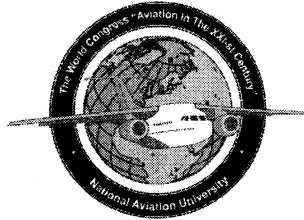


AVIATION IN THE XXI-ST CENTURY

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NATIONAL ACADEMY OF SCIENCES OF UKRAINE
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IMPLEMENTATION OF ENERGY-SAVING TECHNOLOGIES AT AIRPORTS TO INCREASE THE LEVEL OF ENVIRONMENTAL SAFETY

The main reasons and prerequisites of energy losses from administrative and production buildings of airports have been considered in the paper. Energy-saving potential of Ukrainian airports have been analyzed. The most efficient methods and technologies providing conservation of energy at airports are presented.

Aviation is proved to be one of the industries posing a wide range of threats to the environment and human health. The diversity of technological operations, performed at modern airports leads to high variability and complication of environmental impacts. The most known and analyzed impacts of aviation include, but not confined to, air, noise and electro-magnetic pollution by aircrafts and ground transport, as well as airport equipment. Other components of the environment are also affected by air transport processes, namely they cause soil and water pollution, destruction of habitats and violation of atmospheric regimes. Therefore general environmental situation within the area of airport influence is formed under the influence of numerous factors. The volume and intensity of these impacts greatly depend on the efficiency of operations conduction and resources consumption at airports.

Inefficient exploitation of material and energy resources leads to:

- formation and accumulation of excessive volumes of wastes;
- overconsumption of water for technological processes;
- pollution of vast areas of fertile soils around airports not included into their industrial zone;
- intensified pollution of the atmosphere due to emissions from equipment and vehicles, power and heat generating facilities working over the necessary time;
- thermal pollution on the environment due to losses of heat from buildings.

Development and implementation of resource-saving action plans allow reducing usage and wasting natural resources, raw materials and energy carriers. The assessment of energy efficiency at airports could be conducted for airport buildings of administrative and production purpose. Such assessment will give information about ways of energy losses, methods of losses prevention and ways of reducing negative impacts on the environment.

Energy saving is obviously today one of the main trends of development both domestic and world economy. Taking into account current economic and political situation, the issues of energy resources conservation are on the agenda for Ukraine on a continuous basis, and this tendency is from now on the main vector of country progress. More and more Ukrainian producers try to introduce energy efficient solutions to the market. It is especially topical for capital construction, as this branch must not only raise the efficiency of constructed facilities, but also

modernize or replace existing installations with new equipment, meeting the modern requirements. Transport is one of the most important participants of this process, and first of all it is true for air transport. It is conditioned by the fact that aviation industry combines capital construction (airport and its facilities), developed infrastructure and high levels of energy resources consumption, including fuels.

During the last few years Ukraine has demonstrated high rates of development of aviation industry: in 2006 passenger turnover has grown 5,1 times, and the amount of carried passengers – 4,3 times by comparison with 2000. For next period to 2013 the growth rates made 4,8 %. Prognosis made by competent professionals show that general volumes of carried passengers at all air-ports of Ukraine in 2020 will attain 7–8 million passengers a year [1].

The volume of passengers transported via unoperating air-ports, if they are passed to municipal property and function in 2020 year, can be up 120–200 thousand. The main national airport «Boryspil» will develop more rapidly: the volume of passenger transportations in 2020 will make 8300–10500 thousand passengers a year. As for the airport «Kyiv» (Zhulyani) the prognosis data for 2020 set the potential volume of passenger transportations at the level of 355–857 thousand passengers a year [2].

The system of airports of Ukraine includes 72 air fields and 36 operating airports. From statistical information about activity of most domestic airports for the last three years, it is seen that the amount of both trips and passengers, transported through these air-ports, is growing. Therefore the need to increase energy efficiency of these objects is crucial for the improvement of environmental situation around aviation enterprises.

The level of energy efficiency could be assessed with the help of energy audit procedure and resulted in the form of “Energy Passport” for each of administrative or production buildings at the airport. Energy audit involves recording various characteristics of the building envelope including the walls, ceilings, floors, doors, windows, and skylights. For each of these components the area and resistance to heat flow (R-value) is measured or estimated. The leakage rate or infiltration of air through the building envelope is of concern, both of which are strongly affected by window and door construction. The goal of this exercise is to quantify the building's overall thermal performance. The audit may also assess the efficiency, physical condition, and programming of mechanical systems such as the heating, ventilation, air conditioning equipment, and thermostat.

When the object of study is a building under exploitation then reducing energy consumption while maintaining or improving human comfort, health and safety are of primary concern. Beyond simply identifying the sources of energy use, an energy audit seeks to prioritize the energy uses according to the greatest to least cost effective opportunities for energy savings.

Some of the greatest effects on energy use are staff behavior, climate, and age of buildings and facilities. The energy audit may therefore include an interview of the managers and workers to understand their patterns of use over time. So, in general assessment of energy efficiency will include:

- analysis of energy bills;
- survey of the real operating conditions;

- understanding of the building behavior and of the interactions with weather, occupancy and operating schedules;
- selection and the evaluation of energy conservation measures;
- estimation of energy saving potential;
- identification of enterprise concerns and needs.

The term energy audit is commonly used to describe a broad spectrum of energy studies ranging from a quick walk-through of a facility to identify major problem areas to a comprehensive analysis of the implications of alternative energy efficiency measures sufficient to satisfy the financial criteria of sophisticated investors. Numerous audit procedures have been developed for non-residential (tertiary) buildings (ASHRAE, IEA-ECBCS, RESNET). The most applicable for general analysis of the situation with Ukrainian airports is express-audit, which is based on the study of available data about airports structure, buildings parameters and energy systems, required to identify the need for further investigation, existing problems and offer the most efficient and cost-effective ECOs or Measures ECMs. Energy conservation opportunities (or measures) can consist in more efficient use or of partial or global replacement of the existing installations, as well as organizational and technological solutions.

The analysis of preliminary data has shown that the most intensive consumers of energy are the airports «Boryspil», «Simpheropol», «Donetsk», «Dnipropetrovsk», «Odesa», «Kharkiv», «Lviv», as they provide the biggest volumes of transportation. At the same time these airports has recently came through certain level of reconstruction, which has also included installation of energy efficient equipment. The rest of the airports at the territory of Ukraine are still far not that energy efficient as they must be to guarantee financial reliability and environmental safety of the adjoining areas.

The analysis of airport facilities resource consumption efficiency has been conducted with the help of score system, based on the energy efficiency scale. This scale ranges from 0 to 200, where 0 corresponds to the facilities, which do not consume energy at all, meaning that it doesn't loose energy and even produce it using certain alternative power installations. The opposite value is established for those objects which loose a lot of energy in all forms (electric, heating, hot water, conditioning steam etc.). Traditional aviation objects, constructed over 30 years ago, have rating close to 130-160, while newly rebuilt facilities tend to have rating around 100. Practically, obtained rating reflects situation with energy conservation practices at the study object, but it also gives clues to the direction of further improvement and shows the most problematic areas of energy system at the object.

Using available information resources from open databases the energy audit of airport buildings has shown the following results: «Simpheropol» - 133, «Donetsk» - 95, «Ivano-Frankivsk» - 153, «Kharkiv» - 124, «Lviv» - 125, Kyiv «Zhulyany» - 121. Thus, we can conclude, that the most efficient practices are applied at «Donetsk» airport, which could be considered a benchmark, «Kharkiv», «Lviv» and Kyiv «Zhulyany» have demonstrated moderate efficiency, while «Ivano-Frankivsk» and «Simpheropol» have to be considerably improved. The walk-through audit of these objects has detected a range of problems, much of which are common for all of them. Most of the issues are related with inside illumination,

climate control systems and heating. Nevertheless, «Simpheropol» airport has major problems raised due to behavioral patterns of the staff, while «Ivano-Frankivsk» has minimal volume of energy efficiency installations introduced.

The resulted figures are also informative about the reasons of environmental problems around the airports and shows among other, that «Lviv» airport must pay attention to the improvement of wastewaters collection and treatment, «Simpheropol» airport have urgent need to improve storage facilities for petrochemicals to reduce their emissions, «Kharkiv» and Kyiv «Zhulyany» are facing problems with waste management and «Ivano-Frankivsk» airport need to invest in modern heating system. The most common result of inefficient use of energy resources by the airports is air pollution, conditioned by fuels combustion in engines of transport and vessels of power generating facilities. It normally includes carbon dioxide, VOCs, nitrous oxides, carbon monoxide, sulfur dioxide, mercury, cadmium, lead, mercury compounds, cadmium compounds and lead compounds.

So, the level of energy efficiency of national airports is still not satisfactory in most cases and promotes seeking for new solutions. As practice shows, the basic users of energy in airports are the systems of illumination, vapour- and heatgenerators, climate-control and comfort-providing systems. The leading producers of energy saving equipment, such as Danfoss, ABB, Carrier, Siteco, have various solutions for airports. Thus, energy effecient solutions in the field of illumination include installation of daylight reflection systems, providing maximal efficiency of light usage from sunrise-to-sunset. Except of obvious economy of electric power, it helps create soft even illumination, comfortable for visitors eyes. This way power of the electric illumination depends on the level of natural illuminance and is regulated automatically in most premises. Centralized illumination control system also allows an operator of air terminal to watch over fields, ramps, terminals and adjoining areas and to light them up, when airplanes stand in a ramp, landing, taking off or some operations are being carried out. Airport holding zones could also be illuminated in accordance with the flights timetable.

Optimization of microclimate control is also possible with application of special cooling supply charts with variable consumption of cooling agent. It is supplied only to those areas, where the thermal sensors and sensors of CO₂ are fixing increased air temperature (due to illimination, equipment radiation, concentration of people), which is over the comfort level for visitors or personnel that moment of time. Moreover, up to 85% thermal energy could be removed in the process of cooling is then brought back to the system with rotor recuperators – currently the most efficient energy-saving appliances. This is important, as climate-control is impossible without reliable heating system. It could be provided with several independent heating sources instead of a single one, allowing their separate starting to regulate level of heating energy supply and to avoid its wasting. To provide the efficient distribution and use of thermal energy in heating and cooling system, it must be equipped with automatic balancing valves, which provide regulation of heating and cooling agent supply to different parts of building.

There is possibility to reduce power supply of terminals and safety systems, which must always be on. The conservation of 20% electric power could be provided with introduction of reactive-power compensation devices, those allow

decreasing the total load on transformers and supply lines. The use of lighting devices with electronic regulation also diminishes the losses of power by 10%.

Automation of terminal equipment generally allows reducing the amount of necessary operating personnel, to minimize number of errors, predefined by human factor, promotes reliability and safety of all airport systems. It also creates conditions for continuous record and control of energy consumption parameters.

The application of all the above mentioned ECOs and ECMs may reveal nonfunctional redundancy of power supply systems and reduce the power consumption at any object by up to 15%, which is huge relief both technologically and economically. Such a good example of successful implementation of the presented action list has been presented by airport Vnukovo, Russian Federation, when the object from 22 MW originally designed by the European experts reduced energy consumption to 18,7 MW, that is by 3,3 MW.

Conclusions

Conservation of resources in the process of airports functioning is an important element of their profitability improvement, safety enhancement and environmental risks reduction. Energy saving potential of airports is huge due to variety of energy consumers and high demand for permanent power supply. Implementation of ECOs and ECMs considered in the paper may provide conservation of 15% energy. Environmental effect is also considerable: reduction of emissions (emissions of greenhouse gases are decreased by 11-18%), minimization of thermal and electro-magnetic pollution leads to mitigation of microclimate fluctuations around the airport and improvement of general air quality.

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