

Kazan Helicopter Plant Chief Designer's Report

ANSAT helicopter design features.

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Introduction

The Kazan Helicopter Plant is one of the big Manufacturers of the Mil helicopter, viz the Mi-8/Mi-17, which are in steady demand in Russia and abroad. In order to ensure the future of the company the plant management has planned two strategic lines.

One of them is the further development of the Mi-8 helicopter by means of modification (such as avionics renewal, installation of up-to-date equipment, design improvement and so on).

The other strategic line is the development and manufacturing of new light helicopters.

The marketing research, made by the plant in the early 1990s, showed that in Russia and in CIS there is a demand for light helicopters ($G_{\max}=3,300$ kg) expressed by the most various categories of customers: Ministry of Emergency Situations, medical service, research service, geologists, oil industry, military, pilot training centers. The western aircrafts of the same class was not affordable (and nowadays the situation has not changed) to Russian Operators due to their high price, as well as to the absence of required maintenance infrastructure. Also, the use of heavy helicopters instead of light ones is not profitable.

At the same time there is a demand for such aircrafts abroad as well, because almost all the light helicopters have been developed according to FAR-27 (JAR-27) requirements, that is they have $G_{\max}=2,750$ kg.

The aircrafts' Operators have been awaiting such a helicopter, which can be converted into passenger, transport, EMS and SR versions with minimum money and time.

The plant started working at the development of a new helicopter in 1993. For this purpose, the plant established its own design bureau, because any efforts to cooperate in development with other companies (Mil Design Bureau, Eurocopter etc) did not achieve the goal. In 1994, upon the results of the marketing study of the world helicopter fleet, the requirements specification was drawn up and it specifies a multi-purpose twin-engine helicopter (3.3 tons TOW, up to 1,300 kg lifting capacity), which meets АП-29 (FAR-29) aviation regulations and present day safety requirements.

Kazan State Technical University, "Avikon" Research and Production Company, "Aeromekhanika" Close Corp., "Avionika" Research and Production Company and others have been involved in R&D.

For reasons of reliability and effectiveness of the helicopter, in order to speed up the starting of production manufacturing and to adapt the helicopter design to the Kazan Helicopter Plant facilities, the helicopter has all-metal structure.

Structurally, the Ansat is a single-rotor helicopter of classical design with one four-blade main rotor and two-blade tail rotor. The helicopter is powered by two gas turbine engines, this ensured high level of flight safety.

While designing the Ansat helicopter configuration a possibility of use of Russian engines was considered. At that time, engines, having suitable power, were the TVO-100 engine, developed by the Engine Design Bureau of Omsk and the AL-34, developed by "Saturn" research and production company. But we had to reject this idea, because in the early 1990s the development and certification process of the TVO-100 engine was stopped due to the absence of financing; the AL-34 engine project did not advance beyond the technical proposal.

In the early 1990s Pratt&Whitney Canada was going to organize the production manufacturing of the PW206 engines in Russia and established the Pratt&Whitney/Klimov joint venture with location in Saint-Petersburg, for tracking this program. That's why these engines were chosen for the Ansat helicopter.

As a result of negotiations, the Pratt&Whitney Canada agreed to deliver the PW206 engines and accessories required for the helicopter. This choice was greatly motivated by the fact that the PW206 had already obtained the Type Certificate in 1989. Originally the Ansat helicopter was designed to be of interest for international market as well, where only the products certified according to western regulations can be sold. Therefore we decided to solve the issue of the engine certification in good time, especially in Russia there is no such engines.

Helicopter design features

The Ansat helicopter is designed as single-rotor helicopter with a tail rotor.

Main rotor – four blades.

Tail rotor – two blades.

Landing gear – skid type.

The helicopter is equipped with two PW207K gas turbine engines manufactured by Pratt&Whitney Canada, with take off power of 630 shp each, which will be manufactured under license in Russia.

The Ansat helicopter has the following design features:

Hingeless composite hub of the main rotor ensures better helicopter stability in flight, stabilization and automatic control being off. An elastic torsion bar is used instead of drag, flapping and feathering hinges; it ensures all necessary motions of each blade and greatly increases controllability and maneuverability of the helicopter.

The hub has no one lubricated bearing, and the total number of components is much less than the number of components of a hinged hub.

All this facilitates maintenance and decreases maintenance costs.

The main and tail rotors' blades are of fiberglass plastic.

The fuselage has the most spacious cargo-and-passenger cabin in comparison with the helicopters of TOW up to 4 tons – 6.8 m³, where it is possible to transport 9 passengers besides 2 pilots, or, for example, to transport a set of blades inside the cabin with open aft door, or a complete set of ground equipment. The helicopter fuselage is of semi-monoque type of riveted structure, made of duralumin. The cabin has two side doors. The pilot's seat is on the right, the passenger's/trainee's (in training version) seat is on the left. An additional door, designed for luggage or stretcher loading, can be installed in the fuselage aft portion. The tail boom is of all-metal riveted structure, the shrouded transmission shaft is arranged above the tail boom. A tail skid, protecting the tail rotor against the ground impact, is attached to the tail boom. The helicopter is equipped with skid landing gear; the use of the wheeled landing gear for training version is under consideration.

The KSU-A fly-by-wire system has 4-times redundant digital computer and 4-times redundant emergency analogue computer.

One of the advantages of the use of the fly-by-wire system is a possibility to make a training helicopter, which simulates sensation, control response, g-load of, practically, any helicopter: either single-rotor or co-axial one with just some limitations.

Full Authority Digital Engine Control (FADEC) provides complete automatic engine control at all power rating, including OEI. In case of FADEC failure, a mechanical manual control is provided.

The FADEC system provides multiple safe simulation of failure of one of the engines by means of "Training" mode: the "Training" switch of the LH or RH engine being ON, one of the engines (main one) runs into "Maximum continuous power", while the other (assistant) goes to lower power, which is a difference between OEI rating and maximum continuous rating at this altitude and at this temperature, simulating acceleration like the acceleration of one engine running into OEI power. Capability of operation at real OEI rating is kept intact.

This mode allows saving the engines and transmission life, as well as provides safe training even with maximum take off weight.

Automatic starting system allows starting the engines by actuation of just one switch.

BISK-A indication system

The parameters of all helicopter systems are acquired by double redundant airborne indication system (BISK-A), which is provided with a maintenance recorder. Two multi-functional displays (MFD) show all the required information about the systems and units status.

Also the BISK-A system is provided with a capability to record the helicopter systems parameters in case of failure. This allows viewing everything in details after the return to the base, by displaying the information using the MFD, installed on the instrument panel, or using a laptop.

Integrated flight and navigation system

The Ansat helicopter is equipped with integrated flight and navigation system, which ensures total autonomy in preparation of the helicopter to flights and maintenance. Using this system you can fly in automatic, director and manual control modes, under VMC and IMC, day and night.

All the flight and navigation information and information on the engine status is displayed on two multi-functional displays (MFD), which duplicate each other.

The helicopter is equipped with warning system. We plan to install data acquisition system, which will acquire the information on the main units status and the parameters will be displayed on the MFD.

Survivability requirement

For the first time in Russia the helicopter structure has been designed taking into account the requirements for the survivability of pilots and passengers in case of crash landing.

Thrust-to-weight ratio

The helicopter has the highest thrust-to-weight ratio at maximum take off weight in comparison with other Russian helicopters; this ensures high maneuverability characteristics and safety in case of failure of one of the engines.

For example, the ground-level rate of climb at maximum take-off weight is 16 m/s; the continued takeoff is ensured up to 1,500 m of altitude under ISA conditions. With takeoff weight equal to 3,000 m the rate of climb is 17 m/s; the continued takeoff is possible up to an altitude of 2,500 m under ISA conditions.

The helicopter can be used with the highest possible operation rate at any flight modes (for example, the hovering mode is limited in time only by the quantity of the fuel remaining, not by the oil temperature).

Helicopter service conditions

Service life

Helicopter assigned life	20,000 hours
Time between overhauls	2,000 hours
Engine assigned life	30,000 hours
Time between overhauls	3,000 hours
Cost of one flight hour	179.6US\$/FH

(for training helicopter without taking into account helicopter price, salary of flight and maintenance personnel).

The presence of about 3,000 Mi-8/Mi-17 helicopters in service allows including the Ansat helicopter in existing maintenance infrastructure. The same situation is abroad.

The PW207K engine will be manufactured in Russia. General Agreement concerning production manufacturing of the engines in Kazan has been concluded between Kazan engine plant and Pratt&Whitney Canada. This could allow decreasing greatly the engine purchasing price.

According to AP-29 regulations requirements the helicopter is designed for flight in any climatic zones.

Due to the fact that the helicopter meets the AP-29 regulations, category A, it can fly above the cities, including Moscow.

The engine power margin allows maintaining the helicopter operable at high OAT (up to 35°C) and up to an altitude of 3,000 m.

The anti-icing systems of the blades, power plant and cockpit windows allow using the helicopter under icing conditions without any limitations.

The flight control and navigation equipment allows flying by VFR and IFR, day and night.

At the stage of the helicopter designing a possibility of long-term independent operation has been envisaged. All the maintenance jobs, including 100-hours maintenance, can be performed by two crewmembers.

The helicopter is equipped with solid-state flight data recorder, which allows downloading all the flight information into a laptop after landing.

Ansats helicopter main flight performance

Maximum take off weight	3,300 kg
Maximum useful load	1,000 kg
Maximum speed	280 km/h
Cruising speed	250 km/h
Maximum rate of climb	17 m/s
Maximum range with standard fuel tanks	635 km
Ferry range with additional fuel tanks and take off weight of 3,500 kg	1,200 km
Hovering ceiling	3,300 m
Service ceiling	5,700 m
Maximum flight duration	3.3 h

First flight

On the opening day of the IV Moscow Air Show, August 17, 1999, the light Ansats helicopter took off for the first time and performed 12-minutes flight at the flight test station of Kazan Helicopter plant. First in the history of Russia the production Manufacturer managed to design and develop a new type helicopter and to bring it to flight tests.

On the 5th of October 1999, First Vice Director General of Russian Aerospace Agency, Mr. Bardin, approved the "Resolution of the methodic council of the aviation industry about readiness of the Ansat helicopter, designed by Kazan Helicopter Plant, for the first flight and for beginning of the factory certification tests".

October 6, 1999 the Ansat helicopter performed first official flight.

Flight development tests

The Ansat prototype No1, used as full-size test rig for transmission endurance tests and for helicopter systems tests. Its total time of operation is equal to 240 hours.

The prototype No2 performed its first flight on the 17th of August, 1999. It has flown totally 58 hours 20 minutes (by September 9, 2001) and performed 219 landings. But for all that, there was a 6 months break in flights (from January to August 2000) due to the replacement of rigid tail rotor by a hinged one.

The flights have been performed with take off weight up to 3,300 kg, with CG position from +100 up to -50 mm at a speed up to 270 km/h and at an altitude up to 4,000 m, main rotor rpm being 95-100%.

There have been performed: hovering flights at wind up to 10 m/s (all wind directions), at OAT from +28°C to -20°C; hovering turns with angular velocity up to 20°, up to 45 deg. banked turn; gliding up to 20°; climbing at maximum continuous rating with rate of climb up to 14 m/s; power-on glide at descent speed up to 9m/s, which simulated failure of one engine in flight.

At the mentioned above modes there were performed strength measurements, static and dynamic stability characteristics have been obtained, static pressure corrections of the speed indicators have been determined, type and location of the Pitot tubes have been chosen. The helicopter systems serviceability and parameters have been checked and determined. With damping system being on, the helicopter keeps initial flight mode with hands-off control within 15 seconds at hovering in calm air and for 25 seconds at a speed up to 200 km/h. According to pilot's qualitative evaluation the helicopter is stable and well controllable at all tested flight modes.

Fuel consumption at an altitude of 500 m at a speed of 230 km/h is 240 km/h.

The flight with one engine inoperative (OEI), the other running at maximum continuous power is ensured within 60 to 160 km/h speed range with flight weight of 3,300 kg.

There was no failure of hardware in flight.

The prototype No3 has been manufactured for flight tests in September 2001. It is of type design, specified according to AP-29 aviation regulations and it took into account all the remarks of mock-up committee of Aviaregister. The prototype No3 is designed for factory certification tests, which are scheduled to be completed by the end of 2002 and as a result the type certificate will be obtained.

The prototype No4 is designed for fuselage structural static tests. Now it is practically ready. The tests will be started in September 2001.

Ansats helicopter versions

The Ansats cargo and passenger version is designed for transport of 8 passengers or cargo of 1,000 kg inside the cabin or 1,300 kg at sling. The cabin is equipped with quick-detachable seats, this allows converting the helicopter from passenger into cargo version. The helicopter can be equipped with special equipment for patrol, reconnaissance and monitoring missions.

Upon the Customer request, the helicopter can be equipped as VIP version. The VIP version is much more comfortable than the basic one (comfortable seats, mini-bar, air conditioner etc), it is provided with noise and vibration insulation, it is equipped with GPS, entertainment equipment.

The rescue version of the Ansats helicopter is designed for Ministry of Emergency Situations, ambulance aviation, and other rescue services. It provides transportation of rescuers and medical personnel as well as equipment and medicaments to the place of accident, and evacuation of victims to hospitals etc. For this version a provision is made for 3 medical attendant seats and 2 stretchers. In the aft part of the fuselage there is a door designed for loading the stretchers. A 150-kg winch for hoisting persons and cargo is installed on the starboard side. Under the fuselage a searchlight is installed.

The helicopter, equipped with fire fighting equipment can be used for extinguishing of different fires.

The training version is designed for pilot's flying training, simulation of various flight situations, pilot conversion training for other types of helicopters.

Since its first demonstration flight the Ansats helicopter awakened a keen interest of specialists and aircraft operators. With time this interest has become more specific and has passed onto the level of purchasing contract. Such a contract is concluded, for example, with one of the biggest Russian airlines. There are talks about purchasing of license for the helicopter manufacturing in South Korea and Malaysia.

Conclusion

Having developed the Ansats helicopter, Kazan Helicopter plant improved its design-engineering basis. This allows being more flexible and reacting to the Customers' request, making customized design. Improving its helicopters, Kazan helicopter plant makes them more competitive not only in Russian market, but abroad. Today the helicopter Manufacturer became a design center. This new status is certified by the Design Organization Certificate, proved by the development of new helicopter – Ansats.