TWENTY FIRST EUROPEAN ROTORCRAFT FORUM

PAPER NO. III.11

A KA-115 HELICOPTER
A NEW DEVELOPMENT OF KAMOV COMPANY

by

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AUGUST 30 - SEPTEMBER 1, 1995
SAINT- PETERSBURG, RUSSIA

Paper nr.: III.11

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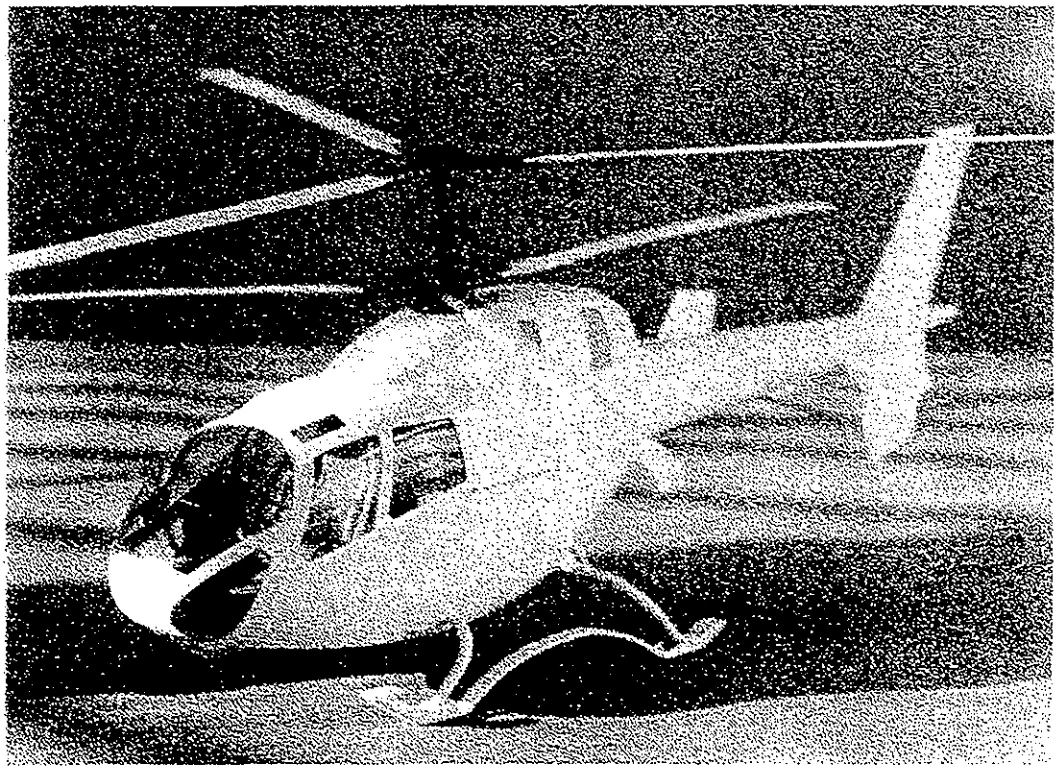

ABSTRACT

The paper presents the main aspects of a Ka-115 new light multipurpose coaxial helicopter development at Kamov Company.

Helicopter description, its specific design features and flight performance are given.

Specific nature of coaxial main rotors aerodynamics and aeroelastisity responsible for the helicopter high operational performance is also described and functional capabilities of the helicopter and its place in the transportation infrastructure are shown.

HISTORICAL BACKGROUND

Kamov Company develops the helicopters for various applications and light helicopter design is one of its priority development lines.

The first helicopters of this family were single-engined:

- two-pilot coaxial ship-based Ka-15;
- four-crew coaxial Ka-18 called once "flying automobile" (fig.1).

The last one was awarded a gold medal in Bruxelles in 1958 for the originality of design.

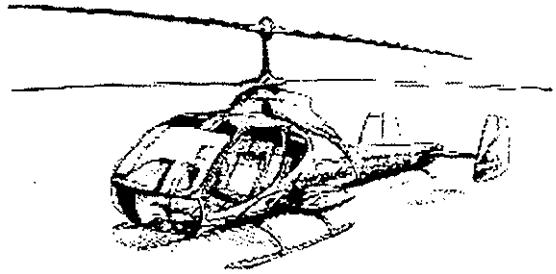

Fig. 2. Ka-18 helicopter modification

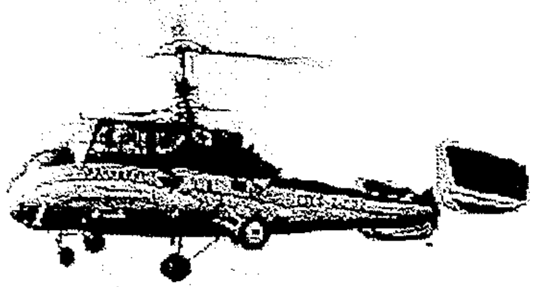

Fig.1. Ka-18 helicopter

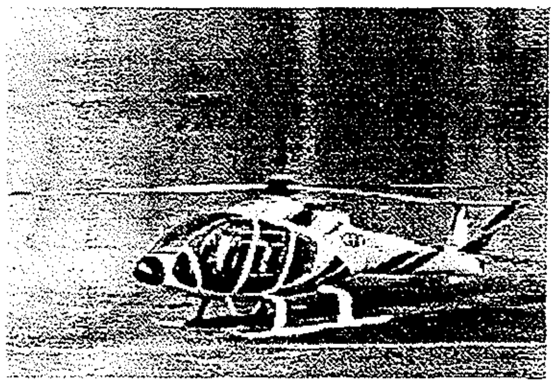

Fig. 3. NOTAR helicopter

For the past period Kamov company, along with the development of other type helicopters, has also persistently continued its search for new design and technology approaches (fig. 2...4) that could be used in creating a new generation of light single-engined helicopters for multipurpose application, answering operation and production requirements as well as those of flight safety, comfortability and ecological compatibility.

The Ka-115 helicopter development is the result of this research.

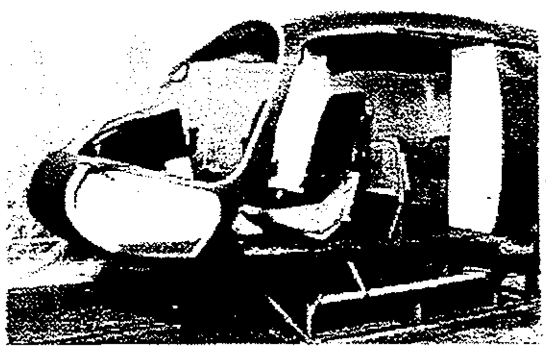

Fig. 4. Ergonometric modelling of a cabin

DEVELOPMENT CONCEPT

The Ka-115 is developed as a multipurpose transportation aircraft to be used for a wide range of both civil and military applications.

Market

A large scale market research undertaken by several institutes of the Russian Civil Aviation Ministry for the past few years has demonstrated that the existing structure of the helicopter fleet on the territory of the former Soviet Union is unreasonably overburdened with heavy helicopters like Mi-8, Mi-26 amounting to 60% of the total thus making the fleet operation rather unefficient.

In this connection a number of government programs was developed and approved in Russia aimed at adequate re-equipping of the fleet and especially at filling it with helicopters of 0.6...1.3 t cargo lifting capacity that cover up to 70% of all air transport operations.

Poor surface transport infrastructure typical for the major portion of the Russian and other CIS countries territory, being also aggrivated by an unhospitable long winter period, also testifies in favour of light helicopter fleet development.

If may clearly be predicted that the problem of providing mobile transportation means in such conditions can most effectively be solved by helicopters and first of all light helicopters as most easily adaptable for the territory laking good roads, for densely populated cities, scarcely populated countryside and mountainous areas.

The helicopter designers are well aware that a market competive helicopter must definitely:

- demonstrate a technological perfection;
- have high flight and operational performance level;
- satisfy a wide range of market requirements throughout its life period;
- be accessible to the Buyer from the price point of view.

All these factors formed a basis of the Ka-115 development to ensure adequate response to the market demands (fig.5).

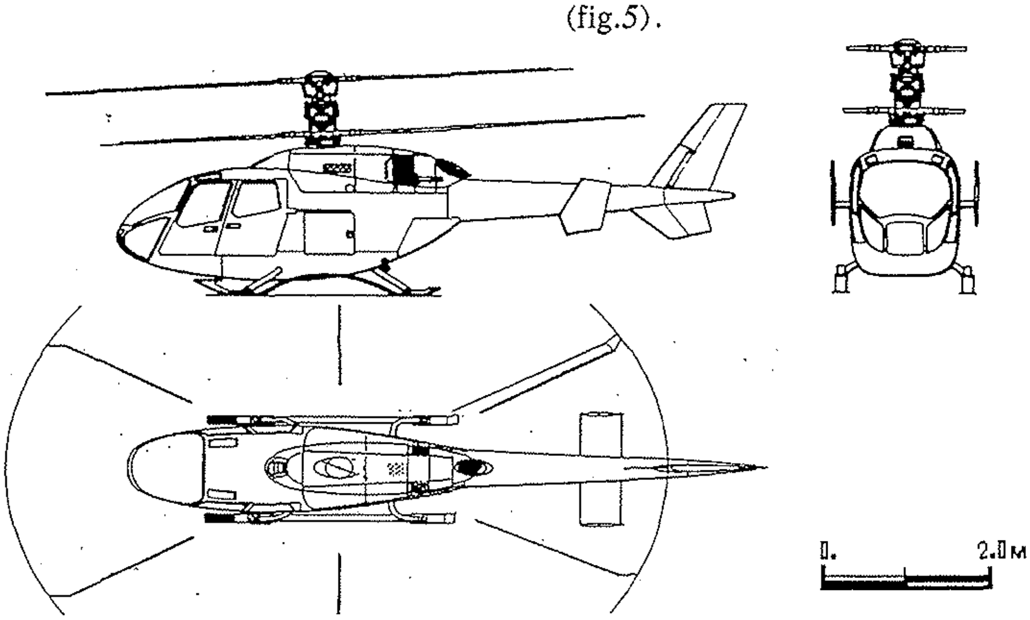

Fig. 5. Ka-115 helicopter (3 views)

Technology Back-log

Taking into account the above described factors and to make the helicopter design technologically feasible its development was based upon the following features:

- improved design of a main rotor hub and a coaxial rotor control system tested at a Ka-50 helicopter;
- adapted manufacture technology for composite airframe components optimizing the structural weight and strength;
- satellite navigation system tested earlier at a Ka-32 helicopter;
- serial production (model PW 206A) engines of PRATT & WHITNEY of Canada manufactured by a joint Russian-Canadian company of PRATT & WHITNEY / KLIMOV in St. Petersburg.

Besides, the development stage also included the following:

- full-scale helicopter modelling (fig. 6) to optimize technological, operational and ergonomic characteristics;
- wing tunnel tests (fig. 7) to streamline the airframe aerodynamic configuration;
- laboratory tests of air intakes with inlet particle separators (fig. 8) to increase their efficiency.

Fig. 6. Ka-115 helicopter frame mock-up

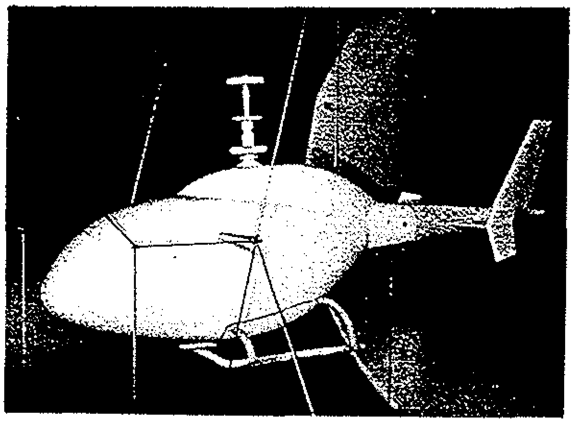

Fig. 7. Ka-115 model tests in TSAGI wind tunnel

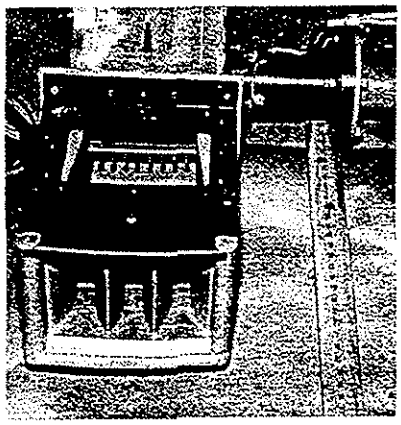

Fig. 8. Testing of an air intake section with an inlet particle separator

SPECIFIC FEATURES OF HELICOPTER DESIGN

The Ka-115 is a coaxial design having two three-bladed counterrotating rotors, demonstrating aerodynamically smooth fuselage contours and well accented tail section.

Coaxial main rotor performance, controls, airframe aerodynamic layout and its design/technology configuration are optimized for high lifting ability, expansion of wind speed/direction limits at take-off/landing in restricted space, simplicity of control at complex transient flight modes and safety at emergency landing.

Coaxial Main Rotors

Selection of coaxial rotor parameters was a trade off between flight performance, mass and operational parameters of the helicopter.

Main Rotor Hub

Simplicity of hub "aeromechanics", supported by the operational experience of the same design at a Ka-50 helicopter, permits to predict with certainty at the stage of development the boundaries of flutter and ground resonance and to ensure their absence in all operational flight modes. The hub design includes a multilayer torsion plate bar connecting the blade to the hub body. The hubs are operated "on condition".

Main Rotor Blade

The blade configuration is based on the latest aerodynamic profiles developed by TSAGI. The blade geometrical twist and tip configuration provide for a low level of alternating loads and vibrations in the coaxial main rotor system.

A low vibration level of such helicopter is explained by peculiar nature of both upper and lower rotor hub loading with alternating loads at the blade frequency without application of special means like pendulums, main gear box shock absorbing suspension etc. as was demonstrated in a wide range of flying speeds (up to 340 km/h) by a Ka-50 helicopter.

Coaxial multi-bladed (6 blades) rotor low tip speed (up to 205 m/s), blade profile configuration and optimization of their azimuthal divergence are evaluated by Ka-26 and Ka-32 helicopters operational experience as adequate for satisfying ICAO terrain noise requirements.

COAXIAL MAIN ROTORS AERODYNAMIC PECULIARITIES

Kamov experience in designing coaxial rotors, exceeding now forty years, permits to state that this configuration has certain energetical advantages over the traditional "main rotor plus tail rotor" configuration.

Full scale tests using upper/lower rotor tip vortex smoke visualization made on a Ka-32 helicopter [1] confirmed that in the lower rotor plane the upper rotor wake contracts to 85% of the rotor geometrical diameter (fig. 9).

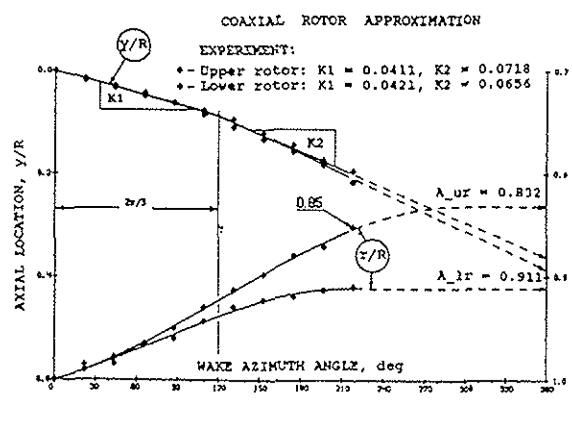

Fig. 9. Smoke visualization approximation of tip vortices structure in Ka-32 helicopter hover

It means that the lower rotor sucks in additional air and thus increases an effective diameter of coaxial main rotors.

Due to this, creation of trust on hover by coaxial rotors demands the order of 7% less of required power in comparison to the traditional single rotor of a similar diameter (neglecting power consumption for the tail-rotor). It may be considered as a 7% increase of coaxial rotor figure of merit.

Very near numerical results were obtained at coaxial and single rotor models figure of merit comparative testing in TSAGI wind tunnel (fig. 10) [2]. It may be seen that a coaxial rotor model figure of merit increase in comparison to that of a single rotor is 1.08...1.1.

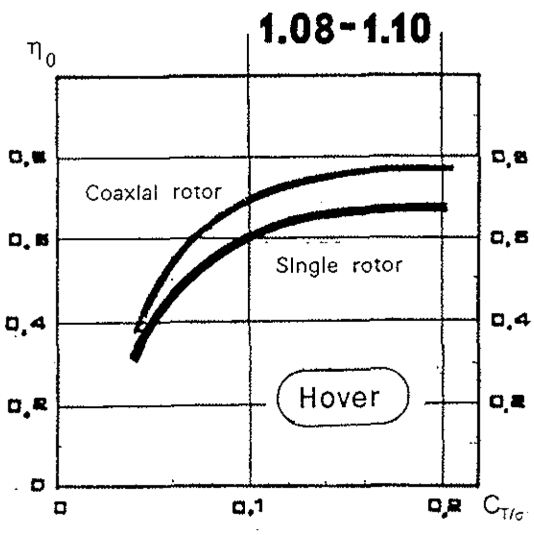

Fig. 10. Coaxial/single main rotor figure of merit comparison versus C_T/σ in the TSAGI wind tunnel tests (model main rotor diameter 2.52 m, tip speed 60 m/s solidity 0.15, blade twist 6 deg) [2]

Another peculiarity of a coaxial rotor is absence of power losses for directional balancing and helicopter control.

As it is known, power consumed by the tail rotor at hover is approximately the range of 9...12% of the total power consumed by the main rotor. It demands for an additional increase of the single main rotor required diameter to create equal thrust (at equal power) in comparison to a coaxial rotor system.

As a result of the above a coaxial main rotor required diameter is 1.2 times less than that of a single main rotor of the same thrust at hover and the coaxial main rotor system is 1.5 times more compact in length then the traditional "main rotor plus tail rotor" system (fig. 11).

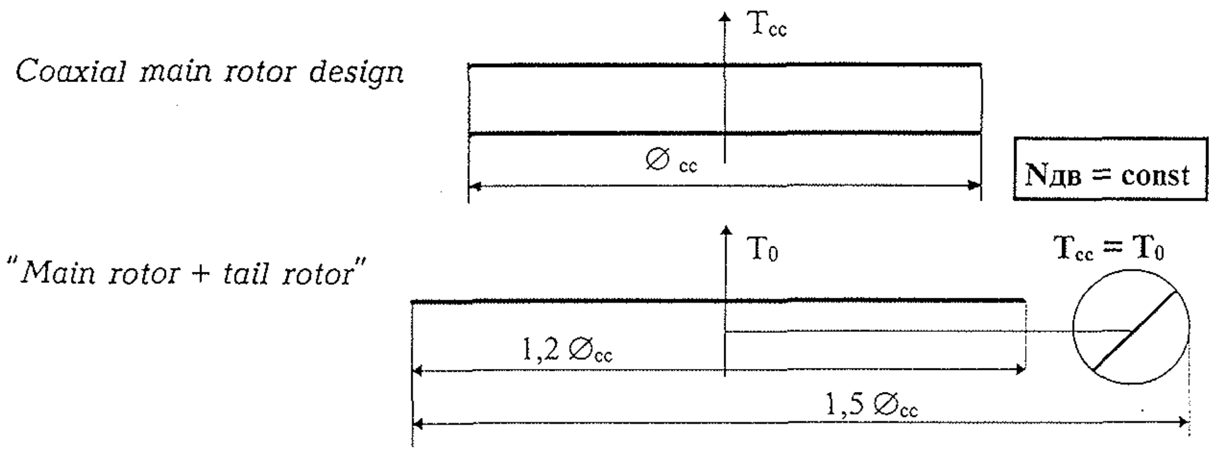

Fig. 11. Comparison of a coaxial and a "main rotor + tail rotor" systems creating an equal thrust at an equal consumed power at hover

As a practical result of it, a coaxial main rotor helicopter is 1.2 times more efficient energetically at hover, it demonstrates a complete aerodynamic symmetry making it easy to pilot, including transient and engine failure modes, and increasing its efficiency and power of control that is especially important at maneuvering within a restricted space.

Power Plant

The Ka-115 power plant includes one gas turbine engine and its configuration permits to accommodate various models of 550-650 h.p. engines of PRATT & WHITNEY of Canada, Allison and Turbomeca families.

The basic Ka-115 configuration discussed here is powered by a PRATT & WHITNEY / KLIMOV joint production engine rated at 550 h.p.

Its static type air intakes with receivers are fitted with inlet particle separators of inertial type made as a modulus.

Crashworthy Design Approach

Structural strength, economical and operation analysis of the project laid a basis for a differential approach to application of both traditional light alloys and composites in the airframe structure including the landing gear.

The main criteria of this approach implied a trade-off compliance of the design with the requirements of cost, weight and crash resistance the latter being necessary for complying with the operational requirements on survivability of the people on board at a crash landing.

The structural components where composites are widely used, in accordance with the above described approach are the following: tail boom, tail section, fuselage belly, cockpit canopy, cabin doors and cargo compartment hatches.

Survivability tasks (fig. 12) are solved by provision of a crashworthy fuselage frame of a hybrid structure, a new technological approach to the landing gear design ensuring its larger energy absorbtion ability, crashworthy fuel system, injury safe helicopter controls, crew and passenger shock absorbing seats installed at the Customer's option.

Inflatable floats are provided for emergency landing on marshy land or water ensuring required buoyancy and stability for the helicopter.

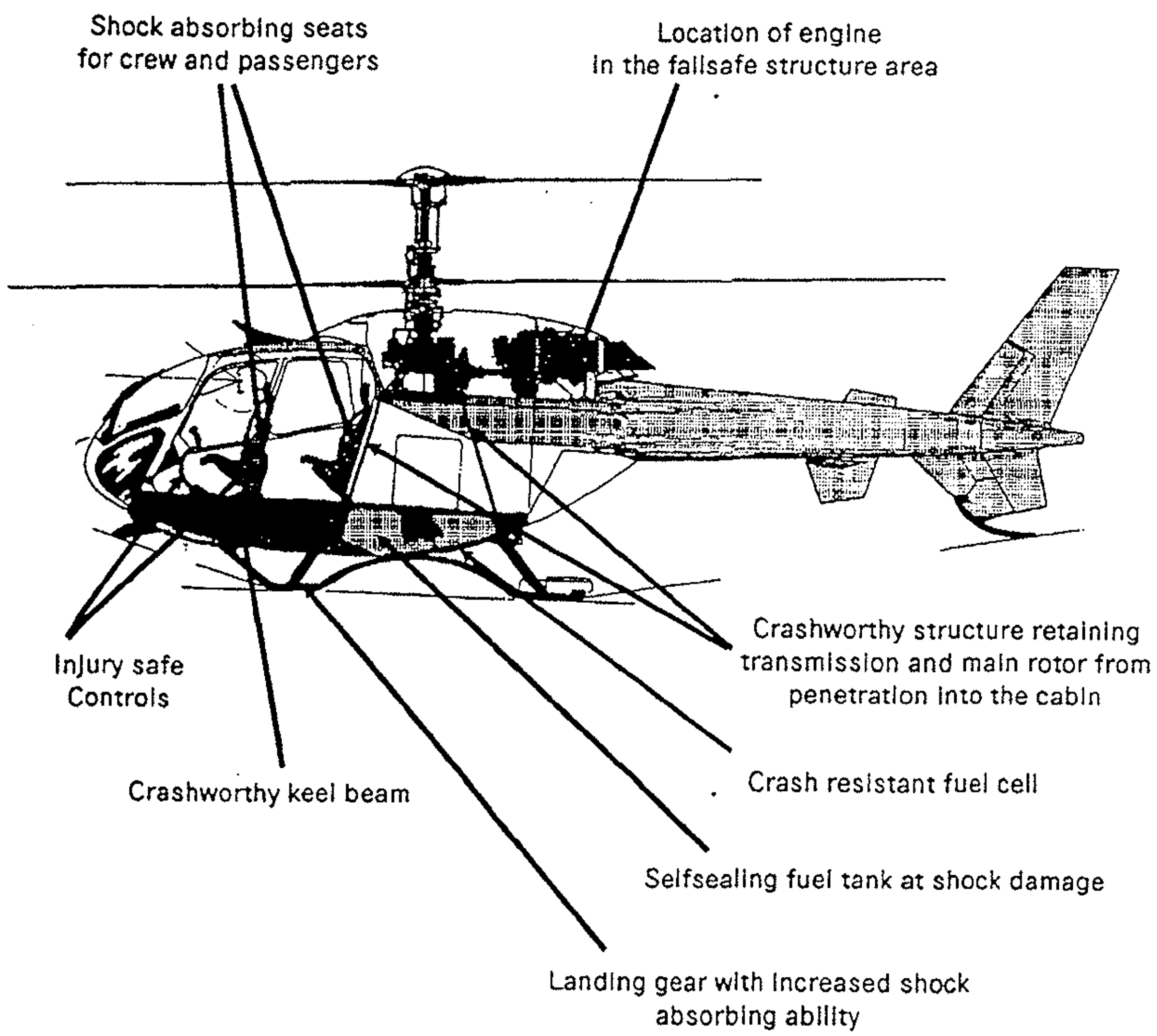

Fig. 12. Ka-115 helicopter crew/passengers survival means

HELICOPTER OPERATIONAL CAPABILITIES

Ka-115 helicopter configuration is optimized for multipurpose application both in cities and in mountaineous and other areas that are difficult to access and the helicopter flight performance is for the maximal extent adapted to a wide range of natural and climatic conditions.

MAIN KA-115 HELICOPTER PERFORMANCE DATA

ISA, H = 500 m, with 30 min fuel reserve

Take-off weight, kg	1850
Crew, persons	1
Cabin accommodation, persons	2+3
Cruising speed, km/h	230
Max speed, km/h	250
Max rate of climb, m/s	11.5
Max flight altitude, m	5200
Hover altitude:	
- IGE, m	3100
- OGE, m	2350
Operational range	
- with main fuel tanks, km	780
- with auxiliary fuel tanks, km	1200
Permissible cargo weight	
- at an external sling, kg	900
Operational conditions	
- external temperature range, deg.C	(-)45...(+)50
- wind speed (any direction), m/s	10...15
- soil density, kg/cm.sq.	3...4
- ground inclination	1:10

Cabin Size

The Ka-115 has a spacious cabin of 3 cubic metres volume accommodating 4...5 persons and an isolated large (1.2 m.cub.) cargo compartment adjacent to the cabin (fig. 13).

The cabin has two doors along each side, one of them sliding, making a large door opening having a clear size of
1.2 m by height and
1.5 m by width.

The cargo compartment can be accessed both from the cabin and through side 0.6x6.7 m hatches and a 0.65x0.6 m hatch located in the tail section.

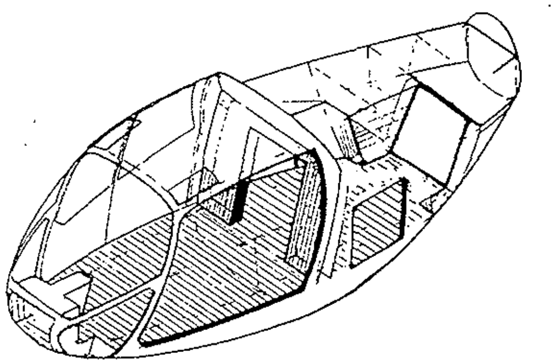

Fig. 13. Cabin and cargo compartment size

Location of the cargo compartment adjacent to the cabin at the same floor level and availability of various approaches to it in actual operation permits to most effectively use their inner space when performing various tasks i.e.:

- cargo/passenger transportation;
- emergency medical service flights;
- search and rescue and patrolling operations.

Passenger Transportation

Four comfortable shock-absorbing passenger seats and luggage (in a separated section) may be accommodated in the helicopter cabin (fig. 14).

Large sliding doors provide an easy access to the cabin. The cabin is lined with noise attenuation panels from inside and is provided with heating and air conditioning ensuring comfortable ride in various climatic conditions.

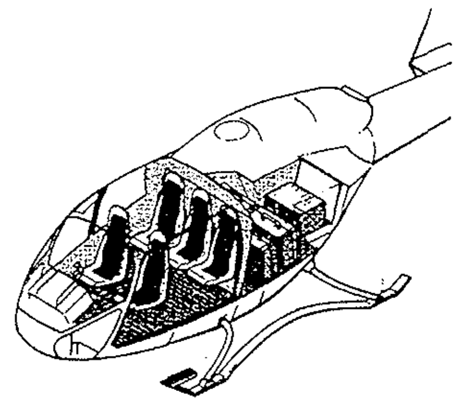

Fig. 14. Passenger version configuration

A cargo/passenger transportation version permits to accommodate inside cargoes weighing up to 700 kg including cargoes of up to 4.0 m length or be adapted for transportation of 4...5 passengers in easily dismantled seats and cargo.

Medical Emergency Service

The helicopter cabin permits to accommodate one patient on a stretcher and provide adequate medical care for him by two attendants (fig. 15).

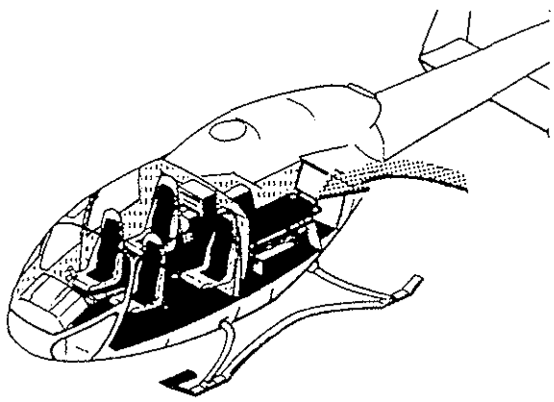

Fig. 15. Emergency medical service configuration

Various special medical equipment and facilities including stretcher/trolley may be also installed on the board.

Search & Rescue and Patrol Operations

The helicopter is capable to perform SAR operations within a 250 km radius zone and stay in the air for more than 4 hours.

In case survivors are detected the helicopter crew can take up two persons on board at hover using a helicopter winch (fig. 16).

In patrolling operations the helicopter can land 3...4 persons with their corresponding equipment using an accelerated go-down system.

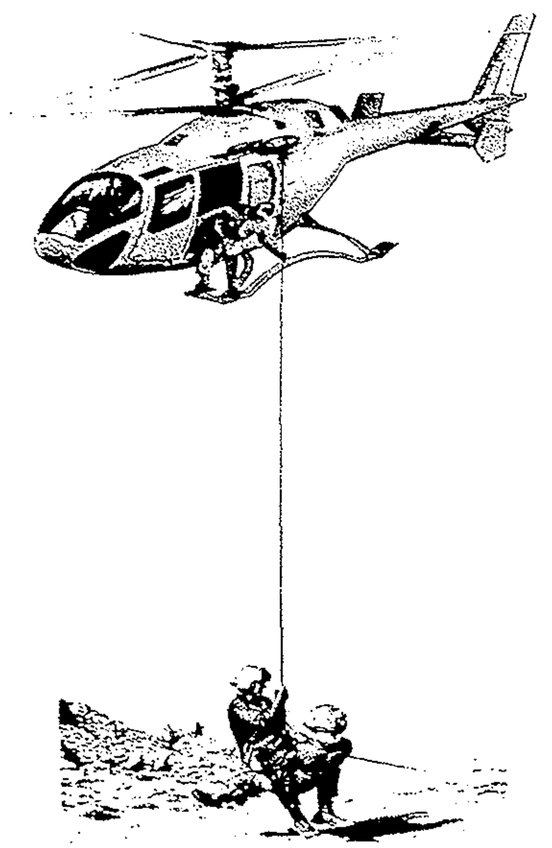

Fig. 16. Ka-115 helicopter conducts a SAR operation

CONCLUSIONS

The Ka-115 helicopter is being developed within the framework of the Russian State Program for the Development of Civil Aircraft till the year 2000 and is aimed at reaching its targets.

Kamov Company takes all the efforts to minimize technological, operational and economical risks in the course of the project development.

Declared operational performance of the helicopter is supported by the advanced aerodynamic configuration of coaxial main rotor system, versatility of cabin layout, improved engine performance, proven technology of applying various materials in the airframe structure.

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