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Tatiana Udartseva

RAISING LEVEL OF FLIGHT SAFETY DURING AGRICULTURAL-AIR WORKS

National Aviation University
1, Kosmonavta Komarova avenue, 03680 Kyiv, Ukraine
E-mail: ute1@meta.ua

Abstract

The article presents an analysis of the causes of a serious incident that occurred during the aircraft-chemical works on the An-2 plane. ***Objective:*** *The aim of this work is to investigate the causes of aircraft collisions with electric power lines during the agricultural-air works and to develop preventive measures.* ***Metods:*** *Using the SHEL model recommended by ICAO, the main and additional causes of the aircraft collision with the electric power line are established.* ***Results:*** *The article contains the results of an analysis of data from investigations of accidents and incidents involving civil aircraft that occurred in Ukraine in 2013 - 2016. During this period, there were five collisions of aircraft with electric power lines, two of them with a fatal outcome. Since such cases are of a non-individual nature, the authors have developed appropriate preventive measures.* ***Discussion***: *Aviation incident prevention during low-level flights consists of the implementation of the ICAO experience, namely flight crew training programs: cabin crew optimization (CRM) and flight training in conditions close to real (LOFT). The introduction of issues related to real aviation accidents and incidents, as well as the use of air stimulators for training pilots, are proposed in the training programs for small airline pilots. As a precautionary measure, it is proposed to mark the wires of electric power lines with plastic balls according to international practice. It is proposed in the cockpit of the An-2 airplane install the car restorer of the instrument panel to obtain objective information about the flight parameters and simultaneously to write the talks in the cockpit.*

Keywords: agricultural-air works; aviation incident; flight safety; training of pilots.

1. Introduction

Over the last 10 years a number of evidences were found to confirm that about 70% of aircraft accidents and incidents were caused (sometimes partially) by inability of crew to use available means optimally. Quite often the crew face the problems related to inability to make group decisions, lack of communication, inadequate management or poor work organisation [1, 2]. Typically aircraft accidents and incidents are the result of the combined effect of the organisational factors (i.e. working conditions are the cause of wrong actions of the crew resulting in disruption of the whole system) and hidden circumstance, which potentially can disrupt the work of existing systems that guarantee flight safety and affect on it [3-5].

2. Analysis of research and publications

Many traditional training programs are focused exclusively on the technical aspects of flight fulfilment, with virtually no attention to the different types of strategies and methods to optimize the operation of the crew, which is also necessary to ensure safety. These findings have led to the emergence of a consensus in industry and government agencies about the need to pay more attention to the factors that affect the coordination of the crew and optimize the use of crew funds available [6, 7].

One of the important components of safety is the provision of information to airmen about

special situations in flight, erroneous operation, incidents. The main observations in providing information to the airlines that illuminate the problematic issues of safety are as follows [8]:

1. The information published on the issues of safety in many cases reflects not the true reason of the event, but the facts stated in the acts of the investigation.

2. The timeliness of receipt of information about aviation events and incidents. Through the media the incident report are received earlier than through official sources.

3. The lack of a unified state system of providing airline information on flight safety and changes in the operational and guiding documents.

4. The lack of information about research and development in universities of civil aviation.

5. The materials safety issues are very rare.

6. Inadequate coverage of prevention measures, the compilation of operating experience. There is no clear reporting system about aviation events.

7. Newsletters in a few sentences state the facts about aviation events, incidents; there is no available analysis of what happened and detailed information delivery to crews.

8. Untimely receipt of information about accidents and incidents, as well as analysis of the causes of their appearance.

A top concern for airlines is information related to the reliability of aviation equipment, the peculiarities of the manifestation of the human factor, training of crews, organization and ensuring of flights on the ground.

Therefore, it is necessary to reorganize the programs of training of flight personnel and include in programs:

1. Information about the real accidents and incidents, their causes and consequences.

2. Consolidation of learning outcomes working off similar situations in the flight simulator.

3. Purpose of the work

The analysis of incidents during agricultural-air works in Ukraine demonstrates drawbacks in the organisation of pilot's flight preparation for specific flight conditions [9-12].

The aim of this work is to investigate the causes of aircraft collisions with electric power lines and to develop preventive measures.

4. Materials and methods of research

The materials of research are the reports of the National Bureau of investigation of aviation events and incidents with civil aircraft for 2013-2016p. [9-12]. The research method is the analysis of data using the SHEL model recommended by ICAO [7].

5. Analys of incident during agricultural-air works

Consider the incident, which happened on 2 September 2013 at 16:32, during agricultural-air works near village Oleksandrivka, Kryukiv district of Chernihiv region, with "Universal-Avia" An-2 UR-62681 aircraft.

The flight crew consisting of the head of flight service and the captain, while processing the edge of the field along the high-voltage electric line, magnetic heading MH = 75^0, before leaving the track, saw high voltage wires across the flight direction, which branched from the main line and were poorly visible across the background of afforestation (fig.1). Because of the short distance to the power line and that the altitude of the flight was less than the height of the power line, the captain made a decision to descent and fly under the power line in order to avoid collision. Flying under the power lines, the aircraft collided with two bottom wires and broke them, damaged the tip of the vertical stabiliser and broke drain system mast. As the result of collision the crew was not hurt. According to the committee conclusion, the cause of serious incident (collision with the power electric line) during agricultural-air works was insufficient preparation of the crew for the flight in terms of studying the ground obstacles located on the field. Factor: human factor (crew). More oven preparation for the observation flight with actual ground observation of the field of works was recommended for the aircraft operators [9].

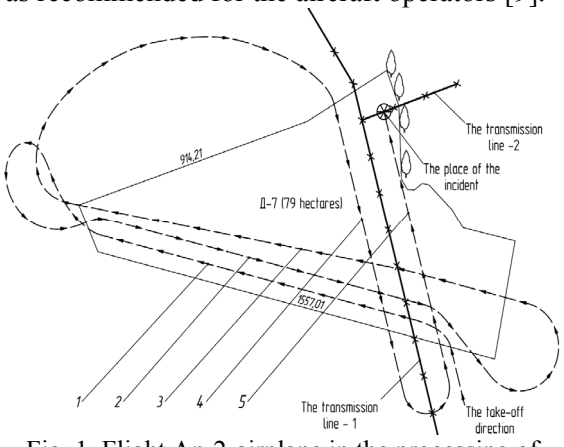

Fig. 1. Flight An-2-airplane in the processing of agricultural lands D-7 (79 hectares)
1 – The first long rut. *2* – The second long rut. *3* – The third long rut. *4* – The route along the transmission line. *5* – Route along the edge of the field

Detailed analysis of serious incident, we considered, shows that its main cause was the disruption of connection "subject-procedure". In particular, execution of the "Rules of the organisation and accomplishment of aviation works in agricultural and forest husbandry" approved by the Ministry of Transport and Communication, order №1179 from 22 December 2006 (The Rules) [13].

According to The Rules before take off for the execution of agricultural-air works the head of flight service must examine the area of works together with crew, paying attention to terrain taking into account local relief (p. 5.6.10); after arrival to the place of agricultural-air works the captain is obliged to instruct (with signatures) customer's staff concerning performance of their duties, safety rules for works near the aircraft, familiarise signalmen (with signatures) with the Instruction of signal organisation and interaction of aircraft crew with signalmen during the execution of agricultural-air works (p. 5.7.3 e), receive from the customer's representative the Task for agricultural-air works, land plans (p. 5.7.3 ж); according to customer's Task for agricultural-air works it is necessary to examine the area of flight (location, topography, agricultural areas configuration); identify presence and type of obstacles, put their location on land plans and on the basis of this circumstances determine the complexity of works over each area, outline the procedure for their cultivation and signalisation, perform necessary calculations for flight (p. 6.1.2).

The captain must investigate each area before cultivation of the field by performing personal detour or in special cases by observation flight on the aircraft; together with customer's representative, who determines areas, which will be banned for cultivation as such that do not provide flight safety; before cultivation the captain performs observation flight along the rectangular route on altitude not less than 50m in order to determine the location of signals, obstacles and specific references (p. 6.1.4).

The Rules provide that before the flights the distance calculations from the signal signs to the obstacles are carried out in order to determine the paths for climb and descent to enter and leave the track (p. 6.3.5). In addition, obstacles located in the area of works and on its surroundings, should be marked by warning signals, warning signs (red flags), which are installed near obstacles. Before the start of flight the captain together with the representative of the customer instructs (with signatures) all workers, including signalmen, regarding their duties (p. 7.3.1). In p.6.3.17 it is clearly stated that the captain is prohibited to flights and works over the areas without signals.

Interaction "subject-object". Evidentias base of the dynamics of overflight of the aircraft under the power line could be only information from the cockpit. The only information source of flight information on An-2 during agricultural-air works is barograph. Consequently, for the proper analysis of the causes of aviation incidents during agricultural-air works, video recorders should be installed on An-2 and other light aircrafts to capture dashboard and control column. For this purpose video recorder DOS LS400W or cheaper option ImCam 2701 (automobile video recorder) could be used.

Interaction "subject-environment". Physical wear of the aircraft and vertical wind gust could create a side effect, which led to serious incident. The Rules state that the captain must get the weather forecast before the start of the agricultural-air works (p. 5.12.4). One reason of the serious incident is that the place, which can be characterised as a "trap" was not marked. The solution of such problem could be marking of the power lines in the areas of the aircrafts operations, e.g. in the United Arab Emirates white plastic balls are placed on the power lines.

Interaction "subject-subject". The communication between the captain and co-pilot was disrupted because of sudden emergency situation and necessity to avoid collision with the power line wires. The interaction between the crew and signalman (the representator of the customer), which ensures the flight safety during the flights near obstacles was not provided during flight preparation phase.

Actions of the captain. According to the Rules procedure and conditions for carrying out agricultural-air works flights are determined by the instruction made by the captain. The flights near the power lines are allowed with the height not less than 10 m over the power lines when the wind speed is lower than 4 m/s and not less than 20 m when wind speed is over 4 m/s (p. 6.3.6). During the agricultural-air works the flights over the power lines (more than 1000 V) are allowed only with turned off agricultural equipment on the height not less than 50 m. During the flight along

the power lines with strain more than 750 kV and more the distance must be increased by 50 m.

Because the height of the flight was less than height of the power line, the captain decided to descent and fly under the wires in order to avoid collision. In the emergency situation, possibility of the collision with the power line the actions of the pilots were correct but the manoeuvre was started too late, which can be explained by poor visibility of the wires across the background of afforestation.

6. Results Discussion

In Ukraine during the period for 2013-2016, there were five collisions of aircraft with electric power lines, two of them with a fatal outcome. In addition to the above serious incident, the following events occurred [9-12]:

1. 17.07.2014 in the unauthorized performance of aviation-chemical works in the area of the np Bilashki, Talne region, Cherkasy region. On the plane AI-10, the plane collided with electric power lines, resulting in falling to the ground and burned. The pilot of the plane was killed.
2. 26.07.2014 in the village of Lisnevichi, Pustomytiv district, Lviv region. During an unauthorized flight on an unregistered X-32 Bekas plane, the plane collided with electric power lines and fell to the ground. As a result of the event, the pilot of the plane died.
3. 09.09.2014 while performing unauthorized agricultural-air works on the plane X-32 Bekas around village Repki, Chernihiv region. The aircraft collided with wires power lines, causing fell to the ground and explosion. The pilot of the plane died.
4. 7.06.2016 near Ivanovka, Novooshitsky area, Khmelnytskyi region, the Cheleng Aero helicopter Robinson-44 UR-LWW, performing a flight to demonstrate the work of agricultural equipment, collided with electric power lines and tore off their helicopter carrying roller shaft. As a result, the helicopter fell to the ground.

The fact that such cases are repeated indicates that there are systemic deficiencies in the preparation of pilots and organization of flights. Their warning in the future requires the development and implementation of preventive measures.

7. Conclusion

In order to prevent aviation incidents and accidents during the agricultural-air works the ICAO experience should be implemented. Namely, crew training programmes: crew resource management (CRM) and line oriented flight training (LOFT). These programmes should be complemented by the critical analysis of specific aviation accidents and incidents, which took place during agricultural-air works.

The full scale CRM training programme is the best decision for small airlines, but a number of problems arise. Among them high staff and instructors turnover, relatively low level of pilots and strict financial constrains.

There are a number of differences between small and large operators:

1. High number of short flight because of a number of areas with frequent take-offs and landings;
2. Minimal financial support of expenses on additional trainings;
3. Limited possibilities to attract crew members to CRM training;
4. Insufficient amount of training equipment available in some small operators [1].

Because of such drawbacks the creation of own programmes for some airlines could be quite difficult. We propose to develop a basic programme for small airlines, which are involved in agricultural-air works. The first stage of this programme is “study”, namely collection and update of the data and its verification. Second stage - “discussion” - presentation of thoughts and doubts and searching of ideas. Third - “decision making” - taking right decisions to ensure flight safety. Fourth – “critical analysis” – a review of plans and results, active feedback.

Financial problems can prevent implementation of the training programme. In this case flight simulators can become a solution. Flight simulators can help for training flights in fog, with strong cross wind and with various failures of equipment.

Among available flight simulators Microsoft Flight Simulator X (FSX), X-Plane, Prepar 3D can be used. The FSX has the following advantages: better visual effects, a number of addons, which have a lot of modern and old planes. X-Plane has better model of flight. Blade element theory used in X-Plane allows more realistic modelling of objects behaviour in flight. Therefore, X-Plane was certified by Federal Aviation Administration (FAA) for training flights. The main features of Prepar 3D are steady software operation and more realistic entourage [5].

The huge step in improving flight safety in future is creation of database with maps and flight steps for processing. This database should be available for airlines members.

For analysis of aviation accidents and incidents during agricultural-air works it is necessary to install video recording equipment in the cockpit, to capture instrument panel and record pilots communications.

The power electric lines should be marked with plastic balls in accordance with international practice as preventive measure.

It is proposed in the cockpit of the An-2 airplane install the car restorer of the instrument panel to obtain objective information about the flight parameters and simultaneously to write the talks in the cockpit.

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Т.Є. Ударцева

Підвищення безпеки польотів при проведенні авіаційно-хімічних робіт

Національний авіаційний університет, просп. Космонавта Комарова, 1, Київ, Україна, 03680
E-mail: ute1@meta.ua

У статті представлено аналіз причин серйозного інциденту, що стався при проведенні авіаційно-хімічних робіт на літаку АН-2. **Мета роботи**: дослідити причини зіткнення літаків з лініями

електропередач під час виконання авіаційно-хімічних робіт та розробити засоби профілактики. **Методи**: з використанням моделі SHEL, рекомендованої ІКАО, встановлено основну та додаткові причини зіткнення літака з лінією електропередач. **Результати:** стаття містить результати аналізу даних розслідувань авіаційних подій та інцидентів з цивільними повітряними суднами, що сталися в Україні на протязі 2013 – 2016 років. На протязі цього періоду сталися п'ять зіткнень літальних апаратів з лініями електропередач, два з них зі смертельними наслідками. Оскільки подібні випадки мають непоодинокий характер, авторами розроблено відповідні попереджувальні заходи. **Обговорення результатів**: профілактика авіаційних подій під час польотів на малих висотах полягає у впровадженні досвіду ІКАО, а саме програм підготовки льотного екіпажу: оптимізації роботи екіпажу в кабіні (CRM) та льотної підготовки в умовах, наближених до реальних (LOFT). Запропоновано внесення до програм підготовки пілотів малих авіакомпаній питань, що стосуються реальних авіаційних подій та інцидентів, а також використання авіасимуляторів для тренування пілотів. В якості запобіжного заходу пропонується маркування проводів ліній електропередач пластиковими кулями згідно з міжнародною практикою.

Ключові слова: авіаційно-хімічні роботи; авіаційний інцидент; безпека польотів; підготовка пілотів.

Т.Е. Ударцева

Повышение безопасности полетов при проведении авиационно-химических работ

Национальный авиационный университет, просп. Космонавта Комарова, 1, Киев, Украина, 03680
E-mail: ute1@meta.ua

В статье представлен анализ причин серьезного инцидента, произошедшего при проведении авиационно-химических работ на самолете Ан-2. **Цель работы**: исследовать причины столкновения самолетов с линиями электропередач во время проведения авиационно-химических работ и разработать меры профилактики. **Методы:** с использованием модели SHEL, рекомендованной ІКАО, установлены основная и дополнительные причины столкновения самолета с линией электропередач. **Результаты:** Статья содержит результаты анализа данных расследований авиационных происшествий и инцидентов с гражданскими воздушными суднами, произошедшими в Украине в 2013 – 2016 годах. На протяжении этого периода произошло пять столкновений летательных аппаратов с линиями электропередач, два из них со смертельным исходом. Поскольку подобные случаи имеют неодиночный характер, авторами разработаны соответствующие предупредительные мероприятия. **Обсуждение результатов:** Профилактика авиационных происшествий во время полетов на малых высотах состоит во внедрении опыта ИКАО, а именно программ подготовки летного экипажа: оптимизации работы экипажа в кабине (CRM) и летной подготовки в условиях, приближенных к реальным (LOFT). Предложены внесение в программы подготовки пилотов малых авиакомпаний вопросов, касающихся реальных авиационных происшествий и инцидентов, а также использование авиастимуляторов для тренировки пилотов. В качестве предупредительной меры предлагается маркировка проводов линий электропередач пластиковыми шарами согласно международной практике.

Ключевые слова: авиационно-химические работы; авиационный инцидент; безопасность полётов; подготовка пилотов.

Udartseva Taniana (1969). Doctor of philosophy, lecturer.
Department of Safety Human Activities, National Aviation University, Kiev, Ukraine.
Education: Ukrainian national medical university, Kiev, Ukraine (1994).
Research area: human factor in aviation, performance of aviation professionals, diagnostics of functional states.
Publications: 40
E-mail: ute1@meta.ua