Infrastructure climate requirements imposed to design of transport airplane for arctic exploration

Mikhail Yu. KUPRIKOV*,[1], Lev N. RABINSKIY[2], Nikita M. KUPRIKOV[2,3]

*Corresponding author
*,[1]Department of Engineering Graphics,
Moscow Aviation Institute (National Research University),
4 Volokolamskoe shosse, 125993, Moscow, Russian Federation,
kuprikov@mai.ru
[2]Department of Perspective Materials and Technologies of Aerospace Designation,
Moscow Aviation Institute (National Research University),
4 Volokolamskoe shosse, 125993, Moscow, Russian Federation,
rabinskiy@mail.ru, nkuprikov@mai.ru
[3]Scientific and Information Center "Polar Initiative",
1 Volokolamskoe shosse, 125993, Moscow, Russian Federation

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Abstract: *The Arctic has been considered as a strategic region, which has economically and geopolitically a key position as the object of growing international competition. The dynamics of ice melting creates new conditions for functioning in the Arctic, and, consequently, ensuring the defense of Russia from the direction of the North Pole. Its active infrastructural development is justified not only by the rich natural resources, but also by the additional strategic logistics opportunities that open up for the Russian economy. The development of a complex of Arctic standards is a necessary step in the implementation of successful activities in the Arctic zone of the Russian Federation. A structural-parametric analysis of the treaties on the Arctic and Antarctic has been done. We are talking about the algorithm for introducing ideas about "polar execution" into different areas of research activity and about its regulatory and legal support in the implementation of projects in the polar regions. In the XXI century.*

Key Word: *arctic, north pole, airplane, ice, aircraft performance characteristics.*

1. INTRODUCTION

The development of activity in the polar regions of the Russian Federation depends on the availability of specialized aircraft for polar exploitation in the fleet of domestic aviation equipment [1], [2], [3].

The geographical location of the Russian Federation highlights the pronounced regional isolation of the Arctic zone of the Russian Federation (AZRF). In Russia, more than 40% of the territories are isolated and remote polar regions - the Arctic, which requires the use of aviation technology (airplanes and helicopters) to ensure uninterrupted aviation and transport accessibility of the Russian Arctic. In these regions, as nowhere else, the issues of increasing the volume of passenger and freight traffic to [4], [5], [6], [7], [8], increasing the efficiency and reliability of operation under severe infrastructure and climatic constraints (ICC) are important.

The solution to the problem of uninterrupted aviation and the transportation accessibility of the regions of the Far North and the Far East is a compromise of the aircraft technical and operational characteristics.

Today, the transport task in the Arctic region is achieved through the use of an obsolete aircraft fleet, as well as through the development of new promising aircraft for polar exploitation (Fig. 1).

The experience of the development of domestic aviation in 1940-1980 shows a direct relationship between the level of progress of aviation technology and the air transport network in remote and hard to access regions and the degree of development of the polar regions of the Far North and the Far East, which are the Russian Arctic (Fig. 2).

Positioning on the world political arena of the Arctic territories as the exclusive economic zone of the Russian Federation [3], [9], [10], [11], [12], [13] requires the increase of a regional transport network, including freight and passenger air traffic [14].

In August 2014, President of the Russian Federation Vladimir Putin said: “Russia should pay more attention to strengthening its position in the Arctic, since this region represents the concentration of the country's interests in many areas. The Arctic is the most significant and very promising region of Russia, and in addition to raw materials, it is also extremely convenient for the development of transport infrastructure”.

The approved on February 20, 2013 by the President of the Russian Federation “of the Russian Federation and the national security strategy of the Arctic region for the period till 2020” [4], there is deficiency of aircraft and technological possibilities for the study, development and use of arctic areas and resources, lack of readiness for transition on the innovative path of development of the Arctic zone of the Russian Federation (paragraph 4).

The development of the presence of the Russian Federation in the Arctic is justified by the resources, logistics and strategic opportunities that the Russian Arctic offers for the economy. Thus, the developed system of servicing the infrastructure of the Northern Sea Route and the Arctic archipelagoes (Spitsbergen, Franz Josef Land, Severnaya Zemlya, Novosibirsk Islands) requires, in turn, solving a number of strategic tasks related to the inaccessibility of the Russian Arctic regions [3], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26] , as well as because of changes in the ICC [27], [28], [29], [30], [31].

The presently observed climate change of the Arctic archipelagoes and ice conditions on the NSR route occurs as a result of accelerated global warming and climate change in the Arctic, which significantly affects the type and nature of the transport operation (Fig. 3).

2. RESEARCH METHODOLOGY

The climate in the Arctic and the components of the natural environment of archipelagoes are sensitive to climate changes of different time scales. The most striking indicator of past and current changes is the temperature regime of the surface layer of air, the circulation of the atmosphere and the state of ice cover. This led to a alteration in requirements for transport operations in the Arctic, which, in turn, leads to a change in the appearance of transport aviation [10].

Ice thickness and ice cover area are the main infrastructural constrictions (Fig. 4) of Arctic-based airplanes (SAB) [10], since other requirements for flying at extreme (negative) temperatures (for example, icing or navigation) satisfied by the use of additional aviation and radio navigation equipment.

Ice thickness and ice cover area are dynamically changing values, and analysis of changes in the ice situation in the Arctic since 1950 allows us to make a estimate about the reduction or almost complete melting of the ice cap of the Russian sector of the Arctic by 2090.

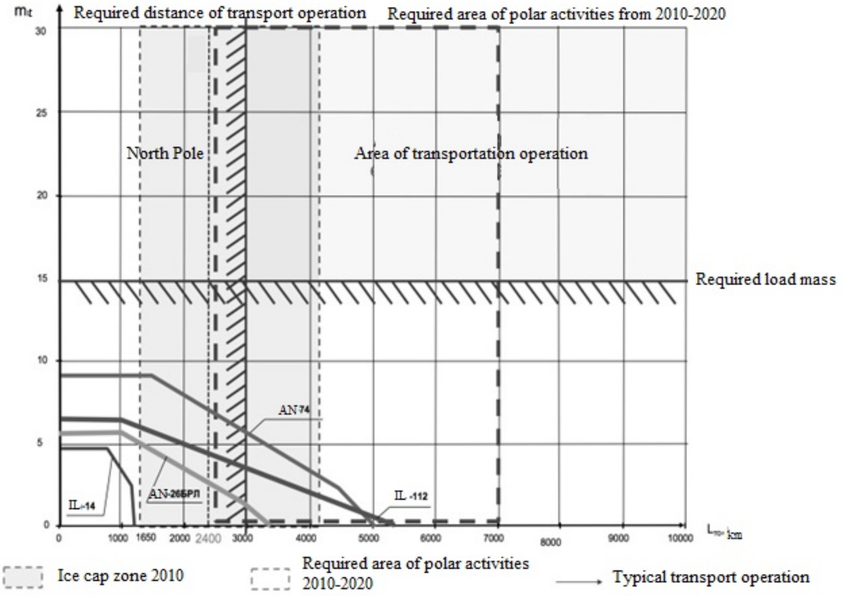

Fig. 1 – Operation of aircraft in the Arctic zone of the Russian Federation

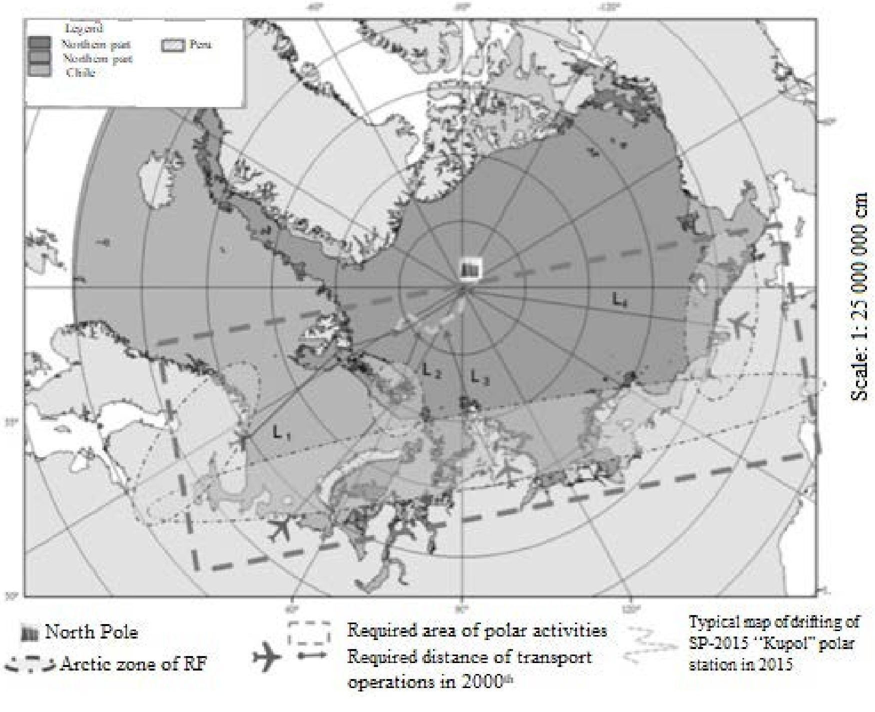

Fig. 2 – Arctic zone of Russia (Source: Center "North" AARI) (Russia)

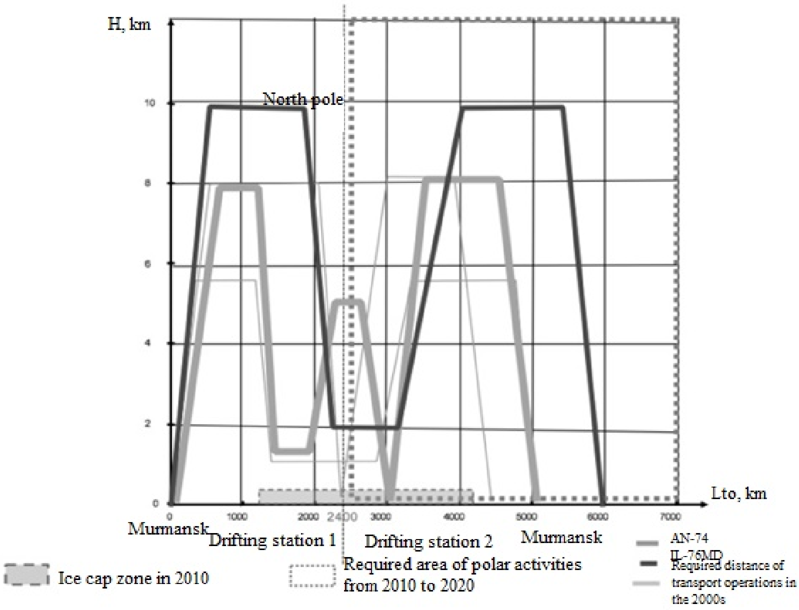

Fig. 3 – Flight profiles when performing modern transport operations in the Arctic

These processes are related to the fact that alongside the NSR (northwest passage) sea and ocean currents lead to ice drift from the Barents Sea to the Bering Strait, while in the northwestern passage off the coast of Greenland, Canada and the USA, ice forms static ice fields or drift within a limited closed area. The difference in climatic zones is a prerequisite for the appearance of “ice islands” (icebergs) [14].

3. RESULTS AND DISCUSSIONS

The operation of various kinds of vehicles in the Arctic (Fig. 4) depends on the infrastructural and climatic constraints, requirements for transportation and overall mass characteristics.

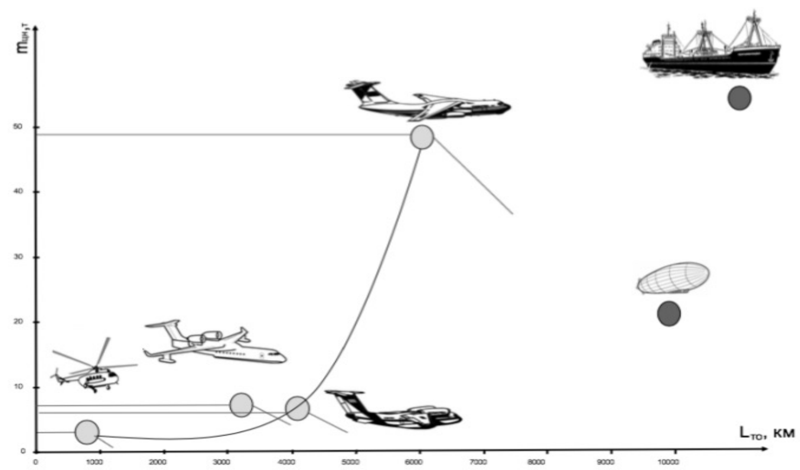

Fig. 4 – Comparative characteristics of various types of transport used in the Russian Arctic to deliver goods

Construction of new aircraft intended for development of Arctic region in terms of ICC, on the basis of the research, requires solution of a number of scientific and technical problems:

- meeting the requirements and cost effectiveness;
- accounting for ICC in the places of intended basing [4], [5], [6], [7], [8[, [15] aircraft in the regions of the Russian Arctic;
- meeting the requirements of the organization of transportation of passengers and cargo in extreme weather conditions;
- the implementation of a shortened takeoff and landing from unprepared runways [5], [13], [14];
- ensuring maintainability in the field conditions of the Arctic.

The variety of tasks [1], [2], [9], [10], [11], [12], facing project organizations during the creation of an automated security system, necessitates the development of scientific and methodological support that meets the current conditions of polar exploitation and the Arctic infrastructure.

In connection with the operation in difficult meteorological conditions, there are increased requirements for aviation equipment for duplication and reliability in the field of navigation, radio communications, control systems, and emergency rescue.

Analysis of the well-known design solutions showed that to create a successful sample of the automated safety system, it is necessary to solve the FOS problem based on the choice of rational options for the aircraft's inner design in terms of placing the payload and fuel [9].

The disposition of the fuel reserves and the mass of the target load affects the control system and leads to a significant change in the moment-inertia appearance both during the flight and during the performance of the transport cycle.

This confirms the relevance of the task of developing scientific and methodological support for carrying out comprehensive research to identify rational design-layout solutions based on mathematical modeling using computers and computer graphics.

A prerequisite for solving this problem is the experience of developing regional aircraft and special purpose aircraft, as well as the scientific and methodological base.

The experience of research and design work and the operation of aircraft in polar conditions creates a scientific basis and confirms the relevance of solving the problems of forming the moment-inertial appearance of the aircraft, taking into account the satisfaction of the "hard" demands of the Arctic ICC. Existing aircraft designed and manufactured in the period 1950-1980, can no longer effectively accomplish Arctic transport operations.

The scientific and methodological support developed in the period 1950-1970 is outdated, the frontier conditions of exploitation in the region and the geopolitical situation have changed. The development of aviation technology (IL-14, An-12 and An-74) in the years 1950-1980 took into account the requirements of the universality of medium-term operation in the Arctic. Modern experience of research and design work and aircraft operation in the Arctic creates a scientific base and confirms the relevance of solving the problems of forming the moment-inertial appearance of the aircraft, taking into account the satisfaction of "hard" infrastructure and climatic restrictions of polar operation.

4. CONCLUSIONS

1. In shaping the appearance of Arctic-based aircraft, the transformation tensor of infrastructure and climatic constraints is decisive, since they uniquely determine the appearance of the aircraft for operation in the Arctic region.
2. The development of promising models of aviation technology for polar performance and innovative technologies is the key to the development of polar activities in all directions and the formation of national competitiveness in the polar regions.

3. Over the past 40 years, the required range of polar activity has increased from 5,000 km to 6,000 km, and the minimum mass of the target load has increased to 15 tons

4. The existing fleet cannot meet the needs of polar activity. A new transport aircraft project is required, which would take into account modern infrastructural and climate changes.

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