan) short-range radio navigation system, a DISS-32-90 Doppler speed and drift sensor, an RV-A036 radio altimeter, DPSM-1 airspeed sensors, DV-15MV altitude sensors, an air data system (four pitot tubes and six static ports), thermometers, the port and starboard MGV-1 SUV vertical gyros, a KI-13K compass, a Greben'-2 compass system (the name may translate as 'haircomb' – or as 'ridge') and a PKV-26-1 flight control system featuring a VUAP-1 Srs 2 autopilot.

The *flight instrumentation* includes a VD-10VK altimeter, a UVID-30-15K cabin altitude and pressure indicator, a US-450K airspeed indicator, an SSA-0.7-2.2 rotor speed indicator, a VAR-30MK vertical speed indicator, an AG-83-15 gyro horizon, PKP-77M flight director indicators, NPP-72-12 horizontal situation indicators,

The *communications suite* comprises an R-863 command link radio, a Yadro-1I-1 (Nucleus) communications radio, an R-861 emergency and rescue radio and an SPU-8 intercom. An RI-65 automatic voice annunciator (*reche**voy** infor**mah**tor*) warns the crew of critical failures (such as fire) and dangerous flight modes.

The IFF system features an SRO-2M Khrom IFF transponder (*izdeliye* 023) or SRO-1P *Pa**rol**'-2D* (*izdeliye* 62-01) IFF transponder. An SO-69 air traffic control transponder transmits the aircraft's registration, speed and altitude for presentation on ATC radar displays and may also operate in 'Mayday' mode.

The electronic support measures (ESM) equipment comprises an L006 Beryoza radar homing and warning system alerting the crew that the helicopter is being 'painted' by enemy radars. ASO-2V automatic device for firing 46 IPP-26 magnesium flares from two dispensers can be mounted in lateral fairings near the engine jetpipes for protection against heat-seeking missiles.

Lighting and signalling equipment includes internal lighting, external lighting (navigation lights on the tailboom and at the wingtips, red revolving anti-collision lights at the tip of the fin and below the centre fuselage, formation lights and blade tip lights to avoid collisions during night-time assault operations), floodlights and two EKSP-46 four-round signal flare launchers.

Other special equipment includes a BTU-15 closed-circuit TV system with three KT-45 TV cameras and a VK-175 TV display for checking the underslung load's condition. A DP-ZA-1 roentgenometer is provided for radiation reconnaissance in NBC-contaminated areas.

The helicopter features a BUR-1-2B (Tester UZ) flight data recorder and an MS-61B cockpit voice recorder.

Armament: Strictly speaking, the Mi-26 is unarmed. However, seven removable semi-flexible mounts are provided near the cabin windows on military examples to be used by troopers for firing their hand-held firearms (RPK general-purpose machine-guns or AKM submachine-guns) through the windows

Assault and cargo handling equipment: The assault and cargo handling equipment comprises: collapsible seats for the transportation of 82 fully-equipped troops; optional medical equipment for the transportation of 60 stretcher cases; cargo handling equipment (two LG-1500 electric winches, two overhead cranes), cargo tie-down cleats, roller conveyers, hooks and a system for the carriage of underslung loads.

The latter system comprises the external suspension hook with a device for measuring the load's weight, an LG-1500 winch, the BTU-1B CCTV system, slings and cables. The external suspension system is hydraulically and electrically controlled; the control devices ensure the disengagement of the load for operational purposes and its jettisoning in an emergency.

Mi-26 in action

So far the production run of the Mi-26 at the Rostvertol plant (all versions included) is about three hundred, and counting. A considerable part of this number was built for the Soviet Ministry of Defence, the Ministry of the Interior and the KGB's Border Guard Troops.

The military began mastering the Mi-26 at the 344th TsBP i PLS in the town of Torzhok. However, the very first machine delivered to the Centre was lost in a crash when one of the main rotor blades suffered a spar failure. The crew captained by the Centre's leader, General Anisimov, was killed in the crash. After this accident the Mi-26s already delivered to service units underwent tethered tests at Torzhok. The machines were subjected to tethered 'running' for 20 to 30 minutes, whereupon several faults had to be rectified on each of them.

Only by 1988 did the designers and manufacturers succeed in ironing out the main faults in the helicopter airframe and systems. The work on the helicopter's development was far from completed when Soviet Air Force service units began taking delivery of the first machines. In 1983 one of the first flight detachments operating the Mi-26 in the USSR was formed within the framework of the Border Guard Troops. This sub-unit had three helicopters on strength and was included into the 4th Independent Squadron (OE – *o**tdel'**naya **e**skadril'ya*) based at Dushanbe. In the same year the first Mi-26s found their way to an Army Aviation regiment stationed in the town of Novopolotsk, Belorussian DD.

Mass deliveries of the Mi-26 to the army did not start until May 1985. In that month two machines were delivered to the 162nd Independent Transport and Combat Helicopter Regiment (OTBVP – *o**tdel'**nyy **trahns**portno-boye**voy** verto**lyot**nyy **p**olk*) which was assigned to the Central Asian DD. That same year the 373rd OTBVP stationed at Kyakhta (Trans-Baikal DD) and the 325th OTBVP stationed at Tselukidze (Trans-Caucasian DD) received their first Mi-26s. Later the new

Above: A Russian Air Force Mi-26 carries an unusual slung load – the fuselage of the first prototype Mi-26, CCCP-06141, minus tailboom and dynamic components.

Mi-26TS HL9261 (c/n 071217) prepares to lift a slung load.

Above: An Indian Air Force Mi-26 in the recently adopted overall grey colour scheme. This particular examples is named *Zanskar*.

XU.269 (c/n 34001212485?), one of two second-hand quasi-civil Mi-26s operated by the Lao Air Force.

helicopters were also delivered to the 793rd OTBVP (Telavi, Trans-Caucasian DD), the 340th Air Regiment (Kalinov, Carpathian DD) and some other units, including the air units of the Ministry of Interior. In every regiment the new helicopters were put on the strength of two squadrons, each of which had a complement of 12-14 helicopters; the remaining squadrons continued operating Mi-6s or Mi-8s.

Full-scale service tests of the Mi-26 were conducted in the 793rd OTBVP in 1988-89. Colonel Yoodin, a GNIKI VVS test, and Lieutenant-Colonel V. Simakov, Commander of the regiment's 4th Squadron, took part in these tests. In all, in the course of 13 months the crews logged 1,414 flying hours; on a number of occasions the crews had to perform flights over the Major Caucasus Ridge, climbing to an altitude in excess of 4,500 m (14,800 ft).

The Mi-26 was well-liked by airmen. The designers and engineers had tried to take into account the complaints voiced with regard to the already obsolescent Mi-6. The pilots liked the excellent view from the flightdeck, the high power/weight ratio, good ergonomics, the comfort and life support amenities of the helicopter's pressurised cabin, but it was the reliable and powerful engines that earned the highest praise.

The Mi-26 started its combat career during the Afghan War. Helicopters of this type were not deployed directly in that country, but missions were flown over the northern areas of Afghanistan by machines from the Border Guard Troops' 23rd Regiment stationed in Tajikistan. They fulfilled the typical tasks for heavy helicopters: transportation of various loads, delivery of reinforcement troops and evacuation of wounded personnel (codenamed *grooz* ***tri****sta*, 'cargo 300') – and, sadly but inevitably, the bodies of servicemen killed in action (known as *grooz* ***dve****sti*, 'cargo 200'). In the course of such missions the crews had to land on pads situated in the mountains at up to 4,000 m (13,120 ft) above sea level. There was no combat attrition, but on 18th October 1985 a Mi-26 captained by Major A. N. Pomykin was lost in an accident. Fuelled with 10 tonnes (22,045 lb) of kerosene, the helicopter took off from Dushanbe with the intention of picking up a load of ammunition at the Moskovskiy border station and delivering it to Kalat-Khuleb in Afghanistan, but during the flight over Moskovsky the tail rotor transmission shaft broke. The uncontrollable helicopter impacted the ground violently and was completely destroyed; the flight engineer was killed and the other members of the crew suffered heavy injuries.

The Mi-26 was put to a heavy test in 1986 when it took part in dealing with the consequences of the Chernobyl' reactor meltdown on 26th April. As early as 2nd May the new heavylift choppers arrived from Novopolotsk to the disaster area. To lessen the pernicious influence of radiation, protective lead plating was installed in the cabins. The Mi-26s were used for transporting various items, and after appropriate modifications they started spraying a special kind of sticky fluid intended to immobilise the radioactive dust on the ground and prevent it from being spread by the wind.

During such flights some of the goo stuck to the helicopter's underside, and the rotor downwash kicked up the deadly dust, which also stuck to the machine's belly. The crust that was thus formed made it virtually impossible to decontaminate the helicopters fully; yet attempts were made to save the costly machines. For example, at the Rostov plant workers scraped off this crust from the bellies of two Mi-26S 'goo spreaders', using wooden trowels; as it often happened in the Soviet Union, not only were these workers not provided with the necessary means of protection, but much effort was used to make them believe that they were working under normal sanitary conditions. However, such work inevitably had its damaging effect on the workers' health. As for the helicopters... On one of the machines the radiation was eventually reduced to a level exceeding the normal value by a factor of 1.8, and it was pronounced suitable for an overhaul. Another Mi-26S had a radiation level that was ten times the normal value. An attempt was made to decontaminate it once again, this time by military personnel, but these efforts were to no avail, and eventually a decision was taken to bury the machine.

The Mi-26 rendered valuable assistance during several other complex operations in Chernobyl'. Since service pilots still lacked the necessary experience, such tasks were entrusted to Mil' OKB crews captained by test pilots G. R. Karapetyan and A. D. Grishchenko who had acquired some skills in transporting loads on an unusually long sling. The first of these operations was the rehearsing of methods of installing a cupola-shaped metal cover measuring 19 m (62 ft) in diameter and weighing 15 tonnes (33,000 lb) over the disabled reactor to contain the radiation. At first Karapetyan together with a military crew transported the cover that had been assembled at the Kiev Mechanical Plant named after O. K. Antonov from Kiev-Svyatoshino airfield to the nearby Gostomel' airfield (the Antonov OKB's flight test facility). There, and later in Chernobyl', some 30 flights were made in which precision installation techniques were evolved, using a mock-up of the reactor. The methods thus developed made it possible to conduct the operation with due regard to the wind direction and to the presence of a very tall chimney located right alongside the object to be enclosed.

The decision to place the cover directly on the reactor was taken when the test pilots were absent from the disaster area, and the actual operation was entrusted to service pilots. However, as Grishchenko recalled later, 'they must have been unaware of some limitations known only to us, and the cover was smashed'. The authorities chose not to manufacture a replacement cover.

When it was decided to restart the reactors that had remained intact, the need arose for supplying purified air into the station; for this purpose it was necessary to install special filter units. These were structures of cubic shape measuring 6 x 6 x 6 m (20 x 20 x 20 ft) and weighing 20 tonnes (44,100 lb). The crew had to refrain from descending too low lest the helicopter should raise clouds of radioactive dust; again, the work had to be performed with the load on an extra long sling. By then G. R. Karapetyan had been recalled back to the OKB, and half of these flights were performed by a crew captained by A. D. Grishchenko, the remaining 50% falling to the lot of three military crews trained by him. The work at the site of the Chernobyl' disaster proved fatal for Grishchenko: he died of leukaemia in 1990. He was posthumously awarded the Hero of the Russian Federation title.

The Mi-26 had occasion to take part in several conflicts that flared up in the Caucasus in the late 1980s/early 1990s. The first of these was the war between Azerbaijan and Armenia for the control over Nagornyy Karabakh which had started during the last years of the Soviet Union's existence. Apart from flights to cater for the needs of the Trans-Caucasian DD's military units, the helicopters based in the district delivered humanitarian cargoes for the local population and evacuated refugees. Not infrequently they were fired upon by both sides and returned to base with bullet holes in their sides.

After the break-up of the USSR a group of the so-called Joint Armed Forces of the CIS (in actual fact, Russian Army troops) remained in the conflict area for a while, and the Mi-26s continued their risky flights. On 3rd March 1992 one Mi-26 delivered 20 tonnes of flour to Polistan settlement in the Shaumyan District of Nagornyy Karabakh and was expected to transport some 50 women and children on the way back. A Mi-24 attack helicopter provided cover for the heavy machine. When the helicopters were already approaching Armenian territory, they were attacked by a Mi-8 without national insignia; the Mi-8 was chased off by the Mi-24. Yet on short finals the Mi-26 was hit by a shoulder-launched surface-to-air missile. The helicopter burst into flames and crashed near the Azerbaijani village of Seidilyar; 12 persons were killed in the accident and the remaining occupants suffered injuries of varying degree.

In the course of 1992 both 'Caucasian' regiments were withdrawn to the territory of Russia. The 325th Helicopter Regiment, which was stationed at Yegorlykskaya AB of the North-Caucasian Military District after the redeployment, took an active part in both russian military occupations in Chechnya.

At present the Mi-26 is operated by all military and law enforcement agencies of Russia. This helicopter type remains the main type for airlifting heavy military materiel and troops to considerable distances. Tragically, in 2003 a Russian Army Mi-26 was shot down by a shoulder-launched SAM fired by the Chechen rebels while landing at Khankala AB near Groznyy on a troop rotation mission. The helicopter crashed, killing all 118 occupants.

Following the demise of the Soviet Union, 28 Mi-26s remained on the territory of the Ukraine; 234 of them were on the strength of the 340th OTBVP of the Army Aviation which was reorganised as the 7th Brigade. The Ukrainian Ministry of Emergency Situations took an interest in the Mi-26, and there were plans for transferring several machines to that agency. In the summer of 1997 the Ukrainian Ministry of Emergency Situations even demonstrated a Mi-26 in a Medevac version at Kiev-Zhulyany airport within the framework of Exercise *Sea Breeze-97*.

The most notable event in the biography of the Ukrainian Mi-26s was their participation in the United Nations peacekeeping mission in former Yugoslavia. Their arrival to the Balkans was preceded by the work of two similar heavylifters which were placed at the disposal of the UN in early 1995 by the Russian airline Air Troika. Wearing the all-white UN Peace Forces livery, these helicopters delivered supplies for the benefit of the fugitives and transported people, including VIPs attempting to broker a ceasefire. During these flights the choppers were frequently fired upon, which eventually led to a decision to withdraw them from the war zone. As a replacement, the Ukraine sent a pair of military Mi-26s, also painted white overall for the occasion. The machines were assigned to the 15th Independent Helicopter Detachment and were stationed in the Croatian capital of Zagreb and in the seaside town of Split. Between 29th July 1995 and 14th February 1996 they flew 452 sorties, logging a total of 467 hours; in these flights they transported 2,172 tonnes (4,789,260 lb) of cargo and 2,746 passengers.

By 1999 the designated TBO of all 28 Ukrainian Army Mi-26s had expired. Costly refurbishment was needed to extend the helicopters' service life, but, though the Ukraine had the facilities to do the job, the state budget failed to provide the money and the Mi-26s had to be grounded. Yet, several machines have reportedly been refurbished and returned to service now.

Civil aviation units operating the Mi-26

Civil Aviation Directorate	United Air Detachment & constituent Flight	Home base	New operator name
Arkhangel'sk CAD	2nd Arkhangel'sk UAD/68th Flight	Arkhangel'sk-Vas'kovo	2nd Arkhangel'sk Air Enterprise
Far Eastern CAD	2nd Khabarovsk UAD/249th Flight/?? Sqn	Khabarovsk-MVL	Aviakompaniya Vostok
Komi CAD	Ukhta UAD/302nd Flight	Ukhta	Komiavia (later Komiaviatrans)
Krasnoyarsk CAD	2nd Krasnoyarsk UAD	Krasnoyarsk	
Tyumen' CAD	Nizhnevartovsk UAD/441st Flight	Nizhnevartovsk	Tyumen'AviaTrans (now UTair)
	Nefteyugansk UAD	Nefteyugansk	Tyumen'AviaTrans (now UTair)
	1st Tyumen' UAD/ '3rd Flight'	Tyumen'-Plekhanovo	Tyumen'AviaTrans (now UTair)
Yakutian CAD	Mirnyy UAD	Mirnyy	Almazy Rossii-Sakha (now Alrosa)
Training Establishments Directorate (UUZ)	Kremenchug Civil Aviation Flying School	Kremenchug-Bol'shaya Kokhnovka	
State Civil Aviation Research Institute (GosNII GA)		Moscow/Sheremet'yevo-1	
VNII PANKh		Krasnodar-Pashkovskiy	PANKh AVia

Production Mi-26s started reaching Aeroflot in 1986. The first of them were delivered to the Tyumen' CAD after testing at GosNII GA. At first civil aviation pilots took a conversion course at the Rostov plant, from 1987 they did that at the Kremenchug Civil Aviation Flying School. The table on this page illustrates confirmed civil aviation units operating the Mi-26.

As was the case with its Mi-6 stablemate, the Mi-26's civil applications were primarily concerned with support operations in the areas east of the Ural Mountains rich in oil, diamonds and other natural resources. The Mi-26 proved especially useful as a means of transporting bulky external loads. Many such operations proved to be unique; they became widely known in Russia and abroad, greatly enhancing the helicopter's reputation. Thus, in October 1994 an extremely interesting job was performed during an expedition to Papua New Guinea by a Mi-26T from the Ukhta UAD with a crew captained by A. Fateyev. The airmen were tasked with extracting a Douglas A-20 Boston bomber from a swamp and delivering it to the port of Manang. During World War Two this aircraft was operated by the USAF's 13th Bomber Squadron; it was damaged by Japanese fighters in 1945 and made a belly landing. After restoration the machine was to be donated to the Royal Australian Air Force Museum. Wide plastic straps were wrapped around the Boston's belly and hooked up to the helicopter's sling. When the cable went taut, the weight-measuring device showed a weight of 13 tonnes (28,700 lb), but when the aircraft was freed from the swamp, the figure was 11 tonnes (24,225 lb). During this flight the Mi-26 was accompanied by an RAAF Sikorsky S-70 Black Hawk helicopter which filmed the operation.

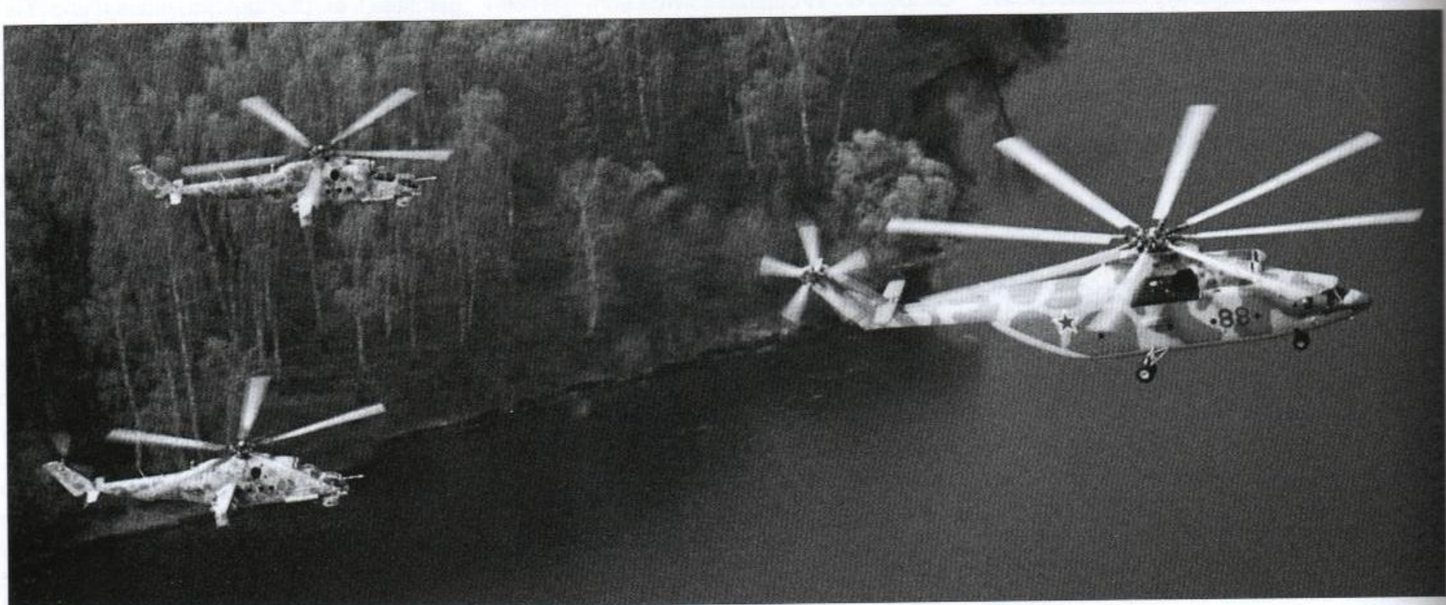
The Mi-26 was equally efficient in the 'flying crane' role. For example, in December 1995 hundreds of inhabitants of Rostov-on-Don watched the installation of a TV relay tower 30-m (98 ft) tall and weighing 16 tonnes (35,300 lb) on the roof of the city's Central Telegraph office. It would have taken some two months, with much greater costs, to perform this job with the help of usual cranes. In 1997 a Mi-26T belonging to the NPK PANKh enterprise was engaged in the construction of a high-voltage power line in the Krasnodar Territory where it installed 120 power line pylons. In the following year the helicopter was employed in Germany where it transported an architectural subassembly weighing 11 tonnes (24,000 lb) and measuring 8 m (26 ft) in diameter from Rostock to Berlin. Several interesting jobs were performed by Mi-26TM HL9261 belonging to the South Korean enterprise Samsung Aerospace Ltd. They included the installation of an 8-tonne (17,640 lb) container of a PCS communications antenna at the summit of the Mt. Sigue, the transportation on a sling of a 15-tonne (33,000 lb) excavator, of a huge statue of Buddha and of a live tree weighing 14 tonnes (30,870 lb) which was to be transplanted to a site 60 km (37 miles) away.

Regrettably, Aeroflot Mi-26s also had their share of accidents. Thus, on 20th March 1990 Mi-26T CCCP-06024 (c/n 34001212400) of the Yakutian CAD/Mirnyy UAD crashed near Preobrazhenka settlement (Irkutsk Region/Katanga District) when a hydraulic booster in the pitch control circuit failed during long line operations. The helicopter started rocking fore and aft uncontrollably; during the ensuing attempted forced landing it hit the ground in a 30° nose-down attitude and burned out, killing the crew. On 18th August 1990, when Mi-26T CCCP-06023 (c/n 34001212323) of the Tyumen' CAD/Tyumen' UAD was lifting a slung load near Khanty-Mansiysk airport, the improperly secured cargo broke off. The resulting abrupt stress caused the helicopter to break up in mid-air and crash, again with no survivors.

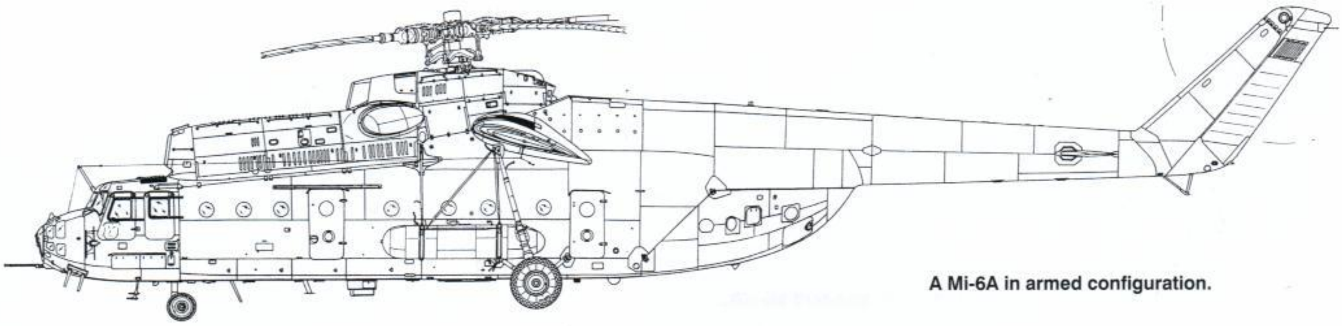
Civil Mi-26Ts also had a chance to participate in UN peacekeeping operations. On 8th December 1992 Rostvertol signed a contract for performing air transport services in connection with the UN peace-keeping mission in Cambodia. On 8th July 1993 a similar contract was signed for operations in Somalia and Burundi.

Few CIS republics operate the Mi-26. The majority of civil and military examples alike have remained in Russia, which has even purchased several former Ukrainian Air Force Mi-26s. Civil (or quasi-civil?) Mi-26s were also registered in Belorussia and Moldova.

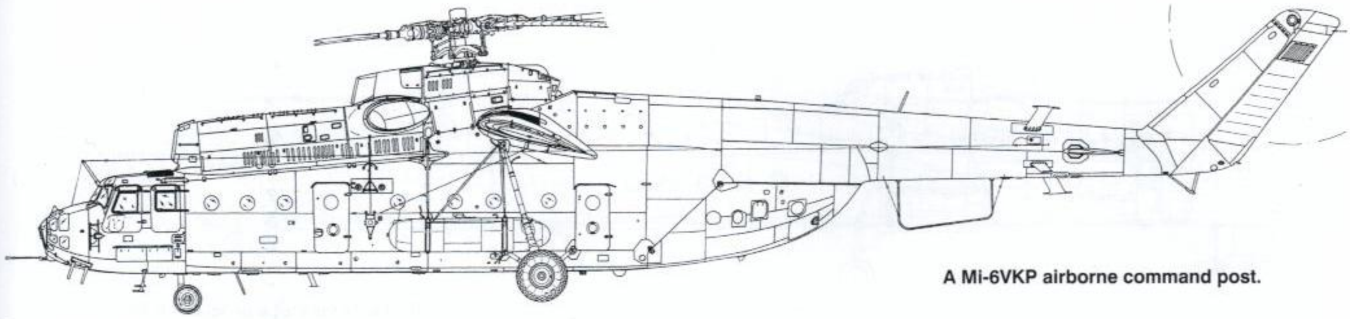
The Mi-26 has had a measure of success on the export market; both new and second-hand examples were exported. India became the first foreign customer; the first four helicopters of this type entered service with the Indian Air Force in the early 1980s, and about a dozen have been delivered as of this writing. The Iraqi Air Force ordered at least eight examples but these were never delivered due to UN sanctions. In addition, two Mi-26s were sold to the Mexican Air Force, two to Malaysia, three to the Peruvian Army Aviation, two to the North Korean Air Force, one to South Korea (it has since been sold back to Russia), two to Cambodia, two to Laos and one to Congo-Kinshasa. The latest importer of the Mi-26 was the Scorpion International company of Greece which purchased one Mi-26TS in September 2000. The Venezuelan Air Force has ordered a single Mi-26TS due for delivery in 2005 as part of a military hardware package worth US$ 120 million. Additionally, the type has been leased to operators in Bulgaria, Belgium and Papua New Guinea.



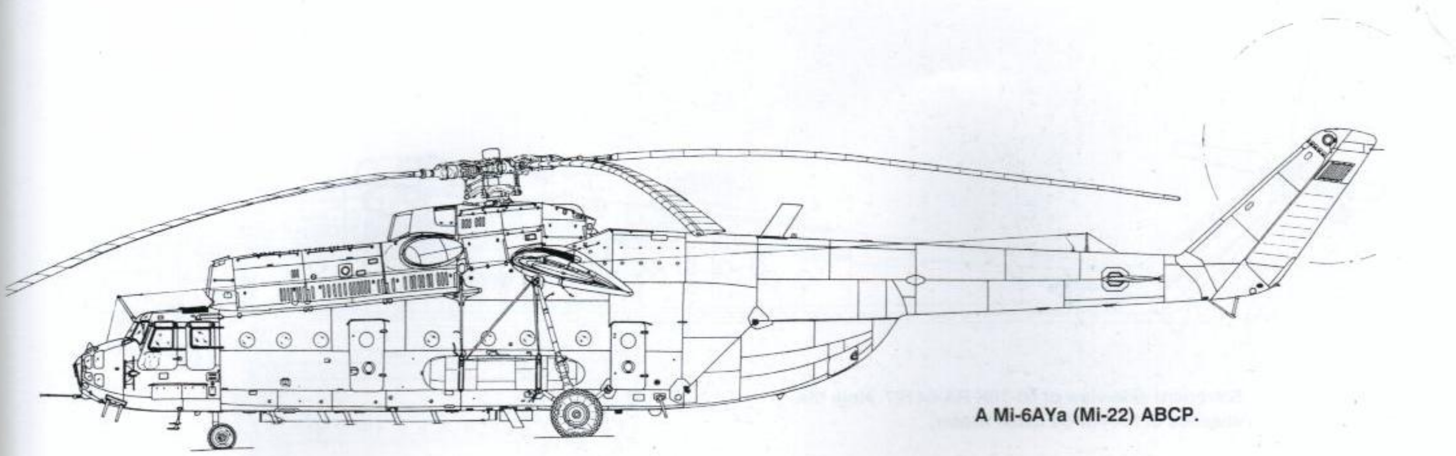
A Russian Air Force Mi-26 is escorted by two Mi-24P attack helicopters during a rehearsal for the 1995 May Day parade.



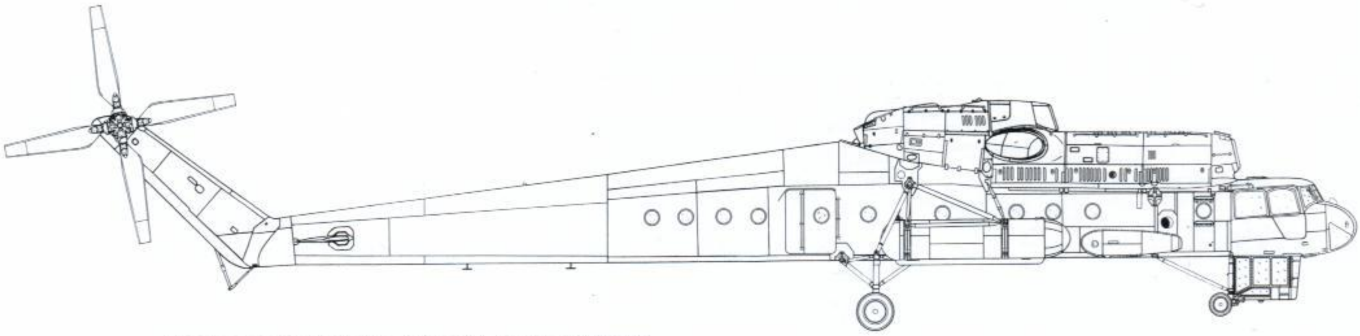
A Mi-6A in armed configuration.



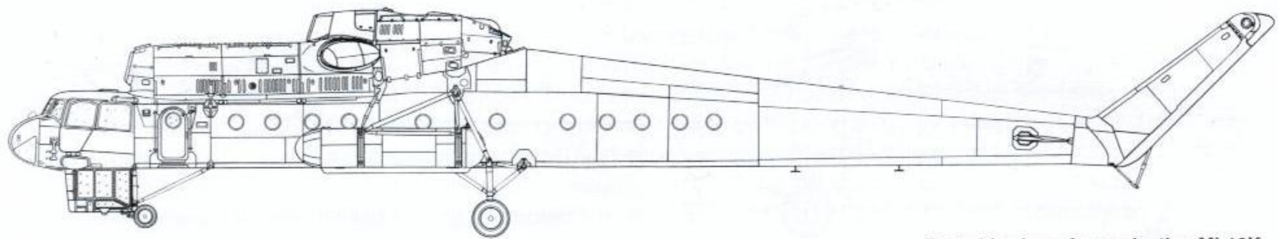
A Mi-6VKP airborne command post.



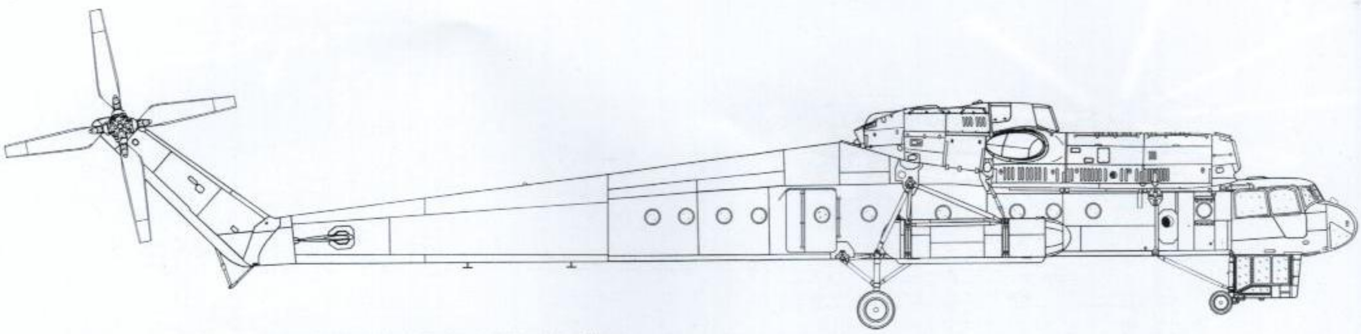
A Mi-6AYa (Mi-22) ABCP.



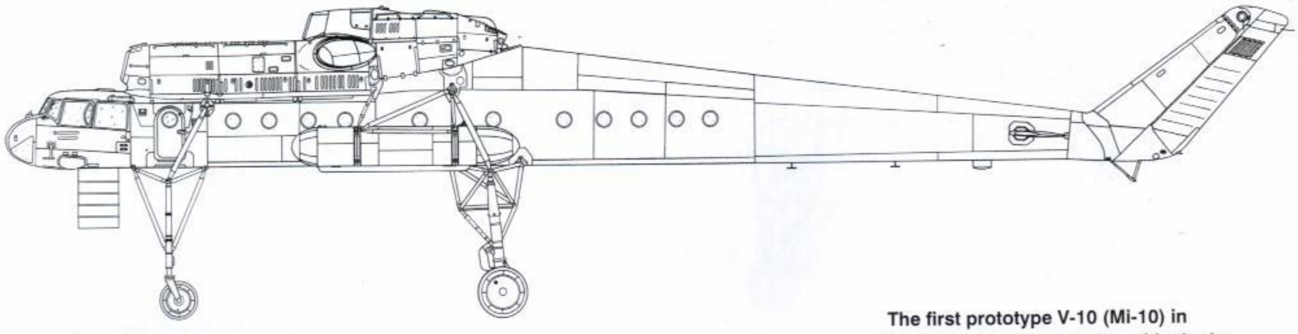
Starboard side view of a production-standard Mi-10K.



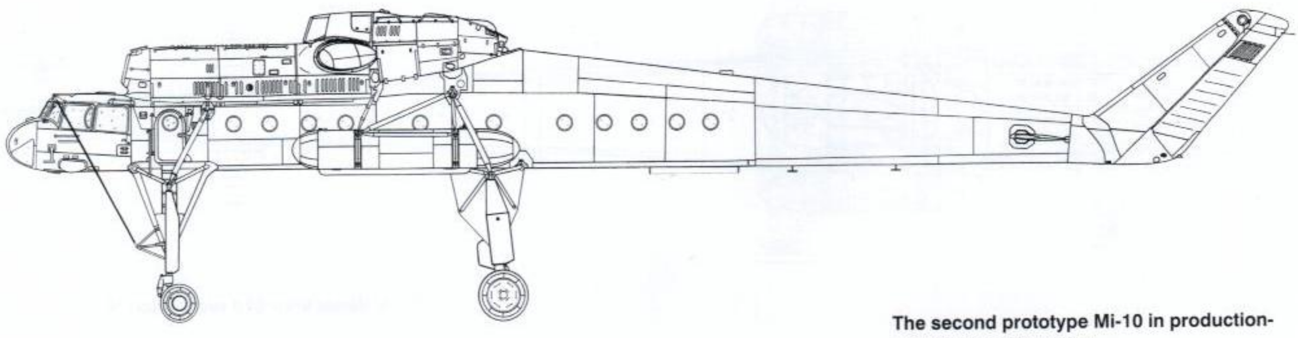
Port side view of a production Mi-10K.



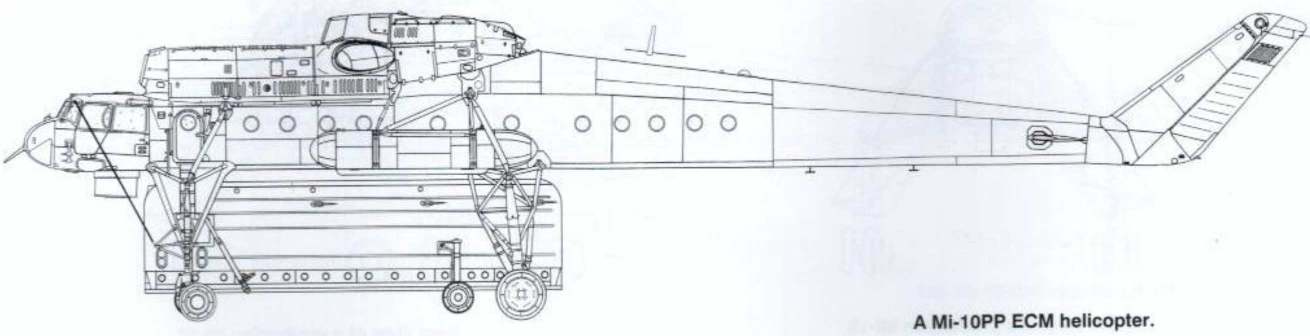
Starboard side view of Mi-10K RA-04127. Note the absence of the KO-50 cabin heater.



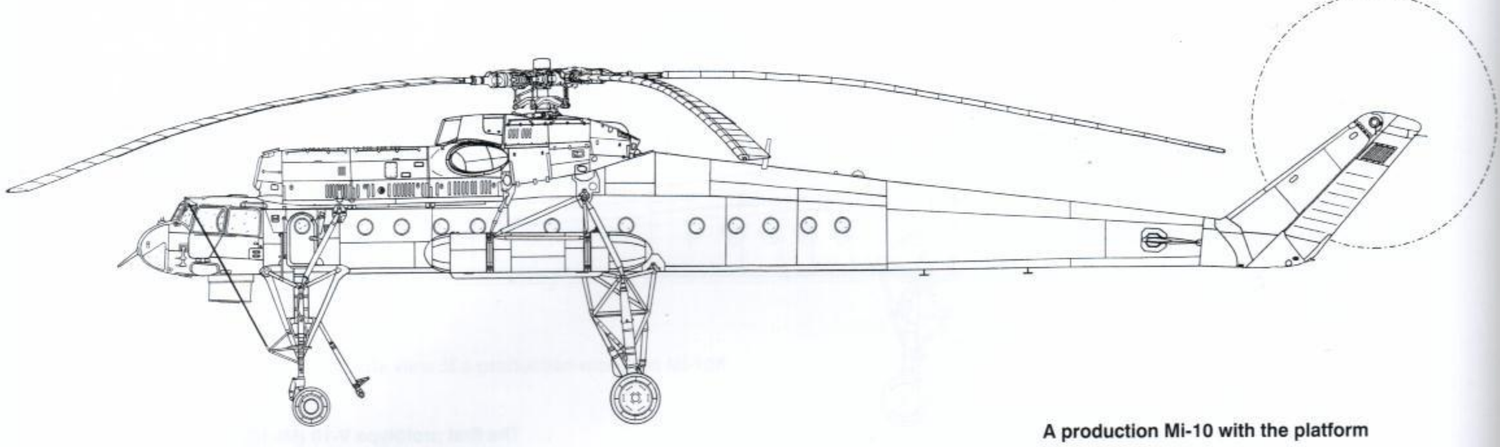
The first prototype V-10 (Mi-10) in intermediate configuration with single nosewheels and twin mainwheels.



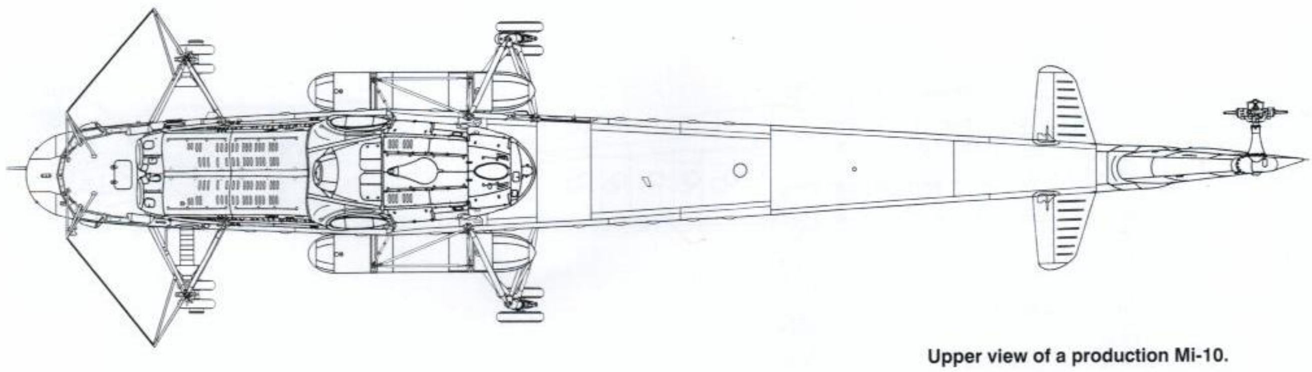
The second prototype Mi-10 in production-standard configuration.



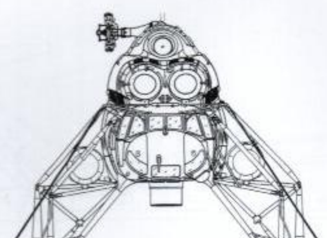
A Mi-10PP ECM helicopter.



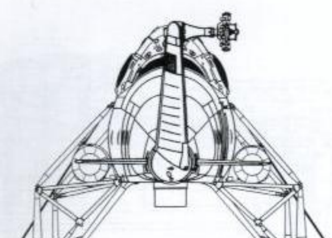
A production Mi-10 with the platform attachment rods in place.



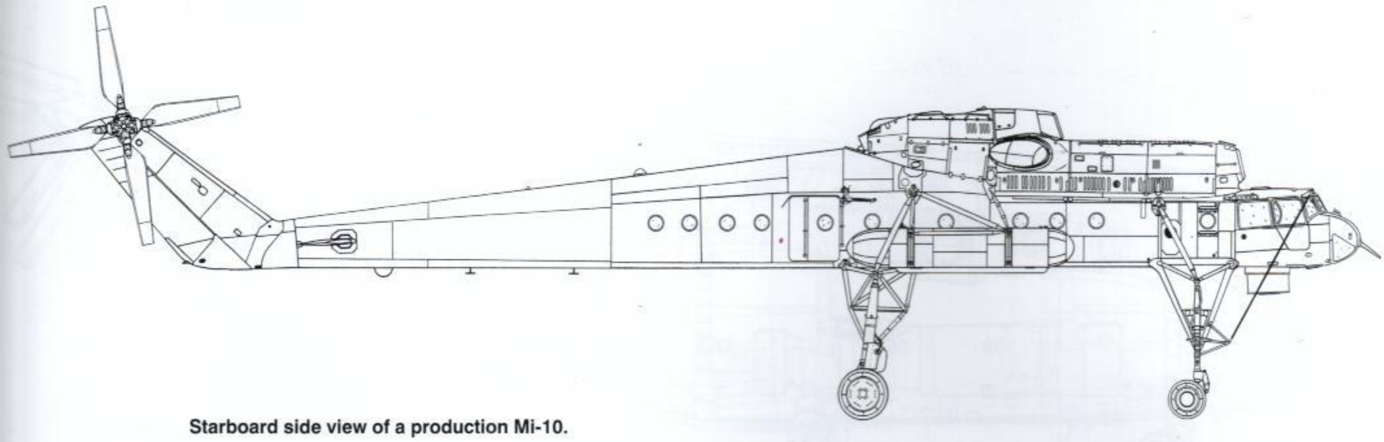
Upper view of a production Mi-10.



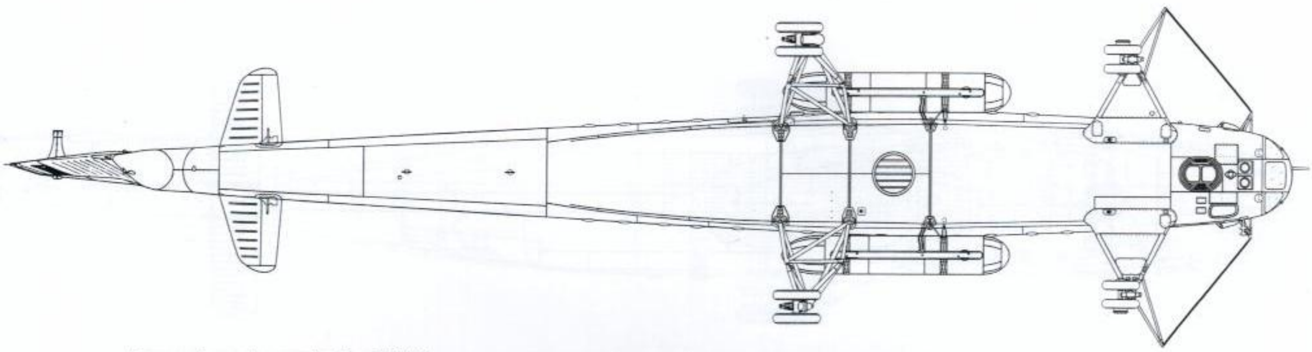
Front view of a production Mi-10.



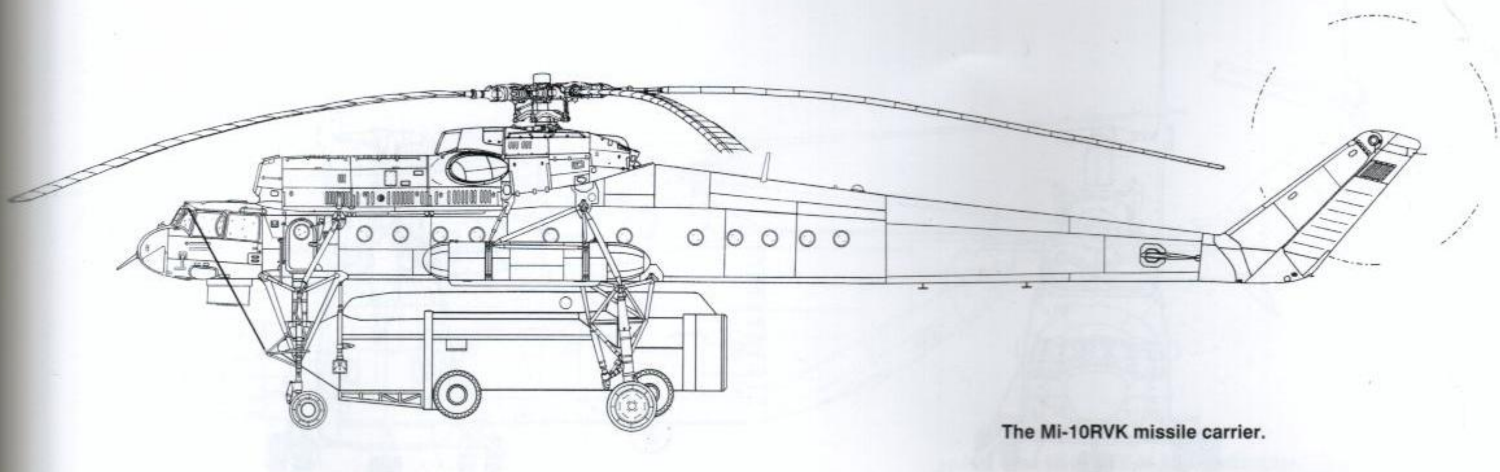
Rear view of a production Mi-10.



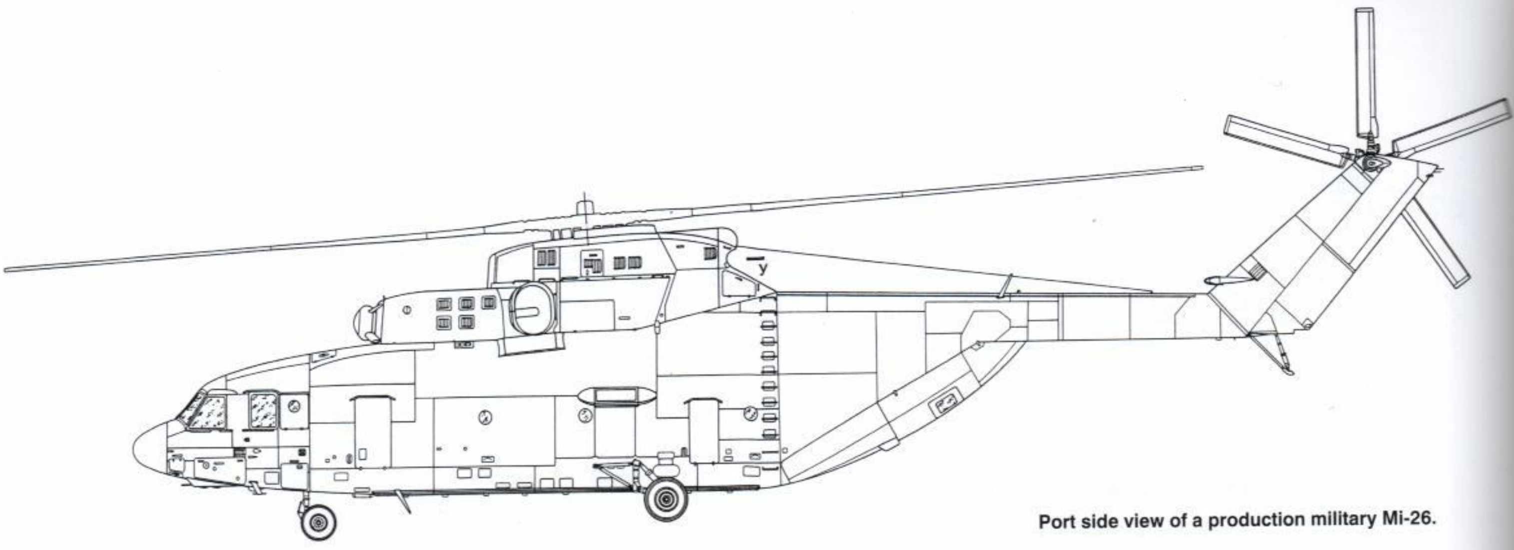
Starboard side view of a production Mi-10.



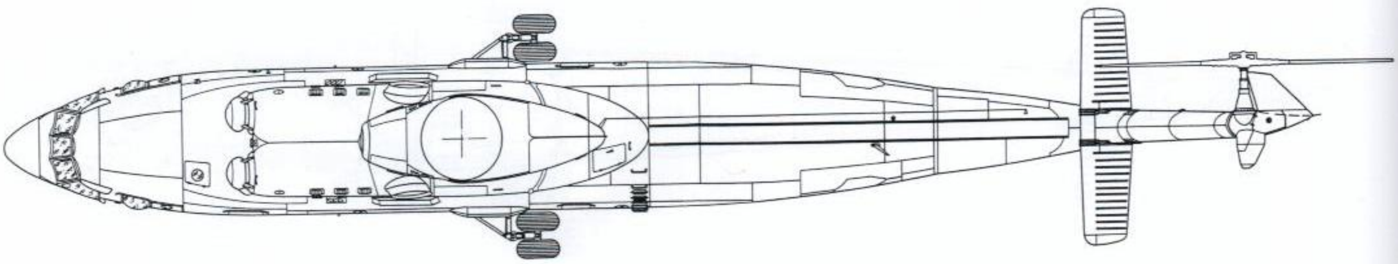
Lower view of a production Mi-10.



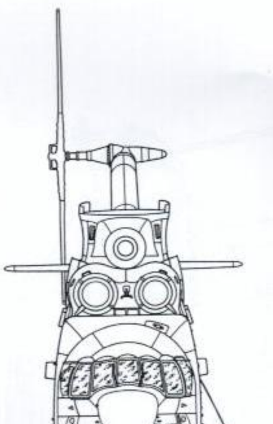
The Mi-10RVK missile carrier.



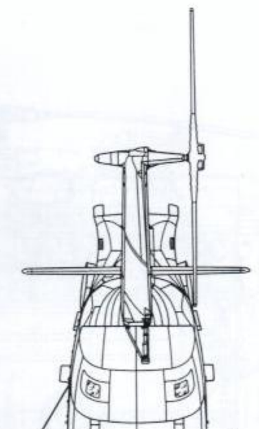
Port side view of a production military Mi-26.



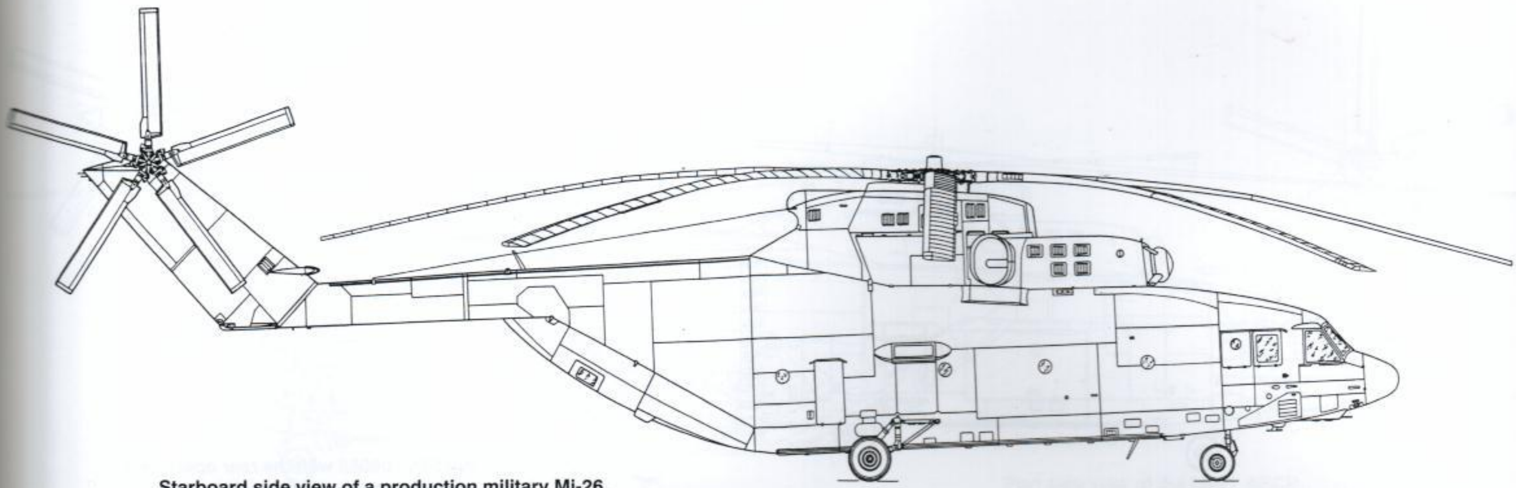
Upper view of a production military Mi-26.



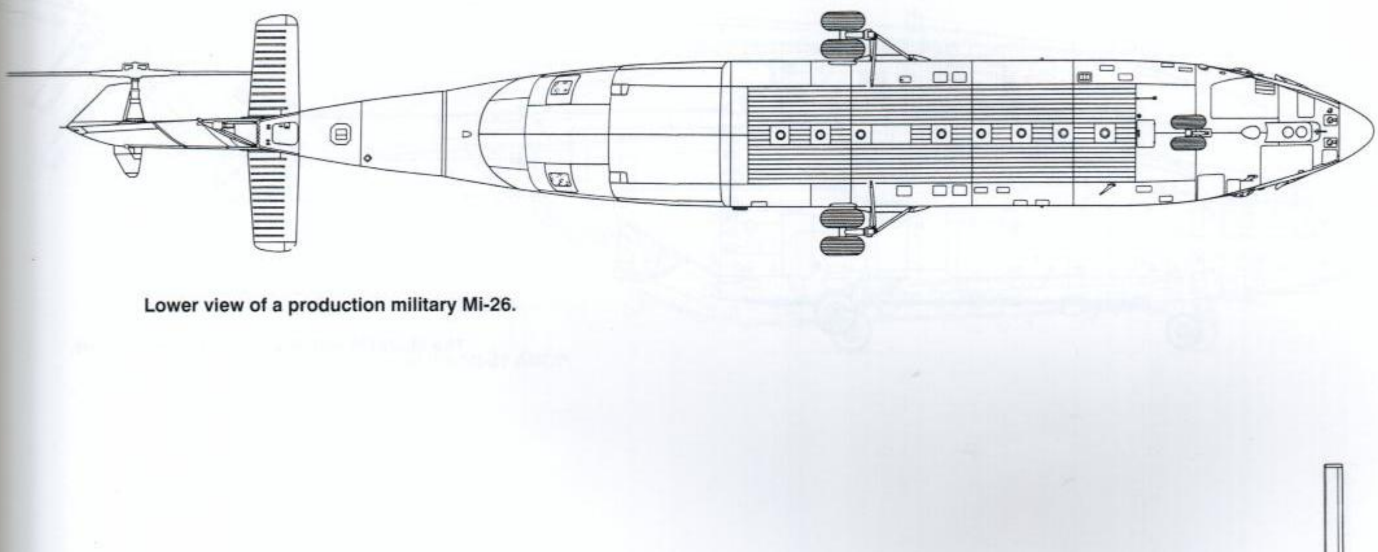
Front view of a production military Mi-26.



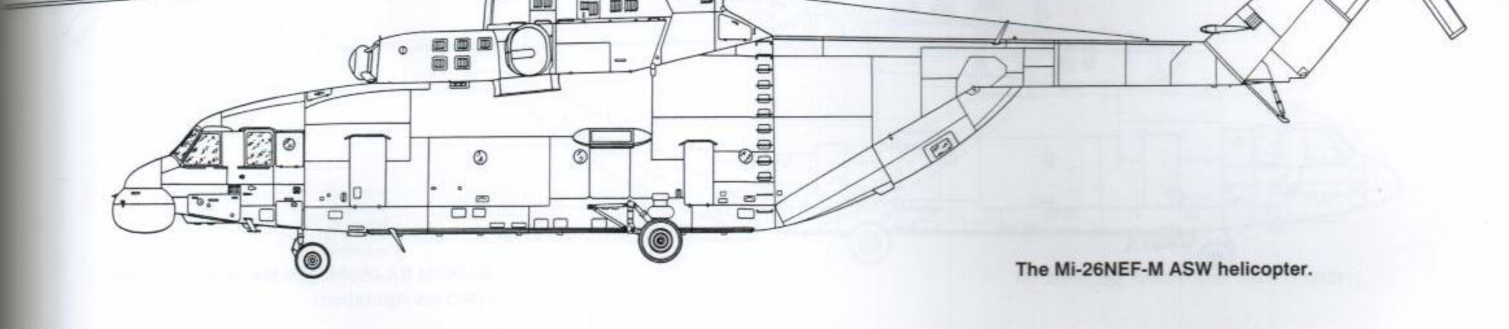
Rear view of a production military Mi-26.



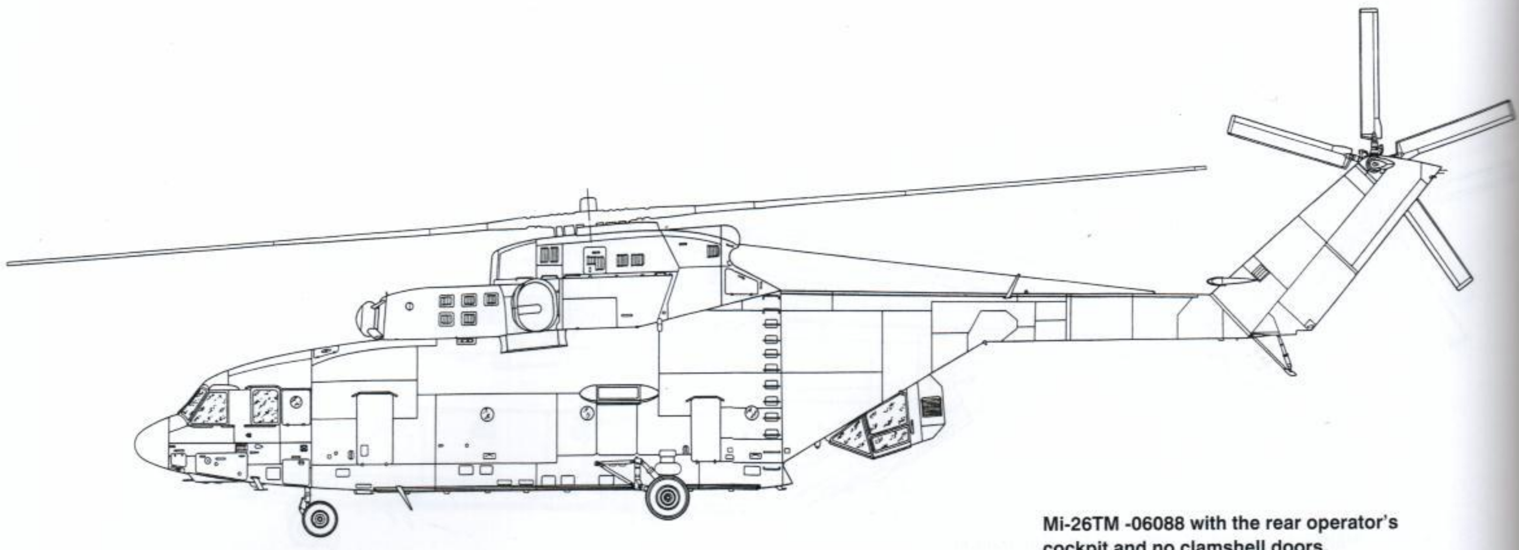
Starboard side view of a production military Mi-26.



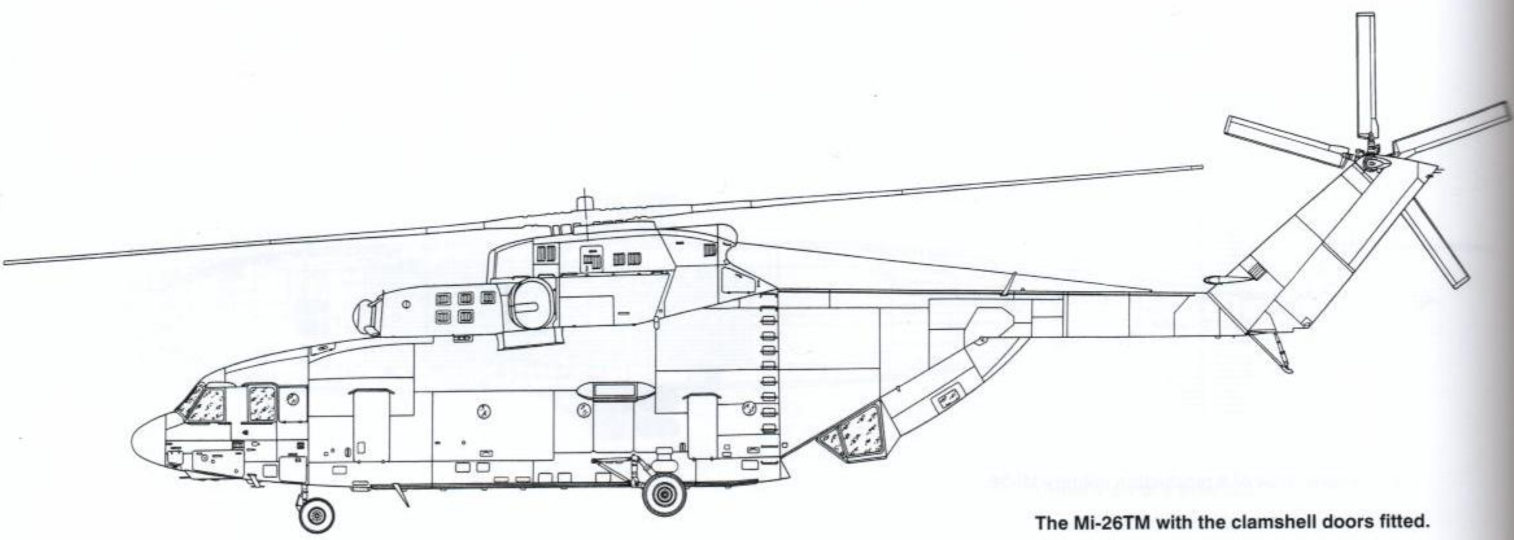
Lower view of a production military Mi-26.



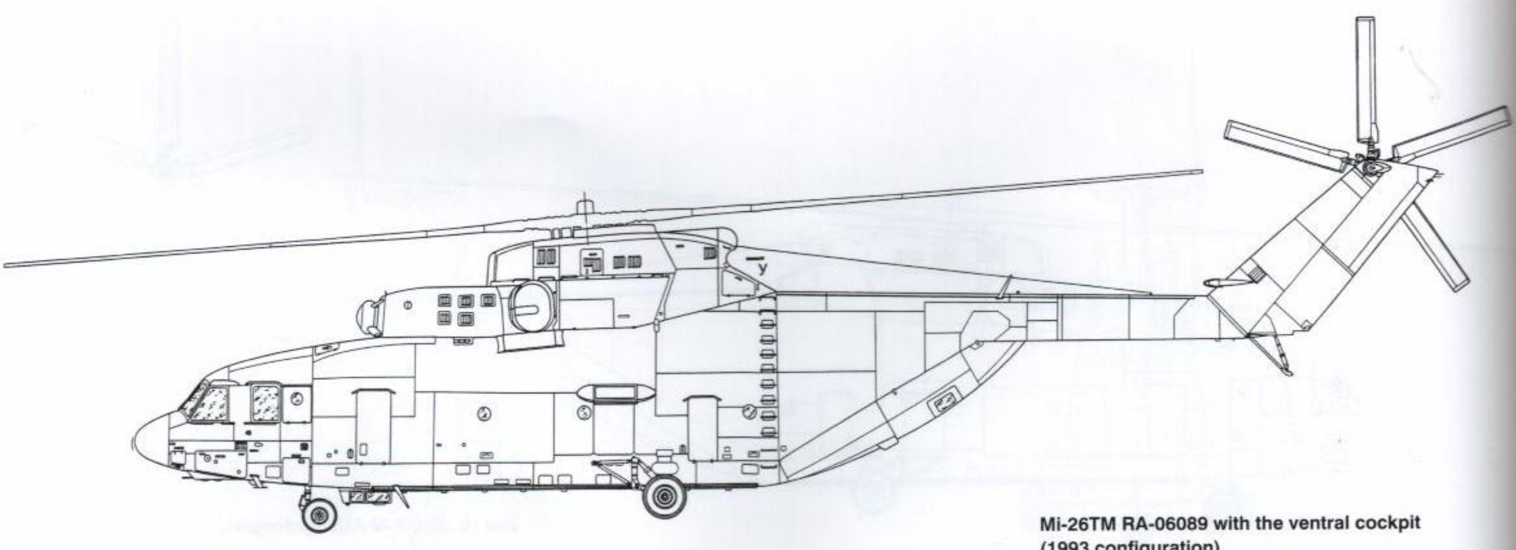
The Mi-26NEF-M ASW helicopter.



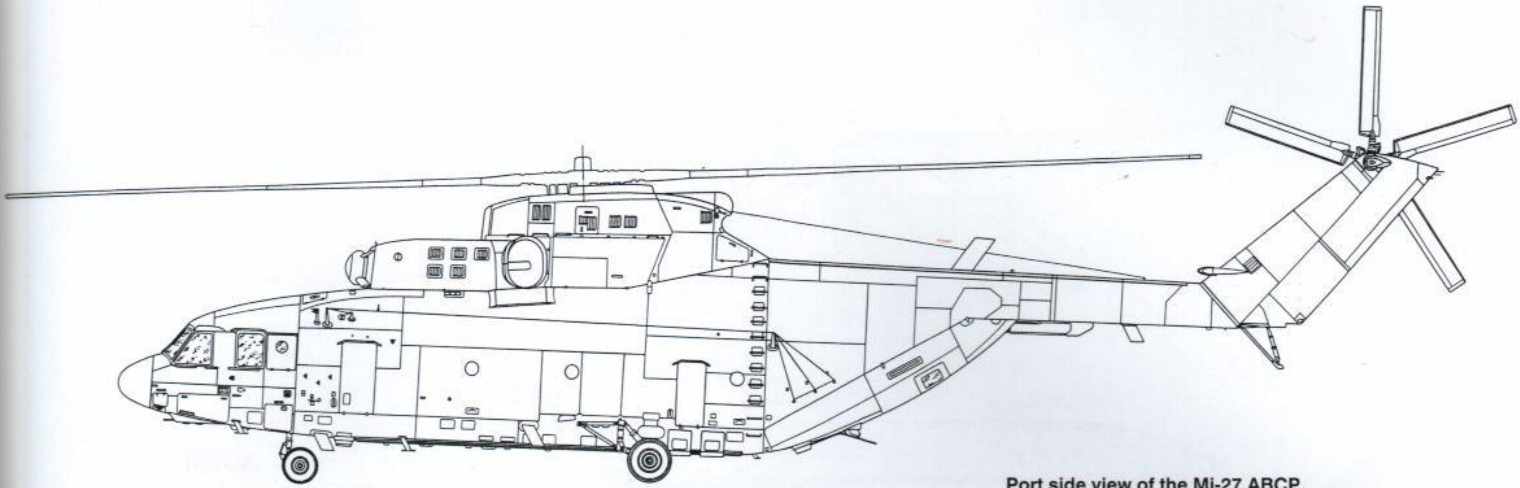
Mi-26TM -06088 with the rear operator's cockpit and no clamshell doors.



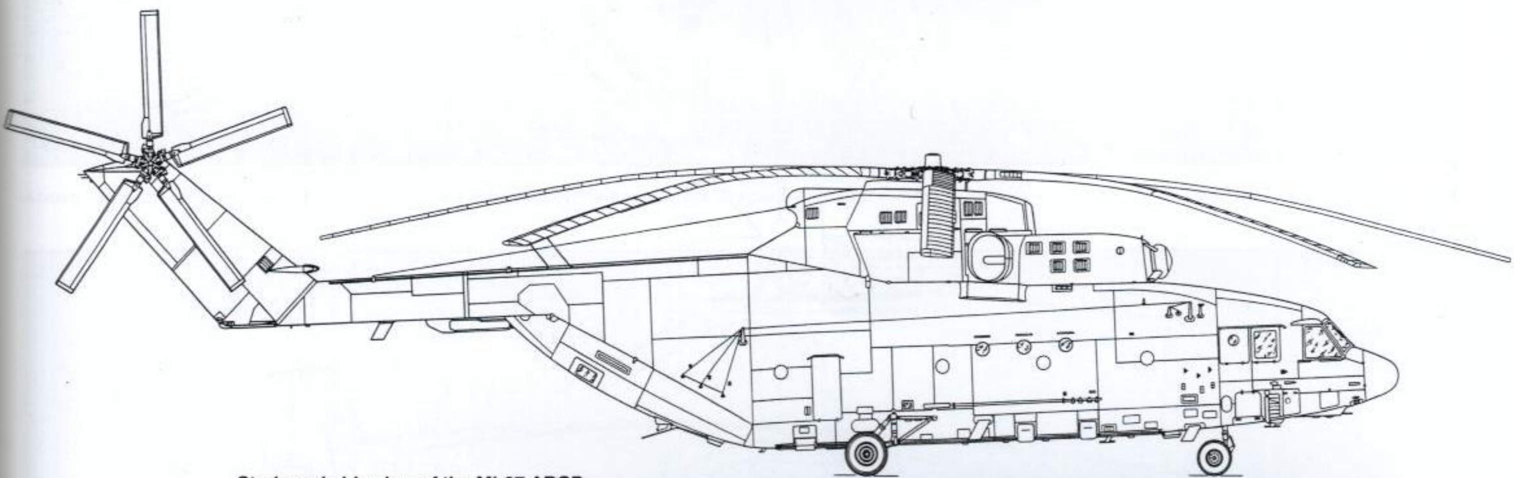
The Mi-26TM with the clamshell doors fitted.



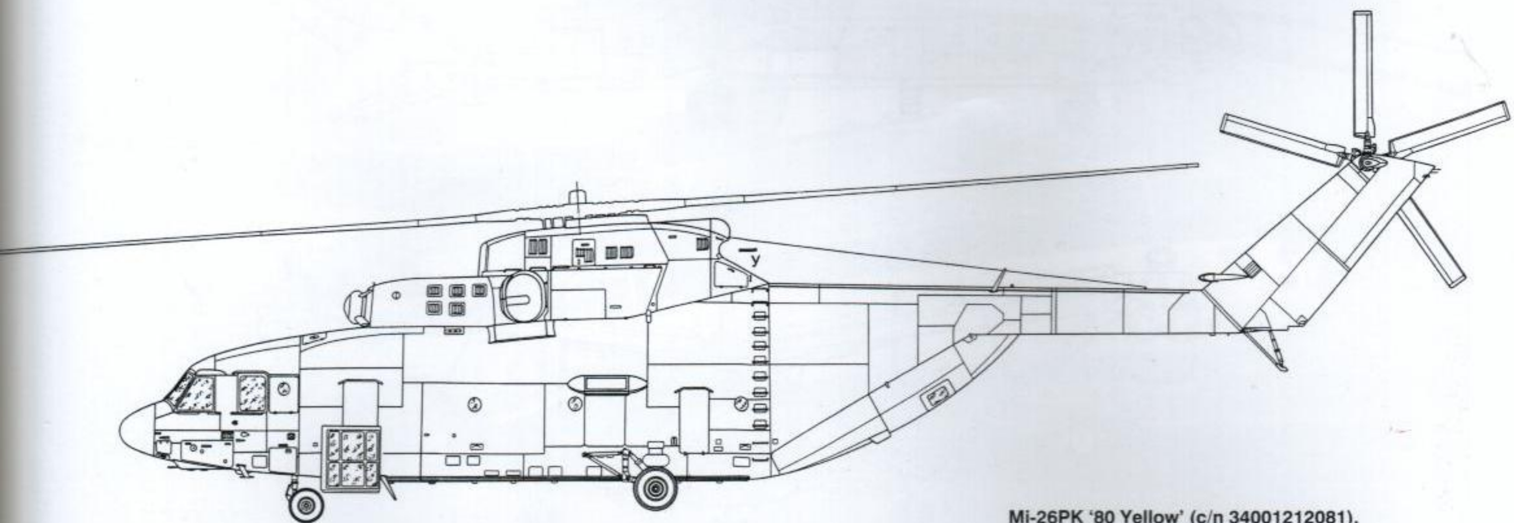
Mi-26TM RA-06089 with the ventral cockpit (1993 configuration).



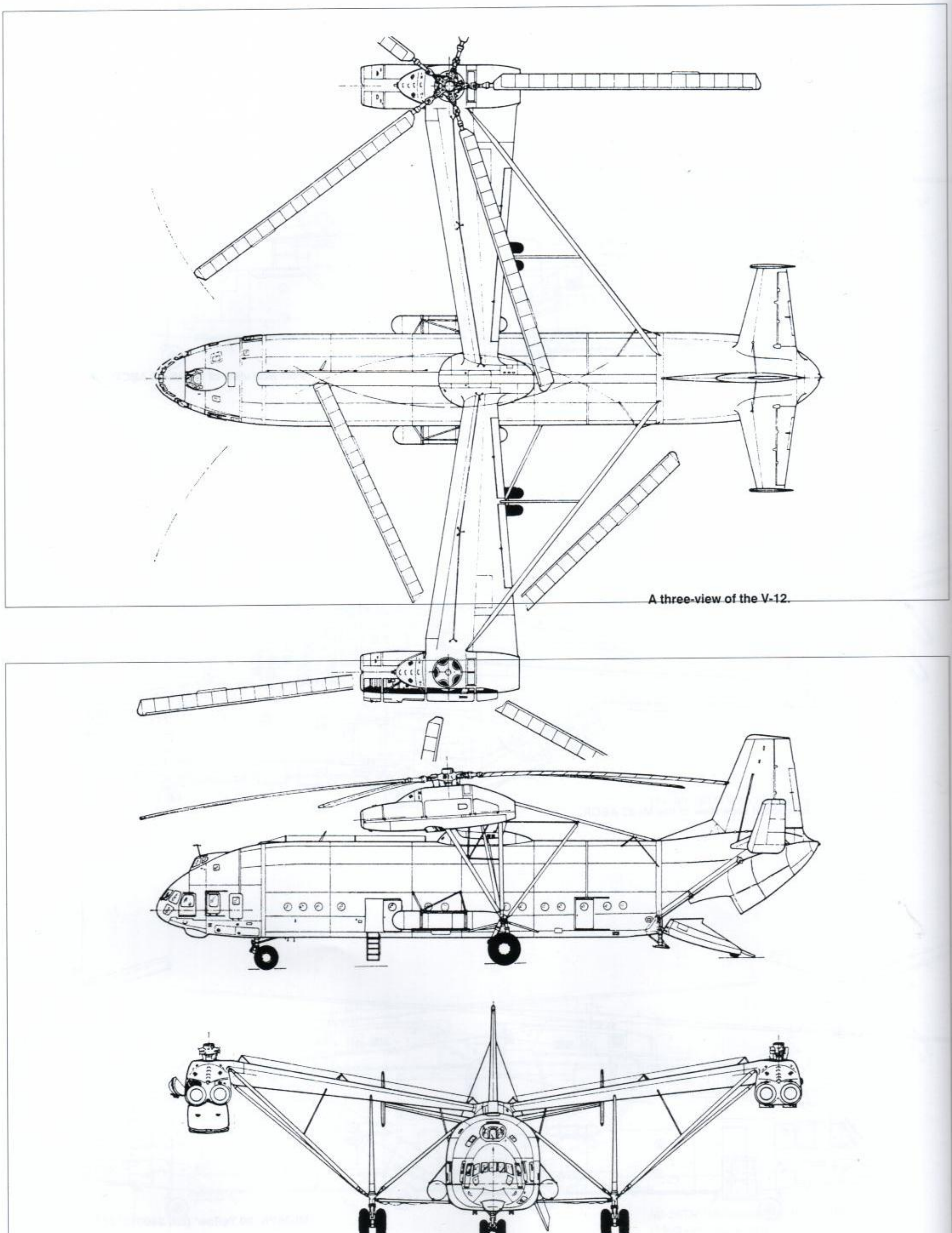
Port side view of the Mi-27 ABCP.



Starboard side view of the Mi-27 ABCP.



Mi-26PK '80 Yellow' (c/n 34001212081).



A three-view of the V-12.

Above: '15 Red', a Soviet Air Force Mi-6, carries a mock-up of the Soviet Vostok space capsule.

Mi-6 CCCP-06174 in its original guise as the commercial version demonstrator in 1965.

Above: Russian Air Force Mi-6A '16 Yellow' (c/n 705305V), seen here at Kubinka AB, wore this gaudy 'bullfrog' camouflage scheme in 1992.

Head-on view of the same helicopter, showing the 'anti-soot' panels contrasting with the pale blue undersurfaces. Note the lack of star insignia on the wings.

Above: This early-production 'dome nose' Mi-6 in the usual overall grey scheme is one of two preserved at the Central Russian Air Force Museum in Monino.

Immaculately restored, this Mi-6A is an exhibit of the Vietnamese People's Air Force Museum in Hanoi.

Above: CCCP-06174 in its new 'fire engine' livery following conversion into the Mi-6PZh prototype. Excess water is spilling from the mouthpiece of the twin water replenishment pipes.

Mi-6PZh2 '41 Yellow' (c/n 9683901V) at Monino – regrettably in less-than-perfect condition.

Above: The second prototype Mi-10 taxies during tests with no cargo platform attached.

The same machine as it featured in the 1961 Aviation Day event at Moscow-Tushino with a prefabricated hut for a geological prospecting team.

Above: A Mi-10 seen seconds after lifting off. Note the ventral hatch for the external sling system amidships.

Another view of the same machine illustrating to advantage the Mi-10's crocodile-like looks.

Above: The second prototype in civilian guise as CCCP-04102 with new nosewheels and faired-over trusses on all four landing gear struts. It was in this guise that the machine was displayed at the 1965 Paris Air Show.

CCCP-04102 takes off with a LAZ-695 *sans suffixe* bus on the cargo platform. The bus was displayed together with the helicopter at Le Bourget.

Above: The special 'short-legged' Mi-10R is prepared for a world record attempt in May 1965.

The ceremonial rollout of the first prototype V-12. The nose gear unit was inaccessible for tugs, so the helicopter was extracted by a KrAZ-255B, using strong cables hooked up to the main gear struts. Note the rotorless Mi-4 parked under the V-12's starboard wing and the MAZ-200 fuel bowser further to the right.

Mil' products come in every shape and size, as this publicity photo of the first V-12 together with a Polish-built Mi-2 testifies. The V-12's colour scheme was rather gaudy.

V-12 CCCP-21142 is an impressive sight as it becomes airborne in a nose-high attitude.

Above: A view of the V-12 in flight. Note the partly open port forward entry door.

The V-12 sits with every engine cowling panel open for inspection as two technicians seemingly make a futile attempt to turn the rotors! The 1965-model GAZ-21R Volga sedan has probably brought members of the design staff to the hardstand. Note the Mi-6 and the Mi-8 parked beyond.

Above: The first prototype Mi-26, CCCP-06141, during ground engine runs shortly before the first hover. Note the open 'gills' of the APU air intake under the co-pilot's sliding window and the lack of Aeroflot titles.

CCCP-06141 takes to the air with an instrumented air data boom fitted. It was the only Mi-26 to feature strakes on the rear clamshell doors.

Above: The first prototype in 1980 as an ATs-40-131 fire engine based on the ZiL-131 6 x 6 lorry and a KrAZ-255B1 6 x 6 lorry are loaded into the cargo cabin. Note the red-painted radome.

A quasi-Aeroflot Mi-26T owned by the Russian Ministry of Interior shares the assembly shop at the Rostvertol plant with two sister ships in Russian Air Force camouflage and a pair of Mi-24 attack helicopters. Note how the radome swings open to starboard.

Above: A fine air-to-air study of a new and shiny Russian Air Force Mi-26 with chaff/flare dispensers.

Escorted by a pair of Mi-24Ps, Mi-26 '88 Red' heads east from Kubinka AB towards Moscow during the dress rehearsal of the 1995 VE-Day parade.

Above: Well-weathered Russian Air Force Mi-26 '04 Yellow' on the hardstand at Kubinka AB in 1992.

Another aspect of '04 Yellow', with Mi-6A '16 Yellow' and a Mi-24P parked alongside.

Above: Mi-26PK '80 Yellow' (c/n 34001212081) operated by Vzlyot in the static park at the MAKS-2001 airshow. The port side cockpit for 'flying crane' operations is not visible here. Note the lack of chaff/flare dispensers.

Mi-26 '88 Red' thunders over Moscow's Kutuzovskiy Prospekt avenue on 9th May 1995, the 50th anniversary of VE-Day.

Above: A very new and shiny-looking Mi-26 parked on the grass at Ghelendjik during the Hydro Aviation-2004 show. This helicopter put on a fire-fighting demonstration at the show, using a VSU-15 'Bambi Bucket'.

As the large Red Cross markings reveal, Russian Air Force Mi-26 '03 Yellow' is outfitted for the Casevac role.

Above: Ukrainian Army Aviation Mi-26 '61 Yellow' (c/n 34001212153) was operated by the 7th Brigade. Note the lesser grade of weathering on the flightdeck section which was usually under wraps when the machine was parked.

Wearing no national insignia but sporting a real scary sharkmouth, this Belorussian Air Force Mi-26 was seen at Machoolishchi AB near Minsk in March 2005.

Above: Mi-26T RA-06276 (c/n 34001212504) wears the stylish livery of the Greek company Scorpion International which leased several Mi-26s in Russia.

Seen in the static display at the MAKS-2003 airshow, smartly painted Mi-26T RA-06273 (c/n 34001212501) of Uralaviatrans sports additional titles of the Vertikal'-T air enterprise on the nose.

Above: Mi-26T RA-06078 of Tyumen'AviaTrans (c/n 34001212045) shown here at the Civil Aviation-2002 show at Moscow-Domodedovo is in fact a former Ukrainian Army Aviation machine, as revealed by the chaff/flare dispensers! These may be quite useful when working for the UN in various 'hot spots'...

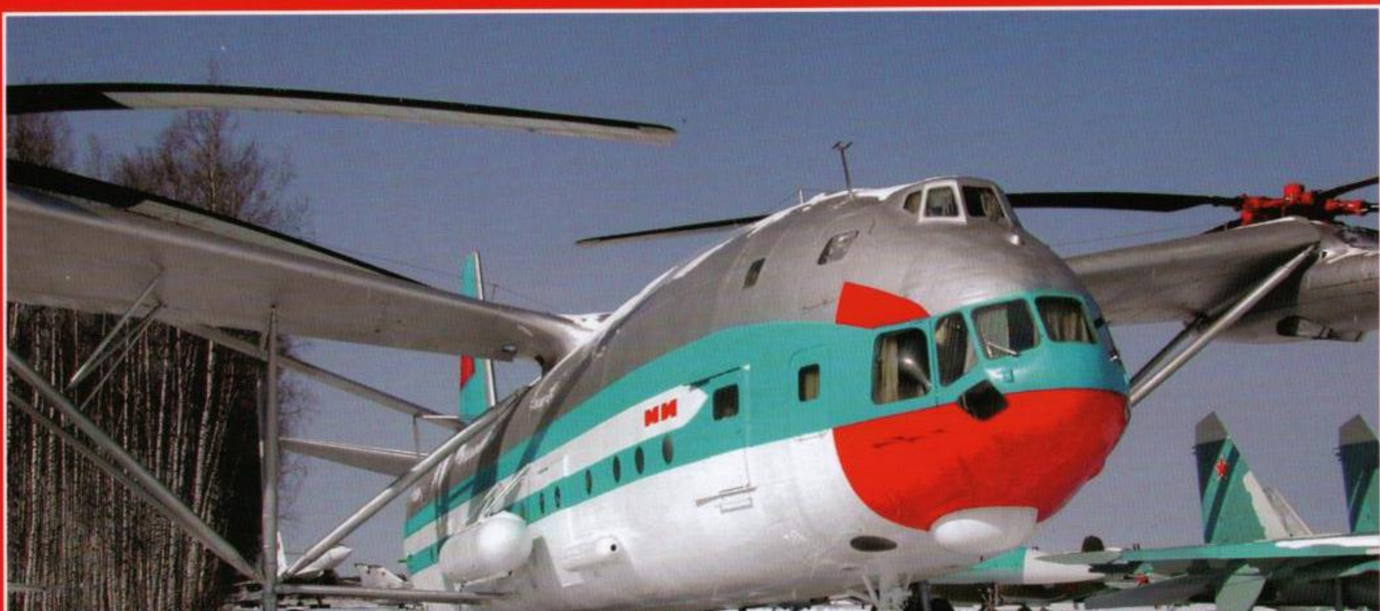
A United Nations Peace Force infantry fighting vehicle is loaded aboard RA-06070, a Tyumen'AviaTrans Mi-26T (c/n 34001212493) in UNPF colours.

Above: Another view of RA-06070 as the helicopter offloads a humanitarian cargo to army lorries seconded to the United Nations Peace Forces.

Wearing very appropriate 'Heavycopter' titles, Mi-26T RA-29112 (c/n 226208) owned by Rostverol has just set down its cargo – a US Army Boeing Vertol CH-47D Chinook salvaged from the place of its emergency landing in Afghanistan. The Chinook had been damaged by Taliban anti-aircraft fire.

Above: Most of the Indian Air Force's Mi-26s, like Z2889 (c/n 223201?) depicted here, were delivered in a two-tone green camouflage.

The Mexican Air Force has two second-hand Mi-26Ts, including 1901 (ex-RA-06271, c/n 34001212495).



ISBN 1-85780-206-3

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USA $36.95 UK £19.99

Midland Publishing