

## AIR VISUAL SEARCH

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**Summary:** the Aim of the article is a solution to the problem of the air visual search the framework of the provision of services to search for the aircraft after the emergency landing. Offers a view of all available methods of search. Analyzes the area of legislation, external conditions and equipment of aircraft for search and rescue in Slovakia and abroad. Abroad is represented by the procedures applicable in Canada and in Australia, which complement each area of search and rescue. The time efficiency of the search, in the context of the various schemes for the search, is in the work evaluated by computing tool that was created for this purpose. Also can be used for the analysis of several schemes of the flight search of the aircraft. The analytical tool is configured through the configuration file. In the configuration file, you set the data for the selection of the display method of the search and for the evaluation of search. For the evaluation of the search are entered into the configuration file of the data as the object of a search, the meteorological visibility, density of vegetation, the height of search, speed of search, the length of the area for the search, the width of the area for the search.

**Keywords:** Time efficiency, visual search, calculation tool, scheme search

### 1. INTRODUCTION

The issue of determining the correct procedure for police services is emerging, usually in situations when air accidents, accidents at sea or searching for missing persons. The legislation gave authority search the legal framework and, thus, to accurately define certain facts. The legislation also includes document Manual search and rescue, which determines the place, time, unit, number, equipment, and other facts in search and rescue in the area of police services. Individual states have their air technique, which is used for search and rescue. In Slovakia in particular, it is the helicopter Mi-17 of the LPZS in Australia e.g. aircraft Dornier 328 and Canada, e.g. the plane of the CC-115 Buffalo. All of these countries use the same scheme of investigation, which are internationally akceptovane, but can you edit them at your discretion. In the first part is referred to the analysis of legislation, external conditions and air techniques and its equipment for search and rescue. In the second part is based on analysis of the designed computational tool for the efficient removal of the scheme the quest from the perspective of time. In the next part of this proposal is transformed into a form of application. The last part validates the analytical tool in a variety of situations.

### 2. THE ANALYSIS OF THE PRESENT STATUS IN THE FIELD OF SEARCH AND RESCUE IN THE SLOVAK REPUBLIC, CANADA AND AUSTRALIA FOR THE LEGISLATION, EXTERNAL CONDITIONS AND EQUIPMENT SEARCH AIRCRAFT

#### 2.1 Legislation in the Slovak republic

Legislation for the search and rescue brings together:

- Convention on international civil aviation Doc 7300/9
- Act 143/1998 Coll. of 2. April 1998 civil aviation
- Act 129/2002 Coll. on the Integrated rescue system
- Prescription L12 Search and rescue
- AIP SR

- A list of differences between national regulations and practices in the SR and the relevant provisions of ICAO in search and rescue
- Agreement on mutual cooperation in the framework of the AIP between the Ministries of transport, defence and the interior
- Manual SAR

These documents determine mainly the responsibilities and procedures to be followed for safe and unconflictful performance.

## 2.2 Legislation in Australia and Canada

The SR, Canada and Australia are based on the Convention on international civil aviation Doc 7300/9. Canada and Australia have their own manual for search and rescue. The individual manuals from each other in at least differ but the essence is the same. For example, some parts may be disordered. Content part is formed on the basis of terrain, the equipment and the number of aircraft of a given country.

## 2.3 External conditions in the Slovak republic

These conditions include the manual of the SAR and are the theoretical basis for the actions of search and rescue. Inform how to determine, adjust, cover and describe the area of police services. How to allocate space quest individual aircraft. How to determine the technique of investigation, the overall probability of error and the scheme of the quest. Using these parameters, you can determine the most effective scheme of investigation from the perspective of time.

**Cover space quest:** Type and number of aircraft eligible for the quest is a crucial factor influencing the space quest. Visibility on the search is the distance at which it is possible to observe the search object. The width of the observations is twice the visibility for the quest on which observers, with certainty, identify the object of the quest.

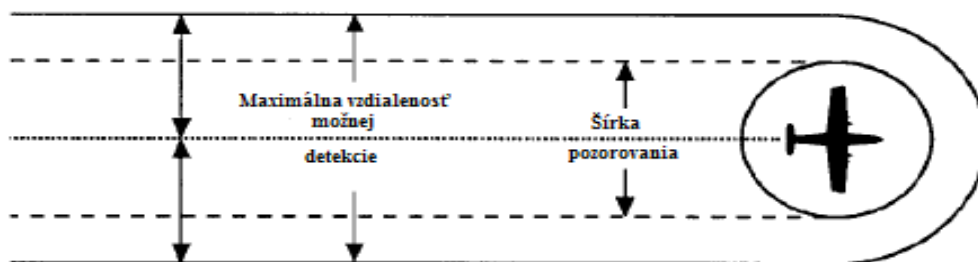


Figure.1 The width of the observation

Factors that may affect the visibility of the quest and the width of the observation: the type of the object, time of day, meteorological visibility, the characteristics of the terrain, the flight height search of the aircraft, the position of the sun, the effectiveness of observers. Between the ground distance equal to twice the visibility in a quest shown in the Table 2, reduced in size by a multiple of the correction coefficient shown in Table 1. The magnification between the line distance allows search more space, but reduces the likelihood of search.

Table 1 Correction coefficient

Object search	15 – 60 % covered by vegetation or hilly terrain	60 – 85% covered by vegetation or hilly terrain	> 85% covered by vegetation
Persons	0,5	0,3	0,1
Vehicles	0,7	0,4	0,1
Aircraft lighter than 5700 kg	0,7	0,4	0,1
Aircraft heavier than 5700 kg	0,8	0,4	0,1

Corrected the width of the observation = (2 x Visibility in a quest for visual search over the mainland) x Correction factor = Between route distance

Factor coverage is the value of the efficiency of police services. It is used to calculate the probability of the search object. The higher the value of the coverage factor means that the designated space will be more thoroughly search.

Factor coverage = Corrected width of the observation / Between the ground distance

The probability of the observation: it is the probability of observation of the object in the designated area police services.

The accuracy of the navigation, search units: this is the accuracy with which they are converted into a research aircraft capable to search in the designated area.

Coordination with the services of air traffic management: Coordinator of the search and rescue must ensure coordination of flights with the individual centres, air traffic control so as to be secured to the prescribed spacing of aircraft search and rescue. In particular, the entry and exit of the allocated space.

Table 2 Visibility for visual search over the mainland

Object search	Height (m)	Meteorological visibility (km)				
		6	9	19	28	37
Persons	150	0,7	0,7	0,9	0,9	0,9
	300	0,7	0,7	0,9	0,9	0,9
	450	-	-	-	-	-
	600	-	-	-	-	-
Vehicles	150	1,7	2,4	2,4	2,4	2,4
	300	1,9	2,6	2,6	2,8	2,8
	450	1,9	2,6	3,1	3,1	3,1
	600	1,9	2,8	3,7	3,7	3,7
Aircraft lighter than 5700 kg	150	1,9	2,6	2,6	2,6	2,6
	300	1,9	2,8	2,8	3,0	3,0
	450	1,9	2,8	3,3	3,3	3,3
	600	1,9	3,0	3,7	3,7	3,7
Aircraft heavier than 5700 kg	150	2,2	3,7	4,1	4,1	4,1
	300	3,3	5,0	5,6	5,6	5,6
	450	3,7	5,2	5,9	5,9	5,9
	600	4,1	5,4	6,5	6,5	6,5

**The scheme of communication:** it is Important to choose the most appropriate scheme of investigation. The choice must be made, until after a thorough assessment of all factors that may affect the actual quest. The scheme of investigation shall take into account criteria:

Adequacy: The quest ends in the defined time limits.

Feasibility: The search is carried out within the scope of the abilities and opportunities of the search units.

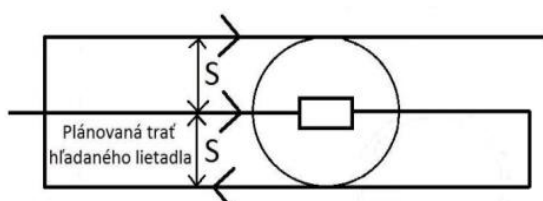
Acceptability: The result of the search must match the time and effort expended.

If it is probable that the persons who survived the accident aircraft may use the emergency radio beacon, it is necessary to perform an electronic search using the quick aircraft flying in a larger

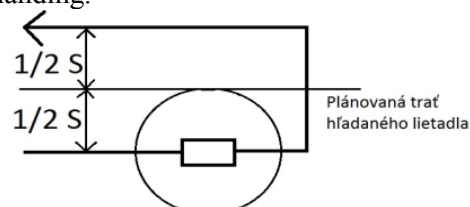
amount according to an appropriate scheme of investigation and at the same time to perform a visual search with a plane-flying along the same track in a small amount.

**The scheme of the visual quest:**

The quest along the route: is used in cases of disappearances of aircraft and are not available information on the state of emergency, or the intended safe landing.

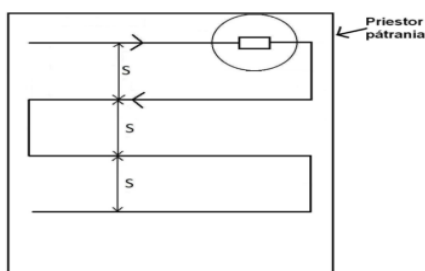


**Figure.2 The search along the track with one plane with the return of the**

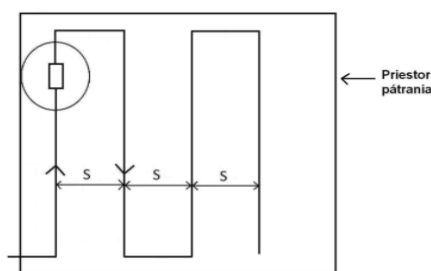


**Figure.3 The search along the track with one of the plane without a return**

Parallel quest: is used if the space quest is a great and relatively flat, it is known only the approximate position of the aircraft, requires uniform coverage of the space.



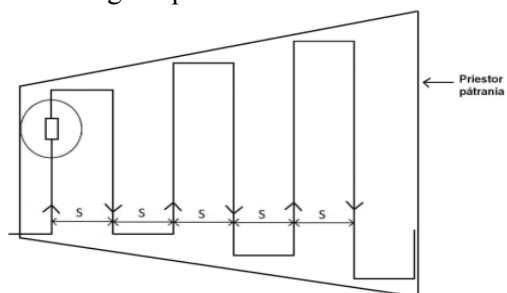
**Figure.4 Parallel quest with one plane**



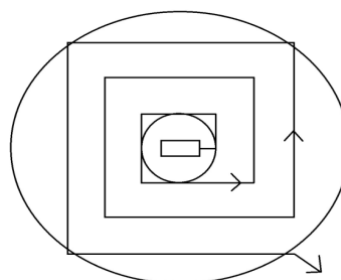
**Figure.5 Quest flight after the wavelength line with one plane**

Quest flight after the wavelength line: is used if the area of investigation is narrow, long and straight; it is assumed that the probable position of the aircraft is between the two known points; is required to cover the most probable area.

The quest to square: it is used in a relatively small space. The starting point of the search becomes the most likely location of the aircraft or its last known position. The track of the flight is in the shape of the larger squares.



**Figure.6 Quest flight after the wavelength line in an asymmetrical shape with one plane**



**Figure.7 Quest in a square with one plane**

**Sectoral quest:** Is used if known estimated position of the aircraft and the area of investigation is relatively small radius.

**Contour of the quest:** it is used in complex terrain, where it cannot apply the previous quest. In the mountains the father from the top to the bottom.

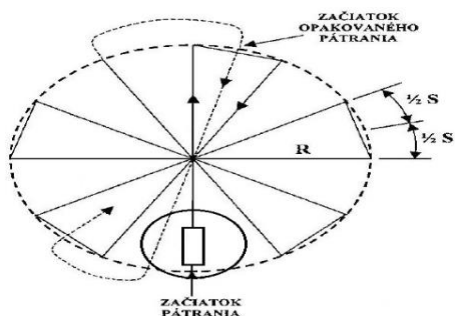


Figure.8 Sectoral quest with one plane

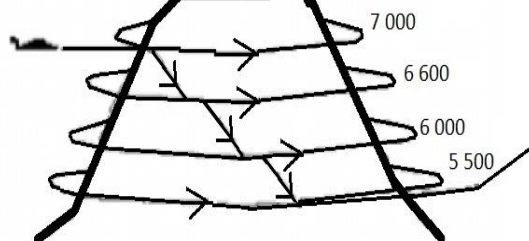


Figure.9 Contour of the quest with one plane

## 2.4 Outdoor conditions in Australia

Complement the outdoor conditions in a choice of units; forecasting, the determination and the description of space quest; the total of probabilistic error; the time of landing or impact; visibility to the search; technology communication; the width of the observation; the factor of the coverage and scheme of investigation.

## 2.5 Outdoor conditions in Canada

Supplying the external conditions in the determination and forecasting of space quest, the probable location of the visibility on the quest, the width of the observation and the scheme of the quest.

## 2.6 Equipment search aircraft in the SR

The aircraft are divided according to the boot on the near and remote areas. They are divided into short, medium, long, very long, and extra long distance. Helicopters are divided into short, medium and long distances. Rescue search unit is located in Bratislava for the aircraft L410, Z37P, and helicopters Mi-2, Mi-17 and in Prešov for the helicopter Mi-17. Aircraft L410 has the speed for the quest of the 150 – 330 km/h and range of 1520 km. Aircraft Z37P has the speed for the quest of 100 – 250 km/h and a range of 640 km. These aircraft are used in a quest only during the day for visual search. Helicopter Mi 17 LPZS performs the search and rescue tasks at night. Equipment consists of, a deck reel, weather avoidance radar, a system of night vision, the system displays on the helmet (HUD), termovision and a television camera, a search searchlight, search radiocompass, jack for connection with search and rescue units, health developed.



Figure.10 Termovision and a television camera, a search searchlight and night vision of the pilot of the helicopter



Figure.11 Systém HUD



**Figure.12 Internally, the equipment of the helicopter MI-17 LPZS**



**Figure.13 Stabilized electro optical system**

Helicopter Mi-2 has the speed for the quest to 200 km/h and range 580 km. Option parachute to landing party of persons and material. Into the cabin, accommodates 10 people. Helicopter Agusti A109K2 made directly to the rescue operation and to transport the patients. It has a built-in autopilot, digital map, viackanálovú radio, mobile phone and devices allowing night flights and flight deck crane. In rescue adjustment allows the transport of one of the reclining patient, and three members of the medical attendant with the necessary medical device. Speed for the quest to 230 km/h and range 964 km.

## **2.7 Equipment search aircraft in Australia**

Aircraft Dornier 328 has the speed for the quest to 600 km/h and range 580 km. Equipment includes communication equipment such as UHF, VHF, HF and satellite phones. Sensor systems such as a search radar, termovízia (FLIR), goggles night vision (NVG), radio targeting (RDF), the aeronautical information service (AIS), ultraviolet and infrared light (UV/IR), longitudinal scan. Stabilized electrooptical system, an integrated management system for missions, a System for the search direction. Option parachute to landing party of persons and material. The rescue helicopter Westpac has pátraciú speed of 225 km/h, the range of 540 km and a winch with a capacity of 275 kg. The rescue helicopter BELL 412 has search speed of 225 km/h and a range of 500 km. It uses the system AFCS together with control of the flight in conjunction with a navigation system. The equipment consists of a system of FLIR, GPS, two go-even for newborns and external winch, 76 m long with a capacity of 276 kg.

## **2.8 Equipment search aircraft in Canada:**

The aircraft CC-115 Buffalo with a maximum speed of 467 km/h and range 1112 km. Take the 41 passengers or 24 sedan chair. The crew consists of a pilot, kopilot and the boss of the crew. The aircraft CC-138 Twin Otter with a maximum speed of 337 km/h and range 1427 km. Take 20 people. The aircraft CC-130 Hercules reaches a maximum speed of 556 km/h and range 7222 km. Take the 92 persons with luggage. The crew consists of 2 pilots, 1 an aerospace engineer, 1 person at the ramp. The equipment consists of two devices for search and rescue operations. The rescue helicopter CH-149 Cormorant reaches a maximum speed of 278 km/h and the range 1018 km. Its equipment consists of two rescue winches, which kidnap the weight of 273 kg. Hijacks 4536 kg suspended load. Contains storage racks for equipment for search and rescue and 12 sedan chair. Helicopter Ch-146 Griffon with a maximum speed of 260 km/h and range 656 km. His equipment consists of a GPS system and a radar system Doppler. Can be equipped with electrooptical display system, FLIR and winches. The crew consists of 2 pilots and 1 flight engineer. In addition to the crew of the helicopter will take 10 people.

### 3. PROPOSAL CALCULATION TOOLS

The computational tool is an application realizing the result in text and image form on the basis of the parameters entered at the input. Carries out operations with formulas. To establish the correct output must enter regular input parameters

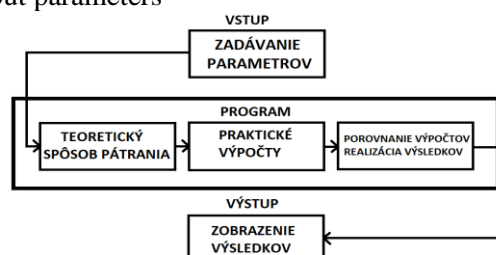


Figure.14 Graphical view of the development diagram

#### 3.1 Input parameters

The parameters are entered on the INPUT (the configuration file .txt format). Divided into 2 parts. The first part shows the different ways of communication. The second part evaluates the 3 defined methods of communication. They are called parallel quest with one aircraft, a quest for the wavelength line with one plane and quest in a square with one plane.

The method of search consists of 14-ers of schemes quest and displays the quest as the quest: along track 1 aircraft with the return, along the line 1 of the plane without a return, along the track more aircraft with the return along the track more aircraft without return, in parallel, 1 plane, in parallel, more aircraft, after the wavelength line 1 aircraft, after the wavelength line 1 aircraft in an asymmetrical shape, after the wavelength line more aircraft, in a square 1 plane, in a square more aircraft, sectoral, contour, helicopter with the use of lighting flér.

Evaluation of the quest is used to write the external conditions.

#### 3.2 Program

Program reads the input parameters from a configuration file and assigns them as needed, where needed. They are divided into: a theoretical method of investigation, practical calculations, a comparison of the calculations of the implementation of the results.

A theoretical method of search: enables visual recognition of the individual quest.

Practical calculations: are used to perform the calculations.

Comparison of the calculations, the implementation of the results: comparison of calculations and profit results.

#### 3.3 Display the results

The resulting data generated in .txt file called results. Pictures of the comparison of the quest will be shown in the format .JPEG. The scheme of search will be in the directories.

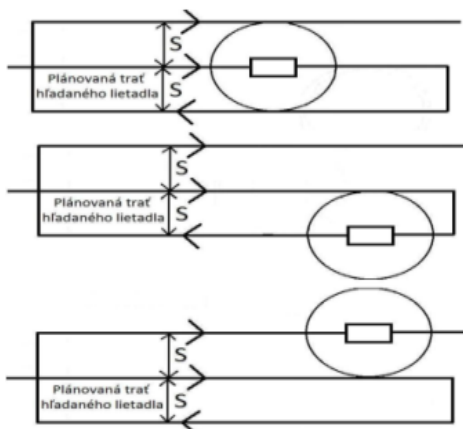
### 4. THE IMPLEMENTATION OF THE CALCULATION TOOL

The input parameters are implemented in the calculation tool. These parameters entered by the user. If the user has provided the input parameters and run the program, so generates the results.

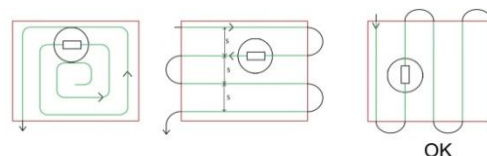




The scheme of search, which the user wants to view and the display of the comparison for (the whole track of each quest and each area of the quest), the shortest way to the quest marked OK.



**Figure.17** Graphical scheme of the quest  
Along the route with 1 plane free return



**Figure.18** Graphical view of the comparison for  
the whole track in the area of the quest



**Figure.19** Graphical view of the comparison for  
the whole track

## 6. CONCLUSION

We have analyzed the legislation, external conditions and equipment search air units. To make the calculations, it is necessary to have knowledge of the issues. For the creation of a calculation tool, it was essential to get the information from the external conditions, search and rescue. The basis of the calculation tool consists of tables 1 and 2. On the basis of these tables to obtain the essential data for the calculation of distance and time. The results are compared and selects the value with the shortest time. All data shall be entered in the výsledky.txt file. Then create two views JPEG format, where it is clearly shown that the scheme of the quest is the most effective. In case, if the dials also one of the 14 ways a quest or all the ways the quest, then appear also in JPEG format. The result of the solution is in the form of a program that runs as an application archive format .jar. Sets the configuration file.

The problem occurred when in table 1, the missing values of the visibility in search. Such a situation, the program did not know to evaluate. In such a situation, the program displays a warning. This computational tool can be adjusted according to different requirements, within the limits of the configuration file. This tool is tested on Windows 7 and Windows 8. In the future can change some values and this tool has a space for their make or add some data. For example, any text between the line distance or the factor of coverage.

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