AEROSPACE SYSTEMS FOR MONITORING AND CONTROL

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ENSURING THE GUARANTEED LEVEL OF FLIGHTS SAFETY – THE VIEW OF THE FUTURE

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Abstract

Considering statistics for the last decade on accident/incident of a question of providing guaranteed flight safety level is the most relevant as shortcomings and problems of functioning aviation activity are explained by lack of general-theoretical basis and the standard scientifically based approaches to safety management system which development has to be guided upon the demand of ICAO which defines that any region should not have accident/incident frequency level more than twice exceeds universal. These are the following main areas: introduction of an acceptable level of flight safety in the state; mandatory procedures for the development and implementation of safety management system; obligatory procedures for ensuring direct management of the level of the flight safety within acceptable or established level of the enterprise (continuous monitoring and regular assessment of the flight safety, corrective actions required to maintain the agreed flight safety indicators and monitoring, flight information analysis, risk management, etc.) [1,2].
Purpose of methodology consists in association in the only complex of tasks of assessment, providing and verification of safety aviation activities as complex hierarchical structure with independent critical elements and also hardware, program, network and ergatic komponen which are both means, and subject to safety.
The realization of ensuring the guaranteed result consists in realization of management processes so that not to allow transition of infrastructure or its systems to potentially dangerous state and to provide blocking (exception) of the corresponding technical object in case of threat of transition or upon transition to a dangerous state and minimization of consequences of such transition.

Keywords: flight safety; guaranteed flight safety level; safety management system; rysk analysis

1. Introduction

The safety management system is the main managerial function which has to be considered at the level, at least adequate behind importance degree to other business functions of any airline which realization has to rely on the balanced allocation of resources on production targets and means of protection which will promote establishment of safety limit.

The similarity of the nature of the appearance of risks and the increasing relevance of their reduction to an acceptable level for various critical applications determines the relevance of the establishment of a methodology to ensure and maintain a guaranteed level of safety of future flights.

By consideration of aspects of flight safety the accepted postulate that absolute safety does not exist– after acceptance of protective measures the residual risk always remains. It should be noted that this term is used only in that case when there is a possibility of approach of negative consequences. The risk as a measure of probability of infliction of harm to safe functioning of system and the environment and also weight of this harm is considered by us. "Loss" is defined as physical damage or harming, the state of health connected with deterioration or vital signs of the person who reduces his abilities to normal full functioning from the point of view of its physiology. The loss can be caused as directly, and is mediately and qualitatively classified behind levels as catastrophic, critical, limit, insignificant. In separate works assessment of a loss is offered to be stated in monetary units (if it is loss of property) and or the number of the human victims. Generally safety functioning of aviation activity is reached due to reduction to risk to admissible level.

Thus there is a need to have the system of indicators of efficiency of providing flight safety which would consider a ratio of results and process for assessment of a possibility of management of risk factors at the aviation activities.

Measurement of efficiency of providing flight safety has to provide a role of regulator and its influence on efficiency of processes of safety management system in suppliers of production/service, and their influence on results at the aviation activities.

In assessing the effectiveness of the provision of flight safety, account must be taken of the characteristics of the process, which leads to the expected results, and indicators should be developed accordingly. The proposed method of estimating the flight safety, based on three levels of system behavior: the results of high level in the provision of flight safety, the behavior of service providers and the activities of regulatory bodies, is one of the guarantees flight safety level [3,4,5].

2. Analysis of the latest research and publications

The Integrated Management System allows for the application of static and dynamic information management principles, which makes it possible to identify restrictions and limitations. This concept of the Integrated Management System operation is based upon the separation of static and dynamic information as well as its graded use in the context of implementation of retroactive, proactive and predictive approaches to the management during the services provision.

Retroactive approach is based on the application of corrective measures on the ground of static information received *after* the fact of a non-conformance or an occurrence has already happened. Distinctive items of static component for this approach are the results of relevant audits (inspections) and investigations of occurrences in the course of which the facts of incompliance with the established requirements are recorded [3, 4].

Proactive approach combines application of the static component's information particularly analytic efforts and project evaluation in order to manage or take appropriate corrective measures *before* the fact of non-conformance or an occurrence has already happened. Analytic efforts and project evaluation towards the changes enable the development of preventive measures concerned with the services rendered together with other items of static and dynamic components.

Predictive approach involves application of dynamic information. Such an approach to management processes enables non-conformances identification *under conditions of day-to-day operations* of the ANS system and taking adequate measures for it correction, based on prompt response and predicting the actual state of services if relevant deviations, occurrences, etc. are present [6, 7, 8].

According to the information received from the results of operation of static and dynamic components of information collection process, routine and periodic analysis, management review, risk assessment and other measures the appropriate corrective measures are being developed. The above measures address the following:

- development of non-conformances correction strategy;
- approval of non-conformances correction strategy;
- allocation of responsibilities on non-conformances correction;
- execution of non-conformances correction strategy;
- development of preventive measures which will disable recurrence of non-conformances in the field of services provision [3, 4].

Corrective measures are planned in line with the procedure for planning of the Integrated Management System operation.

Turning now to a description of the major trends in the matter of rational choice of strategies aimed at ensuring and maintaining a guaranteed result, it is necessary first of all to emphasize that the activity is no unambiguous relationship between the prediction of the results (outcomes) and the problem of decision-making. It has been said that the chaos of possible outcomes facing the decision maker. At the same time, decision should be made, and it should eventually be uniquely. It is important to draw attention to the fact that even the mathematically and the information problems of forecasting and decision-making is usually not the same.

At present there are the following principles of rational choice.

Isolationism — replacement of the i-th participant only its criteria so as to reduce the number of variables that affect the i-th criterion of efficiency, and ideally to reduce it to the criterion of the type that has to be optimized and no matter what the rest of the participants. This method of action is generally accepted in the presence of random factors as efficiency criterion is replaced by its expectation.

Collectivism – introduction of a single general criterion (general purpose) for the group participants. In this case we speak of coalition and compromise between the parties**.** The second principle is the formation of rational strategies in the pursuit of good mutual awareness, allows for constant performance criteria form a rational strategy.

The quest for knowledge as the basis of rational choice behavior, of course, is not contrary to the first principle, but rather complements it. For example, the coalition unthinkable substantially without a collective sharing of information, and the extracted individual information reduces the amount of required clotting individual member separate criterion.

The third and very important principle of developing rational behavior consists in the pursuit of *sustainability*, understanding which vary widely**.** Here, above all it deserves special mention *the principle of guaranteed* ***result*** calling side operates with the lack of information based on the consideration of the worst possible situations, taking into account available information. It is widely understood principle of guaranteed result can be applied in the selection of rational strategies and the results expected. This principle includes, of course, the usual maximum is used in an antagonistic activity and interaction with the environment, but is not limited to it.

It should be emphasized, however, that a reasonable reduction of the number taken into account the values of x_1 is reasonable and even an inevitable step. Such a process usually referred to as the method of test, and the 'choice of variables accounted for xx, usually performed by expert procedures.

The most common form of representation of the relationships and interactions of disparate processes and events is a cause-and-effect relationship [7, 8, 9].

The causal relationship and interaction of processes, events and phenomena in real systems are formed and implemented between objects of different nature. Related technological, informational, administrative, economic, social and other processes are combined in a complex interaction, which is currently not sufficiently precise and easy to use mathematical models. Development of models and methods focused, usually for a specific kind of process and results in a formal apparatus, which is not always convenient to combine disparate processes, objects and phenomena. With the development of common models and methods for solving problems with the use of such models is needed to move from specific and specialized concepts to more general categories of causation. An important and crucial tool models are tangible, imaginable, math.

Isolation in a variety of interactions between objects (processes, events, phenomena) causality is fundamentally difficult.

One option for harmonization of the complex set of developers and users is the availability of the agreement the developer and the user of the universe of objects, processes, events and phenomena used in the synthesis of the complex. Cybernetic sense of purpose related to the behavior of cybernetic systems, presented the process of changing states of the system and the achievement of the desired state of the system. This behavior can be represented by a phase trajectory in the space of states of the system and the set of all possible trajectories of the phase picture [9].

Model is not a second copy of the original. The model contains or may contain:

- properties that are available and the original,
- properties only model,
- properties for which is not yet known that they belong to the original.

3. Theoretical part

The mathematical models of the iconic, not all designs have a direct interpretation in the model application. Broadly speaking, the development of the formalism of causal systems connected, first of all, with the desire for representation of determinism in the interaction of system components and system actions. "In order to use mathematical methods for the analysis of those or other processes necessary for a mathematical description of this process, ie, a description of the language of mathematics. It is what we call a mathematical model." The human mind from the experience tends to perceive reality through the causality. It comes down to a causal relationship.

In assessing the overall meaning of the exchange of information, it should be noted that it should help to reduce the uncertainty in the production process, leaving a narrow variation limits for the selection of operators – in a word, to make the situation more definite.

So, it is advisable to introduce the information sent by one operator to another.

Intuition and experience suggest the reasonableness of collective decisions. One can distinguish three levels of collective action operators *m(m≤n)* (we assume that the coalition includes the first m operators):

The exchange of information on activities and process conditions;

The pooling of resources and the subsequent selection of a joint course of action, based on the combined resources.

It is clear that each successive stage creates great opportunities coordination. The possibility of combining in the second or third stage is, in fact, collective rules of conduct, collective strategy. Unification, producing such a strategy, according to tradition will be called coalitions.

A very common type of collective aspirations should be considered joint mixed strategies - distribution laws $\omega_c=x_c$, depending, in general, on the elections $\boldsymbol{x_j}$operators that are not included in the coalition, and natural uncertainty β. Thus, you can enter ω_e the same as previously defined x_1.

The use of mixed strategies associated with the introduction and averaged criteria coalition:

$$w_i = \int w_i d\omega_c(x_c), i = 1,...m.$$

Regarding the criteria for operators outside the coalition, they are averaging can only be discussed as one of the possible options.

In discussing the possibilities of coalition cannot forget about the additional interactions between the members of the coalition, and between members of coalition and the rest of the operators, although they can be considered as already included $\boldsymbol{x_c}$, in the future, given their importance, we usually write them separately. Therefore, together with $\boldsymbol{x_c}$ we consider the vector $Z_c=\{Z_{c1}, ..., Z_{cm}\}$, representing the additional interaction of the coalition as a whole.

$$z_1 = \left\{\sum_{j=1}^{m}\lambda_{ji}z_{ji} - \sum_{j=1}^{n}z_{if}, \text{ and } u_i = \sum_{j=m+1}^{n}\lambda_{ji}z_{ji}\right.$$

But if $i \rangle m$

$$t_i = \left\{\sum_{j=m+1}^{n}\lambda_{ji}z_{ji} - \sum_{j=1}^{n}z_{if}, \text{ and, } v_i = \sum_{j=1}^{m}\lambda_{ji}z_{ji}\right.$$

Then the performance criteria can be written as:

$$w_i = f_i(x,\beta) + z_i + u_1, i = 1,...,m,$$

$$w_i = f_i(x,\beta) + t_i + v_1, i = m+1,...,n,$$

where the coalition chooses v_1 and t_1 determined by the actions of other operators. If the coalition is exchanged only with additional interactions between its members, then

$$w_i = f_i(x,\beta) + z_i, i = 1,...,m,$$

$$w_i = f_i(x,\beta) + t_i, i = m+1,...,n,$$

where now

$$z_i = \left\{\sum_{j=1}^{m}\lambda_{ji}z_{ji} - \sum_{j=1}^{m}z_{if}, \text{and,}\right.$$

$$t_i = \sum_{j=m+1}^{n}\lambda_{ji}z_{ji} - \sum_{j=m+1}^{n}z_{ij}$$

As traditional research has not led to a manageable and unambiguous guidelines, we shall proceed from the inability to complete the formalization of the problem of rational choice, including the choice of coalitions is now necessary to study the process rather particular form, but the study of the processes of rational choice in which it should be possible exhaustive. In addition, analysis of the question of the benefit of joining the union of different species, taking into account possible changes in the mutual awareness of the players. This analysis may be, will reduce the amount considered coalitions and thus make the task of rational choice more transparent. For all these purposes, it is desirable to create a sufficiently flexible formalized description of the behavior of the coalition, similar to reality and yet is relatively simple [9].

It seems that one way of formalizing this is the introduction of the common goals of the coalition, reflecting a compromise between the respective characteristics of the operators. Thus, the coalition turns as if to a single operator.

Of course, the efficiency criterion of the coalition can be anything. However, judging from this, it will be difficult to introduce the study of collective action in any foreseeable limits. It is desirable to limit the kind of reasonable compromise criterion on the basis of common sense and the possibilities of mathematical research. Of course, there should be enough space for informal selection criterion performance compromise [4 – 7].

The strategy of ensuring the guaranteed security and reliability of aviation activity determines a set of approaches, principles and measures that ensure the stable functioning of the blood pressure with the specified safety and reliability indicators. Today, administrative, legal, economic, technical methods and tools, as well as methods and means of risk assessment are advocated. Risk is usually assessed as a combination of the probability of occurrence of a dangerous event and its possible consequences. Recently, risk assessment has become increasingly important in security management. At the same time, the basis of safety management are the following principles:

- absolute safety does not exist – after acceptance protective
- actions there is always some residual risk;
- safety is reached by decrease in risk to established
- admissible level, at the same time the residual risk is below admissible level;
- the admissible risk level is established and corrected at all stages of life cycle of the object or process connected with safety.

Here first of all deserves a special mention of the principle of the guaranteed result that is called operates the party at insufficient knowledge to be based on consideration of the worst possible situations taking into account the available information So widely clear principle of the guaranteed result can be applied also at the choice of rational strategy, and at assessment of the expected result. This principle contains, of course, usual maximized used at antagonistic activity and interaction with environment, but to it is not built at all.

The risk management system is a tool for supporting management decisions based on the assessment of the risks associated with traffic safety. In order to provide a given level of security, risk management should be effective and of a systemic nature. The risk management process can not be carried out without identifying the strategic, tactical and operational objectives of the aviation activity.

The purpose of the management of risks related to traffic safety, is to reduce the existing levels of risk to the established level and to maintain the achieved levels of risk at the established maximum allowable level. The main tasks of risk management related to traffic safety: quantitative, semi-quantitative or qualitative assessment of the levels of risks of different types; development of criteria for establishing acceptable levels of risk and effective measures to reduce risks to established admissible levels; analysis of the hazards that arise as a result of security breaches movement and systematic assessment of the conditions of production or activity, are considered potentially dangerous; ensuring the management of risks in accordance with the rules, rules and procedures, the execution of which has been ordered by international and corporate standards.

4. Conclusions

Total actual damage due to accidents and other adverse events is determined by the sum of these components as a consequence of the damage of each individual event, and taking into account the real damage for a certain period. To correctly predict the losses need to evaluate two factors determines their value: the average value of the expected losses in the event of an accident or an event and the probability of an accident or event.

In some cases, implemented in the area of guaranteed safety of air navigation services investment project is aimed at reducing the incidence of accidents and events. In this embodiment, a complex calculation that takes into account all types of losses should be performed. Building a risk management system in the area of guaranteed safety and reliability of air navigation services, it is necessary to provide:

- full and timely implementation of measures aimed at achieving the strategic security objectives;
- optimal use of resources allocated to the investment; obtaining additional effect due to optimal matching of mutual investment projects implemented, including their location and the time of implementation;
- more efficient use of technical means used and the optimal use of the results of projects implemented in previous periods.

On the basis of the strategic objectives in the field of safety and reliability of air navigation services need to solve a number of the following tasks:

1. Objectives of the formation and perfection of normative-methodical safety and reliability management database.

1.1. The revision and updating of the existing regulatory framework and its harmonization with international standards.

1.2. Development of normative-methodical documents aimed at improvement of safety management practices.

1.3. Development and implementation of risk management practices related to safety, and the development of a safety management system.

1.4. The development of guidelines and training material for the development and assessment of safety culture.

2. Challenges for the development of technical and technological base

2.1. Development and implementation of measures to upgrade the technical technological base associated with safety and reliability of air navigation services.

2.2. Conducting periodic analysis of efficiency of the use of technology and the results of the ongoing scientific and technical work.

3. Challenges for the development of human resource capacity in the management of safety and reliability of the transportation process.

3.1. Improving personnel management system relating to safety and reliability.

3.2. Adaptation of vocational training to the changing technological requirements.

3.3. Organization of training processes and risk management practices related to safety.

3.4. Organization of training personnel management practices, risk and reliability in the stages of the life cycle of aviation operations.

4. Challenges for the development of information technology to ensure the safety and reliability of the transportation process.

4.1. Creation of information decision support systems to ensure the safety and reliability.

4.2. Implementation of an automated knowledge testing system in terms of safety requirements.

4.3. Development and implementation of automated management systems, risk and reliability in the stages of the life cycle of the air navigation system.

4.4. Improving automated systems to ensure safety performance monitoring functions of technological safety processes.

4.5. Improvement and development of situational monitoring and control safety and reliability of air navigation services, taking into account the existing political situation.

4.6. Improve the recording and investigation of accidents and liability allocation rules.

4.7. Development of methods for identifying causal relationships safety violations.

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Забезпечення безпеки гарантованого рівня польотів – погляд майбутнього

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З огляду на статистику авіаційної авірійності за останнє десятиріччя питання забезпечення гарантованого рівня безпеки польотів є найбільш актуальним, оскільки недоліки та проблеми функціонування авіаційної діяльності пояснюються відсутністю загальнотеоретичної основи та стандартними науково обґрунтованими підходами до системи управління безпекою який розвиток повинен керуватися вимогою ICAO, яка визначає, що в будь-якому регіоні не повинно мати частотного рівня аварій / інцидентів, більш ніж удвічі перевищує загальний. Це наступні основні напрями: запровадження прийнятного рівня безпеки польотів у державі; обов'язкові процедури розробки та впровадження системи управління безпекою; обов'язкові процедури забезпечення прямого управління рівнем безпеки польотів на прийнятному або встановленому рівні підприємства (безперервний моніторинг та регулярна оцінка безпеки польотів, коригувальні дії, необхідні для підтримання узгоджених показників безпеки польотів та моніторингу, аналізу інформації про польоти, ризику управління тощо) [1,2]. Метою методології є об'єднання в єдиний комплекс завдань оцінки, забезпечення та перевірки авіаційної діяльності в галузі безпеки як складної ієрархічної

структури з незалежними критичними елементами, а також апаратними, програмними, мережевими та ергатичними компонентами, які є обома засобами і підлягають безпеці. Реалізація забезпечення гарантованого результату полягає у реалізації процесів управління таким чином, щоб не дозволяти перехід інфраструктури або її систем до потенційно небезпечного стану та забезпечити блокування (виключення) відповідного технічного об'єкта в разі загрози переходу або при переході до небезпечна стан і мінімізація наслідків такого переходу.

Ключові слова: аналіз ризиків; безпека польотів; гарантована безпека польотів; система управління безпекою

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Обеспечение безопасности гарантированного уровня полетов – взгляд будущего

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Рассмотрение статистики авиационной аварийности за последнее десятилетие обусловила необходимость рассмотрения вопроса создания методологии обеспечения гарантированного уровня безопасности полетов, поскольку недостатки и проблемы функционирования авиационной деятельности объясняются отсутствием общетеоретической основы и стандартными научно обоснованными подходами к системе управления безопасностью полетов развитие которого должно основываться на требовании ИКАО, которое определяет, что в любом регионе не должно быть превышения частоты авиационных происшествий более чем в два раза от общепринятого. Это следующие основные направления: введение приемлемого уровня безопасности полетов в государстве; обязательные процедуры для разработки и внедрения системы управления безопасностью; обязательные процедуры обеспечения непосредственного управления уровнем безопасности полетов на приемлемом или установленном уровне предприятия (постоянный мониторинг и регулярная оценка безопасности полетов, корректирующие действия, необходимые для поддержания согласованных показателей безопасности полетов и мониторинга, анализа полетной информации, риска управление и т. д.) [1,2]. Цель методологии заключается в объединении единственного комплекса задач оценки, обеспечения и проверки деятельности авиационной безопасности как сложной иерархической структуры с независимыми критическими элементами, а также аппаратных, программных, сетевых и эргатических компонентов, которые являются одновременно и средними, и подлежат безопасности. Реализация обеспечения гарантированного результата заключается в реализации процессов управления, чтобы не допустить перехода инфраструктуры или ее систем в потенциально опасное состояние и обеспечить блокировку (исключение) соответствующего технического объекта в случае угрозы перехода или при переходе на опасное состояние и минимизация последствий такого перехода.

Ключевые слова: анализ рисков; безопасность полетов; гарантированный уровень безопасности полетов; система управления безопасностью

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