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SELECTION OF THE APPROPRIATE TYPE OF HEMS HELICOPTER FOR THE SLOVAK REPUBLIC

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Abstract

The diploma thesis deals with the issue of choosing the appropriate type of helicopter for the implementation of the Helicopter Emergency Medical Service (HEMS) for the Slovak Republic. Currently, the Helicopter Emergency Medical Service is operated by a private company Air Transport Europe, Ltd., based at Poprad-Tatry Airport. The fleet of helicopters for rescue missions consists of three types helicopters. The oldest helicopter is the Agusta A109K2, then BELL 429 since 2013 and Eurocopter EC 135 T2+/P2+ since 2019. The aim of this thesis is to create an analysis of the current state, review affecting parameters such as operator options and possibilities, operating costs, maintenance costs, use due to the geographic features of the Slovak Republic and use of the helicopters for transporting patients with Covid-19 and other highly contagious diseases. The result will be the selection of the appropriate type of helicopter of the Helicopter Emergency Medical Service to be used under the conditions of the Slovak Republic.

Keywords

helicopter, Helicopter Emergency Medical Service

1. I NTRODUCTION

Today, helicopters are an integral part of air traffic. Thanks to their flight characteristics and a wide range of applications, they have also been used in the air rescue service. Here it has become an almost irreplaceable means of saving lives, a means of evacuation in the event of natural disasters and, last but not least, in transports between medical specialized workplaces. This is mainly due to the flight characteristics of the helicopter, the ability to hang over one place, perform technical interventions in inaccessible terrain, use the suspension and the possibility of vertical takeoff and landing on a relatively limited area, as close as possible to the place of need. As primary interventions in unavailable terrain are very often performed in Slovakia at present, it is necessary to ensure the highest possible level of safety for the crew, patient and third parties. Despite the fact that there are strict regulations and strict procedures for the operation of the Helicopter Rescue Medical Service (HEMS), we still face various helicopter accidents, which could be prevented by taking adequate measures. One of them was the fall of the Agusta A109K2 helicopter in the area Pod Kláštornou roklinou - Slovenský Raj, in which a four-member crew perished. The accident was caused by direct contact of the helicopter with the wires of the power line. It was the equipment of the helicopter with the WSPS (Wire Strike Protection System) system that could help avert the catastrophe and save the precious lives of the crew. The main reason for choosing a specific topic is the effort to increase the quality of the helicopter rescue medical service, which is already at a high level in the Slovak Republic. This is evidenced by the successful expansion of the operator Air Transport Europe, Ltd. to the territory of the Czech Republic, where it provides VZZS at two stations in Ostrava and Olomouc. The aim of the diploma thesis is to analyze the currently used VZZS helicopters and then prepare the basis for technical possible unification of the fleet to one type of helicopter, which will be the most suitable for the operation of helicopter rescue medical service in Slovakia. Due to the current pandemic situation associated with the COVID-19 disease in 2019-2022, the secondary goal of the diploma thesis is to include the transport of patients with highly contagious diseases among the frequent uses of VZZS. Therefore, this parameter is important when selecting the appropriate helicopter type.

2. SELECTION OF APPROPRIATE HELICOPTERS ON THE BASIS OF ESTABLISHED TECHNICAL AND OPERATING REQUIREMENTS FOR THE SLOVAK REPUBLIC

The choice of a suitable type of helicopter for the Helicopter Rescue Medical Service for the Slovak Republic is influenced by a large number of criteria and factors. Therefore, the selection is difficult and it is not possible to clearly identify one type of helicopter. An important factor in the selection is the cost of operation. As this is sensitive data that the author did not have available when writing the work, this factor will take into account and the design of a suitable type will be oriented to the price category of currently operated helicopters.

The following criteria and factors were taken into account in the selection:

1. Current fleet of the operator
2. Geographical conditions of the Slovak Republic
3. Maintenance
4. Performance and technical parameters
5. Construction and interior construction of HEMS
6. Avionics

3. BELL 429

The Bell 429 is a multi-purpose helicopter that has excellent flight characteristics, thanks to which it achieves high flight speed, high seeding performance and improved safety systems. The interior is equipped with a digital cockpit, best-in-class WAAS navigation and IFR-compatible dual control. [1]

The Bell 429 provides much more space in the cabin than helicopters of the same class. The flat floor and 159cm wide side doors provide enough space to perform the most complex actions. [1]

The Bell 429 provides increased security by integrating redundant systems into avionics, hydraulics and electronics systems. The result is greater stability of the helicopter in each phase of flight. The helicopter meets category "A" and complies with EU-OPS regulations. In addition, the automatic flight control system reduces the pilot's workload on IFR flights, which increases the level of safety. [1]

The Bell 429 is compatible and certified to current impact and damage resistance standards. The configuration includes integrated avionics with BasiX-ProT flight control, which is designed specifically for the needs of twin-engine helicopters. [1]

The Bell 429 is the first helicopter in its class to use the same maintenance process as commercial airlines to maintain airworthiness. This process is led by a steering group composed of representatives of BELL, regulators and operators. This approach improves safety by addressing the maintenance of significant components at the system level by zone, instead of the individual component level. The goal is to maintain the highest level of security and reliability while maintaining lower costs. [1]

The Bell 429 is designed in the HEMS version with regard to the current needs of the Helicopter Rescue Medical Service. The floor height and stretcher attachment are designed to be handled by one person, through a side or optional rear door. The design of the cabin allows the crew to access the entire patient's body, thus optimizing patient care. [1]

The Bell 429 is available in two major versions with the option of additional configuration according to the purpose and action it will perform. [1]

- Bell 429 with ski chassis
- Bell 429WLG with variably retractable, wheeled chassis

4. EUROCOPTER EC135

The Eurocopter EC 135 helicopter is a light twin-engine, multi-purpose helicopter. Underlining its versatility, the helicopter can be delivered in a controlled configuration for one or two pilots with IFR flights. The helicopter combines the latest Eurocopter technologies, such as advanced cockpit design, modern avionics, Fenestrone - the balancing rotor technical solution and the all-composite main rotor bearing system, which makes the helicopter excellently manoeuvrable. The optimized main rotor blades with advanced geometry in combination with fenestrone with uneven blade spacing make the EC 135 the quietest helicopter in its class, while its noise level is well below the strict ICAO limit. The built-in anti-resonance insulation system filters vibrations caused by the rotor and thus increases in-flight comfort to the maximum. The result is minimal vibration during all phases of flight, emphasizing during hanging. [2]

Thanks to the simple design of the rotor system with the highest safety standard, the level of maintenance is significantly simplified. The first scheduled maintenance is an intermediate inspection after 400 flight hours. Thanks to its simple design, the rotor system together with the gearbox has a long service life. [2]

Depending on the operator's requirements, it can be equipped with a Turbomeca Arrius 2B2 or Pratt & Whitney PW206B2 power unit, both power units are controlled by the FADEC system. These powerful and reliable propulsion units, together with the helicopter design, provide excellent performance during all phases of flight and critical power reserves in crisis situations. The reliability of the powertrains is complemented by a tandem hydraulic and dual electrical system, as well as a redundant main transmission lubrication and cooling system. Other safety aspects of the EC 135 are components such as the energy-absorbing fuselage and seats and the impact-resistant fuel system. [2]

The Eurocopter EC 135 helicopter has a wide range of quick-change options, such as emergency floats, a hoist, a SX16 searchlight, a simple or expensive suspension, ski accessories for landing on snow and softer surfaces and much more. [2]

4.1. Agusta A109 Trekker

The Agusta AW109 Trekker is a lightweight twin-engine, multi-purpose helicopter that can be supplied with a skid-on skid version or with a three-point, variable wheeled landing gear. The Agusta AW109 Trekker can be configured with one or two IFR pilots. The helicopter combines the latest technologies, excellent flight characteristics, excellent maneuverability and a high level of active and passive safety. The result of these features is a universal helicopter suitable for performing the Helicopter Rescue Medical Service. [3]

The Agusta AW109 Trekker has been designed to provide a solution for the most demanding tasks in various sectors. The Agusta AW109 Trekker has excellent performance with sufficient reserves for the most demanding technical interventions. The cabin is characterized by its spaciousness and intuitive layout of equipment. [3]

The Agusta AW109 Trekker is equipped with a Pratt & Whitney PW207C power unit. These powerful and reliable propulsion units, together with the helicopter design, provide excellent performance during all phases of flight and critical power reserves in crisis situations. Energy-absorbing seats are important safety features of the Agusta AW109 Trekker. [3]

The Agusta AW109 Trekker has a wide range of quick-change options such as emergency floats, a hoist, a searchlight, a simple or cargo suspension, ski accessories for landing on snow and softer surfaces, wheel accessories for landing on snow and softer surfaces and much more.

5. SELECTION OF THE APPROPRIATE TYPE OF HEMS HELICOPTER FOR THE SLOVAK REPUBLIC

After careful consideration of the results of the comparison, the most suitable type of helicopter is Bell 429 for the performance of the Helicopter Rescue Medical Service for the Slovak Republic.

Rationale for choosing a Bell 429 helicopter:

1. It has been actively used in the Slovak Republic since 2013.
2. It is appropriate for all geographical conditions located in the Slovak Republic.
3. Maintenance is performed at the Poprad-Tatry home airport. The operator Air Transport Europe, Ltd. has its own maintenance division with the Bell 429 license.
4. Unification of the operator's fleet - unification of operations for one type of helicopter for the Slovak Republic. As a result, helicopters can be exchanged between operating sites without additional staff training.
5. The unified fleet is more economical in terms of operating costs.
6. It is the largest of the compared types with the size of the cabin.

The final design of the helicopter deployment consists of two versions. The first version is to use the Bell 429 helicopter at all operating sites. In the second version, the Poprad site is complemented by a Bell 429WLG helicopter with a three-point, variable wheeled chassis, which will be specially designed for use in mountain conditions.

Fig. 1. First version of the Helicopter deployment

Bell 429 helicopters are equipped with a winch in mountainous areas with an increased chance of technical interventions. These operating areas include: Trenčín, Žilina, Banská Bystrica and Poprad.

The Bell 429 WLG helicopter is equipped with a winch for the Poprad work area.

The diagrams below show the operating radius in the form of circles with the center at the point of take-off, ie at the operating location.

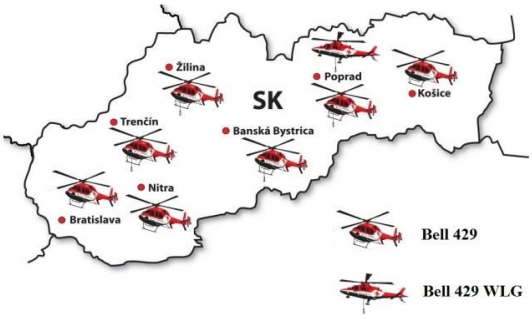

Fig. 2. Second version of the Helicopter deployment

The first diagram shows a circle that has a radius of 50km and the reaction time of the crew from the moment of obtaining information about the intervention is 10 minutes. The calculation is performed with conditions such as ideal weather, standard fuel, helicopter and crew in standard configuration. The cruising speed of the Bell 429 helicopter was set at 240 km / h. When calculating time with respect to distance and speed, we get a time of 12 minutes and 30 seconds. After counting together with the reaction time, the crew is ideally able to arrive from the operating site to the peripheral site of the circle within 23 minutes, which significantly increases the patient's chances of survival and reduces the risk of fatal consequences.

Areas outside the circles are also fully covered by operational sites. The crews will get to these places later than within a radius of 50 km from the operating site, but thanks to the deployment, it is still significantly below the critical value of patient survival - 60 minutes.

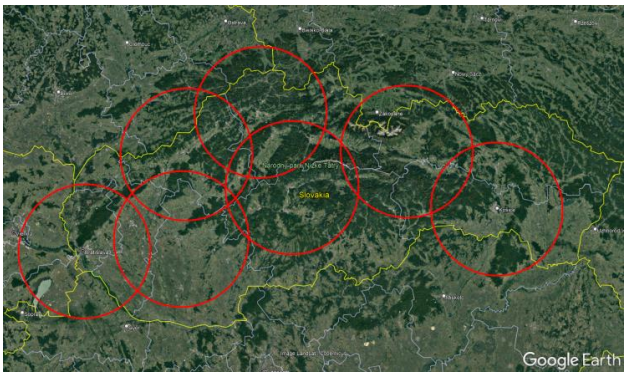

Fig. 3. Scheme of operating circles with a radius of 50km

The second diagram shows a circle that has a radius of 85km and the reaction time of the crew from the moment of obtaining information about the intervention is 10 minutes. The calculation is performed with conditions such as ideal weather, standard fuel, helicopter and crew in standard configuration. In the case of the Krištof 03 Poprad operating site, the radius is set at 50 km due to operation with a lower amount of fuel in the helicopter. This is due to interventions in alpine conditions. The cruising speed of the Bell 429 helicopter was set at 240 km / h. When calculating time with respect to distance and speed, we get a time of 21 minutes and 15 seconds. After counting together with the reaction time, the crew is ideally able to arrive from the operating site to the peripheral site of the circle within

32 minutes, which also significantly increases the patient's chance of survival and reduces the risk of fatal consequences.

Areas outside the circles are eliminated as much as possible. The smaller area of Eastern and Southern Slovakia is beyond the 32-minute operating radius, but due to the minimum distance from the edge of the circles, it is possible to determine an increase in time of the order of a minute. For this reason, the flight time together with the reaction time is significantly below the critical patient survival value of 60 minutes.

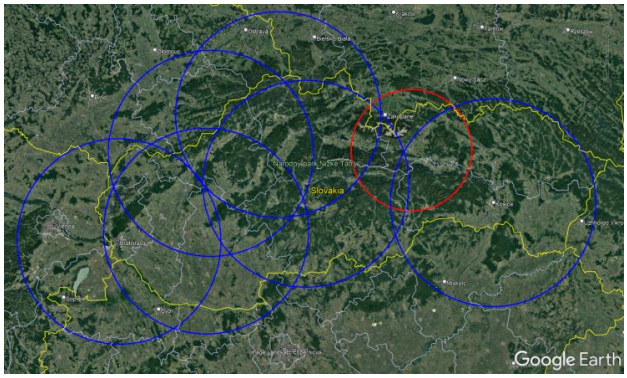

Fig. 4. Scheme of operating circles with a radius of 85km.

6. AIR REQUIREMENTS FOR PATIENTS WITH COVID-19 AND OTHER HIGHLY CONTROLLING DISEASES

Covid-19 has significantly affected the daily lives of all people. From day to day, the life of the entire population changed. The new coronavirus SARS-CoV-2, began to spread in late 2019 in the Chinese city of Wu-chan. From this epicenter in China, the disease has gradually spread throughout the world. A major problem with SARS-CoV-2 is the speed of its spread. The virus has an incubation period of 2 to 14 days, while the infected patient is infectious at all times. There is also a significant risk - the patient may be infected, but he has not yet shown symptoms, but he is still infectious. For this reason, too, measures at airports that helped stop the spread of SARS a few years ago are very problematic and reveal only a fraction of cases. [4]

The virus is transmitted in the classic way of influenza and other diseases, ie in the form of droplet infection. On 28 January 2020, the National Health Commission (NHC) said the virus could also spread through direct contact. However, she did not specify the form of this contact. At the same time, she also stated that all age groups of the population are at potential risk. However, the most serious course of the disease is in the elderly and also in people who already suffer from some disease. [4]

As the virus gained momentum, the use of the Helicopter Rescue Medical Service was increasingly mentioned in connection with the transport of positive patients. As with land transport, the priority in the helicopter was to ensure maximum crew protection against covid-19 infection. Crews, whether ground or air rescue, set out on a daily basis to patients they did not know were infected or not. For this reason, procedures and regulations for the operation of the Helicopter Rescue Medical Service in connection with the new covid-19 have been rapidly established and approved. [4]

The helicopter crews were equipped with full-body suits, had several layers of disposable gloves on their hands, their airways were covered with a respirator, and goggles were worn on their eyes. It was this large amount of protective equipment that restricted the crew in their normal duties. Protective equipment caused major problems, especially for the pilot while piloting the helicopter. Covering the airways with a respirator in combination with safety goggles caused the goggles to mist up and, to a large extent, to complicate the helicopter's view and control. The high summer temperatures only contributed to the discomfort that the crews experienced every day. [4]

The design of the solution comes from the manufacturer EpiGuard in the form of an insulated bed EpiShuttle for adult patients. The EpiShuttle bed isolates the patient from the environment while allowing the doctor to perform most of the necessary procedures with the patient. The EpiShuttle bed has a variable lounger with seat belts. The unit is equipped with a filter device that ensures clean air for the patient inside and, conversely, filters contaminated air from the patient. [5]

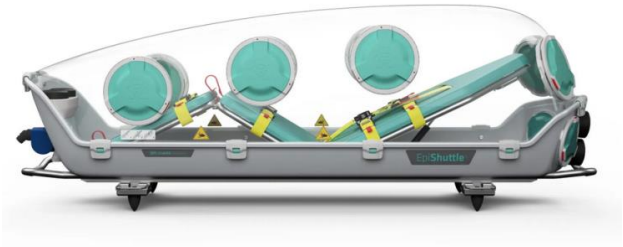

Fig. 5. EpiShuttle insulated bed

The air ventilation system generates more than 15 air changes per hour to ensure maximum patient comfort and safety. Filters and airtight seals ensure that all dirt remains inside the EpiShuttle bed, even in the event of rapid decompression of the aircraft cabin. [5]

The air flow is directed through the inlet filters at the front and passes out through the outlet filters at the bottom. Vacuum and outlet filters prevent contaminated air from escaping from the bed. For optimal handling during transport, the EpiShuttle has eight interchangeable personnel ports integrated in a sturdy case. The ports are located to provide access to all parts of the patient's body, including the airways. This allows for intensive care of the patient with the possibility of angulation such as intubation, infusion or urinary catheter. The ports have internal and external lids, under which there are rubber gloves, a waste bag or a patient service bag. [5]

EpiShuttle is a suitable solution for transporting patients with covid-19 and other highly contagious diseases. The Bell 429 helicopter, which is designed as a suitable type of helicopter for the performance of the Helicopter Rescue Medical Service, is compatible with EpiShuttle and its use in combination with the Bell 429 helicopter is suitable. [5]

EpiShuttle can be used in the Slovak Republic according to two models. The first model proposes equipping the largest medical facilities with EpiShutle beds. If necessary, use the Helicopter Rescue Medical Service for transport, the staff of the medical facility will prepare a bed with a patient, which will then be handed over to the helicopter crew immediately after landing.

This model saves time and shortens transport time between specialized workplaces. [5]

The second model proposes equipping operating sites with EpiShutle beds. In case of need to use the Helicopter Rescue Medical Service for transport, the helicopter crew will fly to a specific medical workplace, where they will hand over the EpiSuttle bed. Subsequently, the patient staff will prepare and hand over the patient for transport. This model is more time consuming and requires a longer deployment of the helicopter for one specific transport between specialized workplaces.

7. CONCLUSION

Helicopters are an integral part of our daily lives. However, this was not always the case. In the past, rescue services relied solely on the use of available technology. Only the gradual development in our country and in the world offered the use of more effective means, thanks to which the Helicopter Rescue Medical Service is at a very well-functioning level today. At present, the Helicopter Rescue Medical Service in Slovakia is operated at seven operating sites 24 hours a day, 365 days a year. The tactical deployment ensures that crews are ready to provide effective pre-hospital care within one hour of reporting to the operations center. This significantly increases the patient's chances of survival.

The content of my work can be divided into four parts. The first part is dedicated to the Helicopter Rescue Medical Service from its beginnings to the present. The first attempts at air rescue in Slovakia date back to 1962. The use of an available Mi-4 helicopter at the time opened up completely new possibilities in the field of saving human lives using a helicopter. Especially thanks to the courage and determination of the pilots and members of the Mountain Service at that time, today the Helicopter Rescue Medical Service is at such a high level as we know it.

The second part is devoted to helicopter accidents of the Helicopter Rescue Medical Service. In the past, several helicopter accidents occurred in Slovakia during rescue operations. In recent history, we find in 2006 an accident of the Agusta A109K2 OM-ATC helicopter near the village of Jánova Lehota. During the night flight to the medical facility, the helicopter crashed after contact with the treetops. Another tragic accident occurred in 2015. The Agusta A109K2 OM-ATC helicopter crashed into power lines as it approached its final location and subsequently crashed. The last tragic accident occurred in 2016, when the Bell 429 OM-ATR helicopter crashed into treetops in the early summer shortly after takeoff, resulting in the crash and death of the crew and patient. All three accidents ended tragically and none of the participants survived. Appropriate selection of a helicopter with sufficient equipment for rescue flights can eliminate the risk of further helicopter accidents of the Helicopter Rescue Medical Service.

The third part is devoted to the selection of a suitable helicopter in the Helicopter Rescue Medical Service for the Slovak Republic. At present, the helicopter fleet consists of three types: Agusta A109K2, Bell 429 and Eurocopter EC135. The aim of the work is to compare suitable candidates and select a suitable type of helicopter, which would lead to unification and modernization of the operator's fleet. The result of the comparison and selection is the Bell 429 helicopter. Ideally, the use of the Bell 429 helicopter at all operating sites and the use of the Bell 429 helicopter in the Bell 429WLG configuration with variable three-point wheel chassis in the High Tatras are proposed.

The last part is devoted to the requirements for the transport of patients with Covid-19 and other highly contagious diseases. The current situation associated with the new coronavirus pandemic has also affected the operation of the Helicopter Rescue Medical Service. It is important to use all available systems and means to ensure the highest possible level of safety for the crew and patient against coronavirus infection. A suitable system is the EpiShuttle insulated bed, which provides perfect isolation of the patient from the surrounding environment in the cabin and at the same time does not restrict the doctor in performing all important medical procedures.

It is necessary to keep in mind that this is only a design of a suitable type of helicopter for the Helicopter Rescue Medical Service. The comparison and selection was created from the materials that the author had at his disposal at the time of writing the thesis.

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