THE METHOD FOR CORROSION PREVENTION AND CORROSION PROCESSES MONITORING OF STRUCTURAL COMPONENTS IN AIRCRAFTS

METODA ZAPOBIEGANIA I NADZORU NAD PROCESAMI KOROZYJNYMI ELEMENTÓW KONSTRUKCJI STATKÓW POWIETRZNYCH

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Abstract: Operation, maintenance and overhauls by technical condition of equipment with simultaneous monitoring of the reliability level consists in acquisition, storage, verification and analysis of information related to reliability and efficiency of the operation process involving a set of products classified to a single, common type. Results of the completed analyzes serve as a basis for taking decisions on the scope of necessary prophylactic works. Each item of the product is replaced after such a defect that presents no harm to the overall functioning of the system. In such a case an extremely important task is to determine the schedule and scope of inspections intended for restoration of full operability of the aircraft in respect of corrosion spots and condition of protective coatings. The proposed method comprises four phases consisting of the following operations: initial assessment, indirect examinations, direct tests and final evaluation.

Keywords: corrosion inspection, condition-driven operation, structure, fault, aircraft

Streszczenie: Obsługa i remont według stanu z kontrolowaniem poziomu niezawodności polega na gromadzeniu, weryfikacji oraz analizie danych o niezawodności i efektywności procesu eksploatacji zbioru wyrobów jednego typu. Na podstawie przeprowadzonych analiz podejmowane są decyzje o koniecznych zakresach prac profilaktycznych. Wymiana każdego z wyrobów jest dokonywana po jego uszkodzeniu, będącym bezpiecznym dla funkcjonowania systemu. Niezwykle istotnym zagadnieniem do rozwiązania jest wyznaczenie okresów i zakresów wykonywania przeglądów przywracających zdolność statku powietrznego w obszarze występowania procesów korozyjnych oraz stanu pokryć ochronnych. Zaproponowana metoda obejmuje czteroetapowy proces, na który składają się następujące działania: ocena wstępna; badania pośrednie; badania bezpośrednie; ocena końcowa.

Słowa kluczowe: przegląd korozyjny, eksploatacja według stanu, konstrukcja, uszkodzenie, statek powietrzny

1. Introduction

The newly proposed method intended for prevention of corrosion processes and monitoring of their progress comprises four steps that involve the following actions:

- **initial assessment**, that comprises analysis of all the information acquired during the past operation of the aircraft as well as the engineering documentation in order to find out locations where corrosion may possibly appear,
- **indirect examinations** with measurements of corrosion potential demonstrated by the atmosphere in order to establish how the protecting system can cope with the hazard as well as thickness measurements of protective coatings within the determined regions,
- **direct tests**, where the objective is to directly investigate structural components of aircrafts to detect occurrence of corrosion spots, their size and intensity with the consequential deterioration degree of protective coatings,
- **final evaluation**, covering analysis of measurement data from direct and indirect investigations carried out for the specific aircraft with further development of scope and schedule of necessary repairs and maintenance as well as time intervals for subsequent inspections and tests.

The final assessment is the process when all the information acquired from preceding phases are compiled, compared and validated. They also present the input information for the first step of the subsequent investigation and data analysis for the specific aircraft unit.

The proposed method is a sophisticated and interdisciplinary process that requires collaboration of a number of experts from various fields of science and technology, starting from data acquisition and integration up to multi-aspect engineering analysis. It is reasonable to explain here the meaning of the term “integrity of the aircraft structure” that is used in this study. Its Polish meaning, understood as ‘indivisibility’ stands here for ‘keeping within defined boundaries’, i.e. maintaining the unaltered status and preventing any possible alterations.

The initial assessment includes:

- analysis of gathered operational data,
- selection of methods for indirect examinations,
- identification of critical areas.

The scope of necessary information stored in the database is established with consideration of the past history of the aircraft operation and its current condition. It defines the crucial preconditions that are indispensable to make the process successful. The minimum scope must include information on the aircraft and its construction, properties of the environment, corrosion protection and operational information.

Selection of indirect investigation techniques should enable to carry out assessment of corrosive aggressiveness of the environment in relation to the aircraft and to

detect and evaluate dimensions of possible damage to protective coatings. It is necessary to select complementary techniques, i.e. drawbacks of some routines should be compensated by advantages of other ones.

Critical areas are established after analysis of information acquired during the initial phase of the investigation process.

The indirect examinations make up the second phase of the process. They are focused on identification of possible failures within protective coatings and determination how large they are. The same refers to other anomalies and areas where corrosion hazard exists or may appear in the future.

The objective of direct tests is to determine, which of the locations established during indirect examinations is the most hazardous and to collect information for assessment of corrosion threats. The criteria for selection of locations for direct tests are set up upon completion of indirect examinations. It is the process that answers whether or not the direct tests are necessary for each location, whilst the answer is provided on the basis of probability related to currently existing corrosion hazard as well as size and consequences of previous corrosion. It is necessary to establish the expected condition of protective coatings as well as define own requirements related to measurement techniques and type of information to be collected. For spots where corrosion pits are detected the remaining strength of the material must be calculated. The routine activities that make it possible to assess condition of protective coatings include:

- identification of the coating type,
- assessment of the coating condition,
- measurement of the coating thickness,
- assessment of the coating adhesion,
- determination of the coating deterioration (bubbles, delamination, etc.),
- taking samples of corrosion products,
- identification of corrosion pits,
- photographic documentation

Prior to identification and determination of corrosion pits the overlaying coating must be removed and the affected surface should be cleansed. All significant corrosion pits and cavities should be measured and documented. At locations where corrosion cavities are found the operator should determine and calculate the material strength. When the calculated value is less than the required threshold acceptable for the specific aircraft component, it is necessary to have the component repaired or replaced. All the significant corrosion hazards must be found and identified. The subject of the final evaluation is to establish a schedule of subsequent investigations and general assessment of the process efficiency.

2. Estimation of frequency of corrosion inspections of airframe structural components

The term ‘operation’ is understood as a set of purposeful organizational, technical and economic activities of humans in relation to aircrafts as well as mutual

relations between them from the moment when the equipment is taken over for the intended use until the equipment disposal after final withdrawal. Current technical condition of the aircraft, reflected by measured values of status parameters, serves as a basis for the decision on further operation of the equipment. Correct implementation of the operational strategy needs application of efficient methods and measures for technical diagnostics and skilled technical staff. It is also necessary to overcome distrust of executives with regard to efficiency of such an operation scheme. Economical benefits from such an operation method are immeasurably higher than in the case of different strategies, which is the reason for growing interest for the method and precondition of its eventual success. The indispensable requirement for making the strategy successful is availability of simple and efficient diagnostic methods, the best adapted to the manufactured aircrafts as well as monitoring of the aircrafts within a system of condition surveillance.

Currently the aviation engineering uses a combined method of aircraft operation. That solution consists in the approach that the operation systems that follow the operation strategy according to technical service lives are provided with diagnostic subsystems that support reasonable operation measures. These diagnostic subsystems, depending on their application area, are referred to as:

sequential subsystems that carry out diagnostic operations within the cycle that is limited only to the selected sequences (nodes, subassemblies) of the equipment, quasi-dynamic systems that carry out supervision by monitoring of alterations affecting the selected diagnostic signals when values of such signals affect or may lead to changes in schedules or scopes of maintenance and repair operations, intermediate systems that perform continuous diagnostics of machinery within the degrees and scopes that are justified by the cost-effectiveness where the diagnostic strategy fills the gap between the aforementioned operation strategies.

In order to find a reasonable approach to execution of works aimed at determination of the degree of deterioration or damage of the protective coatings the model was proposed that makes it possible to find out the frequency of required corrosion inspections.

The model is based on 10 variables that determine the process of aircraft operation. These variables are the following: age, flying time, number of landings, average flying time per year, load to the structure, region of operation, operational vulnerability to development of corrosion processes, effect of destructive processes taking place during operation on the condition of airframes, technical wear of airframe components within airframes.

Fig. 1 presents subsequent steps of the procedure that should be adhered to when frequency of corrosion inspections is to be evaluated.

Fig. 1 Evaluation of frequency of corrosion inspections execution

3. Evaluation of the atmosphere corrosion aggressiveness on the basis of results from examination of reference samples taken within the region of the aircraft operation

One of the most detrimental factors that affect technical condition of aircraft structures is the adverse effect of the environment where the aircraft is operated. The corrosive environment is meant as set of conditions that occurs within vicinity of the aircraft and that comprises at least one or more corrosive factors, i.e. such substances that are conducive to corrosion when come in contact with a specific metal.

The development and course of corrosion processes are affected by both internal and external factors. The internal factors include the sort and grade of the metal, its chemical composition, structure, surface condition, thermal treatment, machining and internal (no-load) stress. The external factors are the following: temperature, humidity, amount of precipitation, moistening time, intensity and duration of sun radiation, direction and power of wind (flow velocity), concentration of SO_2 , NO_2 and O_3 in ambient air, pH of precipitation, concentration of sulphates SO_4^{2-} ,

nitrate NO_3^- , chloride Cl^- in precipitations, atmospheric pressure, external polarization.

Information on internal factors can be sourced from the engineering documentation of the equipment, whilst information related to external factors, their presence and concentration in the ambient atmosphere can be obtained from records kept by the Chief Inspectorate of Environmental Protection and from the Hydrological and Meteorological Centre of the Polish Armed Forces. Based on the analysis of the effect of substances contained in the ambient atmosphere on the corrosion rates, one can schedule some maintenance operations, for instance how often the aircraft structure should be washed, which may slow down the corrosion processes. The factors leading to corrosion defects and deterioration of coatings are taken into account when the possibility of prolonging technical service lives is being considered and the operation of the equipment is driven by its actual technical condition.

Aircrafts are chiefly affected by factors that occur in the ambient atmosphere. Therefore the research studies of the Air Force Institute of Technology (ITWL) are by their nature focused on examination of corrosion under natural atmospheric conditions on the basis of exposing material samples to the effect of the ambient conditions and then performing periodic measurements within the predefined schedule and determination of weight and volume loss due to corrosion, their form, appearance and alteration of physical parameters of the samples.

Assessment of the atmosphere corrosion aggressiveness on the basis of weight and volume loss of samples exposed to the effect of atmosphere and examination procedure for corrosion samples made of materials applicable to the avionic engineering is the issue that needs a really responsible attitude and repeatability of all the operations. The ITWL has launched the system for examination of atmospheric corrosion that is a part of the management system and operations that are carried out during examination with the use of that system are shown in Fig. 2.

A number of structural components within aircrafts are inaccessible and cannot be viewed, neither directly nor indirectly – with the use of laboratory instruments. These components that are accessible with great difficulty include:

- inner space of flaps behind wings, front flaps, wing, tail plane, fin, compressed air balloon, air cylinders incorporated into shock absorber legs,
- outer surfaces of components included in the steering system and inaccessible when only the operations specified in the maintenance documentation are executed and accessible exclusively after operations exceeding the scope specified in the maintenance documentation,
- surface of components that make up the fuselage structure, these surfaces are accessible exclusively after operations exceeding the scope specified in the maintenance documentation.

Fig. 2 Operations carried out during research studies aimed at assessment of the corrosion degree demonstrated by samples exposed to the effect of atmospheric conditions.

By monitoring corrosion loss in materials that are used for making structural components of aircrafts and interference samples and being aware of correlation between weight loss of corrosion samples made of materials used for avionic components and reference samples it is possible to roughly estimate the degree of corrosion for components hard to access. The diagram in Fig. 3 explains how to evaluate hidden corrosion with the use of monitoring results for atmospheric corrosion.

Results of completed investigations are used to measure weight loss due to corrosion and the corrosion degree of samples is then determined. Based on these results it is possible to:

- estimate frequency of corrosion inspections for specific units of aircrafts on the basis of operation by technical condition of equipment,
- obtain information about behaviour of metals in the natural atmospheric environment,
- find out, which metal is the most suitable for the specific type of natural atmosphere,

- determine resistance to corrosion of metals in specific types of atmosphere by establishing corrosion rates and corrosion degree of materials within scheduled time intervals,
- compare corrosion resistance of two or more metals under specific atmospheric conditions,

Fig. 3 Diagram of assessment of hidden corrosion with use of examination results for atmospheric corrosion [1]

- determine mechanism of corrosion affecting particular metals and alloys,
- predict loss caused by corrosion,
- determine the class of the surface preparation for application of protective coatings,
- select the most suitable and efficient painting system and, in consequence, achieve the most cost-effective corrosion protection by application of the protective coating with the most appropriate thickness and of the best suitable material,

- specify the corrosion protection period,
- monitor corrosion processes detrimental to materials that are used for structural components of aircrafts,
- reduce acquisition of environmental information and determine impact of environmental factors by weight loss of reference samples,
- develop a mathematical model applicable to prediction of the corrosion aggressiveness of the ambient atmosphere,
- establish relationships between results of test under laboratory conditions (accelerated investigations) and corresponding results for natural environment of operated aircrafts.

Investigation of the atmospheric corrosion present one of the most important aspects of works associated with the analysis of opportunities to prolong service lives of aircrafts and operate them by the actual technical condition. Operations that are to be carried out within the scope of examinations should adhere to already developed procedures, methodology and instructions but nevertheless they must be updated in pace with accumulation of experience and extension of the knowledge.

4. Vulnerability of airframe structural components to corrosion defects occurring during operation of aircrafts

Operational vulnerability to development of corrosion processes is estimated by the method of expert assessment based on information about corrosion defects and other failures that may affect development of corrosive processes. Information about defects is sourced from the database of operational failures. The system that has been developed to store information on historical defects and make it available whenever necessary is called SAMANTA.

The following keywords are associated with various forms of defects that are conducive to development of corrosion: coloured tarnish, thermal deformation, mechanical (plastic) deformation, corrosion, intercrystalline corrosion, microcracks, chipping, tear, deformation, exfoliation, enamel splinters, scalding, abrasion, cracking, surface cracks, pipeline rupture, cracks of welding joints, corrugation, material porosity, mechanical puncture, overheating, rubbing through, scratches, burns, wears, material loss, damage of protective coating, water penetration into the system, dents, bends, spalling, burnups, abrasion, cavities and pits, delamination, carbon deposit, surface contamination, scratching, excessive polishing, surface defect, squeezing, peels, lustreless appearance.

5. Estimation of effect exerted by operating environment on technical condition of airframes

The coefficient that describes the effect of ambient environment existing during operation of airframes on the technical condition of the same may adopt values that depend of failures caused by a number of reasons: technical, meteorological, collision with birds or animals, manufacturer-dependent circumstances,

incompetent repairs, improper operation by the flying staff, staff faults, incorrect maintenance, insufficient discipline of the staff, damage caused by a foreign body. The relationship between processes that occur during operation of airframes and their technical condition may be determined on the basis of the following indices:

P_{IT} - the index that characterizes for the cause of a fault classified as other technical irregularities,

P_P - the index that characterizes for the cause of a fault classified as meteorological drawbacks,

P_Z - the index that characterizes for the cause of a fault classified as collisions with birds or animals,

P_F - the index that characterizes the cause of a fault classified as manufacturer-dependent failures,

P_R - the index that characterizes the cause of a fault classified as incompetent repairs or overhauls of the aircraft;

P_E - the index that characterizes the cause of a fault classified as improper operation by the flying staff,

P_B - the index that characterizes the cause of a fault classified as a staff fault,

P_T - the index that characterizes the cause of a fault classified as incorrect maintenance of the aircraft;

P_D - the index that characterizes the cause of a fault classified as insufficient discipline of the staff,

P_{CO} - the index that characterizes the cause of a fault classified as damage by a foreign body.

Only defects and failures recorded with use of the IT system called SAMANTA should be taken into account during the analysis of indices characterizing the impact of operating environment on technical condition of airframes.

6. Estimation of technical wear demonstrated by structural components of airframes

The coefficient that describes the effect of wear and tear processes occurring during operation of airframes on technical condition of the same may adopt values that depend on defects and failures caused by reasons classified as technical wear of components or subassemblies.

Technical wear of airframes is estimated on the basis of the P_{TZ} – index that characterizes for the cause of a fault classified as technical wear of the aircraft components or subassemblies.

7. Analysis of the flying time, landings, age, average flying time values and number of landings per year.

Age of each aircraft substantially affects development of corrosion processes; the older the aircraft the more it is exposed to the hazard of corrosion faults. The coefficient that describes the impact of the aircraft age on technical condition of the same may adopt values that depend of past history associated with the aircraft operation on the basis of the data acquired with use of the SAMANTA system and applicable to the population of aircrafts that are subjected to analyses.

Flying time of aircrafts is expressed in hours of their operation and is counted from the beginning of their service. It is a sum of hours of execution of subsequent air tasks from starting up of on-board equipment until having them switched off. It is the parameter that characterizes the degree of susceptibility of the airframe to development of fatigue cracking. The arising microcracks are conducive to development of corrosion processes, which is associated with execution of many tasks during the time period.

The average flying time per each year of the aircraft operation reflects the fact that the aircraft that performs more missions per year than other units is more exposed to development of corrosion processes.

The number of working cycles expressed as a number of the aircraft landing operations is counted from the beginning of the service and represents the sum of working cycles dedicated to execution of subsequent avionic tasks. This number of missions that comprise take-off and landing operations characterizes susceptibility of airframes to development of fatigue cracking. The arising microcracks are conducive to development of corrosion processes, which results from execution of many landings during the time period.

The average number of landings per each year of the aircraft operation reflects the fact that the aircraft that performs more missions per year than other units is more exposed to development of corrosion processes.

8. Operation intensity

Operation intensity depicts the impact of the configuration of missions that are performed by specific aircrafts on the development of corrosion processes. Operation intensity of each unit of all the aircrafts in operation is expressed by the coefficient of operation intensity. That coefficient is calculated on the basis of the multiplication factor for load cycles factors n_z and is expressed by means of the following formula:

$$k_{ie} = \frac{\sum_i N_i P_i^m}{\sum_i W_i P_i^m}$$

where:

N_i – multiplication factor for the i^{th} level of load factors n_z for the working cycle,

P_i – value of the i^{th} level of load factors n_z for the working cycle,

W_i – value of the i^{th} level of load factors n_z for the working cycle obtained from the reference characteristics curve,

m – exponent of the S-N curve.

The coefficient of operation intensity reflects the actual loads to which the aircraft structure is subjected during its operation. The interpretation of this coefficient is following:

$k_{ie} < 1$ – the aircraft has been utilized with less intensity as the design engineers assumed in determination of the technical service life,

$k_{ie} = 1$ – the aircraft has been utilized exactly in accordance with the assumptions of design engineers in respect of the technical service life,

$k_{ie} > 1$ – the aircraft has been utilized with higher intensity as the design engineers assumed in determination of the technical service life.

9. Washing of external surfaces on structural components of aircrafts

External surfaces of airframes should be washed in order to remove all the contaminations deposited during operation of the aircraft, to maintain its decorative appearance and to keep all the aviation and technical characteristic parameters unaltered. Washing should be combined with overall technical inspection aimed at detection of corrosion defects and carried out for all aircrafts operated under regular service conditions. Fresh water should be used for washing aircrafts, only in the case of contaminations that cannot be removed with water special washing agents can be used. Solid contaminations that are difficult to remove and stuck to external surfaces should be removed with the use of brushes with short hair. Every time when washing agents are used they must be flushed out with further rinsing of washed surface with fresh water. Water should be supplied with a hose very carefully to avoid penetration of washing agents into gaps and cavities of the structure. To remove grease or oil from aircraft components any washing agents can be applied. In such a case, the products of avionic engineering should be reconditioned. Operational contaminations that are irremovable with washing agents and water are to be cleaned with cotton cloths soaked with mineral spirit.

Washing agents should be applied in strict accordance with their intended use as improper application or exceeding of their concentration in the washing solution may lead to acceleration of corrosion or damage to the aircraft equipment. Washing agents should be flushed out with fresh water. When external surfaces of aircrafts are washed due care must be taken to avoid penetration of washing agents into aircraft interiors.

It is forbidden to leave remnants of non-flushed washing agents on the aircraft plating, to wash external surfaces of aircrafts with solvents or other agents that are not allowed by the washing instruction, to use scrapers or other sharp tools that may damage painting coatings which may lead to formation of corrosion spots.

Information on atmospheric condition defined for the region of a corrosion station and used to determine washing frequency for structural components of airframes can be sourced from the Air Force Meteorological Centre. That information includes:

- T_{sr} – average temperature;
- T_{min} – minimum temperature;
- T_{max} – maximum temperature;
- RH – relative humidity;
- T_r – dew point temperature;
- V_w – wind velocity;
- N – wind blowing from the north;
- NNE – wind blowing from the north-north-east;
- NE – wind blowing from the north-east;
- ENE – wind blowing from the east-north-east;

- E – wind blowing from the east;
- ESE – wind blowing from the east-south-east;
- SE – wind blowing from the south-east;
- SSE – wind blowing from the south-south-east;
- S – wind blowing from the south;
- SSW – wind blowing from the south-south-west;
- SW – wind blowing from the south-west;
- WSW – wind blowing from the west-south-west;
- W – blowing from the west;
- WNW – wind blowing from the west-north-west;
- NW – wind blowing from the north-west;
- NNW – wind blowing from the north-north-west;
- C – dead calm;
- t_{zw} – moistening time.

Wind is a movement of air with the predominant horizontal component with respect to the Earth surface. Observations regarding wind consist in determination of its direction (where the wind blows from) and its velocity. Wind direction is determined by the 16-component scale in units of angular measurement. The scale is based on subdivision of the full circle (the horizon) into 16 equal sectors. The denominations are specified above, these directions are associated with mean lines measured in angular degrees as well with directional sectors. Velocity is expressed in m/s and stands for the path that is travelled by air particles during a time unit. Fig. 4 shows directional components of wind.

Fig. 4. Components of wind directions

The moistening time (t_{zw}) is a time period when the metal surface is coated with a film of electrolyte that initiates atmospheric corrosion. The values of moistening time can be calculated from temperature and relative humidity (RH) by totalizing hours when $RH > 80\%$, and temperature exceeds zero ($t > 0^\circ\text{C}$).

- Amount of water in air, i.e. so called humidity, can be expressed in weight units, in units of steam pressure or with the use of the so-called dew point. The dew point is the temperature where an air sample with specific content of steam achieves the saturation status. The distance from the saturation status is expressed in the so-called saturation degree (in percents). It is the percentage ratio of water weight in a volume unit of air to the water weight contained in the same volume of air in the saturation state. The same can be expressed as the relative humidity, i.e. the partial pressure of water vapour in the air-water mixture, given as a percentage of the saturated vapour pressure in the saturation state.
- Other information that is used for establishing washing frequency of airframes includes the content of sulphur dioxide (SO₂), nitric oxide (NO), nitric dioxide (NO₂), ozone (O₃), airborne dust (PM₁₀), nitric oxides (NO_x), carbon monoxide (CO), benzene (C₆H₆), xylene (C₈H₁₀), toluene (C₇H₈), MP-xylene (C₈H₁₀), ethylbenzene (C₆H₆), O-xylene (C₈H₁₀), atmospheric pressure (PH), effective radiation stream (UV), amount of precipitation within vicinity of the corrosion station and total radiation (RAD).
- In order to determine the effect of atmospheric conditions on structural components of airframes it is necessary to carry out analysis of correlation between parameters that depict corrosion processes of samples exposed on the corrosion station and parameters that characterize the ambient atmosphere.

Correlation is the measure of relationships between two or more variables. The measurement scales that are used for such an analysis should be at least interval scales but the correlation coefficients are also defined that enable the analysis of data of other types. Correlation coefficients adopt the values from -1.00 to +1.00. The value of -1.00 represents a perfect negative (reverse) correlation whilst the value of +1.00 – the perfect positive (coinciding) correlation. The value of 0.00 stands for no correlation. Most often the Pearson product-moment correlation coefficient is used, referred to as the coefficient of linear correlation and typically denoted by r . It is the basic parameter. The correlation coefficient r expresses linear dependence between two variables. If squared, the value of the determination coefficient (r^2) is obtained that expresses the proportion of the mutual variability of two variables (goodness of fit or power of convolution). To determine correlation between two variables it is necessary to know its power (value) and the significance of the correlation coefficient.

The correlation analysis is carried out to find out interrelationships between the corrosion processes and the analysed parameters and phenomena in the environment where corrosion samples are placed. Eventually, the established correlation makes it possible to determine washing schedule for structural components of aircrafts.

10. Inspection of structural components aimed at assessing technical condition of an airframe with respect to corrosion and condition of protective coatings

Inspection of airframes constitutes the process of regular examinations, checking and testing of their structural components, subassemblies and systems. Inspections

are carried out to detect existing or potential circumstances that makes the airframe unusable.

On the basis of completed examinations and analyzes the most sensitive areas of aircrafts are determined, which are particularly exposed to development of corrosion processes. Such regions usually include coatings of structural components, plating of the fuselage within the regions affected by high temperatures from hot components of the engine, areas of fuel inlets, the battery compartment, nodes where the main undercarriage is fixed to the fuselage, nodes where the front undercarriage is fixed to the fuselage, the edge of attack in the tail plate, suspension brackets of the tail plate, nodes of fixing of engines, plating of covers for legs of the main undercarriage, leg pits for the main undercarriage, coating of wing plating, nodes where wings are fixed to the fuselage, components of the aircraft steering system.

Due to the fact that the corrosion lifetime depends both on the material (its chemical composition or manufacturing technology) and on operating conditions, the decision whether a components can be kept in use must take account for the following factors: properties of the material the component is made of, corrosive aggressiveness of the ambient atmosphere, operational intensity, flying time of the aircraft, operational parameters (speed, loads), analysis of service lives and overhaul lives.

Numerical coefficients and relationships should be determined in accordance with guidelines included in instructions that make up components of the methodology.

Information about technical condition of the aircraft with respect to corrosion deterioration and defects of protective coatings should be acquired from the regular operation of the aircraft with use of the 'SAMANTA' system.

The aircraft inspection should be carried out in line with the established inspection route and sequence, as specified in the maintenance manual.

Prior to starting the inspection of the airframe it is necessary to prepare the aircraft in accordance with requirements of unified maintenance kits for aircrafts and with additional requirements imposed systematically by verifying inspectors; aircraft components shall be inspected with naked eye and with the use of a magnifying glass with the minimum magnification factor of 3. When any corrosion traces are detected and repairing or overhauling operations are required, it is necessary to keep records of these areas; assess the corrosion degree of aircraft components; assess visually or, if necessary, with the use of a 3x magnifying glass, the condition of coatings that protect these components against corrosion.

11. Conclusions

- a) Inspections with the aim to restore sound technical conditions and to guarantee safe operation of airframes should be carried out in accordance with the established plan (updated every 12 months) as well as with frequency calculated on the basis of data referring to a specific aircraft unit.
- b) Time intervals between subsequent inspections aimed at assessment of the corrosion damage of aircraft structure should be established on the basis of the following factors:
 - flying time;

- number of landings;
 - operation intensity;
 - corrosion aggressiveness of the atmosphere;
 - operational vulnerability to development of corrosion processes;
 - processes and events occurring during the equipment operation;
 - technical wear and tear.
- c) In order to carry out analysis aimed at estimation of time intervals between subsequent inspections within operation according to the method of condition-driven operation of airframes, the following measures should be taken:
- collection of information about failures and defects detected during regular operation,
 - keeping records on environmental conditions,
 - keeping records on flying time and number of landings.

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