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ELECTROMAGNETIC LOAD ON THE AIRPORT STAFF AND BASIC METHODS OF ITS REDUCING

Summary. The work is devoted to investigation of electromagnetic load on the airport staff and providing practical, scientifically- grounded recommendations to minimize its impact.

Аннотация. Работа посвящена исследованию электромагнитной нагрузки на персонал аэропорта, и изучение практических, научно-обоснованных рекомендаций для минимизации ее влияния.

Анотація. Робота присвячена дослідженню електромагнітного навантаження на персонал аеропорту та надання практичних, науково-обгрунтованих рекомендацій для мінімізації його впливу.

Introduction. Development of aviation communications in Ukraine, increasing the frequency of aircraft movements increases a pressure on service and traffic control staff. The result is an increasing the load on the psycho-emotional sphere of workers and increasing of impact of the physical environment factors. The last is caused by quantitative and qualitative composition of the equipment used in production processes; simultaneously working aircrafts and continuous work with high load of all airport systems. One of the main factors, that affect workers, are electromagnetic fields and emission of almost the whole frequency spectrum, which require a meticulous study of their quantitative values and determining the conditions to minimize them.

Actuality of the problem. At the moment, the working conditions of the airport's personnel receive significant attention, however, most studies of this problem are devoted to such issues as reducing aircraft noise [1], emissions from aircraft engines [3, 4]. But these factors hardly affect the working conditions of air traffic control staff, and the main factors, that influence them and all other airport staff, are electromagnetic fields and emission, caused by arrangement of sources of their formation and high permeability. Studies of the impact of electromagnetic factor on airport workers are sporadic and concern primarily the high-frequency - microwave band (UHF RF) of mobile network objects, operating frequencies of which fall in this ranges [5, 6]. Nevertheless the specificity of the formation of the electromagnetic environment at the airport and its surroundings is a wide spectrum of electromagnetic emission, generated by radio equipment of air traffic control, navigation and landing.

Integral electromagnetic load is determined on the base of actual values of the electric and magnetic components of the electromagnetic fields and the energy flux density of electromagnetic emissions, generated by technical means, the principle of superposition and maximum permissible levels of these factors for each frequency range. [7]

Obtaining of the necessary baseline data is possible with the help of calculation methods, regulated by current method of determining of the electromagnetic fields of HF SHF ranges [8], and technical documentation for radio objects.

But experience of such studies showed significant differences between calculation methods and results of natural measurements, which are beyond the admissible errors. Typically, the calculated values of the quantitative characteristics of electromagnetic fields and emissions are lower than measured. Moreover, the measured values of the characteristics of electromagnetic fields and emissions are different for similar radio equipment.

This is explained by several reasons: 1) unpredictability of intensity of emission of parasitic petals of diagrams of emitter orientation, consideration of which is mandatory, according to the requirements of public health planning and development regulations of populated areas [9]; 2) in many cases, in the points of determining the levels of electromagnetic radiation an effect of other techniques is observed, that cannot be predicted even on the basis of their location.

The feature of formation of electromagnetic environment at airports, located within settlements, is the influence of base stations and radio impact of the airport on the situation in the areas of residential development. Operating frequencies of radio equipment airports of UHF range and base stations are very close and are not divided by standard gauges. But the maximum permissible level of radiation of these frequencies for aerodrome equipment is 10 mkW/sm2 [3], but the corresponding figure for the base stations is 2.5 mkW/sm2 [7]. This necessitates a separate determination of the contribution of these sources to the overall electromagnetic background using precision equipment of calibrated high-resolution.

To get the correct data of the electromagnetic environment at the airport and its surrounding areas, using only instrumental methods is impractical. This is due to large amounts and timing of the required work. The most rational are field measurements at critical points around the radio facilities and use of the results to refine the necessary coefficients corresponding mathematical functions and calculation methods as boundary (initial) conditions.

Aim of the work is to determine the actual values of electromagnetic emission of radio equipment of the airport and to provide practical, evidence-based recommendations to minimize their impact on employees.

Basic material. Almost all the airports in Ukraine use the same type of equipment to ensure safety. Some exception is the airfield of the airport in Lviv, which is combined with the military airfield "Skniliv", this is why the airfield "Lviv" was chosen for the research. It is characterized by the following composition of the fleet: civil aircraft - A-320, A-319, B-767, B-737, MD-83, ATR-42, F-100 and others. Military - SU-27 and MiG-29.

Specified aircraft fleet requires an increase in the number of sources of electromagnetic radiation.

The nomenclature of sources of electromagnetic emission of airfield "Lviv" is presented in Table 1.

Table 1.

Sources of electromagnetic radiation emitted by airfield "Lviv"

Type of facility, the magnetic declination, the type of operations	Denotation	Frequency	Work hours	Exceeding the transmitting antenna DME	Notes
VOR/DME	LIV	115,50 MHZ	H24	333.5M/1094FT	
LOC 13 ILS CAT II	ILO	109,50 MHZ	H24		
GP		332,60 MHZ	H24		3^0 , RDH 15.0 m
LOC 31 ILS CAT II	ILV	110,30 MHZ	H24		
GP		335,00 MHZ	H24		3^0 , RDH 15.0 m

Where:
VOR - directed on all tracks azimuthal radio beacon;
DME - directed on all tracks rangefinder radio beacon;
LOC - Course radio beacon;
GP - hlisadic radio beacon.

Also used ATCR (overview locator) and ARDF (automatic radio direction finder).

Preliminary evaluation of the level of electromagnetic mission of all radio equipment was performed by the method [8]. Calculated results allowed to determine the most critical points of the airfield working zone, where full scale measurements were performed. Measurements were performed by calibrated energy flux density meter PZ-31.

Measured levels of electromagnetic emission for radio equipment of flight at the height of 1.8 m above the ground and the distance 0-400 m from the foundations of transmit antennas are:

Radio beacon DVOR/DME - 8,22 - 0,31 V/m;
Course radio beacon (SP-200) – 9,0 – 0,17 V/m;
Glideslope radio beacon (SP-200) - 0,68 - 0,09 mkW/sm2;
Automatic radio direction-finder (ARP-75) – 0,36 – 0,04 mkW/sm2;
Surveillance radar (R-25Wt) – 10,48 – 1,13 mkW/sm2.

Whereas, according to the norms of planning of air traffic control objects, radio navigation and landing BCH-7-86 construction restrictions zones are defined within: course radio beacons - in working sector ± 30° and in critical areas; glideslope radio beacons - 1000 m in working sector of ± 30°; airport observation radars - 3000 m (limited angle 0,5°, h - 5 m); radio beacon DVOR/DME – 600 m. the maximum permissible levels given [7], for radio equipment of flight facilities it is necessary to establish protection zones: for radio beacon DVOR / DME – sanitary protection zone of radius 25 m counting from antenna’s blade; for a course radio beacon (SP-200) – sanitary protection zone of radius 25 m in the direction of the main emission; for glideslope radio beacon – sanitary protection zone of radius 25 m in the direction of the main emission; for the radio direction-finder (ARP-75) - sanitary protection radius of 25 m; for surveillance radar - sanitary protection zone of 30 m centered at the locations of the antenna. For buildings up to 25 m and above limiting radius of a residential building is 220 m.

The evaluated levels of electromagnetic emission lead to the conclusion about the possibility of reducing the impact of this factor on workers to levels lower than the norms. This is realized through the following measures:
- Antennas of station should be placed on embankments (trestles) or natural hills;
- The negative tilt angles of the antenna should be limited.

Service areas at the object's territory should be placed mainly in places, protected from electromagnetic fields ("radio shadow", "dead zone"), and orient them in way to prevent windows and doors from radiation, if necessary - to shield.

The routes of personnel at the object's territory should be set to prevent from radiation at levels that exceed the maximum permissible.

Emission zones with energy flux density above 10 W/m2 (1000 mkW /sm2) must be marked with special warning signs.

If necessary to work in the antenna emission area with levels of EMF, exceeding the permissible levels, must be used mobile shields and personal protective equipment (Table 2).

Table 2

Materials for production of electromagnetic shields

Name of material	ДСТ, ТУ	Dimensions, mm	Attenuation, dB
Metal sheets, 3	ДСТ 19903-74	20x1000x1,4	100
Aluminum foil roll	ДСТ 618-73	width 460…600	80
Copper foil roll	ДСТ 5638-75	width 20…..1500 depth 0,8	80
Steel woven mesh	ДСТ 5336-73	Depth 0,3..1…1,3	30
Radioprotective glass with semi-conductor coated on one or both sides	ТУ-21-54-41-79	1000x2000x6	20…40…40
Cotton with microwire, art.6911	ОСТ 17-28-70	Width 930	20…40
Amorphous metal alloy	ММ – 11N	Depth 20-50 microns	60…80

Conclusions and prospects for research.

1. Rationalization of planning and implementation of airport personnel protection from effects of electromagnetic fields and emission is achieved as by calculation, as by experimental methods of evaluation of the emission capacity of airfield's radio equipment with the definition of integrated quantitative indicators.

2. Actual levels of electromagnetic emission of equipment, which is used in air traffic control system, can reduce their impact on working personnel through their appropriate placement and creation of zones for working people.

3. Personnel in close proximity to the source of generation of electromagnetic fields (such as magnetron radar) should be protected with the help of special electromagnetic shields (standard housing and doors of electronic equipment do not always provide their electrical sealing) the configuration and the material for the shield is selected in accordance with the actual level of emission).

The work done can be considered as first step of implementation of electromagnetic safety of all airport personnel.

Taking into account the wide frequency range of electromagnetic fields and emissions, as well as certain unpredictability of their distribution, it is reasonable to perform measurements of quantitative characteristics of these factors (including electromagnetic fields of industrial frequency 50 Hz) in the airport's control rooms and determine their compliance with sanitary norms and rules for this category of workers.

Such activities should be performed on integrated manner, ie, with simultaneous control of other physical factors (noise, air ionization, etc.), which is caused by a certain interdependence levels of electromagnetic fields and air ionization (deionization) and noise level and power of technology equipment, which is used by air traffic controllers. This is a subject for further research.

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