Chapter 3

THE IMPACT OF AVIATION ON THE ENVIRONMENT AND THE DEVELOPMENT OF ECOLOGICAL LOGISTICS

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3.1 RELIABILITY OF MONITORING OF AVIATION INFLUENCE ON ENVIRONMENT

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Information support for environmental monitoring of aviation influence on ecosystems under the conditions of increasing requirements for the quality of environment and environmental standards is of particular importance. Only reliable and exhaustive information guarantees the efficiency of the tasks set for the system with minimal pressure on the environment and with minimal energy consumption. Moreover, it is also important to be able to predict situations in order to make managerial decisions in advance, which is impossible without effective monitoring system.

The main tasks of monitoring of aviation influence on environment are:

– collection of data that directly characterizes the state of the environment (types of contaminants, their concentration, migration, ability to concentrate – for example, precipitation to the bottom or exit to the surface, the ability to metamorphosis – for example: sublimation, metabolism, dissolution with the formation of new compounds, ability to self-decomposition, dependence on external influences, as well as data characterizing the conditions in which they were gathered);

– comparison of new collected data with relevant data collected at the same points during the previous data acquisition cycle in order to detect the dynamics of pollution and factors that could affect the state of the indicators;

– analysis of the reliability of the monitoring data (evaluation of the methods used to characterize the data, and the means of data determination – measuring instruments, evaluation algorithms, etc.);

– placement of data evaluated from the point of view of reliability, in the data bank indicating the coordinates of the place of receipt of data, dates and all related information;

– analysis of data relevant to this system at certain time intervals and taking into account external factors in order to predict state changes;

– elaboration of recommendations for measures aimed at stabilizing or improving the state of system or improving efficiency of purification process [1–3].

The aviation technical systems are sets of elements of a certain material nature, which are in the relationship. In each of these relations there is a certain variable, the set of its states, and the set of mathematical properties defined on this variable. It is known that if there is a finite sequence of relations that allow a predetermined element of the set $x_1 \in X$, then such a sequence of relations is an effective identification process.

A system is considered to be observable if it can be determined by a certain multiple experiment, when the inputs of the system that is in an unknown state are fed into the set of inputs and then the corresponding output values are observed. The observation channel forms a measuring system that includes measurement devices and procedures that determine the rules for using devices under different conditions.

The aviation technical system’s effect on environment as a system that is exposed to external influences, some of them are poorly controlled or not defined (since assumptions about the properties of this usually avoid some of the essentially important components, less formal objects are taken into account than is necessary, etc.), is observed only in a limited number of points, can be regarded as an open system, for which there is a characteristic presence of at least one element of a set for which there is no effective identification process, and a decision regarding the state of the system accepts the conditions of uncertainty. Uncertainty arises also in those cases where the conditions of the technological process are evaluated within the area of the monitoring channel or at the boundary that divide the two specific states. By the way, the monitoring zones of the monitoring channels do not have clear boundaries, and the results of observation near these fuzzy, blurred boundaries can be characterized only by degrees of membership, and not by clearly defined functions.

In both cases, the uncertainty of the results of the observation leads to unreliability of the assessments of the state of the process. Such a falsehood is characterized by the value inverse to the membership function. That is, the inverse relationship between the degrees of affiliation of an element to a given set from a certain base variable and the rules used or metrics [3]:

$$\mathrm{d(xm,\ xr)} = \left\{ (\mathrm{n}-1)^{-1} \sum_{i=1}^{n} (x_{mi} - x_{ri})^2 \right\}^{1/2} \tag{1}$$

which evaluates the degree of proximity of model estimates (predictions) of signal values (state parameters) x_m, or their distributions to the real values of these signals x_r. Here, under model estimates, we understand not only the results of the actual modeling (mathematical or physical), but also the data of measurements using the usual (non-standard) means. Results of measurements using means at the output of which the quality of information is guaranteed are considered as real (true).

This corresponds to situations for which the «usual Euclidian distance» as the criterion of proximity (or discrepancy) is justified:

– the observations are mutually independent and may have the same dispersion;

– the components of the observation vector are homogeneous in their physical content and they are equally important in terms of their use during identification;

– the sign space coincides with the geometric space and the notion of proximity of objects of observation coincides with the notion of geometric proximity in this space.

In practice, it is often more convenient to use a value that is a reverse metrics, a complement of a metrics, with the reliability (*TW*), and for a quantitative assessment of reliability, which is usually considered in the range [0, 1], use the relative metrics

$$D\mathrm{r(xm,\ xr)} = \frac{d(x_m, x_r)}{d_{\max}(x_m, x_r)}, \tag{2}$$

where $d_{max}(x_m, x_r) \geq d(x_m, x_r)$ is the metrics value in which the causal relationship between x_m and x_r is not detected or insufficient to make responsible decisions [3].

The size of this metrics depends on the number of states of variables, on the measure by which the restrictions on the variables are set, and on a number of other factors. Considering the following generalized expression for d_{max}:

$$d_{\max}\mathrm{(xm,\ xr)} = 2 \cdot \partial \cdot \xi_{\max}(\mathrm{x_{mi}} \cdot \mathrm{x_{ri}}) \tag{3}$$

where $\delta > 1$ is a certain proportionality factor which takes into account the degree of fuzziness of the observation channel data and which depends on its own characteristics of the channel and the degree of clarity of representations about the properties and behavior of the object (process); ξ_{max} is the maximum permissible value of the relative error of the simulation (forecast) or the permissible error of the integral estimates.

In the cases considered, authenticity is presented as an addition to the unit, i.e.:

$$TW = 1 - dr\,(x_m \cdot x_r) \qquad (4)$$

As a characteristic of reliability, one can also use the functions of modeling estimates for the true value, for example:

$$TW = \exp\,[-(x_r - x_m) \cdot 2] \cdot \partial - 2 \qquad (5)$$

where δ is fuzzy of the data, which should not exceed the measurement error by more than 1–2 orders [3].

Reliability is not the only characteristic of the quality of information. Information is characterized by the following properties:

– value, which is expressed in the form of increasing the probability of achieving the goal set, after receiving this information;

– inactivity, that is, inequality of influence on the final result of the joint use of several information and the consistent use of the same information separately;

– non-commutatively, that is, the dependence of influence on the final result of the order, which uses a series of information;

– non-consistency, that is, the difference of results in the consistent use of a number of information, irrespective of the results, when part of this series is used sequentially in part, and part – as a result of the joint use;

– completeness, that is, the degree of reflection of the real object (process) in the message;

– reliability, that is, the degree of conformity of the models used or the data taken and the errors of their determination by the true value.

However, from all the properties listed above, authenticity – is the most important, since it directly affects the value of information and the ability to achieve the goal that is directly related to the effectiveness of the information system.

As reliable can be considered those data that have successfully passed the procedure of critical analysis and generalization of the results of measurements and / or calculations, taking into account known regularities that include the estimation of errors. Reliability can be considered in terms of formally technical (no hidden occasional errors) and socio-psychological or behavioral (lack of distortion due to improper interpretation or reluctance to open the truth). Distinguish also engineering reliability, that is, deterministic confidence in the truth of information, and statistical reliability, that is, reliability, which follows from statistical conclusions.

Errors leading to a reduction in reliability can be classified into three categories:

– which do not directly lead to a decrease in the quality of the system's operation, but may, under adverse conditions or combination of such conditions, or in the presence of other similar errors, lower the quality of the functioning of the information system;

– which lead to a slight decrease in quality under normal conditions or to a significant one – under adverse conditions;

– which lead to a sharp deterioration in quality.

Reliability is the function of the state of any system, to which one or another extent is affected by various factors: random obstacles and noises, environment conditions, aging processes that change the characteristics of the components of the system hardware, the degree of load (overload), the volume of prior knowledge of object or process, etc.

The nature of the errors that are present or periodically occurring in the process of functioning of the information system is different. There are several groups of errors that do not depend on technical parameters of system. The first ones include:

– methodological errors that are caused by the imperfection of mathematical models that underlie the functioning of the system: the inadequacy of the adopted model for a real object or process in statics or dynamics; lack of a priori information about the nature of the object, or about the processes taking place; fuzzy connections and functional dependencies; attempts to simplify models due to the technical impossibility or complexity of taking into account individual parameters; the impossibility of an objective justification for choosing an optimal model in the presence of a set of quasi-equivalent models;

– methodological ones, which are caused by the imperfection of the chosen methods of calculation, that is, the errors of numerical methods, approximation, errors, which are caused by a limited number of iterations, etc.;

– output, that is, errors which are caused by inaccuracy of the initial data, statistical fluctuations of processes and interactions, interferences and distortions in the communication channels, errors of the operator, limited redundancy of the information necessary for statistical processing, etc.

The second group has instrumental errors, which, in turn, are divided into component errors, structure, interface and processing.The errors of individual components and system nodes are due to the drift of their characteristics under the influence of external factors and aging processes, the unessential characteristics, the effect of noise and interference, and so on.Structural errors are characterized by the finiteness of the bit representation of real numbers due to the constraints due to the finiteness (for each particular system) of bits of processors, memory, channels, converters and peripheral equipment, which forces to refer to the procedures for representing numbers by a limited number of significant senior discharges and, accordingly, to rounding off or rejecting the rest (junior) digits.

Interface errors are due to the fact that, when docking various technical means with each other, the accuracy of the representation of data is limited by the possibility of means, which has the slightest accuracy, that is, the smallest bit. In addition, they include errors that arise due to time or phase shift, as well as during human interaction with the system (errors when entering data into the system using a keyboard, oral or written sentence, errors during the preparation of intermediate storage media etc).

Processing errors are the most branched class of error, which is characterized by noise and interference, temporary hardware failures and self-abandoned failures, distortion of information during conflict situations, violation of the sequence and (or) loss of particular pieces of data or their duplication, overflow of memory, overloading channels or processors, by cycling programs, etc. A separate group of processing errors consists of integral errors that are associated with the accumulation of errors in individual steps of multi-step processes of information processing, when as a result of a systematic (methodological) error caused by an unrealized data processing algorithm from step to step, information that is not significant is lost at one step, but it is important if it breaks up at a number of processing intervals. In addition, the accumulation of error is possible due to the systematic overflow of registers and other buffer storage devices, as well as (with the use of adaptive data sampling methods) due to the deviation of the true laws of the distribution of random events from those used as working hypotheses and the rejection of data with low (supposed) priority.

The third group includes project errors that are due to syntactic and semantic errors, made during application programming, system programming errors, system developer errors, operator errors due to fuzzy instructions, etc.

Methods for eliminating errors, and thus ways to ensure reliability, depend on the type of error, the requirements put forward to the system, the working conditions and the level of knowledge about processes and phenomena that can cause errors.

All this suggests that for the successful development and application of methods for improving observation and identifying the state of the process, it is necessary to research specific sources of unreliability of the process data, as well as sources of unreliability of the integral estimates of the state of environment.

Sources of unreliability of data on the status of environment include:

– data detectors (indicators in a form that is acceptable for display, communication with channels, storage and documentation);

– measuring networks (it is economically inexpedient, and sometimes physically impossible to perform measurements at any point in the system, so large areas remain uncontrolled, and data about their conditions is obtained by interpolation based on data obtained at separate points – nodes of the measuring network, and so the reliability of the data on the state of the process is the function of the density of the measurement network and selected interpolation procedures);

– the influence of external factors and time.

Existing methods for increasing the reliability of the results of observation and identification of states use mainly two approaches:

– passive, when using a number of design solutions that objectively contribute to increasing the reliability of data, but the evaluation of actual results either is not implemented or is not used to improve the quality of information promptly;

– active, when the actual state of the system and the actual results of data processing are evaluated continuously or periodically, and on the basis of these estimates, decisions are made to adjust the data, characteristics of the individual components of the systems, algorithms of their operation, or to decompose the systems in order to improve the quality and efficiency of their work.

Passive methods for improving observation and identification of system conditions are widely used in monitoring procedures. However, the lack of permanent control and prompt processing of the results obtained and the possibility of providing timely adequate corrective actions does not allow adapting such systems to changing operating conditions (internal and external), which reduces their effectiveness in the presence of strong obstacles, deviation of actual data (statistics) from calculation and degradation as separate components of systems and systems as a whole.

Using of an active approach, a huge role is played by control, all the variety of procedures of which can be reduced to three types: syntactic, semantic, and pragmatic [3, 4].

The task of syntactic control can be formulated as follows: collecting and evaluating information in order to decide on the legality (admissibility) of the state and structure of technical and software tools, as well as the format of individual elements of the message in general and in a particular situation in particular. The syntactic control has a formalized and, as a rule, deterministic character, and has the following varieties:

– a statement of the fact of exceeding the allowable waiting time;

– control of the number of words in the message;

– control of the length of the time interval between the words of the message;

– control of the form of pulse code;

– correctness of discharges of synchronization;

– number of digits in the data word;

– correctness of the address of the subscriber in one of the words of the message;

– parity control;

– control of the word (byte) of the state of the technical means.

The task of semantic control is the analysis of consistency, logics, consistency of data, that is, meaningful evaluation of control data, which may have the following varieties:

– output of data values received, permissible range;

– exceeding the permissible deviation from the average value in the redundant data set;

– unacceptable discrepancy between data received from functionally reserved devices;

– the presence of the record "1" in the control levels of the equipment of the built-in control.

Pragmatic control aims to identify the value, availability, timeliness of data, the impact of errors in individual data on the performance of the system as a whole, the economic efficiency of data.

The realization of control tasks (regardless of the type of control) is associated with decision-making processes. These procedures can be classified as follows:

– in accordance with the nature of the decision to be made (the only choice from a limited number of alternatives; a unified assessment of the continuous field of possible solutions; the combination of the first two);

– according to the nature of the observed quantity;

– depending on the length of the observation interval.

By the technique of implementation methods of verification of reliability can be divided into the following groups: accounting, mathematical, introducing redundancy, logical, combined. Accounting methods include the following procedures:

– an account with the release of a known control result;

– calculation of checksums;

– calculation of records;

– checksum summary;

– control format;

– cross-checking;

– control count of rows and columns of matrices.

Mathematical methods use the following procedures:

– mathematical modeling;

– substitution in the output equation of the found roots with the subsequent solution and evaluation of the results;

– introduction of additional links (including correlation);

– detection of trends and displacements in measurements;

– verification of limit values;

– interpolation of missing data, with the assumption that the data locally represent a polynomial of a certain odd degree;

– statistical forecasting;

– filtration.

Methods of introducing redundancy use both procedural and informational redundancy. Procedural redundancy implies either multiple consecutive (or simultaneous – with the use of different technical means) solution of the problem with the same source data and, accordingly, the same algorithm with subsequent comparison of results and decision on their reliability, or simultaneous solution of the problem using several different algorithms (equivalent or different in accuracy and time of implementation), as well as a comparison of the results and the assessment of their reliability.

Using of information redundancy involves the following control options:

– entering control digits into messages;

– plurality of data sources instead of one with the following evaluation;

– mediated data and a priori information;

– feedback (demand for additional data).

Logical methods include:

– meaningful checks (detection of those values that are logically incompatible with a priori knowledge about the plausible boundaries of the change of individual variables);

– control over deviations (detecting significant deviations that are characteristics of hardware failures; detecting deviations that reflect the spread of characteristics due to fluctuations in technological factors or the environmental impact; the detection of deviations that are a function of time, that is, due to the «aging» of technical means);

– control of the given sequence of data;

– control of «templates», that is, the justification of the use of members of a particular data array;

– time control of task decision;

– expert evaluation of the received data.

Combined methods are based on:

– selective validation by re-processing the output data to obtain the final result (including alternative algorithms);

– control examinations-tests (with verifications, i.e. pre-entered data);

– selective assessment of the reliability of the results with the help of special control evaluation programs;

– other procedures.

The methodology for organizing monitoring of environment involves the stages of determining the current field of pollution, associated factors and their impact on the spectrum and magnitude of pollution, the dynamics of pollution in comparison with past measurements, checking the relevance of trends in the trend of pollution, which take place, as well as decision making on reliability of monitoring data and forecasts [1, 5, 6].

The first stage of monitoring includes the development of a measuring network by presenting it in the form of a Peano curve, which ensures the continuity of monitoring of the studied territory and the absence of jumps between individual points of observation. After determining the structure of the measuring network, the volume of the samples (measurements) is optimized in order to exclude the possible influence of random obstacles. Determination of the range of pollution is carried out using methods of the theory of fractals.

The next step in the first stage is the use of hybrid monitoring methods, which is aimed to select from a plurality of relevant models (which are simultaneously used to predict the migration of pollution) one of the models whose Euclidean distance is the smallest relatively to the real measurement data performed at the time specified by the model. If we consider the metrics that characterize the distance between the curve of the point distribution during real measurement *(f^r)* and the curves obtained by modeling with the help of the model *mj (f^{mj})*, then the increment of information characterizing the degree of closeness *(f^r)* and *(f^{mj})*:

$$d[f^{(r)}, f^{(m)}] = \{(x_i^{(r)} - x_i^{(m)})\}^{1/2} \qquad (6)$$

where *N* is the number of points at which the measurements are made $x^{(r)}$and $x^{(m)}$ and – respectively, the value actually determined by measurement and calculated using the model of the value of pollution at the *i*-th point.

At the same time, the smallest of the calculated metrics corresponds to the model that better describes the process of migration of pollution. That model satisfies the following equation:

$$\mathrm{opt} \cdot dj[f^{(r)}, f^{(mj)}] = \min\{d2[f^{(r)}, f^{(mi)}], \ldots, dj[f^{(r)}, f^{(m2)}], \ldots, dk[f^{(r)}, f^{(mk)}]\} \qquad (7)$$

The first stage ends with the definition of the number and nomenclature and the absolute values of pollution that are not previously observed in this area, the boundaries of critical pollution, the development of the equidistant contamination (using one of the algorithms for the construction of fractal curves) [5–7] and the formation of the corresponding (source) file in bank of facts.

The second stage of monitoring is identification of correlations between concomitant and mediocre factors and actual monitoring data, as well as analysis of migration and metabolism of contaminants under specific conditions (taking into account such processes as transfer, gravity deposition, dissolution, deflation, chemical and biological processes, radioactive decay, etc.).

The associated environmental factors significantly affect the reliability of the detection of actual discharges of pollutants, the determination of the type and source of contamination, and, consequently, the ways of reducing the anthropogenic impact on the environment. In addition, taking into account the additional factors of the processes of migration and transformation of pollution in the environment determines the potential of the stability of the ecosystem, that is, its ability to self-purification and recovery.

Determining the dynamics of pollution is extremely important. It indicates the possibility of irreversible changes in the ecosystem, which may lead to its degradation.

The third stage of the monitoring is performed by calculating the metrics that characterizes the distance of the points of the current and previous measurement cycles (like in stage I), as well as the vector of changes (the last one is detected by determining the centers of the contours of the equinity of the current and previous measurement cycles). Detection of the dynamics of contamination ensures an early change in the methodology for the determination of pollutants and the replacement of measuring equipment, which is associated with a change in the range of measurements and the possible decrease in the sensitivity of the instruments.

The task of identifying the dynamics of the range of pollution is to analyze the observations and compare their results with each other by estimating the metrics.

The fourth stage of the environmental monitoring of pollutants involves (in the case of a deviation from the trend by the value of $\Delta x > 2\sigma$) the analysis of possible influences of external factors, which are presented in the format of monitoring data as concomitant or mediocre factors. If the deviation from the trend is not significant, and external factors take place and are characterized by significant amplitude, an analysis of the reasons for the invariance of the monitoring results is necessary.

The fifth stage of the monitoring is verification of the hypothesis of the monitoring results (including, if necessary, requesting additional information from the monitoring system and using the Bayesian theorem to correct the initial hypothesis), the overall assessment of the reliability of the data and the formulation of the decision on the correctness of the estimates and forecasts. The use of the Bayesian theorem allows determining, and subsequently clarifying, the probability of the validity of the accepted hypothesis of the data distribution in the conditions of uncertainty that exists during monitoring. According to this method, probability is calculated taking into account both previously known and new received information. The evaluation results with a mark of reliability are sent to the relevant fact file to replace the relevant output file (which is formed at stage I).

The consistent implementation of the above-mentioned stages of the evaluation of information ensures the reliability of the data obtained to make responsible decisions in environmental management [7, 8].

The analysis of the consequences of accidents and disasters at industrial sites associated with the release of significant masses of toxic substances into the environment, as well as measures aimed at minimizing its consequences, allows revealing the following:

– in case of an accident, the equipment for monitoring the state of the system or completely out of order (in any case directly to the location of the accident, where its data are particularly important), or does not reflect the current state of the system due to the discrepancy between the levels of parameters actually measured, the operating range of devices, which are used and are designed for normal or (at least) abnormal modes of objects;

– as a result of accidents, communication channels are completely or partially failed, which results in the fact that some of the information does not reach the decision makers (DM) in order to organize adequate measures aimed at minimizing the consequences of the accident;

– the measuring equipment remaining under working conditions, under extreme conditions that affect its performance, may indicate fuzzy or even ambiguous information in the presence of strong interference that may distort the actual picture and obstruct the work of the ATS;

– there are no technical and software tools (essentially expert systems) for operational forecasting (based on incomplete, incorrect, as well as indirect and concomitant data) possible (near and far) consequences of disasters and elaboration of alternative, appropriately evaluated measures for their minimization;

– the actions of personnel, deprived of operational reliable information on the magnitude of the accident or disaster and its possible consequences, in times of shortage of time and high psychological stress, as a rule, complicate the situation further.

As it is clear from the above, in all cases it is actually to say that DMs lack adequate information at the time they are most in need of it. At the same time, the importance of evaluated in terms of reliability of information in a similar situation, is large. After all, decision making is usually associated with enormous costs and moral shocks (in the event of unreasonable consequences of a reassessment of the degree of danger of the consequences of a catastrophe evacuation of a population from a threatened zone, a stoppage of the enterprise, etc.) or with victims and economic losses, as well as a loss of confidence in the authority's (under conditions of underestimation of the degree of danger and the rejection of timely radical measures).

But under normal conditions of functioning of aviation technical objects, as well as during natural processes, and under conditions of mutual influence of man-made and natural factors on an environment, there is a number of problems, there are certain changes, there is a violation of the balance of various factors in the limited territories or and on a global scale. In all of the above cases, monitoring of the state of the system and its dynamics and predicting the probable future problems (as well as their causes) is of utmost importance.

The monitoring process includes a set of procedures that can be attributed to the following types:

– determination (by direct or indirect physical measurements) of parameters characterizing the current state of the system (physical monitoring and biomonitoring);

– calculation (using mathematical models) of those state parameters that are not available (physically or in time) for physical monitoring procedures (model monitoring);

– analysis of the data of physical and model monitoring (in other words, hybrid monitoring data) from the point of view of their completeness (adequacy) and reliability with execution, if necessary, procedures for ensuring the adequacy and reliability of data (analytical monitoring);

– comparative analysis of relevant current and past hybrid monitoring data in order to identify trends in changing the state of the system and forecasting the consequences of these changes (predictive monitoring);

– decision-making based on predictive monitoring of measures aimed ultimately to minimize pollution at the environment and / or their impact on the ecosystem.

The monitoring problem has the next four aspects:

1. A thorough detection of the «natural» background of pollution (before the development of a new facility – a source of pollution, or in the case when previously such monitoring in this region was not performed at all) in order to further compare the background values of pollution with those that will occur as a consequence of functioning of this new object (or the further operation of the whole complex of objects in the region).

2. Periodic control of the status of an environment under conditions of normal operation of objects – sources of pollution in order to confirm objectively the safety for the population and the environment of controlled levels of pollution, as well as to identify abnormalities and trends of pollution, which need to be considered when evaluating the prospects for further development such facilities in the region.

3. Operational control over the development of the state of the system in abnormal and emergency situations with the purpose of assessing the extent of emissions or discharges of pollution and predicting their environmental consequences (taking into account hydrometeorological and other factors that influence the processes of the spread of pollution), as well as working out recommendations for further functioning of certain objects and (if necessary) the development of protective structures and the use of other means of environmental protection.

4. Post-accident control in order to clarify the patterns of distribution of pollution, to identify the effectiveness of measures to protect the area or to minimize the impact of pollution on

the environment, forecasting of the boundaries and terms of normalization of the environment.

Environment under influence of aviation technique systems is characterized by the presence of plural elements for which there is no effective identification process, and decisions on the state of the systems are made in uncertainty. The uncertainty of monitoring results leads to unreliable estimations of state of system.

For effective analysis of the state environment, justification of the purpose of collecting information, sampling points, frequency of updating of data, their nomenclature, and alternative variants of information provision should be provided.

The developed methodology of analysis of technogenic hazardous objects of aviation allows to analyze the sources, conditions and circumstances of emergencies and processes of their development, as well as to assess their environmental impact for adoption of management decisions in order to minimize environmental impacts.

Monitoring of environmental pollution includes definition of the structure of the measuring network, the range of the area and the density of pollution on the basis of the data measuring network and the corresponding algorithms of interpolation and smoothing, as well as determination of the dynamics of the range of pollution.

The above-mentioned approaches to increase the reliability of monitoring data ensure significant improvement of the functioning of information systems and facilitate the adoption of more substantiated decisions to minimize the consequences of man-made and natural disasters and accidents. However, their use in the absence of accepted patterns of dissemination of pollutants and characteristics of measuring equipment, making them sensitive to external influences and focused on precise input information, requires new, non-standard approaches, one of which is the interpretation of information used in the system in terms of theory fuzzy sets and the theory of possibilities that form the basis of intelligent information systems.

РЕФЕРАТ

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ДОСТОВІРНІСТЬ МОНІТОРИНГУ ВПЛИВУ АВІАЦІЇ НА ДОВКІЛЛЯ

Вплив системи авіаційної техніки на навколишнє середовище спостерігається в обмеженій кількості точок, для яких існує щонайменше один елемент з множини, для якого немає ефективного процесу ідентифікації, і рішення про стан системи допускає умови невизначеності. Для успішного розроблення та застосування методів покращення спостереження та визначення стану процесу необхідно вивчити конкретні джерела ненадійності даних процесу та інтегральних оцінок стану навколишнього середовища. Надійна методологія моніторингу включає визначення поточної сфери забруднення, пов'язаних з нею факторів та їх впливу на спектр і величину забруднення, динаміку забруднення порівняно з минулими вимірами, перевірки відповідності трендів, прийняття рішень щодо надійності даних моніторингу та прогнозів. Впровадження таких етапів гарантує достовірність отриманих даних для прийняття відповідальних рішень в екологічному менеджменті.

Ключові слова: екологічний менеджмент, моніторинг, надійність даних.

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ДОСТОВЕРНОСТЬ МОНИТОРИНГА ВЛИЯНИЯ АВИАЦИИ НА ОКРУЖАЮЩУЮ СРЕДУ

Воздействие системы авиационной техники на окружающую среду наблюдаемо в ограниченном количестве точек, для которых присутствует хотя бы один элемент из множества, для которого нет эффективного процесса идентификации, и решение о состоянии системы допускает условия неопределенности. Для успешной разработки и применения методов улучшения

наблюдаемости и определения состояния процесса необходимо исследовать конкретные источники ненадежности данных процесса и интегральных оценок состояния окружающей среды. Надежная методология мониторинга включает определение текущей области загрязнения, связанных с ней факторов и их влияние на спектр и величину загрязнений, динамику загрязнения по сравнению с прошлыми измерениями, проверку актуальности трендов, принятие решений о достоверности данных мониторинга и прогнозов. Внедрение указанных этапов обеспечивает достоверность данных, полученных для принятия ответственных решений в экологическом менеджменте.

Ключевые слова: экологический менеджмент, мониторинг, надежность данных.

ABSTRACT

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RELIABILITY OF MONITORING OF AVIATION INFLUENCE ON ENVIRONMENT

Aviation technique systems effect on environment is observed in a limited number of points, for which there is a presence of at least one element of a set for which there is no effective identification process, and a decision regarding state of system accepts conditions of uncertainty. For successful development and application of methods for improving observation and identifying state of process, it is necessary to research specific sources of unreliability of process data and of integral estimates of state of environment. Methodology for monitoring includes determining current field of pollution, associated factors and their impact on spectrum and magnitude of pollution, dynamics of pollution in comparison with past measurements, checking relevance of trends, decision making on reliability of monitoring data and forecasts. Implementation of such stages ensures reliability of data obtained to make responsible decisions in environmental management.

Key words: environmental management, monitoring, data reliability.

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