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CIVIL AVIATION ACCIDENTS AND INCIDENTS CLASSIFIED ACCORDING TO GROUPS OF AVIATION SPECIALISTS

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Abstract. During an operational process, activity is implemented through an ordered sequence of certain actions united by a common motive. Actions can be simple or complex. Simple actions cannot be split into elements having independent objectives. Complex actions can be presented in the form of a set of simple actions. If the logical organisation of this set is open, a complex action can be described as an algorithm consisting of simple actions. That means various kinds of operational activities develop from the same simple and typical actions, but in various sequences.

Therefore, human error is always generated by a more elementary error of action. Thus, errors of action are the primary parameter that is universal for any kind of activity of an aviation specialist and can serve as a measure for estimating the negative influence of the human factor (HF) on flight safety. Aviation personnel are various groups of experts having various specialisations and working in various areas of civil aviation. It is obvious that their influence on conditions is also unequal and is defined by their degree of interaction with the performance of flights. In this article, the results of an analysis of air incidents will be presented.

Keywords: accident, incident, human factor, technical operation, risk factors.

1. Introduction

The human factor (HF) is one of the main concepts used when considering flight performance issues. This concept is extremely broad and serves to characterise various phenomena in aviation practice related to many human activities.

The term HF comprises a person's moral, social, psychological, physical, professional and other qualities that influence the results of his activity. In aviation, all processes of the organisation, maintenance and performance of flights are carried out by people – various types of aviation experts – and each type influences the security of flights.

Throughout the operational process, activity is performed by the ordered sequence of certain actions united by a common motive. These actions can be either simple or complex. Simple actions cannot be extended to elements that have independent objectives. Complex actions can be presented as a set of simple actions. If the logical organisation of this set is open, a complex action can be described as an algorithm consisting of simple actions. This means that various kinds of operational activities develop from the same simple and typical actions, but in different sequences. The mistake of a person's activity is always generated from a more elementary error of action. Hence, errors of action are that primary parameter that is universal for any kind of activity of aviation experts that can serve as a measure for estimating the negative influence of the HF. Aviation personnel are various groups of experts having various specialisations and working in various areas of civil aviation. It is obvious that their influence is also uneven and is defined by the degree of interaction with flight performance. A typical classification of serious aviation accidents (SAA) caused by various groups of aviation personnel is described in the table below (Tab. 1). Aviation personnel are divided into nine groups. Aviation occurrences that are the fault of engineering personnel make up only 4% (Tab. 2) of aviation accidents and up to 30% of the incidents. According to research (Analysis of Influence 2002; Denisov 1986) 35% of accidents and incidents in civil aviation in summer over the past 20 years are the fault of aviation engineering services, mainly due to the poor quality of maintenance service.

Therefore, this is the HF to be addressed hereinafter in the text.

2. Role of the human factor during aircraft maintenance and repair

The role of the human factor increases during complicated aircraft maintenance and overhaul operations. The work efficiency of maintenance specialists influences not only the safety and regularity of flights, but also the economic indices of maintenance enterprises due to the idle time of an aircraft while maintenance is being carried out.

Table 1. Classification of aviation accidents and incidents according to the leading aviation personnel groups

Aviation Personnel Groups	Number of accidents and incidents	
	Aviation accidents %	Aviation incidents %
Personnel management	29	6
Crew	59	37
Air traffic control dispatcher	5	5.5
Engineering personnel	4	30
Airport staff	0.5	8
Technical light insurance	–	1.3
Fuel/grease refuel	0.5	1.6
Transport service	–	0.1
Dedicated motor depot	–	7

1. P. PLAN
   - Setting up purposes and tasks;
   - Determining methods and means (strategies);
   - Elaboration of plans for measures;
   - Teaching and training of specialists.
2. D. DO
   - Performing work.
3. C. CHECK
   - Controlling work results.
4. A. ACTION
   - Realising control. Corrections.

The correct application of contemporary statistical methods at all stages of Deming's cycle is not restricted to these stages only. They are also applied to market analysis; production design; and definition of reliability, durability, service life, etc. specifications.

Specific statistical methods and fields of application include, but are not limited to, factor analysis, dispersion or regression analysis, risk analysis, and criteria of significance evaluation.

An important task in quality control is the evaluation of the significance of deviation in quality indices (danger of production defects). The correct quantitative determination of the potential danger of some event (deviation, defect) permits preventive measures to be put into place at the proper time and in the correct direction: introduction of new techniques or improvement of existing ones, personnel training for activity under certain conditions, etc. The estimate of significance indicates weak spots in the assurance of quality. This evaluation of events is essentially its ranking according to accepted criterion[1].

Probabilistic indices are in practice basic criterion of significance degree. These may be both probability itself, obtained using statistical means, and quantity (see Tab. 2).

Table 2. Parity of incidents by basic reason and type of aircraft

Aircraft	Per 105 flight hours		
	Engineering defect %	Maintenance fault %	Other %
Il-86	88.6	3.4	8
Il-62	88.8	6	5.2
Tu-154	77.9	11.7	10.4
Tu-134	68.1	21.1	10.8
Yak-42	86.6	8.1	5.1
An-24	73.9	15.9	10.2

During maintenance, approximately 87% of the entire time is required for detecting failures and only 13% for their elimination. According to research data, 25–30% of air accidents over the past 20 years have occurred through the fault of maintenance, basically owing to its low quality. According to US data, 30% of general failures of computer facilities have occurred due to insufficiently qualified service personnel.

The table demonstrates that many incidents are connected with TU-154, TU-134 and AN-24 aircraft.

Human errors, in general, can be divided into four categories:

- non-performance of the required work;
- inaccurate performance of the required work;
- performance of unnecessary work;
- delayed performance of the required work.

Anyway, when human errors are analysed, there are a number of additional collateral complexities that occur because an error has not been detected and eliminated, it is hard to determine the primary reason for the error, etc.

Analysis of the main errors admitted by service personnel during maintenance procedures shows the multifaceted nature of the external phenomena (Aljanskis 1985). As an example, it is possible to mention some mistakes that have been made by service personnel during the maintenance of TU-154. In one incident, after landing there was no back bottom engine cover. In another incident, take-off was interrupted due to noises in the engine, because a tool was left in the inlet channel of the engine. In yet another incident, having started the engine before take-off, the crew noticed that there was no pressure in the second hydraulic system. The reason was that there was no hydro pump in the system, as it was removed according to the bulletin and was not replaced. Another time there was a forced landing due to the left chassis not being cleaned. This happened because the shock absorber maintenance procedure had been performed by a new technician whose work had been not supervised. The aforementioned examples show that even though there are systems in civil aviation that are supposed to ensure the quality of maintenance by considering its basic principles of continuous control at all phases of operations and elasticity of the control (cooperation, periodicity, choice, inspectors, etc.), errors are still being committed during maintenance services.

Table 1 provides a classification of incidents that involve TU-154 systems (the results of data collected) and that took place as a result of the unsatisfactory maintenance of aircraft by technicians or engineers. The most typical errors committed by personnel took place during the maintenance of the chassis (34%), engine (18.5%), airframe (22.4%), and engine lubrication systems (11.6%). It to a certain degree this can be explained by the structural complexity of these systems, which have units, aggregates and elements that require the performance of specific work during the maintenance process. Besides, the systems are difficult to gain access to for viewing, offering a narrow field of vision and insufficient conditions for using illumination and control and testing equipment for detecting defects.

As part of the analysis of the specific errors of service personnel in the process of preparing an aircraft for flight, a group of the most characteristic errors of engineers and technicians can be listed (Goraj *et al.* 2007). Typical errors are:

- when preparing engines for start-up and when starting and testing aircraft engines, which leads to their damage as a result of permissible temperature being exceeded and working conditions not being observed, not closing or not fully closing covers or engine-room hatches; leaving parts of instruments or control and measurement devices in inlets of engines; presence of ice on the aircraft surface; and leaving small objects on the ground under aircraft engines, which leads to these objects entering and damaging the engines during testing and flight;
- not removing snow and ice from the aircraft control system and from air-oil radiators, which

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leads to some elements and systems of aircraft being damaged;
- breach of instructions when driving to aircraft by land transport or towing aircraft, which leads to the entire aircraft or some of its parts being damaged;
- incorrectly performing adjustment work, which leads to damage of aircraft systems;
- incompletely or poorly eliminating of damage and failures detected during aircraft operation or maintenance, which leads to repeated failures of aircraft;
- violating technical requirements for dismantling and assembling systems or parts, using filters of different aircraft systems, using unmarked instruments, etc.;
- incorrect control or no control after finishing work on parts or systems, which leads to parts coming loose during subsequent operation, disconnection of pulling rods of control systems, screw mechanisms, etc.;
- incompletely filling aircraft systems (fuel, oil, hydraulic systems) with fuel, lubrication materials, special liquids, or gases, which leads to the failure of aircraft systems;
- not performing all required maintenance work in conformity with regulations and technological instructions, because of the insufficient quality control of maintenance work;
- delayed and poor quality execution of maintenance documentation, which leads to delay of flights, etc.

3. Conclusions

Analysis of the errors (violations) made by staff during maintenance operations permits the main reasons for these errors to be revealed. It is hardly possible to unequivocally determine all the reasons for the errors made, because of ambiguous records in the report documentation, insufficient statistics, incomplete manufacturing documentation, the complexity of completing documentation, etc. Errors committed by maintenance staff are more accurately provided in the research of accidents in Russia related to different types of aircraft (Aljanskis 1985). Data for the TU-154: the reasons for most staff errors (57.6%) are related to indiscipline (among them, 57% – non-observation of the technical discipline, 15.8% – poor-quality performance of fastening work, 13.8% – incorrect towing of aircraft and poor driving of special transport, and 11.9% – penetration of foreign objects into engines and other systems of aircraft). Regrettably, the bulk of the incidents (25.9%) occur due to the low level of professional knowledge (of which 63% – errors during replacement of units related to poor-quality performance, 10.9% – poor-quality performance of adjusting work, and 21.8% – insufficient professional knowledge of specialists). The occurrence of incidents is also influenced by deficiencies in engineering documentation, which is related to the incompleteness of the maintenance technology and discrepancies in management documents.

Correctly organised and well performed aircraft maintenance allows eliminating some manufacturing and design deficiencies that can lead to incidents. To implement it, civil aviation companies, together with manufacturers, have to take the appropriate measures to increase the quality of aircraft maintenance (Dahlström 2008; Methodology… 1990).

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