NATIONAL BUREAU OF AIR ACCIDENTS INVESTIGATION

OF UKRAINE

(NBAAI)

FINAL REPORT

OF INVESTIGATION INTO SERIOUS INCIDENT, WHICH TOOK PLACE WITH CESSNA C510 AIRCRAFT, NATIONALITY AND REGISTRATION MARK YR-CMO, ON MARCH 03, 2021, DURING PERFORMANCE OF FLIGHT EN-ROUTE KYIV (ZHULYANY) – ODESA

OPERATOR:	**CONARG MOTION S.R.L.**
AIRCRAFT TYPE:	**CESSNA C510**
NATIONALITY AND REGISTRATION MARK:	**YR-CMO**
MANUFACTURER:	**TEXTRON AVIATION (USA)**
SERIAL NUMBER:	**510-0433**
AIRCRAFT MANUFACTURE DATE:	**NOVEMBER 20, 2013**
STATE OF OCCURRENCE:	**UKRAINE**

The repot is published with the sole purpose to prevent air accidents in the future

APPROVED BY

Acting Director
of the National Bureau of
Air Accidents Investigation
of Ukraine

Igor MISHARIN

February 15, 2022

FINAL REPORT

of Investigation into Serious Incident (Take-Off from Left Shoulder of RW-26), Which Took Place with Cessna C510 Aircraft, Nationality and Registration Mark YR-CMO, Operator – CONARG MOTION S.R.L., on March 03, 2021, During Performance of Flight En-Route Kyiv (Zhulyany) – Odesa

City of Kyiv **15.02.2022**

The NBAAI Investigation Team, which was designated by the NBAAI Order dated 06.04.2021 No. 21, within the period of 06.04.2021 to 15.02.2022, conducted the investigation into the mentioned occurrence.

The NBAAI received information on the occurrence from the Municipal Enterprise International Airport Kyiv (Zhulyany) on March 04, 2021, at 13:29 local time (UTC+2 hours) in a format of the mandatory occurrence reporting. The report informed of destroyed edge lights No. 42 and No. 44 found by the aerodrome service during a routine runway inspection. Due to absence of the information about the presence of a high safety risk level, the NBAAI did not take a decision to investigate the occurrence. On March 16, 2021, at 13:17 local time, the NBAAI received from the Municipal Enterprise International Airport Kyiv (Zhulyany) an additional report of the occurrence that was classified by the provider as a serious incident (take-off of the flight YRCMO to the south of RW-26 edge lights, during which, two runway edge lights were damaged.) On April 06, 2021, the NBAAI received a report on the results of the internal investigation into the occurrence from the Municipal Enterprise International Airport Kyiv (Zhulyany), assessed the safety risk as non-acceptable and decided to conduct an investigation. On April 13, 2021, at 12:12 local time, the NBAAI informed the Romanian Safety Investigation and Analysis Authority (SIAA) of the investigation initiation and requested to appoint the Accredited Representative. On April 14, 2021, the NBAAI forwarded the Notification of Serious Incident to ICAO and NTSB of USA as the State of Design and Manufacturer of the aircraft.

To assist in the investigation into the serious incident, the SIAA has appointed the Accredited Representative.

In accordance with the Part 3 of Article 119 of the Air Code of Ukraine, based on the results of the investigation, the NBAAI shall not take a decision on guilt or responsibility of legal entities and individuals. The purpose of this investigation is to prevent accidents and incidents in the future.

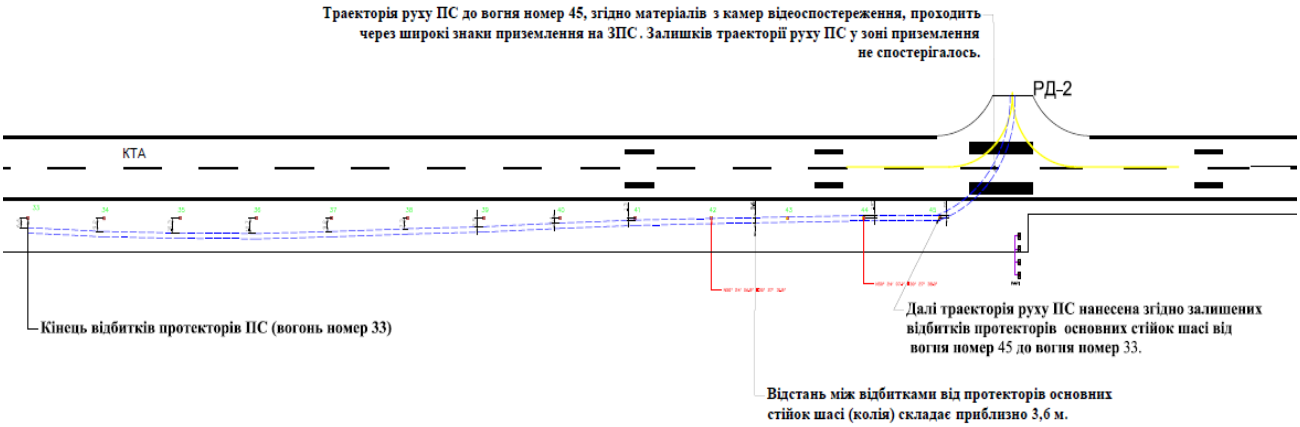
The present report and materials of the technical investigation cannot be used by administrative, official, public prosecutors, judicial authorities, insurers for establishment of fault or responsibility according to the requirements of Part 5 of Article 119 of the Air Code of Ukraine.

Note: This report is a translation of the Ukrainian original investigation report. The text in Ukrainian shall prevail in the interpretation of the report.

Synopsis. Brief Description of Serious Incident

On March 03, 2021, Cessna C510 YR-CMO aircraft operated by CONARG MOTION S.R.L. (Romania), at 18:13 (hereinafter – UTC), performed the flight YRCMO en-route UKKK-UKOO. The flight was performed at night under the visual meteorological conditions.

At taxiing-in RW-26, the aircraft crossed the runway, passed over the edge light No. 45 and took off over the left edge lights of RW-26 (Fig. 1.)



Inscription on the top of the Sketch: Aircraft movement trajectory till light No. 45 according to CCTV passes through wide touchdown marks on the runway. Aircraft movement trajectory remainders were not observed in the touchdown zone.

РД-2 = TW-2

Inscription on the left side of the Sketch: End of aircraft tread footprints (light No. 33)

Inscription on the bottom central side of the Sketch: Distance between the main landing gear tread footprints (wheel track) is about 3.6 m.

Inscription on the bottom right side of the Sketch: Further on, the aircraft movement trajectory is plotted according to the main landing gear footprints from light No. 45 to light No. 33.

Fig. 1. *Sketch of the serious incident with Cessna C510 YR-CMO aircraft.*

As a result of the encounter, the runway lights No. 44 and No. 42 were destroyed. The aircraft sustained no damage.

The difference between the local time and UTC time is +2 hours.

The investigation was conducted in accordance with the provisions of Annex 13 to the Convention on International Civil Aviation.

The Final Report is to be forwarded to the following addressees:

- NBAAI (original copy);

- State Aviation Administration of Ukraine (copy);
- Romanian Safety Investigation and Analysis Authority (SIAA) (copy);
- CONARG MOTION S.R.L. Airline (copy);
- Municipal Enterprise International Airport Kyiv (Zhulyany) (copy);
- State Air Traffic Service Enterprise (UkSATSE) (copy);
- International Civil Aviation Organization (ICAO) (copy).

The investigation was instituted on 06.04.2021.

The investigation was completed on 15.02.2022.

Contents

List of Abbreviations Used in This Report

AMSC	Aviation Meteorological Station Civilian
ATS	Air Traffic Service
AMM	Aircraft Maintenance Manual
AOM	Aircraft Operation Manual
CVR	Cockpit Voice Recorder
CTR	Control Traffic Zone
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
FPL	Flight Plan
HIL	High-Intensity Lighting
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
Kfriction	Friction Coefficient
MH	Magnetic Heading
MHlanding	Magnetic Heading for Landing
METAR	Meteorological Aerodrome Report
NOTAM	Notice to Airmen
PCN	Pavement Classification Number
PIC	Aircraft Pilot-in-Command
TAF	Terminal Aerodrome Forecast
TMA	Terminal Maneuvering (Control) Area
TW	Taxiway
UTC	Universal Time Coordinated

1. Factual Information

1.1. Flight History

On 04.03.2021, at 06:40, the shift supervisor of the UKKK Aerodrome Service (AS) entered the runway in the service vehicle for a routine inspection of the runway. At driving along the runway, the AS shift supervisor found damaged runway edge lights Nos. 42 and 44. The AS shift supervisor reported the damage of the edge lights to the shift engineer of the Electric Lighting Flight Support Service (ELFSS.) In order to repair the damage of the lights, ELFSS specialists arrived at the site and noted the damage to two lights, in particular: light No. 44 was completely destroyed, the light fragments were scattered in the area between lights No. 44 and No. 43. Light No. 42 had damage to the outer and inner dissipating lenses and their attachments. Faintly visible tracks from the wheels of the nose and main landing gears of the aircraft were found on the attachment bases of the No. 44 and No. 42 lights and along the line of the RW-26 left edge lights. The visible wheel track spacing was about 3.6 meters. AS and ELFSS specialists, and airport inspector-engineer photographed the damage and made the Sketch (Fig. 1.)

Having reviewed the recording from the video surveillance camera located in front of the RW – TW-2 junction, it was established that the take-off run over the runway lights could have been performed by Cessna C510 YR-CMO aircraft, which took off on 03.03.2021, at 18:13, en-route UKKK-UKOO.

On 03.03.2021, at 18:02:58, the crew of the Cessna C510 YR-CMO requested the Tower taxiing controller to clear the taxiing start. Aircraft taxiing from Stand L-8 to the approach end of TW-2 was performed on the apron behind the follow-me car. The crew then taxied along TW-2. After the crew's report of approaching the holding area near RW-26, the aircraft was switched to the Tower controller’s frequency. Ahead of the Cessna C510 aircraft, an An-74 aircraft of the National Guard of Ukraine was taxiing for take-off.

At 18:08:21, the Cessna C510 crew contacted the Tower air traffic controller and reported reaching the holding point near RW-26 on TW-2. The controller then allowed the crew to taxi-in RW-26 and instructed to hold for further commands.

At 18:12:15, the Tower controller cleared Cessna C510 crew’s take-off. According to the aircraft landing gear wheel tracks left along the runway, it was determined that the aircraft encountered edge lights Nos. 44, 43 and 42, then shifted to the left of the lights line and took off with the heading of 259º. As a result of the collision and encountering, lights No. 44 and No. 42 were damaged. The aircraft sustained no damage.

1.2. Injuries

As a result of the occurrence, nobody was injured.

1.3. Aircraft Damage

As a result of the occurrence, the plane was not damaged. Upon the aircraft return from UKOO to UKKK and placing at L-17 Stand, an airport inspector, together with a handling company representative, took pictures of the right main landing gear of the Cessna C510 YR-CMO aircraft. Red paint traces of from the spring-loaded markers of the runway edge lights were clearly visible on the right landing gear (Fig. 2).

Fig. 2. *Photo of the right landing gear with a red mark from the spring-loaded markers of the runway edge lights.*

1.4. Other Damage

As a result of the occurrence, the runway edge lights No. 42 and 44 were damaged.

Runway edge light No. 42:

the light upper part is damaged, in particular, the outer and inner dissipating lenses, and their attachments. The track from the aircraft landing gear wheel is visible on the light attachment base.

Fig. 3. *Destroyed runway light No. 42.*

Edge light No. 44:

the light is completely destroyed, the light fragments are scattered in the area between lights No. 44 and 43. On the light attachment base, the aircraft wheel track passing through the center of the attachment base is clearly visible.

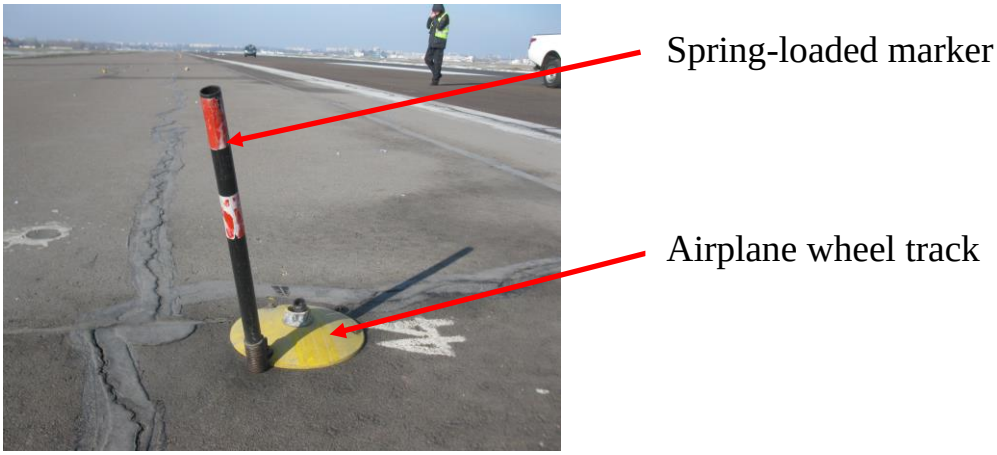


Fig. 4. *Destroyed runway light No. 44.*

1.5. Personnel Information

Position	**Pilot-in-Command**
Gender	Male
Age	55 years old
Total flight hours	6000 h
Flight hours on this type of aircraft	530 h
Flight hours for the last 24 hours	-
Flight hours for the last 7 days	10 h 25 min
Flight hours for the last 90 days	81 h
Pilot license number and date of issue	RO.FCL/ATPL/000940/A, 12.10.2020
Date of the last professional inspection	10.02.2021
Validity of Certificate of the ICAO 4th level of English language proficiency	Till 09.08.2024

Position	**First Officer**
Gender	Male
Age	59 years old
Total flight hours	14,000 h
Flight hours on this type of aircraft	887 h
Flight hours for the last 24 hours	-
Flight hours for the last 7 days	10 h 25 min
Flight hours for the last 90 days	81 h
Pilot license number and date of issue	RO.FCL/ATPL/000553/A, 12.10.2020
Date of the last professional inspection	10.02.2021
Validity of Certificate of the ICAO 5th level of English language proficiency	Till 15.09.2023

According to the information provided by the aircraft operator, on the eve of the flight, on March 2, 2021, the crew had a day off.

b) data on the ATM personnel of "Kyiv" (Zhulyany) Tower

Position	**Flight Supervisor**
Gender	Male
Age	52 years old
Education	Completed higher education, State Flight Academy of Ukraine (Specialist)
Validity period of the Air Traffic Controller Certificate	Till 12.04.2024
Sector/workplace admissions	- TWR/KK1 rating/supplement ADI/AIR, validity – till 12.04.2024; - TWR/KK2 rating/supplement ADI/GMC, validity - till 12.04.2024;

Medical Certificate validity period	Till 26.10.2021
Admission to work as Tower Flight Supervisor	Valid till 18.01.2024
Validity of Certificate of ICAO 4th level of English language proficiency	Till 23.03.2024

Position	**ATC Controller (acting as Senior Controller on the day of the occurrence)**
Gender	Male
Age	56 years old
Education	Completed higher education, State Flight Academy of Ukraine (specialist)
Validity of Air Traffic Controller Certificate	Till 25.09.2021
Sector/workplace admissions	TWR/KK1 rating/supplement ADI/AIR, validity – till 25.09.2021; TWR/KK2 rating/supplement ADI/GMC, validity - till 25.09.2021;
Medical Certificate validity period	Till 09.10.2022
Admission to work as Tower Flight Supervisor	Certificate validity – till 16.03.2023
Validity of Certificate of ICAO 4th level of English language proficiency	Till 15.07.2023

1.6. Aircraft Data

Aircraft	Cessna C510
MSN	510-0433
State and registration marks	YR-CMO
Operator	Conarg Motion
Manufacturer	Textron Aviation
Aircraft manufacture date	20.11.2013
Flight hours since new/last repair	1860 h/38 h
Engine No. 1:	
Engine type	PW615F-A
Factory number	LB0887
Operating time since new	1860 h
Engine No. 2:	
Engine type	PW615F-A
Factory number	LB0886
Operating time since new	1860 h

1.7 Meteorological Information

According to the information on the actual weather (MET REPORT) provided by the AMSC "Kyiv", at the time of the occurrence, the weather was as follows at "Kyiv" (Zhulyany) aerodrome:

at 18:00: wind in the touchdown zone of RW-26 250º 4 m/s, at the end of runway 250º 4 m/s, good weather conditions, air temperature + 02ºC, dew point temperature -02ºC, atmospheric pressure reduced to mean sea level according to standard atmosphere: 1023 GPa, atmospheric pressure at the runway threshold level: 1002 GPa, landing forecast – no significant changes;

at 18:30: wind in the touchdown zone of RW-26 230º 3 m/s, at the end of the runway 230º 2 m/s, good weather conditions, air temperature + 02ºC, dew point temperature -02ºC, atmospheric pressure reduced to mean sea level according to standard atmosphere: 1023 GPa, atmospheric pressure at the runway threshold level: 1002 GPa, landing forecast – no significant changes.

1.8. Navigation Aids

Information on the lighting system installed at the aerodrome

At the Kyiv (Zhulyany) aerodrome, a high-intensity lighting system has been installed and operated to ensure accurate approach, landing, taxiing and take-off of aircraft of the 1st ICAO category with the magnetic heading MHlanding 259º/079º. The length of approach lights with MHlanding 259º is 300 m. The system has been in operation since 2011. The manufacturer – IDMAN (Finland.) Certificate of Equipment Suitability for Operation No. AO 09-02-192 was issued by the State Aviation Administration and valid until 01.09.2023.

The lighting facilities include the following subsystems of lights:

- with MHlanding259º: edge lights, runway end lights, approach threshold lights, visual glide-path indication lights of PAPI-type, simple touchdown zone lights, approach, lead-in and crossbar lights 300 m long;

- with MHlanding079º: edge lights, runway end lights, approach threshold lights, visual glide-path indication lights of PAPI-type, simple touchdown zone lights, approach, lead-in and crossbar lights 900 m long, pulsed approach lights;

- edge lights of Taxiways-1,2,4, centerline lights on Taxiway-4, clearance bar on Taxiway-4, runway protection lights on Taxiway-1 and Taxiway-2, aerodrome signs, edge lights of runway expansion.

Runway Edge Lights

Edge lights, which include damaged lights No. 42 and No. 44, are IDM 5848/150W-type elevated 360 deg visibility lens lights.

Note*: the elevated-type lights are of a breakable design and located quite low above the ground to provide a margin of clearance to the aircraft propellers and engine nacelles.*

In places where the runway is widened and at joints with taxiways, bidirectional in-pavement lights such as IDM 4062/2x105W are installed. Edge lights are permanent white color radiation lights, yellow color radiation is on the last 600 m of the paved runway in the direction of aircraft landing. The average value of light intensity for the paved runway lights is more than 10 kilo-Cd. On the section from the paved runway approach end to the displaced threshold with MHlanding79º, the lights emit red color in the direction of aircraft landing.

The edge lights are equipped with spring-loaded “markers.”

Note: *the edge lights are additionally equipped with spring-loaded "markers" in order to prevent their damage during snow-clearing operations in the autumn-winter period (the corresponding recommendation is contained in paragraph 5.2.15 of the Manual on Aerodrome Service in Civil Aviation, according to which, when performing snow cleaning or snow compaction work, on the runway and other elements of the airfield, it is necessary to ensure that the landing lights and other lighting equipment are not damaged, and for this purpose, the lights and equipment should be marked with visual pinpoints, red flags or branches. Over the past few years, the "markers" have been used not only in winter, but remain for the whole year.*

The marker consists of a black polyethylene tube (diameter 32 mm, height 55 cm, wall thickness 2 mm) and a metal spring with a ring (spring height 7 cm, inner diameter 32 mm.) On the top of the tube, there are two red reflective strips glued to it.

According to the specialists of the Electric Lighting Flight Support Service (ELFSS), the height of the tube was chosen on the basis that it should not exceed a height equal to the height from the ground to the lowest point of the aircraft engine (for the aircraft with the engine under the wing) and the height of the snow cover, based on experience and observations of the past autumn-winter periods

From the explanations of the ELFSS electromechanical technician, on 04.03.2021 at 06:50, before leaving for a scheduled inspection of the lighting equipment, the shift engineer of the airfield service informed the ELFSS shift engineer about the detection of two damaged lights on the runway. Upon arrival at the site, two runway edge lights damage was found, i.e.: edge light No. 44 was completely damaged, its fragments were scattered in the area between lights No. 44 and No. 43; and light No. 42 had a damaged upper part, namely, the outer and inner dissipating lenses and their attachments. Works were then carried out to restore the functionality of the damaged lights by replacing them with new ones.

Fig. 5. *Photo of damaged runway edge light No. 42*

Fig. 6. *Photo of the base of the attachment of destroyed runway edge light No. 44*

As explained by the ELFSS chief and specialists, after the lights were restored to serviceability, the last recorded events of the lighting condition were analyzed by the remote control and monitoring equipment. As a result of the analysis, it was found that this equipment did not record the cessation of operation of the two runway edge lights, because, as it later turned out, despite the damage to the upper part of the light No. 42, the light continued to work, and the manufacturing plant made such settings of the system, in which the occurrence is recorded only at failure of two or more lights connected to the same brightness controller.

Note*: The Investigation Team visited the workplace of the ELFSS electromechanical technician and found that the monitor of the lighting remote control and monitoring equipment is installed in such a way that it is on the side of the electromechanical technician and does not allow him to constantly monitor the lighting operation. At the same time, in case of failure of one or another light subsystem, the light alarms on the main display of the monitor are accompanied by audible alarms.*

During the runway edge lights inspection on 27.04.2021, the Investigation Team recorded that one of the threaded rods, on which the light attachment base was installed,

protrudes over the base-locking nut; that can damage the tire and pose a hazard in case of encountering the light attachment base.

Fig. 7. *Photo of the renewed runway edge light No. 44*

As explained by the ELFSS specialists, during the reconstruction of the aerodrome in 2010-2011, threaded 11.5 cm-long rods M10 and the special mastic, which hardened after reaction with a thickener and firmly held the rod in the asphalt pavement, were used to install the elevated-type lights. Three of these rods were used. The light base was then placed on these rods and secured with nuts. The height of the rod above the base body was about 10-15 mm. Over time, the mastic cracks around these rods, which can cause the rod protrusion or bad locking. Thus, there are no restrictions on the height of the rod above the base body in the aerodrome's technological or instructional documents. That is, during the light maintenance, those parameters, for which there are no requirements in the regulatory documentation, are taken by ELFSS specialists on the basis how they looked at the time of putting into service. In general, the requirements for the personnel's actions during the lights maintenance are described in paragraph 5.3 of Procedure 10 for the inspection, as well as planned and emergency maintenance of visual and non-visual approach and landing aids, and aerodrome electrical system (Part E of the Aerodrome Manual.)

1.9. Communication

The radio exchange between the crew and ATS controllers was carried on the operating frequencies of the Tower of Kyiv (Zhulyany) Aerodrome.

1.10. Aerodrome Information

"Kyiv" (Zhulyany) Aerodrome is a certified civil aviation aerodrome listed in the State Register of Civil Aerodromes of Ukraine. The Aerodrome Certificate No. AP 09-02 in force on the date of the occurrence, was valid till March 16, 2021.

On March 17, 2021, the State Aviation Administration of Ukraine issued the Aerodrome Certificate No. UA-004 in compliance with the Aviation Regulations of Ukraine "Technical Requirements and Administrative Procedures for Aerodrome Certification."

The owner of the aerodrome is the Kyiv City State Administration, the operator is the Municipal Enterprise "Kyiv" (Zhulyany) International Airport."

The paved runway has the dimensions of 2310x45m (with two take-off and landing headings – MH 79º/MH 259º), pavement type – mixed, PCN 46/R/C/X/T, equipped for I category precision approach. On MHlanding259º, the runway threshold is displaced by 48m, on MHlanding79º it is displaced by 150 m.

The aerodrome class is B (4C).

The aerodrome is suitable for day and night operations all year round.
The aerodrome elevation is 179 m.
Magnetic dip is 7ºE.

Runway Status Information

Date	Runway Inspection Time (UTC)	Aerodrome Status Log Records
03.03.2021	15:40	Paved Runway MH259 is wet, Kfriction = 0.58/0.58/0.58, treated with a liquid anti-icing agent the braking action was assessed as "Good", R26/190058. No. foreign objects found.
	17:01	
	19:14	
	20:58	
	23:03	
04.03.2021	02:20	Paved Runway MH259 is wet, Kfriction = 0.58/0.58/0.58, treated with a liquid anti-icing agent the braking action was assessed as "Good", R26/190058. No. foreign objects found.
	04:42	
	06:15	
	06:52	

Note:

- In accordance with Clause 6.1 of the Flight Services Interaction Technology at Works on Movement Area of Kyiv (Zhulyany) Aerodrome dated 22.02.2018 No. 7.4-06-01, inspection and evaluation of the surface condition of paved surfaces of the movement area, as well as runway friction coefficient measuring shall be performed by the officials (shift supervisor, shift engineer) of aerodrome service during their shift acceptance, during changes in the surface condition, during changes in air temperature crossing 0ºC and at least once every three hours of duty at no precipitations. In case of intensive rainfall (rain, dry snow, wet snow, fog, etc.) the state of the aerodrome pavement shall be inspected every 30 minutes at least. Thus, there were no violations by employees of the aerodrome service in terms of compliance with the inspection frequency and assessment of the airfield status during the above-mentioned period;

- from the explanatory note of the aerodrome service shift supervisor: on 04.03.2021, at 06:40 UTC, he entered the runway for a routine inspection and found two damaged edge lights – No. 42 and No. 44. At the same time, the information about the found damaged lights in the record for 06:52 is not mentioned in the Airfield Status Log.

During inspection of the runway and aircraft taxiing routes on 29.04.2021, the Investigation Team noted the fact that marking of the runway centerline, especially in the touchdown zones with both landing headings, is not clear because of the presence of rubber traces on it and requires renewal.

Fig. 8. *Photo of the runway centerline marking state*

At the same time, the Certification Specifications developed for the Aviation Regulations of Ukraine "Technical Requirements and Administrative Procedures for Certification of Aerodromes" contain requirements only for the location and size of the runway centerline. However, there are no requirements for the marking clarity,

brightness, renewal frequency. The airport guiding documents, which regulate the aerodrome service activities and airfield operation procedure, lack the criteria for assessing the state of the aerodrome elements marking, in particular, the runway centerline state.

1.11. Flight Recorders

The aircraft is not equipped with recording means.

1.12. Wreckage and Impact Information

Not relevant.

1.13 Medical Information and Brief Post Mortem Examination Results.

Not relevant.

1.14 Fire.

Not relevant.

1.15 Survival Factors

Not relevant.

1.16. Tests and Research

Not conducted.

1.17 Information on Organizations and Administrative Activities Related to Occurrence

Not relevant.

1.18 Additional information

2. Analysis

According to FPL, at 18:00, on 03.03.2021, the crew of Cessna-510 aircraft, state and registration mark YR-CMO, operated by "CONARG MOTION SRL", consisting of PIC and First Officer, was planned to perform a nonscheduled flight YRCMO en-route Kyiv - Odessa.

Note: *The aircraft arrived at Kyiv (Zhulyany) aerodrome from Prague at 18:55 on 01.03.2021. On the eve of the event, on 02.03.2021, the crew had no flights.*

The crew had a pre-flight briefing 2 hours before the flight and used the Jeppesen Navigational Charts permitted by the airline, placed on Electronic Flight Bags, and attached taxiing charts. The crew had previously flown to Kyiv (Zhulyany) aerodrome several times – had 8 take-off/landing operations for the last 90 days before the day of the occurrence. The flight was performed in darkness in the visual conditions.

According to the transcript of radio exchange between the aircraft crew and Kyiv (Zhulyany) Tower Controller, at 18:02:58, the crew requested the Tower taxiing controller for clearance to start taxiing. Aircraft taxiing from Stand L-8 to the TW-2 approach end was performed behind the follow-me car. The crew then taxied along TW-2. After the crew's report of approaching the holding area near RW-26, the aircraft was switched to the Tower controller's frequency. Ahead of the Cessna C510 aircraft, an An-74 aircraft of the National Guard of Ukraine was taxiing for take-off.

At 18:08:21, the Cessna C510 crew contacted the Tower air traffic controller and reported reaching the holding point near RW-26 on TW-2. The controller then allowed the crew to taxi-in RW-26 and instructed them to hold for further commands. According to the footage of the surveillance camera located in front of the TW-2 junction with RW-26, at 18:10, the Cessna C510 aircraft crossed RW-26, passed over edge light No. 45 and stopped along the edge (left) lights of RW-26 (see Figure 1. Sketch of serious incident with Cessna C510 YR-CMO aircraft.)

The Tower controller could not see from his workplace the aircraft position relative to the runway centerline. According to the Zhulyany aerodrome Tower ATS specialists, it is impossible or difficult to observe the aircraft location from the Tower controller's workplace in the dark time of day.

Note: *video recordings from video surveillance camera No.3 were provided to the commission of ME "IA "Kyiv" (Zhulyany).*

According to the Instruction on Use of Ground Surveillance Means at TOWER Workplace of Kyiv (Zhulyany) Tower dated 28.05.2019 No. 4.4.15-14-1, approved by the Head of Kyiv ATS of UkSATSE, one of the ground surveillance means of the TOWER workplace is a monitor of the apron and runway surveillance, which displays information from 4 video cameras. Camera No. 3 displays the TW-2 connection with the runway.

According to sub-paragraph h) of paragraph 2.3 of the Kyiv/Zhulyany Aerodrome Control Tower Operating Instruction, the monitor of the apron and runway surveillance is an auxiliary device, which is used exclusively for performing auxiliary functions (operations) at the TOWER controller workplace.

According to paragraph 4 of the Kyiv/Zhulyany Aerodrome Control Tower Operating Instruction, the Tower ATC controller should constantly monitor all flights over and around the aerodrome, as well as the movement of vehicles and people in the aerodrome maneuvering zone: visually and/or by means of surveillance cameras; in areas not observed visually and in low visibility conditions – by reports from the crew or vehicle driver.

At 18:12:15, the Tower controller cleared Cessna C510 crew's take-off. According to the aircraft landing gear wheel tracks left along the runway, it was determined that the aircraft encountered edge lights Nos. 44, 43 and 42, then shifted to the left of the lights line and took off with the heading of 259º. As a result of the collision and encountering, lights No. 44 and No. 42 were damaged. The aircraft sustained no damage.

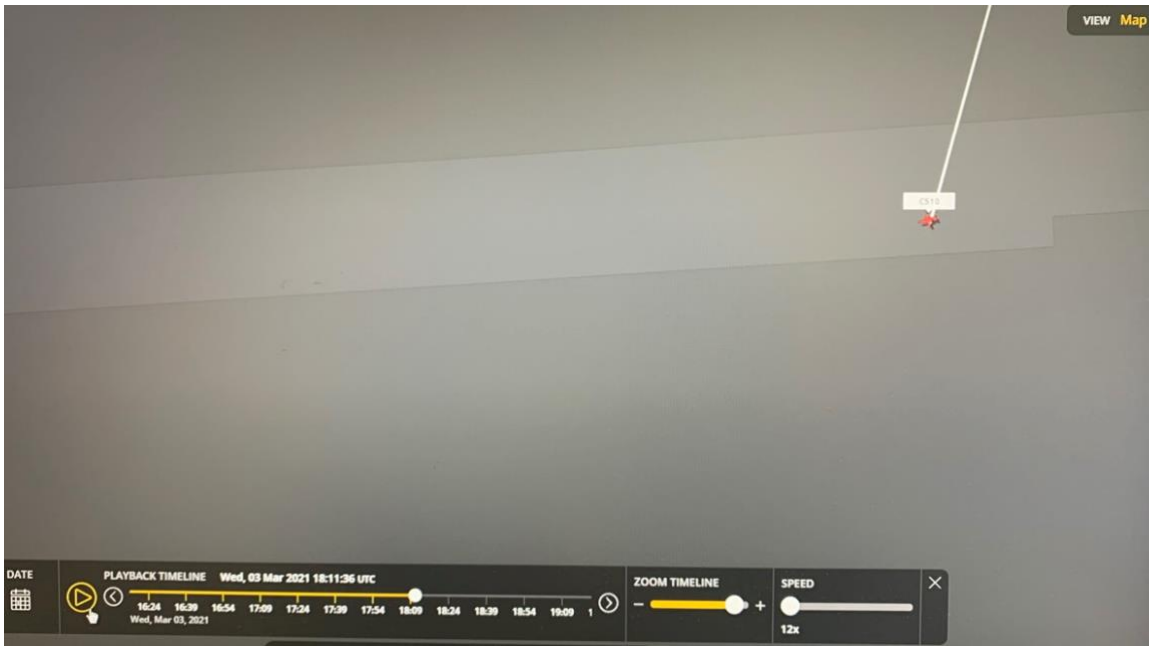


Figure 9. *Aircraft movement diagram from Flightradar24 website*

Flightradar24 website data, which was used in the investigation, indicates that during taxiing before take-off, the aircraft was significantly shifted to the left of the runway centerline (see Fig. 9).

According to the crew, during taxiing, take-off and touchdown, the pilots felt or heard no any unnormal things, and no parameters of the aircraft systems changed. Also, during the pre-flight and post-flight aircraft inspection, no abnormalities related to the technical condition of the aircraft were found.

On 04.03.2021 at 06:40, the shift supervisor of the UKKK aerodrome service (AS) drove onto the runway in the service vehicle for a routine inspection of the runway. During the inspection, damage of runway edge lights Nos. 42 and 44 was found. The AS shift supervisor reported the damage of the edge lights to the shift engineer of the Electric Lighting Flight Support Service (ELFSS). In order to repair the damage of the lights, ELFSS specialists arrived at the site. Damage to two lights was found on the runway, in particular: light No. 44 was completely destroyed, the

light fragments were scattered in the area between lights No. 44 and No. 43. Light No. 42 had damage to the outer and inner dissipating lenses and their attachments. AS and ELFSS specialists, and airport inspector-engineer photographed the damage and made the sketch at the occurrence site. Faintly visible tracks from the wheels of the aircraft main landing gears were found on the attachment bases of lights No. 44 and No. 42 and along the line of the RW-26 left edge lights. The visible wheel track spacing was about 360 cm. Having reviewed the recording from the video surveillance camera located in front of the RW–TW-2 junction, it was established that the take-off over the runway lights could have been performed by Cessna C510 YR-CMO aircraft, which took off on 03.03.2021, at 18:13, en-route UKKK-UKOO.

The NTSB was requested for the data regarding the dimensions of the Cessna C510-type aircraft – in order to confirm the assumption about the type of the aircraft that left tire tracks while performing take-off from the RW-26 shoulder. According to the information provided by the aircraft manufacturer, the track width of the Cessna C510 aircraft is 11.79 feet (3 m 59 cm), which corresponds to the track width left on the left shoulder of RW-26.

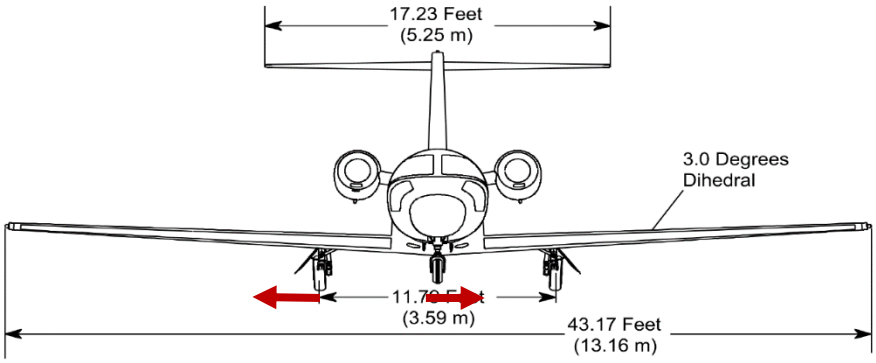


Fig. 10. *Dimensions of the Cessna C510-type aircraft*

According to the daily flight plan for the corresponding period of March 3 and 4, no other aircraft, besides the Cessna C510 YR-CMO, departed with the similar landing gear wheel track width.

In addition, it should be noted that before the reconstruction of the Kyiv (Zhulyany) aerodrome, which took place in 2008-2009, the runway had dimensions of 1800x80m. Now the runway width is 45 m, but the concrete pavement of 17.5 m on both sides of the existing runway remained at a distance of 1800 m from Taxiway 2. Due to the presence of concrete pavement areas outside the runway width, the crew may have believed that the runway width was larger than it actually was and mistakenly perceived the southern runway edge lights as runway centerline lights, and started the take-off run over the runway edge lights line.

3. Conclusions

1. The PIC and First Officer have acting flight personnel certificates and medical certificates as required by the civil aviation authority.

2. The aircraft is entered into the Romanian Aircraft State Register and has the Airworthiness Certificate.

3. The level of training of the PIC and First Officer corresponded to the flight assignment performance.

4. The crew was not aware that the aircraft was taking off from the left shoulder of RW-26.

5. According to the crew's explanations, they did not notice any abnormalities in the operation of the aircraft systems during the stages of taxiing, take-off from Kyiv (Zhulyany) aerodrome, en-route flight and landing at Odessa aerodrome.

6. The analysis of departures/arrivals from/to Kyiv (Zhulyany) Airport, the nature of damage to the runway edge lights, width of the landing gear track and traces of paint from the spring-loaded marker of the edge light on the right main landing gear of the aircraft, which were recorded by the Kyiv (Zhulyany) Airport's Flight Safety Inspection, indicates that the Cessna C510 YR-CMO aircraft encountered the lights as a result of taking off along the left edge lights row of the runway.

4. Causes

The investigation failed to establish the cause of the serious incident – CESSNA C510 YR-CMO aircraft take-off from the left shoulder of RW-26, which took place on 03.03.2021 during take-off from Kyiv (Zhulyany) aerodrome.

The fact of the aircraft take-off run along the left row of the runway edge lights may indicate that the crew mistakenly perceived the runway edge lights in the dark time of day as the runway centerline lights, which are not present in the aerodrome lighting.

5. Recommendations

5.1. To: State Air Traffic Service Enterprise

In order to improve the control over aircraft location and movement along the runway and taxiways – improve the quality of the existing equipment or install the additional one that would allow aircraft surveillance from the Tower controller's workplace.

5.2. To: Municipal Enterprise International Airport "Kyiv" (Zhulyany)

In the Aerodrome Operating Procedures – describe the requirements for:

- frequency of control over the lighting operability by means of the operational control monitor located at the workplace of the shift engineer of the operational group of the Electric Lighting Flight Support Service;

- strict observance of paragraph 5.3 of Procedure 10 for inspection, as well as planned and emergency maintenance of visual and non-visual approach and landing aids, and aerodrome electrical system (Part E of the Aerodrome Manual), in particular, as regards the lights maintenance and replacement, and check of light fitting attachment reliability;

- criteria for assessing the state of the aerodrome elements marking for the purpose of timely renewal of the marking.

5.3. To: CONARG MOTION S.R.L.

Add the Standard Operating Procedures and checklists with the requirement that the PIC and co-pilot, prior to take-off, should jointly verify that the aircraft is on the runway centerline, especially, at the aerodromes with no runway centerline lights.

Appendix

to the Final Report on Investigation into Serious Incident (Take-Off from Left Shoulder of RW-26), Which Took Place with Cessna C510 Aircraft, Nationality and Registration Mark YR-CMO, on March 03, 2021, During Performance of Flight En-Route Kyiv (Zhuliany) – Odesa

Comments of Civil Aviation Safety Investigation and Analysis Authority of Romania.

No.	Comments	Decision on Taking into Account	Investigation Team's Rationale
1	Aircraft at take-off follows a rectilinear trajectory, during which it accelerates continuously. In our case the YR-CMO aircraft, the movement was performed from edge light no. 45 to edge light no.33 (figure 1 in the report). It is unlikely that, during this movement, the edge light no.43 not to be affected, being between edge light no.44 and no.42 (both damaged).	Rejected	According to the sketch drawn up at the occurrence site according to the aircraft wheel tracks remained, during the aircraft line up, the edge light No.45 was between the nose landing gear and left main landing gear. During the take-off run, the nose landing gear wheel knocked down light No.44. The aircraft passes light No.43 between the nose landing gear and right main landing gear. The right main landing gear door damages the upper part of light No.42. In addition, surveillance camera footage and Flightradar24 data indicate that the YR-CMO aircraft started its movement almost over the runway edge lights.

2	It was been identified visible traces of landing gear wheels from edge light 45 to edge light 33. An aircraft tire leaves marks on the tread during BRAKING process, immediately after contact with runway, by no means in the take-off phase, when the aircraft is in the process of ACCELERATION. In addition, according to Aerodrome Status Log Records, the runway was wet at the time of the incident and treated with liquid anti-icing agent every 3 hours from 03.03.2021, 15:40 UTC to 04.03.2021, 6:52 UTC – that means the runaway will not keep the traces.	Rejected	The surveillance camera footage shows that the Cessna-510 started its movement with a deviation, almost over the runway edge lights. According to the Flightradar24 data, as well as to the aircraft wheel tracks remained, the aircraft started its movement along the row of the left edge lights. There were no aircraft landings at this time with a similar landing gear wheel tracks. During the runway operation, the shoulder surface is contaminated by dust and dirt, which are washed away from the runway, and, consequently, the traces remain on the shoulders and along the edge lights. In addition, according to the information set out in the Airfield Status Log, the runway was wet, which also enabled the tire traces to remain. We also note that the tire tread traces left at the aircraft landing are different from those left at the take-off run.
3	Figure 4 shows the edge light no. 44 destroyed / missing, but does not show fragment of bulb or protective body. Instead, edge light no. 42 there are damaged fragments of the edge light around its vertical body. Considering the dynamics of the aircraft in take-off phase, it would have been normal for edge light no.44 to be less damage that the edge light no.42. In this case, edge light no. 44 was completely destroyed and scattered towards edge light no.43, and similarly fragments of edge light no. 42 should	Rejected	Figure 4 shows the consequences of destruction of the edge light No.44. This photo was taken after the light fragments had been removed by the airfield staff as foreign objects for safety reasons. Unfortunately, the person, who had first arrived at the occurrence site, did not record the destroyed light, and the flight safety inspection documented by that time the consequences of hitting the light. The same thing happened with the photo of edge light No.42.

	have been found scattered towards edge light no. 41 and not around the edge light mounting bracket. Considering the position of the landing gear wheel tracks in relation to the body of edge light no. 42, it could not remain upright after impact, as it would have been hit by the landing gear hatch (located outwards of the wheel), which should have suffered damages.		The elevated-type lights, to which the runway edge lights are attributed, are of a frangible design, which prevents serious damage upon impact.
4	During the passage over the middle of edge light no. 44 and its destruction, due to its relatively small size, the aircraft should present a braking moment on the right wheel of the main landing gear and consequently a moment of rotation to the RIGHT. It is very unlikely that the crew did not felt/notice this.	Rejected	The elevated-type lights, to which the runway edge lights are attributed, are of a frangible design, which prevents serious damage upon impact. At the same time, the Investigation Team considers that the crew must have heard the sound of the impact.
5	In the photos received from NBAAI on 13.04.2021, there are inconsistencies between the dimensional values of the tracks existing on the mounting bracket of the 2 edge lights and the dimensional values of the tire profile of the main right landing gear. Therefore, the traces on edge light no. 44 are different from those on edge lights no.42, under the conditions in which that the same wheel hit both edge lights. These issues should have been clarified and analyzed in the investigation report.	Rejected	The traces on the bases of lights No.44 and No.42 are indeed different because, according to the tracks left by the aircraft and the occurrence site sketch, the edge light No.44 was hit by the wheel of the nose landing gear, and light No.42 was hit by the door of the right main landing gear.
6	It is unlikely that a CESSNA 510 Mustang aircraft will not suffer serious landing gear damage (hatch mechanism and landing gear hatch, landing gear lock, landing gear tire, etc.) after the destruction of one edge light and damage to second one.	Rejected	Upon return from Odesa, the crew was interviewed by a flight safety inspector in the presence of a handling company representative, during which, the crew was told that there were traces of red paint from the spring-loaded marker on the right landing gear. At the inspector's request, the crew was unable to explain the origin of these traces. At the same time, the crew offered to compensate the airport for the destroyed edge lights.

			The elevated-type lights, to which the runway edge lights are attributed, are of a frangible design, which prevents serious damage upon impact. *According to paragraph 5.3.1.6 of ICAO Annex 14, "Elevated runway, stopway and taxiway lights shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft".* ***(Frangible Object.** An object of low mass that is structurally designed to collapse, deform, or bend in the event of impact so as to present minimal danger to the aircraft.)*
7	Considering the dynamics of the aircraft's movement and the level of damages at edge lights no.44 and no.42, it is likely that they were damaged by an aircraft larger than the Cessna 510 Mustang, possibly during landing in direction 26.	Rejected	According to the daily flight plan, there were no larger aircraft on the runway at that time. Moreover, the width of the landing gear tire footprint corresponds only to the width of the landing gear wheel track of the Cessna-510 aircraft.