OPERATION OF LIGHT SIGNAL HEADS IN AIRPORT OPERATIONS AT THE AIRPORT IN LOW VISIBILITY

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In this diploma work we present the lighting systems of airports in general and their technical solution. It intents on the operation of lighting signal heads and it concentrates on the activities of workplaces at the airport during the low visibility and its security. We describe lighting glide systems, approach systems and monitoring system. We analyze CAT I, II and III and it specifies lighting systems at the airport during the low visibility. We deal with the preparation, continuance and completion of the operation during the low visibility.

K e y w o r d s : Operation during the low visibility, lighting signal heads, central monitoring system

1 INTRODUCTION

The main reason why we have decided for this theme was the interest in the problematic – the lighting systems at the airport, their technical solution, the activities of workplaces at the airport and the security of the operation during the low visibility.

The aim of the present diploma work are suggestions of approach systems, which analyze the operation of lighting signal heads at the airport during the low visibility. Furthermore, another aim was to draw up the scheme of the operating practices of separate workplaces at the airport during the low visibility. Our ambition was to master the theoretical characteristics of the lighting signal heads of airports and the specification of the airport operation during the low visibility.

Every airport suggests the own direction under the conditions of low visibility of appropriate category, which has to be approved by The Certificating Authority

2 THE CHARACTERISTIC OF THE LIGHTING SIGNAL HEADS AT THE AIRPORT

From the beginning of the air forces till now the visual contact of pilot with the land has always been the essential condition by performance of safe taking off and landing of all types of planes. The safe landing has been more dangerous matter than taking off. The biggest number of aerial accidents has been by landing of the plane from the reason of bag meteorological conditions at night and during day.

The lighting signal heads at the airport afford the pilot the image of airport, which is usually during the day, it means the lighting marking and the assignation of areas. The lighting signal heads started to be used for the assurance of flight after the 2. World war. At night and during the low visibility on a day they replaced the visual information about the location of airport, it means RWY and other areas of the airport.

The role of the lighting signal heads is to make easier for the pilot in low meteorological conditions to decide in time for a right maneuver, which allows make safely the taking off or landing, based on the information achieved from the lighting security system.

It is important to identify the land lighting at the airport and its closeness, because whatever not aerial lighting can endanger the safety of plains.

2.1 The lighting insured equipment on RWY (Runway)

The lighting signal heads are assigned to the lighting insured equipment on RWY, they compose axial and side lighting rank, liminal and ending lighting crossbars. The lighting signal heads mark the runway and areas of landing and taking off.

The axial and side lighting rank on RWY is used for guidance of pilot, who makes a landing or taking off in the appropriate direction.

The liminal and ending lighting crossbars are adjusted on RWY, where are located the side lighting ranks of RWY and are situated on the vertical line to the axe of RWY.

Other lighting signal heads on RWY are lighting signal heads of the contact area and

stopway on RWY, which make the pilot the safer landing.

2.2 Lighting security system on TWY and APN (Taxiway and Apron)

The lighting signal heads come under the category of lighting security system on TWY and APN and they compile the axial and side lighting rank and lighting signal heads of holding areas. They mark the areas TWY and APN during the low visibility.

The axial and side lighting rank TWY is instrumental to pilot for the security of direction of the plane on the taxiway during the low visibility and operation at night. There are the same assignations by axial and side lighting rank on TWY for heliports.

The holding areas TWY and APN are the places where plains or cars stop and wait, till there is available the agreement to continue from the airport service of the operation of the airport operation. The lighting signal heads of holding areas are created, when RWY is assigned for the operation by the railway visibility less than 350 m. There are concerned the lighting signal heads of intermediate holding areas, holding areas for communication and STOP crossbars.

2.3 The lighting obstacle signal heads

The lighting obstacle signal heads mark the objects and they are used for the decrease of the danger of collision of plane and other object. These objects are highlighted by the lighting obstacle signal heads of low, middle, big glariness or of the combination of these lighting signal heads and they are situated as nearest as possible to the top of the object. The number and arrangement of the lighting obstacle signal heads is so, that there has to be well-preserved the general character of the marked object. The Certificating Authority in Slovakia inform about the survey of lighting obstacle signal heads for application in the civil air craft.

2.4 Approach lighting system

The approach system is located in direction to the brim of RWY in horizontal plane and they are a big help by accession and landing of the plane.

The simple approach system is compiled primary on instrumental RWY. It consists of the rank of the lighting signal heads or the short crossbar in distance of 420m from the crossbar in continuation of RWY axe. The part of the system is the lighting crossbar built in the distance of 300m from the RWY crossbar and its length is 30m. The lighting signal heads produce the white light.[10]

The approach lighting system RWY CAT I consists of many lighting signal heads or short crossbars in the distance of 900m from the crossbar in continuance of RWY axe. The part of the system is as well as the lighting crossbar built in the distance of 300m from the brim of RWY and its length is 30m. The lighting signal heads have the white light.

When the approach system is composed of the lighting signal heads, then are the lighting crossbars built in the distance of 150m, 450m, 600m and 750m from the brim of RWY. When the approach system is made from the short crossbars, then the part of the system are flesh signal heads. Minimal length of the short crossbar is 4m.[7]

The approach lighting system RWY CAT II and III are composed from the rank of the short lighting crossbars made to the distance 900m from the brim in continuance of RWY axe. The parts of the system are as well two lighting crossbars situated in the distance of 150m and 300m before the brim of RWY. The axial lighting approach rank and the lighting crossbars produce the white light. The system is added in the part of 270m before the brim of RWY by side short crossbars, which produce the red light.

2.5 Lighting glide systems

Lighting glide systems are adjusted by RWY as the aid to approach to the RWY. For their building are not necessary any other visual and not visual equipment for RWY. Systems as PAPI, APAPI, T-VASIS and AT-VASIS belong to the standard glide systems.

The system PAPI consists of the lighting crossbar, which consists of four equally deployed more flash lighting signal heads and it is situated on the left side of RWY.[1]

The system APAPI consists of the lighting crossbar, which consists of four or more equally deployed flash lighting signal heads and it is situated on the right side of RWY.[1]

The system T-VASIS is constructed of 20 lighting signal heads ordered equally on both sides of RWY and it contains two half-crossbars. The system AT-VASIS is generated of 10 lighting signal heads situated on the one side of RWY and it contains one half-crossbar. One half-crossbar contains four signal heads and it is divided into lengthwise rank of six lighting signal heads.[1]

2.6 The lighting systems of heliport

Heliport is the airport assigned for landing, taking-off and overland moves of helicopters. The lighting systems of the surface of ending approach, bearing surface and the final point are adjusted on heliport, which is used at night.[8]

The examples are clear; there are the lighting systems of the ending approach and taking-off surface, the lighting system of bearing surface and the surface of taking-off, the lighting system of the final point, light beacon, area lighting of surface, lighting approach systems and lighting glide systems PAPI, APAI AND HAPI.

3 TECHNICAL RESOLUTION AND OPERATION OF LIGHTING SIGNAL HEADS AT THE AIRPORT

The service of lighting signal heads and systems is the essential detail of keeping of high level during the aerial operation. There has to be established the appropriate technical resolution and the operation of lighting signal heads.

3.1 Lighting signal heads and their demands

Lighting signal heads are divided into overground and plugged. The overground signal heads are located over the level of land. The plugged signal heads are located in the runway and their upper part is a few millimetres on the surface, which is suitable for the plane wheels. Demands on the lighting signal heads are declared by instructions, documents and norms. For example there are lighting, mechanical, electrical and other demands.

3.2 Service of lighting signal heads

The service workers of lighting signal heads – technical controllers assure certain function of equipment. The lighting signal heads have to be in order with demands of ICAO and electric norms. There are many influences which influence the service: quality of signal heads, technical level, level of projective resolution, fitting works, organisation of service, knowledge and ability of service workers. The important parameter by monitoring of operation of lighting signal heads is the number of operative signal heads. The operative signal heads are these, whose light did not decrease fewer than 50% luminance in required direction.[10]

For system CAT I have to be fewer than 85% of the operative signal heads in systems for correct approach, runway side, brim and ending lighting signal heads.[9][3]

Demands for the system CAT II and III are higher; they have to have the serviceability at least 95% of signal heads in systems of axial, brim signal heads and inner 450m of approach system CAT II and III. Other demands are, to have operative at least 90% of signal heads from contact area, 85% of signal heads on approach systems in the distance of 450m from RWY brim and 75% of runway ending lighting signal heads. In axial systems of RWY and TWY must not be two lighting signal heads which have a problem with lighting and by STOP crossbar is flowing fail of one signal head.[9][3]

Service worker – technical controller takes the introductive course by fitting of lighting signal heads. There are controls and works according to the methodology. They have to in time remove all crashes. In operating diaries are written forces and activities of service. The service depends on climatic conditions, equipment and personal occupation. In winter season the forces of service are more complicated. The service has the appropriate vehicle for effective service of lighting signal heads. The main part of service is addressed to the cleaning and changing of lighting sources of

signal heads. The signal heads are cleaned with the pressed air, pressed liquid or mechanical brushes.

They may be cleaned with the combination of present methods. In service workroom by changing of lighting sources of plugged signal heads is made absolute cleaning of optical parts, control of light and thickness of appointments.

The lighting systems claim the alternative source of electrical energy which depends on the airport accessories.

3.3 Monitoring system

The monitoring of lighting signal heads by means of computer techniques has economical advantages. They control and monitor the parts of lighting security equipment, STOP crossbars, airport energetic, meteorological and radio equipment. The monitoring system elaborates the record about the condition of lighting signal heads, forces of control aerial service, crashes and their elimination.

The monitoring system works in real time and it is one demand of establishment of operation under the conditions of a low visibility CAT II and III. To the informational systems at airports belong the automatic monitoring system AMS, which assigned for the operation, signalling and monitoring of lighting signal heads at the airport.

4 THE OPERATION OF AIRPORT DURING LOW VISIBILITY

By plain accidents during low visibility were determined the conditions of order by approach and landing during low visibility. Important factors by flying during low visibility are technical accessories of planes, certification of crews and landing accessories of RWY. All components of lighting systems at airports which are under the control of the state professional direction in civil air forces in sense of aerial law are accepted by aerial office. Aerial office determines demands on assurance of aerial operation during low visibility at airports. The airport operator is responsible for assurance of demands and conditions at the airport.

4.1 Categories of operation during low visibility

There are concerned categories, which are designated as CAT I, CAT II and CAT III for exact instrument approach. These categories characterize the accuracy of system and possibilities of application of ILS, which are specified for every airport. Each category has different demands on lighting safety accessories and other meteorological limit for landing, which is mentioned in table.[1]

Tab.1 Categories of operation during low visibility

Categories	**Landing with amount of decision**	**Runway visibility**
CAT I	Over 200 ft (60 m)	Over 550 m *
CAT II	under 200 ft, but over 100 ft (30 m)	Over 350 m
CAT III A	under 100 ft, or without limitation	Over 200 m
CAT III B	under 50 ft (15 m), or without limitation	under 200 m, but over 50 m
CAT III C	Without limitation	Without limitation

Legend: * Runway visibility is specific for every airport, it depends on runway accessories of lighting signal heads, it can be higher than 550

For measuring of runway visibility under the conditions of CAT II are used at least two equipments, where one is situated at the beginning of RWY and the second in the end of RWY. During the measuring of runway visibility CAT III are used three equipments situated at the beginning, in the middle and in the end of RWY. The highness of basic cloud amount is measured with ceilometer, which is recommended to locate under the glide axe. The measuring of direction and fastness of ground wind is performed by anemometer, which is recommended to locate in

the nearness of RWY contact zone. The operation disability of equipment for measuring of highness of basic cloud amount has not influence on the operation during the conditions of CAT II and III.

By conditions of CAT II and III is necessary to know a lot of lighting systems, it means to switch on and switch off the appropriate lighting systems and to regulate the luminance of signal heads. The regulation of luminance has to be on one hand fluent to assurance of adequate luminance during low runway visibility. On the other hand the regulation of luminance insures the situation when lighting systems do not dazzle pilots in condition of good visibility, for example at clear night. The regulation of systems has at least 5 grades with exception of axial ranks of TWY, which are possible to regulate in 3 grades and side ranks TWY, which must not be regulable. The lighting security equipments are before the beginning of operation CAT II and III always switched on the maximal luminance and decrease of luminance is possible only on request of pilot after the achievement of visual contact. Supply of lighting signal heads with electrical energy is from the main source of electrical energy and in case of energy interruption from alternative sources. The lighting systems have to be maintained in operative condition.

The service is ensured by technical controller, who has the appropriate competences and he is suitable for service of equipment. All workers in the operation of airport during low visibility have to be trained and one per year certified with pointing on conditions of low visibility. During the operation of CAT II and III is essential to switch off the lighting glide system.

In Slovak Republic at the airport in Bratislava is possible the operation under the conditions of low visibility of CAT I, II and III A on RWY 31 and at the airport. In Košice is possible the operation of CAT I and II on RWY 01.

4.2 Draft of scheme and activities of workplaces by operating practices under the conditions of low visibility

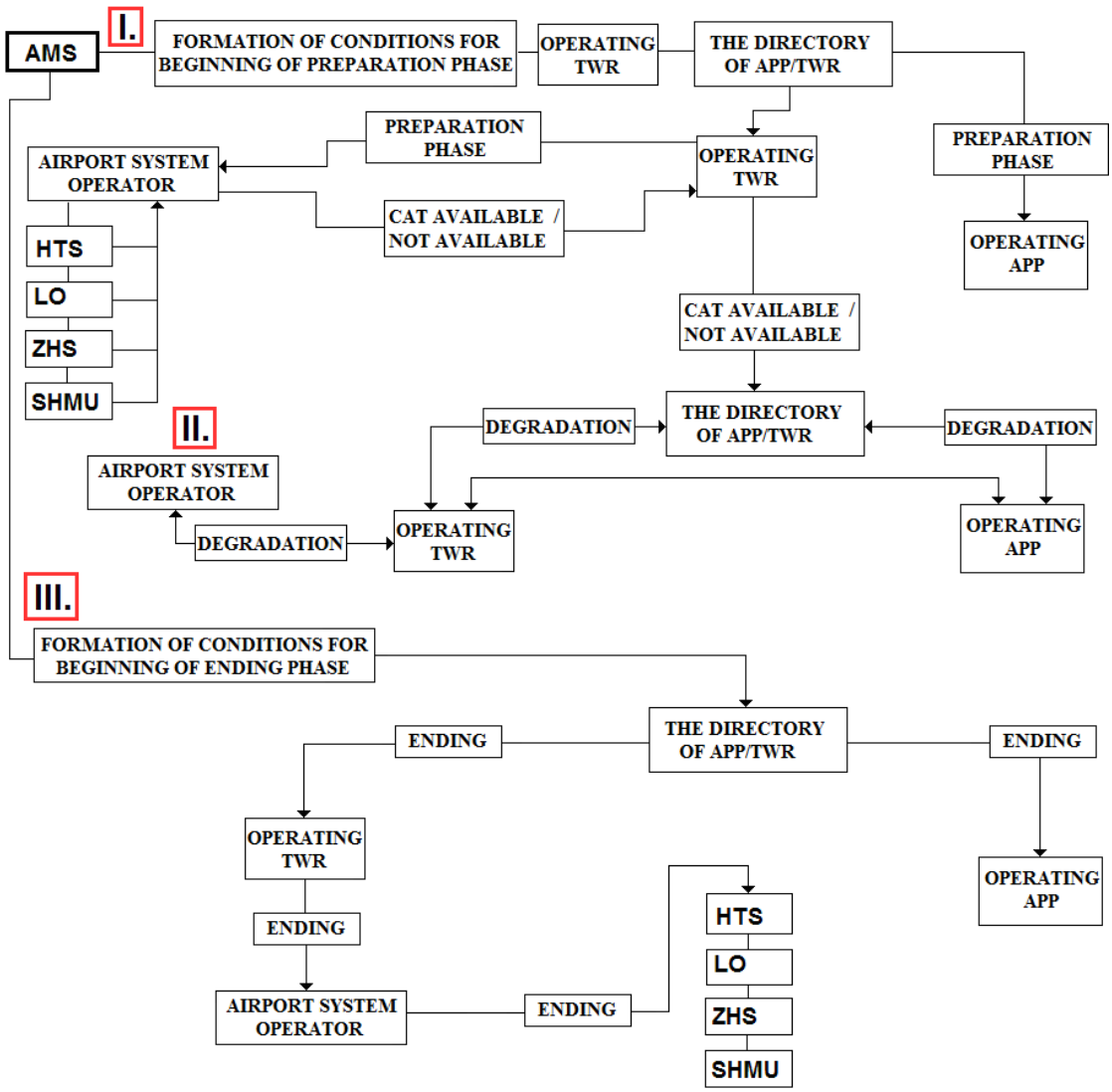
By maximal safety during aerial operation under the conditions of low visibility are defined the operative practices. The operative practices are divided into phases. The safety is provided by responsible workplaces and systems. The following scheme represents the order of workplace by airport operation under the conditions of low visibility.

In preparation phase I. the controller of TWR/APP change gets the information from directory TWR about findings of the preparation phase on operation during low visibility and he notes it to the operative diary. He gives the information to his directory TWR, directory of APP about the beginning of operation under the conditions of low visibility. The workplace of APP directory accepts the information from the controller of APP/TWR change about the beginning of operation during low visibility. The workplace of TWR directory accepts the information from the controller of APP/TWR change about the beginning of operation under the conditions of low visibility and gives the information about the beginning of operation under the conditions of low visibility to airport system operator.

In operative phase II. the controller TWR/APP change in case of system malfunction, who is informed from individual workplaces, gives the definite message about the readiness or not-readiness on conditions of low visibility. The workplace of APP directory ensures pitches and observes actively the possible deregulations of system. He gives information to planes which are going to land. He informs the controller of APP/TWR change about the possible degradations of system. The workplace of controller of TWR gives the information to planes which are going to take off and observes actively the possible degradations of system. He informs the controller of APP/TWR change and the airport system operator about the possible degradations of system.

In ending phase III. of the operation, the AMS system signalizes the conditions for ending of operation under the conditions of low visibility. The controller of TWR/APP change decides about the ending of operation according to the operative situation and notes it to the operative diary. He gives the information about the ending of operation to the controller of TWR and APP directory. The workplace of APP directory accepts the information form the controller of APP/TWR change about the ending of operation and ensures

normal pitches. The same case is in the workplace of TWR directory when he accepts the information from the controller of APP/TWR change about the ending of operation. He deactivates the operation during low visibility on AMS system and ensures normal pitches. He gives the information about the ending of operation to the airport system controller. The airport system controller informs the workplaces HTS - main transformer, LO - airport security, HS – fire rescue service, SHMU - meteorological workplace, about the ending of operation under the conditions of low visibility.



Pic.1 The scheme of operative practices under the condition of low visibility

5 CONCLUSION

We characterize in this work the lighting systems of airports; we specify and analyze the operation of airport and lighting signal heads during low visibility. In introduction we describe the individual kinds and types of lighting systems, which are standardized by International organization of civil air craft ICAO. The lighting systems offer the useful information by movement of plane on the railway, by its landing and taking off to the pilots.

Furthermore, in work we deal with the service and monitoring of lighting systems which are parts for keeping of high level of aerial operation safety. The lighting systems are monitored by AMS system which gives the information to the workplace of aerodrome control tower, approach control service, aerodrome control system and the main substation. The main part deals with the lighting system of approach lighting system CAT I, II and III which are provided by plane direction by approach to the airport and punctual downcome on RWY on day, at night and in low conditions of visibility. In the last part of the work we imply the scheme of operative orders under the conditions of low visibility, connection and activity of individual workplaces at the airport.

This diploma work may serve as the study guide for audience of Faculty of aeronautics or as the help by planning of instructions under the conditions of low visibility at airports.

BIBLIOGRAPHY

[1] ICAO - Doc 9157 Airport DesignManual, Part 4 – Visual Aids

[2] ICAO - Doc 9157 Airport Design Manual, Part 5 - Electrical Systems

[3] Smernica SM 2 - Smernica na vykonávanie letiskovej prevádzky za podmienok malej hodnoty dohľadnosti, Letecký úrad SR,1998.

[4] KAZDA, A. Letiská design a prevádzka. Žilina, Moyzesová 20: Vysoká škola dopravy a spojov, 1995. 377 s. ISBN 80-7100-240-2.

[5] KOŠČÁK, P. – FERENC, J. Organizácia a riadenie prevádzky letísk. Košice : TU Letecká fakulta, 2010. 183 s. ISBN 978-80-553-0357-7.

[6] DŽUNDA, M.: Syntéza rádionavigačných systémov. Monografia, Košice, 1998.

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