THE AIRPORT MOVEMENT AREA RADARS

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For airports primary radars are an inherent part of the services. However, during the last decade airport areas are so overcrowded that the security of flight lines decreased and therefore they started to use other types of radars. Accidents on airport runways are very unusual and are caused by heavy traffic, human error or reduced visibility. To try preventing these risks airports radars were developed and applied which function is to monitor the situation on several airport areas. In a conclusion these radars are not exact enough so they can not monitor the situation on big airports by itself. According to the proposal of international organization ICAO the system "Surface movement guidance and control system" (SMGCS) was developed. Nowadays it is called "Advanced Surface Movement Guidance and Control system" (A-SMGCS). Thanks to this system the security has been largely increased and strongly progressed compared to airport radars.

K e y w o r d s: Air transport safety, airport radar, technology, legislation, A-SMGCS.

1 INTRODUCTION

The issue of airport radar is currently very hot topic as more and more began the international organizations in aviation focus to improve safety of airports and operational areas. The aim of work is to get insight into what can airport radars, how they work and how they are able to increase airport security. Aim was to determine if they are currently well advanced technologies such as airport radars. Estimated work was supported by the supervisor of this work has contributed valuable advice already in its seed.

2 PRINCIPAL DIVISIONS OF RADARS

Today's civil and military radars vary from each other in construction, measures, power, accuracy, presentation and many other parameters. The principal divisions are the divisions by radar function; therefore in this case we distinguish between two main groups –the primary and the secondary radars.

The primary radiolocation – primary radars transmit electromagnetic waves in space, where are they reflected from the target and a part is returned to the receiving antenna which capture it. This is the basic principle of the operation which had worked with the first type of radars. Primary radars provide information not only about the position, but also about the target rapidity. For their proper functioning and operation is not required any other cooperation with the target object.

Secondary radiolocation – the secondary radar to its correct operation requires cooperation with the spotted object, which in this case may be an aeroplane. The transmitting antenna of the secondary radar sends an electromagnetic signal to the given aeroplane, so called query, and waits until the aeroplane answers for the appropriate query.

Currently, the secondary radar belongs to the standard equipment of the stations which manage air traffic of the airport and its surroundings. A transmitting device is placed to the airport, so called interrogator-radar, which periodically sends electromagnetic queries to aeroplanes. In a contrast, there are special transmitters on the aeroplane boards, so called responders, which reply queries with an own code assigned to them according to the flight by the control centres of the air traffic. The relevant responses of aeroplanes are captured by the receiving antenna of the secondary radar, after which they are decoded and particular aeroplanes are identified on the basis of these responses.

This division is just on of the many. Another division can be a division of the radars according to the electromagnetic wave transmission mode. Also in this type of the division there are two types of radars. Pulse radars, which transmit the particular pulses, and continuous wave radars, which have analogue transmission.

Pulse radar – these types of radars have only one antenna, which is cross-connected to the transmitter and the receiver and it Works by this way during the total time of the targets detection.

Firstly, short electromagnetic pulse is send from the particular antenna after which this radar automatically switches to the receiving of the reflected signal. With this constant switching of the transmitter and receiver to the particular antenna it is possible to determine the direction, distance and height of the target.

Radar with continuous wave – this type of radar sends a continuous signal that is also steady received back, that are constantly emitted electromagnetic waves which are reflected from the particular targets and are constantly received at the same time. As it results form the preceding context, it is essential to the continuous wave radar to have two antennas, one that constantly sends and one that constantly receives electromagnetic waves.

Radars in aviation are used for many purposes and are regulated exactly for the particular purpose. Beside the basic division, according to the purpose of usage, we can distinguish the following basic radars:

- primary surveillance radar,
- accurate landing radar,
- secondary surveillance radar,
- airport radar,
- meteorological radar,
- passive tracking systems,
- combined radars.

3 THE AIRPORT RADAR

On of the classic airport radar is called ASTRE. Airport radar with the ASTRE label was manufactured by the French company THONSON CSF. The demand of the airport radar usage is necessary for the complex involvement of the current flight lines, which are joined together with other paths, located on the airport area.

The main task of the airport radar is to track and monitor the movement of particular aeroplanes and motor vehicles as well on the paths as on other airports areas. They also monitor and track all the types of mechanical equipments, also beside concrete or asphalt areas of the airport. This follows that they are tracking and monitoring also the grass fields of the airport.

3.1 Principal parameters of the ASTRE airport radar

Each radar as well as the ASTRE airport radar, has its basic parameters. The principal information about radars is the acquaintance with the basic parameters and features which indicate its characterization and capabilities to the defined requirements. Some of the following lines include the most principal parameters of the ASTRE radar, that tell us about its features by the possible recognizing of particular objects on the airport, there are the parameters:

- frequency range: 16GHz,
- transmitter power: 30kW,
- repetitive frequency: 10kHZ,
- pulse width: 40nanosec.,
- polarization: circular,
- antenna scheme: horizontal 0,33°, vertical 0 to 30°,
- antenna speed: 60 rpm,
- resistance to wind cover antenna: up to 240km/hour.

These are, certainly, the most basic parameters that are given to the manufacturers of the airport radar.

3.2 Composition of the ASTRE radar

One of the main parts is the unit of the transmitter and receiver which is located in a stand that is located under the antenna. In this space there is also a processor for signal processing, antenna control panel and there is also a compressor. In this case, compressor is essential for the so-called preservations waveguide.

The antenna for this type of radar is 660 x 400mm and is placed under the so-called cupola, with a diameter of 5m, while i tis composed of 205 triangles made of stretched laminate foil with a thickness of 2mm. This antenna rotates uniformly at 60 rpm and the planetary gear, which partly regulates the rotation. The very material the antenna was made from, is mulled plastic that contains aluminium compounds, which makes it possible to archive very good electrical reflectance that greatly affects the electromagnetic waves.

The construction of the cupola is designed to serve also as a lightning conductor, which ground circuit is associated with technical block and the damage commination of the radar in the dependencies of the lightning is minimalized in this way to the highest level.

The transmitter of the ASTRE radar operates in the super short wave frequency of 16,7 GHz. It means that the wave length is 1,875 cm, while there is a possibility for retune from 15,7 GHz to 16,7 GHz. As for the repetition rate that is 10kHz, ensures, that at regular 60 speed of antenna per min. and 0,33° diagram width, each area of the scanned space is radiated at least twice. That provides highest resolution and high probability of the target detection. Performance of this radar is 30 kW in pulse and provides a minimum 4,5 km reach to the targets that correspond to the size of personal car.

The actual resolution ability in the angle is limited to the width of the diagram which, at a distance of 1 km represents 5,7 m and almost constantly increasing and in a distance of 2 km it is already 11,5 m.

3.3 Processor

The important part of the ASTRE radar is his processor which processing and editing the signal. The main tasks of processor are:

- transfer the received signal from sky wire and editing it to digital version for future possible operations with this signal,
- shifting the threshold level in concrete program in corresponding smooth map which encloses all runways, included the lay-by,
- half -way or absolutely observed suppression of uninteresting areas and depending on the coarse map.

Digitalization of received signal is processing in remote section and in quantity. The treatment is always considered simultaneously two quanta, which in terms of a numeric value is 6 m. For each section is received video signal which is subject to an assessment of amplitude resolution gradation from minimum to maximum of 16 levels. In this case there is a digital indication of the value of the signal by a bounty for each district, as well as step amplitude levels will create a full report, which is based caching, which has been prepared in advance. The reciprocal values of the signal compared to the previous eight and eight continues remote quanta continuing the information from the cache memory to final memory for record signal in the right section of the current coverage area. This comparison between previous and continues remote quanta allows to change recorded information about amplitude in that case, if the surrounding quanta of its values completely or sufficiently approximately equal.

4 Advanced Surface Movement Guidance and Control system

The Advanced Surface Movement Guidance and Control system (A-SMGCS) included technology and processes for increasing the security in airport area, especially during reduced visibility. It is also designed for monitoring and controlling aircraft in those areas. The A-SMGCS include the airport radar, which is not itself able to display completely accurate, but in conjunction with other technologies is one of the main components of a unified system.

4.1 The A-SMGCS trends

Current trends in aviation brought many innovations that are necessary because of increasing traffic density at airports, while new applications are introduced to help managers optimally and safely drive traffic at airports, airfields and in the future will be able through links with other similar systems most these activities from the air traffic controllers and will take the entire system can be automated.

Various applications that are part of the planning process of airport surveillance systems are one of the fundamental components already mentioned the A-SMGCS, and this system provides very accurate information about the current status of the airport in real time and also on the operation of the airport. This information is provided using a mobile device, which is very flexible and precise plans the best route vehicles for airport operational areas.

Based on the previous line, it is clear that the fundamental objective of A-SMGCS is to inform air traffic controllers about the current

position of all vehicles and aircraft that are moving or standing on the airport area. Matter of course is to provide identifying information, all information provided must be the most accurate, reliable and provided in real time. One of the main advantages of using this system is that even the most modern airport radar or other, currently available technology is not able to so accurately reflect all vehicles and aircraft located in airport areas, regardless of whether they move or not, display them and also provide information on their identification data.

Therefore, the only way to combine the individual airport radar technology to create a mutually reinforcing system that can meet all the requirements and even enhance the accuracy of the data available to facilitate the work of flight dispatchers.

4.2 The concept and the main functional elements of A-SMGCS

The A-SMGCS is possible to divide the functional elements of:

- Continuous monitoring,
- Monitoring,
- Management,
- Route planning.

4.2.1 Continuous monitoring

Continuous monitoring is the most important function of A-SMGCS. With this function is possible to monitor each airport area. The aim is to provide information to managers about the location of aircraft and motor vehicles located on the track. Of course they must also be provided with identifying information and, if required, information about the direction of movement and speed, too. Function of continuous monitoring includes information from several sensors and also the airport radar.

4.2.2 Monitoring

The function of monitoring uses and evaluate information from continuous monitoring. Based on the evaluation of the information is then determined whether there is no chance any conflict situation that would require immediate action. Information about such collision situation can be depicted to manager, and such information may be followed by sound and light indication. The A-SMGCS at a higher level such information can directly provide to the flight crew.

4.2.3 Management

This option is available only if the system is operating at the required level. Otherwise, the management function will be represented by command of manager. This function will use information from the previous two functions. At higher levels are operating the A-SMGCS in the management of completely autonomous.

4.2.4 Route planning

The route planning is divided into two phases:

- strategic planning: phase which ignoring the actual situation at the airport,
- tactical planning: phase that adapts to the current state of airport.

The arrangement and order of the functions of system is not random. It is clear that continuous monitoring has priority over all other functions, because all functions are dependent on information from the previous function. Of course that depends on the airport, how much money is ready to grant to build this system and which level of A-SMGCS will be available. It's a form of compromise between the economic aspect and safety required.

Level I:

- Function of continuous monitoring for ATC personnel.
- The possibility of visual monitoring and identification on the screen of an A-SMGCS.

Level II:

- System functions of Level I.
- Monitoring and alarm functions for managers of ATC.
- Security network.

Level III:

- System functions of Level I + Level II.

- Improving abetting, for example, delineation the map of the airport and position of mobile device to flight crews and drivers.
- Planning routes for air traffic controllers.
- Detection of all conflict in the airport areas.
- Alerts to managers of ATC.

Level IV:

- System functions of Level I + Level II + Level III.
- Direction and abetting for managers of ATC, flight and vehicle crew.
- Providing the decision not only for managers of ATC, but for the flight or vehicle crew.

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