

**NATIONAL BUREAU
OF AIR ACCIDENTS INVESTIGATION OF UKRAINE**

**AIRCRAFT COLLISION WITH THE GROUND DURING LANDING
APPROACH**



TYPE OF OCCURRENCE: FATAL ACCIDENT

AIRCRAFT OPERATOR: PJSC "AIRLINE "UKRAINE-AIR ALLIANCE"

AIRCRAFT TYPE: AN-12BK

REGISTRATION NUMBER: UR-CAH

OCCURRENCE SITE: 1117 M TO RW-31 THRESHOLD OF LVIV AERODROME

STATE OF OCCURRENCE: UKRAINE

OCCURRENCE DATE: 04.10.2019

This Report is published for the sole purpose of future accident prevention

APPROVED BY

Acting Director
of the National Bureau of
Air Accidents Investigation

Igor MISHARIN

«__»_____ 2021

FINAL REPORT
of Technical Investigation into Fatal Accident with An-12BK UR-CAH
Aircraft Operated by PJSC «AIRLINE «UKRAINE-AIR ALLIANCE»,
Which Took Place on 04.10.2019 During Landing Approach at Lviv
Aerodrome

Kyiv City

«__»_____ 2021

The Investigation Team of the National Bureau of Air Accidents Investigation (hereinafter – NBAAI) has conducted the investigation into the fatal accident that occurred on 04.10.2019 with An-12BK UR-CAH aircraft during the landing approach at the Lviv aerodrome.

Note:

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

Abbreviations Used in Final Report

SAS – State Aviation Administration of Ukraine;
GPB – glide path beacon;
Local time – time in Ukraine;
OM – Operation Manual;
FOM – Flight Operation Manual;
PIC – aircraft pilot-in-command;
NBAAI – National Bureau of Air Accidents Investigation;
MH – magnetic heading;
TM – torque meter;
TPI – throttle position indicator;
ATS SE – Air Traffic Service of State Enterprise of UkSATSE;
ICAO – International Civil Aviation Organization;
ARW – artificial (paved) runway;
EGPWS – Enhanced Ground Proximity Warning System;
SIGMET – Significant Meteorological Report – decoded warning on the relevant Flight Information Region on the forecasted special weather phenomena that affect the aircraft safety;
FRMS – Fatigue Risk Management System.
UTC - Universal Time Coordinated;
OFP – Operational Flight Plan;
MHI – magnetic heading instrument;
TCO - Third Country Operators;
Lp – takeoff distance;
Vun – unstick speed;
W – wind speed;
Θ – angle of runway inclination;
Hrw – runway elevation;
δfl – flaps angle;
Vclimb – climb speed;
Vinstr – speed by instruments;
Lgpb – distance to the glide path beacon;
Habs – absolute altitude.

Accident Information (Synopsis)

On 04.10.2019, at night, at 03:43 UTC (06:43 local time), during approach at the Lviv aerodrome (UKLL), under low-visibility conditions (fog), a fatal accident took place of An-12BK aircraft, registration number UR-CAH, which was under operation of the PJSC «AIRLINE «UKRAINE-AIR ALLIANCE» performing flight UKL4050 en-route Vigo (Spain) - Lviv (Ukraine).

Five members of the flight crew suffered fatal injuries in the fatal accident. Two aviation technicians and replaced flight engineer, who were on board, were seriously injured. As a result of the accident, the aircraft was destroyed and is beyond repair.



The NBAAI was not informed about the fatal accident by the Lviv aerodrome operator, airline operating the aircraft and ATS unit.

The NBAAI received preliminary information about the crash from the mass

media and made a corresponding request to the State Aviation Administration.

On 04.10.2019 at 10:00 (local time), the State Aviation Administration provided a copy of the notification of the occurrence received at 07:00 from the ATS SE Lviv aerodrome. At the request of the NBAAI, PJSC «AIRLINE «UKRAINE-AIR ALLIANCE» sent a report about the accident. At 11:08 am (local time) on 04.10.2019, the NBAAI sent a report of the accident to ICAO and requested investigation authorities of France (BEA), Spain (CIAIAC) and EASA to assist in establishing the circumstances of the accident and collecting relevant information.

According to the Standards and Recommended Practices of the International Civil Aviation Organization, this report is published with the sole purpose of prevention of the future aviation accidents.

According to the second paragraph of the fifth part of Article 119 of the Air Code of Ukraine, the report and materials of the technical investigation cannot be used by administrative, service, prosecutorial, judicial authorities, insurance organizations to establish guilt or liability.

Investigation of the accident was carried out according to the provisions of Annex 13 to the Convention on International Civil Aviation and Air Accidents and Incidents Investigation Manual approved by Order of the NBAAI dated 28.01.2013 No. 6 (as amended).

Investigation was instituted on 04.10.2019.

Investigation was completed on 01.10.2021.

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1. Factual Information

1.1. History of the Flight

On 03.10.2019, the crew of An-12BK UR-CAH aircraft operated by PJSC «AIRLINE «UKRAINE-AIR ALLIANCE», consisting of flight crew members and two aircraft technicians, performed flight UKL4010 en-route Toronto (Canada) - Toulouse (France) and at 06:15 UTC, it landed at the Toulouse aerodrome (France). The plane delivered 1537 kg cargo to the Toulouse aerodrome (France). After the completion of post-flight procedures, the flight crew went to rest at the hotel, while the technicians remained on the aircraft to perform technical works.

The next flight was scheduled from Toulouse to Birmingham airport (Great Britain). However, during the day, at the initiative of the operator, it was decided to change the route and perform the flight en-route Toulouse - Vigo (Spain) - Istanbul (Turkey).

At the Toulouse aerodrome, the plane was filled with 6,000 liters of fuel. Also in Toulouse, a flight engineer was replaced. At 16:16 UTC, the plane took off from Toulouse to Vigo without cargo.

Landing at the Vigo aerodrome (Spain) was performed on 03.10.2020 at 18:20 UTC.

***Note:** The difference between local time and UTC is 3 hours.*

During the flight preparation at the Vigo aerodrome, the crew received an operational flight plan (OFP) from the airline's dispatch service by e-mail, containing calculated flight data, information on actual and forecasted weather conditions en-route Vigo - Lviv, at the departure, landing and alternate aerodromes, calculation of the aircraft take-off weight, air navigation fuel reserve. At the Vigo aerodrome, the plane was filled with 13502 liters of fuel.

According to the weather forecast used by the crew during the flight preparation, for the estimated arrival time at the Lviv aerodrome, visibility of 500 meters, light shower rain, fog, broken clouds with 60 meter ceiling were temporarily forecasted.

***Note:** The information on meteorological conditions at the landing and alternate aerodromes is set out in section 1.7 Meteorological Information.*

At the Vigo aerodrome, the plane was loaded with vehicle spare parts with a total weight of probably 14078 kg.

From the Vigo aerodrome (Spain), the plane took off on 03.10.2019 at 22:20, flight UKL4050, with a delay of 2 h 20 minutes.

On 04.10.2020, at 03:17:29 UTC, the plane approached the airspace border of the Lviv control area. The crew contacted the controller of the Lviv ACC of LVE + LVW sector and reported about the approach to waypoint MALBE at FL250. The controller informed the crew about the establishment of the radar identification of the aircraft and instructed to wait for the procedure for radar guidance to RW-31 using the ILS system.

At 03:20:27, under instruction the ACC controller, the crew listened to the ATIS "Romeo" information as follows:

“Lviv, ATIS “Romeo” for 03:20. The ILS approach at the aerodrome uses low visibility procedures. Runway in use is RW-31. Runway surface condition known at 19:53 - wet, clear. The measured friction coefficient is 0.55. Estimated surface friction assessed as good. Transition level - 110. Warning: large flocks of birds in the aerodrome area and on the landing final. There is no wind. Visibility - 150 meters; visibility range on the runway at the touchdown point - 550 meters, in the middle of the runway - 550 meters, at the end of the runway - 550 meters, fog. Vertical visibility - 50 meters. Temperature + 3°C, dew point + 3°C. Atmospheric pressure QNH - 1013 hectopascals, QFE - 974 hectopascals. Weather forecast for TREND landing: visibility sometimes is 400 meters, fog; vertical visibility - 60 meters. Attention: the frequency "Lviv-taxiing" does not work, while taxiing, get in touch with the "Lviv-Tower" at a frequency of 128.0 MHz. Please acknowledge receipt of Romeo's information.” ATIS information was transmitted in English.

At 03:22:14, the crew informed the controller about the completion of listening to ATIS information and received clearance to descend to FL120.

At 03:22:40, the aircraft began its descent from FL250 and at 03:28:35 switched to the frequency of the ACC controller of the LVT sector.

After contacting the controller of the ACC of the LVT sector, the crew reported a descend to FL120 to KOKUP point.

At 03:29:08, the ACC controller of the LVT sector instructed the crew to continue descending to an altitude of 10,000 feet at atmospheric pressure QNH-1013 hPa, reported the transition level, and instructed to wait for radar guidance for ILS approach on RW-31.

The crew confirmed the instruction to descent to 10,000 feet, QNH, transition level and reported expectation for radar guidance.

At 03:30:14, LVT sector ACC controller began radar guidance.

At 03:32:49, the controller instructed the crew to descend to 4,000 feet.

At 03:35:33, LVT sector ATC controller instructed to descend to an altitude of 3200 feet, taking into account the temperature correction.

Note. In accordance with paragraph 14.2 of the Regulations on Air Traffic Services Using Surveillance Systems approved by Order of the Ministry of Infrastructure dated 07.11.2011 No. 521, registered with the Ministry of Justice on 01.12.2011 under No. 1382/20120, during vectoring using surveillance systems, the aircraft, which performs a flight according to IFR along a straightened route, which provides for a deviation of the aircraft from the ATS route, the air traffic controller should give to the aircraft crew such control clearances that could always maintain sufficient Minimum Obstacle Clearance until the aircraft crew returns to the independent navigation. If necessary, the corresponding minimum vectoring altitude should include a correction for the low temperature effect.

The procedure for temperature correction at determination of flight levels by an air traffic controller during the radar vectoring was published in the Aeronautical Information Publication of Ukraine, UKLL AD 2.24.7-1 dated 12.09.2019.

At 03:38:33, the ATC controller of the LVT sector provided the crew with information about its location of 27 km from VOR/DME LIV, instructed by the left turn to take a 340° heading, cleared the ILS landing approach to runway 31 and gave the control instruction to inform of “the localizer beam capture.”

At 03:40:01 (the height above the runway was 1170 m, descent rate: -4 ... -4.5 m/s, speed 352 km/h, distance from the runway threshold: 15.7 km), the crew reported of the localizer beam capture.

Radar data for 03:40:01



At 03:40:09, ATC controller of LVT sector instructed the crew to continue the ILS approach to RWY 31.

At 03:40:26, the controller informed the crew about the weather conditions at the aerodrome: RW-31 runway visual range (RVR) in the touchdown zone – 800 meters, in the middle of the runway – 800 meters, at the end of the runway – 750 meters, vertical visibility – 60 meters, fog.

The crew confirmed receipt of the information.

At 03:41:22, the ATC controller of LVT sector instructed to switch the communication to the ATC Lviv controller at a frequency of 128.0 MHz.

Radar data for 03:41:22



There were no irregularities in air traffic servicing of the An-12 aircraft, flight UKL4050, during the flight in the area of responsibility of the TMA Lviv "LVT" sector.

To enter the glide path, the PIC increased the vertical descent rate.

At 03:41:47, the crew established communication with the Tower controller. The distance from the threshold was 11.3 km, the elevation over the glide path was 70 m, the vertical rate of descent was -5.5 ... -6 m/s.

After communication with the air traffic controller, the crew reported an ILS approach to RW-31 and the atmospheric pressure QNH setting of 1013 hPa.

At 03:41:58, the Tower controller informed the crew about the absence of wind on the surface of RW-31 and gave clearance to land.

The crew confirmed the landing clearance. According to the recorders, at this time the distance to the touchdown point was 7.58 km, the plane was 11 m below the glide path, the vertical descent rate was -4.5-5.5 m/s, and the speed was 290 km/h, the flight heading – 315°.

At a distance of 5.0 km to the touchdown point, the plane was 25 m below the glide path. At a distance of 3 km from the touchdown, the plane descended to an altitude of 105 meters and continued the flight with the constant descent.

At an altitude of 60 meters, an audible alarm was triggered on board the aircraft, when the decision height had been reached, to which none of the crew members responded.

At a distance of 1348 meters from the threshold of the RW-31, at an altitude of 5-7 meters, the aircraft collided with trees, fell to the ground and came to rest at a distance of 1117 meters from the runway threshold. Photos of the aircraft location after the crash and the aircraft wreckage are shown in Figs. 1 and 2.

***Note:** the elevation of the accident site over RW-31 threshold is approximately 10 m.*

At 03:43:37, a response came from the onboard transponder to the aerodrome surveillance radar, along which a radar track was created from the air target.

The Alert for the Lviv aerodrome was announced by the Tower controller at 03:49:03. The location of the plane was discovered by the rescue team at 04:41.

1.2. Injuries to Persons

Injuries	Crew	Pax	Others
Fatal	5	0	0
Serious	0	0	3
Minor/None	0/0	0/0	0/0

1.3. Damage to Aircraft

The plane was destroyed as a result of the fatal accident.



Fig.1 Photo of the aircraft location after the crash

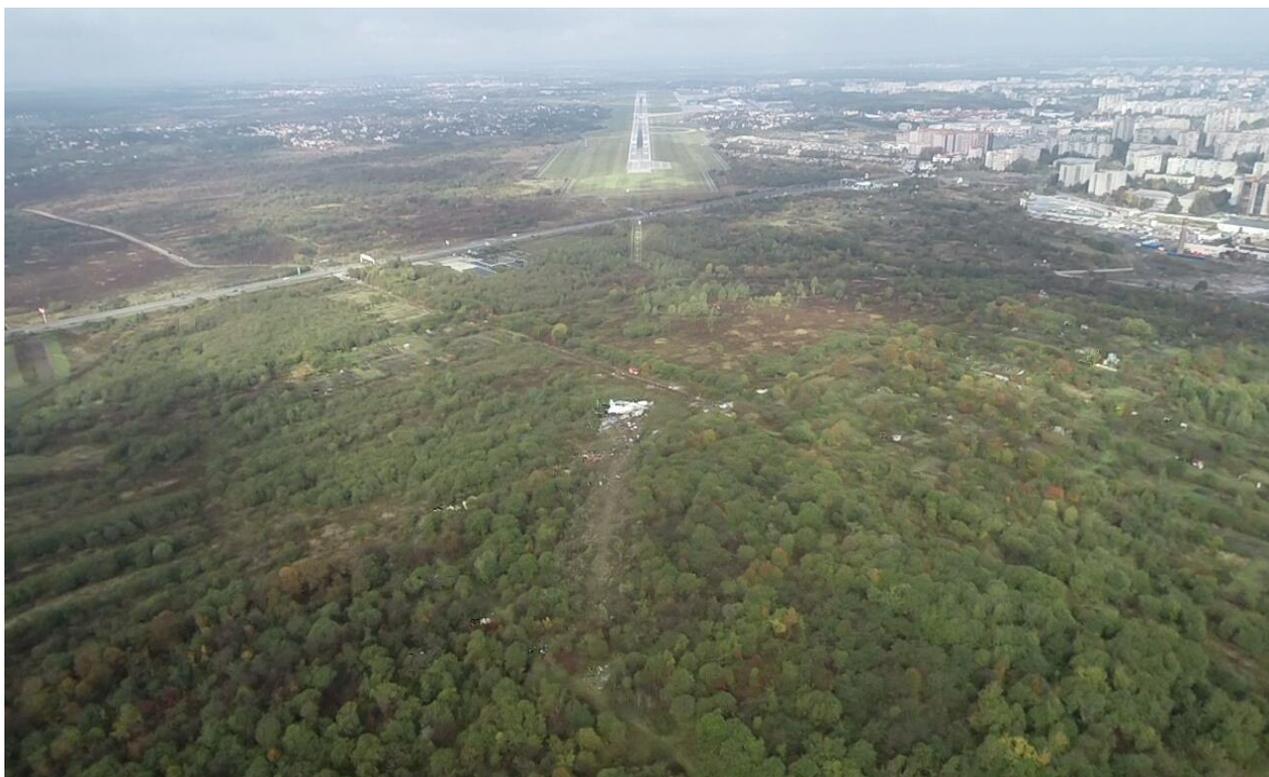


Fig.2 Photo of the aircraft wreckage location

The crash of the An-12 BK UR-CAH aircraft occurred near the Lviv aerodrome. Coordinates of the crashed aircraft location: 49°47.29N 23°59.08E at an altitude of 335 m above sea level, distance of 1117 m from the threshold of RW-31.

The terrain is flat, abandoned garden. The average height of trees is 5-6 meters.

The wreckage of the plane is scattered on the land plot of 281x37m with an area of 10397 sq. m.

The cockpit was completely destroyed.

The front landing gear was destroyed.

The left outer wing (fuel tank) was destroyed.

The leading edge of the wing was destroyed.

The wing flaps were destroyed.

Propeller No. 1 received substantial damage (from left to right of flight direction).

Engine No. 1 suffered substantial damage.

Propeller No. 2 received substantial damage.

Engine No. 2 received substantial damage.

Propeller No. 3 received substantial damage and separated from engine # 3.

Engine No. 3 received substantial damage.

Propeller No. 4 suffered substantial damage and separated from engine # 4.

Engine No. 4 was destroyed.

The right outer wing (fuel tank) was destroyed.

The right landing gear was destroyed.

The right landing gear fairing was destroyed.

Underfloor fuel tanks were destroyed.
 The stabilizer leading edge received substantial damage.
 The fin received minor damage.
 The control panels of the aircraft systems, aviation instruments and network circuit breakers were completely destroyed.

1.4. Other Damage

No damage was done to other objects.

1.5. Personnel Information

a) flight crew members information:

Position	PIC
Sex	Male
Date of birth	08.11.1972
Education	Kharkiv Higher Military Aviation School of Pilots
Total flight hours	6750 h 35 min.
Flight hours:	
on this type of aircraft	6570 h 15 min.
for 2018-2019	729 h 30 min.
last 24 hours	09 h 39 min.
last 7 days	29 h 31 min.
last 30 days	85 h 50 min.
last 90 days	115 h 21min.
Meteominimum	60/550 RVR
Number and validity of the pilot's certificate	TA 001713 till 20.03.2020
Medical certificate	MSP N-004929
Date of qualification test	29.08.2019
Flight inspection date	04.04.2019
Date of the refresher course on type	15.03.2019

According to the ratings, which were indicated in the pilot's certificate, the PIC has permission of the State Aviation Administration to perform landing on the An-12 with the following minimum: decision height – 200 meters, the runway visual range of 550 feet, CAT I ICAO. According to clause 2.5.2 FOM, An-12, the minimum for the director mode landing is: decision height – 60 meters (approx. 200 feet), runway visual range - 800 meters. An approach mode for landing is not indicated in An-12 FOM, which corresponds to Category I ICAO and/or RVR = 550m.

Position	First Officer
Sex	Male
Date of birth	13.09.1955
Education	Aktyubinsk Higher Flight School of Civil Aviation
Total flight hours	14670 h 20 min.
Flight hours on this type	9620 h 45 min.
Flight hours for 2018-2019	465 h 05 min.
last 24 hours	09 h 39 min.
last 7 days	29 h 31 min.
last 30 days	85 h 50 min.
last 90 days	115 h 21 min.
Number and validity of the pilot's certificate	TA 005088 till 14.05.2020
Medical certificate	MSP N-005956
Date of qualification test	03.05.2019
Flight inspection date	08.09.2019
Date of the refresher course on type	29.08.2019
Position	Flight Navigator
Sex	Male
Date of birth	14.05.1963
Education	Kirovograd Higher Flight School of Civil Aviation
Total flight hours	13385 h 25 min.
Flight hours on this type	6280 h 15 min.
Flight hours for 2018-2019	765 h 30 min.
Flight hours for the last 24 hours	09 h 39 min.
last 7 days	29 h 31 min.
last 30 days	85 h 50 min.
last 90 days	115 h 21 min.
Number and validity of the pilot's certificate	FN 003075 till 20.08.2020
Medical certificate	MSP N-007656
Date of qualification test	01.08.2019
Flight inspection date	25.10.2018

Date of the refresher course on type	07.08.2019
Position	Flight Engineer
Sex	Male
Date of birth	25.07.1967
Education	Riga Higher Military Aviation Engineering School
Total flight hours	11950 h 15 min.
Flight hours on this type	11950 h 15 min.
Flight hours for 2018-2019	415 h 20 min.
Flight hours for the last 24 hours	07 h 20 min.
last 7 days	07 h 20 min.
last 30 days	07 h 20 min.
last 90 days	08 h 55 min.
Number and validity of the pilot's certificate	FE 004546 till 26.12.2018
Medical certificate	MSP N-075055
Date of qualification test	02.09.2019
Flight inspection date	14.02.2019
Date of the refresher course on type	21.04.2019

Position	Aircraft Radio Operator
Sex	Male
Date of birth	28.10.1963
Education	Warrant officers school, military registration specialty 171 military unit 55344 (June-November 1983), Kansk, Krasnoyarsk Region, RF. Initial training in the specialty of a flight radio operator - Separate structural subdivision "Aviation Training and Certification Center" of the State ATS Enterprise "UkSATSE" (November 2014 - February 2015).

Total flight hours	9350 h 10 min.
Flight hours on this type	2150 h 45 min.
Flight hours for 2018-2019	835 h 30 min.
Flight hours for the last 24 hours	09 h 39 min.
last 7 days	29 h 31 min.
last 30 days	85 h 50 min.
last 90 days	115 h 21 min.
Number and validity of the pilot's certificate	RO 000745 till 30.08.2020
Medical certificate	MSP N-007706
Date of qualification test	29.08.2019
Flight inspection date	09.11.2018
Date of the refresher course on type	06.03.2019

b) Technical Staff Information

Airframe and engine maintenance technician:

Date of birth: 02/10/1967.

Basic education: higher, Kyiv Aviation College, 2014.

Qualification: mechanical technician.

Training by type: Kryvyi Rih College of NAU, 2007.

Certificate Part-66: UA.66.0352, valid till 03.05.2023.

Certification powers: No. 14 valid until 22.05.2020.

The mechanical technician completed education at the age of 47 and had 5 hours of experience at the time of the accident.

Avionics technician:

Date of birth: 26.05.1969.

Basic education: higher, Achinsk military aviation technical school, 1989.

Qualification: electrical technician.

Training by type: Kryvyi Rih College of NAU, 2006.

Certificate Part-66: UA.66.1273, valid till 12/16/2019.

Certification powers: No. 19, valid until 16.12.2019.

c) ATS Personnel Information

Tower supervisor, born in 1963, has a complete higher education - Civil Aviation Flight Academy of Leningrad City (Russia), total work experience of as a traffic controller is 33 years, as a supervisor – 10 years.

Traffic service controller's certificate was issued by State Aviation Administration of Ukraine on 23.01.2002, valid until 30.10.2019, ratings: TWR/AIR, TWR/GMC (UKLL), approved to work as a TWR/LL1, TWR/LL2, TWR/LL1 + LL2 controller admitted to radio communication in English, certificate dated 01/27/2017, ICAO level 4. The medical certificate is valid until 31.10.2019.

Refresher courses for flight directors of 15.02.2019.

During the ATS, there was only one aircraft in the area of the responsibility.

Air traffic controller of the Tower, born in 1982, has a complete higher education – Kirovograd Flight Academy of Ukraine, total experience of work as a traffic controller is 14 hours, has an admission to work at the workplace of the supervisor of the Tower.

Traffic service controller certificate was issued by the State Aviation Administration of Ukraine on 19.07.2005, valid until 11.04.2021, ratings: TWR/AIR, TWR/GMC (UKLL), approved to work as a TWR/LL1, TWR/LL2, TWR/LL1 + LL2 controller admitted to the radio communication in English, certificate dated 05.24.2019, ICAO level 4. Medical certificate is valid until 04.13.2021.

Refresher courses for supervisors of 12.10.2018.

During the pilot project, there was one aircraft in the area of the responsibility.

1.6. Aircraft Information

Aircraft, type: An-12BK.

State and registration marks – UR-CAH.

Aircraft MSN - 8345604.

Owner - CargoAirChartering (UAE)

Operator - PJSC «AIRLINE «UKRAINE-AIR ALLIANCE».

Manufacturer - Tashkent Aviation Production Association named after V.P. Chkalov, Uzbekistan.

Date of Manufacture – 15.05.1968 (51 hours old).

Total Time Since New - 12922 hours 45 minutes, 6616 landings;

Total Time Since Last Overhaul – 8279 h 41 min., 3111 landings.

Maintenance: Base maintenance work was performed in the form of F-59K + F1Kch according to the Maintenance Program for An-12 of PJSC «AIRLINE «UKRAINE-AIR ALLIANCE», Maintenance Regulations RO-9909.07.2019 and additional work. CRS No. 60/19 of AVIA-ZAR LLC dated 09.07.2019, approval number: UA.145.0106.

Number of overhauls – 3 (05.07.1976 military unit 13801, 09.03.1983 at military unit 13824, 08.01.1990 at military unit 13824).

On the plane, all routine maintenance was completed in a timely manner (according to the Maintenance Program for the An-12 aircraft of PJSC «AIRLINE «UKRAINE-AIR ALLIANCE», approved by the State Aviation Administration of Ukraine on November 30, 2012).

Maintenance work was carried out by AVIA-ZAR LLC, Certificate of approval of the maintenance organization: UA.145.0106, date of initial issue: 29.12.2017. Production base for the maintenance: BTsG AK Bila Tserkva.

Before departure from Vigo airport (Spain) on 04.10.2019, the pre-flight briefing of the aircraft was performed before the flight (Flight Operation Manual An-12, part 3; clause 3.3.1.-3.3.5.).

Airworthiness information:

Registration certificate of the aircraft No. RP 3529/5, issued by the State Aviation Administration of Ukraine on January 16, 2015;

Airworthiness Certificate No. 0446 issued by the State Aviation Administration of Ukraine on 19.12.2014.

Airworthiness review certificate No. 0446/3, issued by the State Aviation Administration of Ukraine on 29.05.2019, valid until 15.05.2020.

Modifications of the An-12 UR-CAH aircraft were made according to the list of airworthiness directives fulfillment (attached).

All work on the An-12BK UR-CAH aircraft was carried out according to the An-12 aircraft maintenance program at a certified station (certificates are attached).

According to paragraph 2.5 of the An-12 Aircraft Flight Operation Manual, as of the accident date, the lowest minimum for landing in the director mode was: decision-making height – 60 meters, runway visual range (RVR) - 800 meters.

Engines and Propellers

Engine No. 1

AI-20M type No. H27826021 series 6A.

Manufacturer: PJSC "MOTOR SICH", Zaporizhzhya, Ukraine.

Operating time since the beginning of operation: 11007 hours 4654 cycles.

Manufactured: on 30.05.1978

Work was carried out to determine the technical condition of the AI20M engine of the 6A series No. 27826021 according to the act No. 171/OCCD-18 dated 23.08.2018 by SE "Ivchenko-Progress".

Airworthiness: CRS No. 60/19, AVIA-ZAR LLC dated 09.07.2019, approval number: UA.145.0106.

Engine No. 2

AI-20M type No. H27726022 series 6A.

Manufacturing plant: PJSC "MOTOR SICH", Zaporizhzhya, Ukraine.

Operating time since the beginning of operation: 10940 hours, 4118 cycles

Manufactured: on 28.05.1977

Number of major overhauls - one, 25.10.2017

Operating time after repair: 233 hours, 65 cycles

Airworthiness: CRS No. 60/19, AVIA-ZAR LLC dated 09.07.2019, approval number: UA.145.0106.

Engine No. 3

AI-20M type No. H2246168 series 6A.

Manufacturing plant: PJSC "MOTOR SICH", Zaporizhzhya, Ukraine. Operating time since the beginning of operation: 13217 h. 8064 cycles.

Manufactured: on 27.12.1972.

Number of major overhauls: two, last overhaul: on 14.01.2001, ARZ No. 123.

Operating time since last repair: 4795 hours 1864 cycles.

Work was carried out to determine the technical condition of the AI20M 6A series engine No. 2246168 according to act No. 173/OCCD-18 dated 23.08.2018 by the State Enterprise "Ivchenko-Progress".

Airworthiness: CRS No. 60/19 of AVIA-ZAR LLC dated 09.07.2019, approval number: UA.145.0106.

Engine No. 4

AI-20M type No. H2136025 series 6.

Manufacturing plant: PJSC "MOTOR SICH", Zaporizhzhya, Ukraine. Operating time since the beginning of operation: 10962 h 5632 cycles.

Manufactured: 01/01/1972.

Number of major overhauls: three, last overhaul: on 12.09.2000 at ARZ No. 412TsA.

Operating time since last repair: 6520 hours; 2424 cycles.

Work was performed to determine the technical condition of the AI20M engine of the 6A series, No. 2136025 according to the act No. 174/OCCD-18 dated 23.08.2018.

Airworthiness: CRS No. 60/19, AVIA-ZAR LLC dated 09.07.2019, approval number: UA.145.0106.

Turbine generator set (APU)

Type: TG-16M No. OM42002108.

Manufacturing plant: LLC "123ARZ", date of manufacture: 30.11.1990.

Number of repairs: 1, date of repair: 30.08.2011 by 123 ARZ LLC.

Operating time since the beginning of operation 1180 hours, number of starts: 984.

Propeller AB68Y series 04A-000PS No. H044290155

Manufactured: on 16.05.1984.

Overhaul completed on 14.02. 2008 by SE "EARZ" with operating hours since the beginning of operation 7886 hours.

Operating time since last repair: 1217 hours.

Operating time since the beginning of operation: 9103 hours.

Installed on engine No.1 on 09.04.2019.

Propeller AB68Y series 04A-000PS No. H055200367.

Manufactured: in 05.1975.

Overhaul: 17.03.2008.

Operating time since last repair: 1936 hours.

Operating time since the beginning of operation: 10836 hours.

Installed on engine No. 2 on 04.04.2019.

Propeller AB68Y series 04A No. H089250431

Manufactured: in 08.1979.

Overhaul 1 on 26.02.2010 by SE "EARZ" CAH.

Operating time since last repair: 2615 hours.

Operating time since the beginning of operation: 5633 hours.

Installed on engine No. 3 on 06.09.2019.

Propeller AB68Y series 04A-000PS No. 124300163

Manufactured: on 28.12.1984.

Operating time since last repair: 3221 hours.

Operating time since the beginning of operation: 8670 hours.

Installed on engine No. 4 on 06.09.2019.

The propeller blades were in the position of the maximum propeller pitch (in the takeoff position.)

An-12BK Aircraft Fuel System

According to an extract from the cockpit crew communication, after 14 minutes of flight, at 22:34 (probably a flight engineer), when asked by one of the crew members (probably PIC), reported that there was 14,050 kg of fuel on board the aircraft.

Note: according to calculations, before starting the engines and starting taxiing on the runway at Vigo airport, there could be 15,000-16,000 kg of fuel in the aircraft's fuel tanks. Considering that, according to the Flight Operation Manual, 450 kg are spent on starting the engines and taxiing, i.e the fuel that is not taken into account in the aircraft take-off weight, the PIC received information after 14 minutes of flight in takeoff mode about the presence of fuel on board the aircraft - 14050 kg.

At the time of the accident, fuel was only in the aircraft wing root tanks.

The "Final Reserve" signal is not recorded by the recorder, therefore, it is impossible to accurately determine the amount of fuel on board the aircraft.

Fault Data:

According to the flight engineer, who performed the previous flights on the An-12 UR-CAH aircraft, and to the avionics maintenance technician, on the eve of the accident, during flight UKL4044 en-route Santa-Maria - Toronto, on 02.10.2019, at the landing approach to the Toronto Airport, there occurred a failure of indication of the landing system glide path beacon parameters on the PIC's SPP flight-navigation instrument. The malfunction was eliminated by the aircraft avionics maintenance technician at the Toronto Airport by disassembling, washing with alcohol, drying, assembling and tightening the plug connectors on the navigation-landing device units and built-in control unit of KURS MP-70 system.

Aircraft Loading

The maximum allowed take-off weight of the aircraft is 61,000 kg, according to the Flight Operation Manual, the landing weight of the aircraft can be equal to the maximum allowed take-off weight.

***Note:** Calculations of the actual take-off weight and aircraft weight at the time of the accident are shown in the Analysis section of the Final Report.*

Due to the lack of aircraft CG calculation data, the Investigation Team cannot accurately establish the range of the aircraft CG during takeoff and landing approach to the Lviv airport.

Aircraft Ground Collision Avoidance System Equipment

An-12BK aircraft, state and registration marks UR-CAH, serial number 8345604, is equipped with EGPWS (MKVIII) system, part number 965-1220-020, serial number 5076, manufactured by Honeywell International. Inc. (USA). According to the CRS/ Maintenance Certificate No. 12/3-08, the EGPWS system was installed on the aircraft on October 22, 2008, by ARS "TEHAVIAEKSIM" (Certificate No. BP 0051 issued by the State Aviation Administration of Ukraine).

The EGPWS system signal during the flight of the aircraft from Vigo to Lviv was triggered only once - at 2:01:43, when the aircraft was in the airspace of Austria (flight level FL250). During the flight on the pre-landing final, the EGPWS system did not give a warning about the ground proximity.

The aircraft is equipped with a RV-5MD1 radio altimeter.



Fig. 4 Radio altimeter indicator

Radio altimeter RV-5MD1

Modulation type: frequency modulation.

Working frequency: 4300 MHz.

Maximum measuring altitude: 750 m.

The radio altimeter accurately measured the flight altitude (according to the CVR decoded data).

1.7. Meteorological Information

The crew received the meteorological information for the pre-flight briefing as part of the OFP. At the time of the decision to take off from the Vigo aerodrome (Spain), for the Lviv aerodrome was acting the forecast for 18:00 03.10.2019 to 18:00 04.10.2019.

The forecast for the Lviv aerodrome was as follows:

The forecast was released at 17:03 on 03.10.2019, valid from 18:00 03.10.2019 to 18:00 04.10.2019: surface wind direction 270°; wind speed 4 meters per second; visibility 3000 meters; mist, broken clouds 210 meters high; occasionally between 18:00 03.10.2019 and 6:00 04.10.2019: visibility 500 meters, light shower rain, fog, broken clouds 60 meters high, cumulonimbus clouds of 540 meters;

gradually, between 6:00 and 8:00 04.10.2019, the direction of the surface wind is variable, the wind speed is 01 meter per second, visibility is 10 kilometers or more, there are no special weather phenomena, broken clouds with a height of 450 meters;

time between 8:00 and 15:00 04.10.2019: light shower rain, broken cumulonimbus clouds 600 meters high.

During the pre-flight briefing, the actual weather conditions at the Lviv aerodrome were as follows:

METAR for 18:30 - wind 280°, 1 m/s, CAVOK, air temperature 06°C, dew point temperature 05°C, atmospheric pressure QNH - 1012 hPa, state of RW-31 - from 51

to 100% of the runway surface covered with puddles (water spots) up to 1 mm deep, friction coefficient 0.55. The forecast for 2 hours from the time of observation - no significant changes.

The weather forecast for the Boryspil alternate aerodrome was as follows:

The forecast was released at 17:01 on 03.10.2019, valid from 18:00 03.10.2019 to 18:00 04.10.2019: surface wind direction 240°; wind speed 5 meters per second, gusts up to 10 meters per second, visibility 10 km or more, broken clouds 450 meters high;

For the time between 18:00 03.10.2019 and 22:00 03.10.2019: surface wind direction 290°, wind speed 10 meters per second, gusts up to 16 meters per second, visibility 2000 meters, thunderstorm, rain, squall, broken clouds with height of 150 meters, cumulonimbus clouds with a height of 450 meters;

gradually from 22:00 to 24:00 03.10.2019: surface wind direction 320°, wind speed 6 meters per second, gusts up to 12 meters per second, visibility 6000 meters, light rain, overcast 240 meters high; time between 00:00 and 7:00 04.10.2019 visibility 1600 meters, light shower rain, mist, broken clouds 90 meters high, scattered cumulonimbus clouds 450 meters high;

for the time between 7:00 and 18:00 04.10.2019: visibility 2100 meters, light shower rain, broken clouds 180 meters high, scattered cumulonimbus clouds 360 meters high.

During pre-flight briefing, the crew received information about the actual meteorological conditions at the Boryspil aerodrome:

METAR for 18:30 03.10.2019 - surface wind direction 250°, wind speed 2 m/s, direction changed from 220° to 300°, visibility 10 km or more, distant thunderstorm, light shower rain, scattered cumulonimbus clouds with a height of 990 meters, broken clouds with a height of 1470 meters, air temperature 15°C, dew point temperature 14°C, atmospheric pressure QNH - 1004 hPa, surface condition of RW88 - dry, clear; temporary direction of surface wind 290°, 10 meters per second, gusts up to 16 meters per second, visibility 2000 meters.

The corrected weather forecast for the Lviv aerodrome, which acted from 04:00 to 24:00, was released at 4:41 (two minutes before the fatal accident):

Surface wind direction is variable, wind speed - 01 meters per second, visibility 400 meters, fog, vertical visibility 60 meters,

for the time from 04:00 to 8:00: visibility 1500 meters, mist, scattered clouds 60 meters high, broken clouds 120 meters high,

gradually from 08:00 to 10:00: visibility 3000 meters, mist, scattered clouds 120 meters high, broken clouds 210 meters high,

from 10:00 to 16:00: visibility 2100 meters, light shower rain, scattered clouds with a height of 900 meters, cumulonimbus-~~rain~~ clouds with a height of 450 meters,

for the time from 18:00 to 24:00: visibility is 400 meters, fog, vertical visibility is 60 meters.

The weather at the Lviv aerodrome at the time of the accident was as follows:

Special report (SPECIAL) drawn up at 03:40 04.10.2019: surface wind RW-31: landing zone is quiet, at the end of the runway, the direction is variable in the sector between 230 and 300 degrees, speed is 1 meter per second, visibility in the landing zone RW-31 is 250 meters; runway visual range at RW-31: touchdown zone 800 meters, middle of the runway 800 meters, end of the runway 750 meters, fog, hidden clouds, vertical visibility 60 m, air temperature 03°C, dew point temperature + 03°C, pressure QNH 1013 hPa, pressure QFE 0974 hPa, forecast for landing TREND: visibility time 400 meters, fog, obscure clouds, vertical visibility 60 meters, additionally: at an altitude of 600 meters wind direction 300 degrees 6 meters per second, RW-31 is clear; dry.

At 03:40:27 am, the LVT sector air traffic controller provided the aircraft crew with the following meteorological information:

runway visual range (RVR) - touchdown zone - 800 m, middle - 800 m, runway end - 750 m, vertical visibility - 60 m, fog.

The Alert was not sent to the Aerodrome Meteorological Station Civil "Lviv", therefore, unscheduled meteorological observations were not carried out.

Note:

1. According to the Annunciation Scheme for rescue teams, airport officials and cooperating organizations at the accident on the territory of the State Enterprise "IA "Lviv" and in the area of the airport, approved by the General Director of the State Enterprise Lviv Danylo Halytskyi International Airport on 08.08.2019 and agreed by the director of the Lviv Regional Subdivision of UkSATSE, the Alarm signal shall be announced by the aerodrome control tower via circular communication, the Aerodrome Meteorological Station Civil "Lviv" is not included in the circular communication correspondents to receive the Alarm signal.

2. According to clause 4 of Section VI of the Instruction on meteorological service of aircraft flights at the Lviv aerodrome, approved by the Director General of the State Enterprise Lviv Danylo Halytskyi International Airport and agreed by the Director of the Lviv Regional Subdivision of UkSATSE on 28.08.2019, after receiving a notification of an accident or an incident with the aircraft at the aerodrome and/or in the area of the aerodrome, the meteorological technician shall conduct extraordinary meteorological observations in full and compile local weather reports. Based on the results of meteorological observations closest to the time of the accident or incident with the aircraft, the Aerodrome Meteorological Station Civil shall draw up a weather report for the aerodrome and/or the aerodrome area. The act is signed by the head of the aerodrome meteorological office and the specialist who has carried out meteorological observations.

According to the senior controller of the Flight Planning and Support Service of the PJSC «AIRLINE «UKRAINE-AIR ALLIANCE», the meteorological information was provided to the crew as part of the previous operational flight plan (OFP) for take-off, landing and alternate aerodromes.

1.8. Navigation Aids

The aerodrome with two landing courses is equipped with a high-intensity lighting system (HIL-II) "IDMAN" to ensure the approach, landing, taxiing and take-off of the aircraft. The system has been in operation since 2012, Certificate of Aerodrome Equipment Operation Suitability No.AO 13-01-173 issued by the State Aviation Administration of Ukraine on 01.10.2019 till 01.10.2022.

According to the Archive of the lighting equipment control monitoring system and Information on the operation of the lighting equipment HIL-II (High Intensity Lighting-II) of "IDMAN" type, dated 25.10.2019, prepared by the lighting flight support division of the Lviv airport, starting from 03:13:35 to 03:25:15 04.10.2019, the aerodrome lighting system with MHlanding 310° was switched on, in particular, runway edge lights, runway centre line lights, taxiway lights, stop bar lights, approach lights, stopway lights, threshold lights, light units at 30% and touchdown zone lights at 10%, which met the requirements of CRCAU.

The procedure for using the lighting system lights at the aerodrome is established according to the Instruction on the use of the lighting equipment of the Lviv aerodrome, approved in February 2017 by the General Director of the State Enterprise Lviv Danylo Halytskyi International Airport and the director of the Lviv Regional Subdivision of UkSATSE. According to the requirements of this Instruction, the control of the lighting equipment can be carried out from two workplaces of the Tower controllers or from the workplace of the TP-2 shift engineer. For the technical condition of the lights and information about them, the personnel of the aerodrome flight lighting department shall be responsible. In the Table of regulation of luminous intensity, which is contained in the Instruction on Use of Lighting Equipment of Lviv Aerodrome, at the visibility less than 800 m, the pulse lights ON is required, which in fact are not included in the lighting equipment set at the Lviv aerodrome.

Note: at the time of the accident, the requirements for the regulation of the luminous intensity of high-intensity lights were established by Clause 8.2.6.1 and Table D.11.2 of the Certification Requirements for Civil aerodromes of Ukraine (hereinafter – CRCAU).

The lights of the lighting equipment complex HIL-II with MH310° were turned off at 5:26:25 on 04.10.2019. According to the archive of the electrical and lighting support of flights, there were no critical comments on the operation of the lighting equipment on 10.04.2019.

The flight check of the MH310°/130° HIL-II IDMAN system was carried out in the period from 12.06.2019 to 13.06.2019. According to the conclusions of the inspection, the parameters of the system, having HIL-II with MH310°/130°, were meeting the requirements of the operational and technical documentation. The system, having HIL-II, is suitable for aircraft flight support.

The aerodrome is equipped with landing systems - DVOR/DME and a radio beacon system of the SP-200 type (certificate of serviceability of the RMD-90NP rangefinder radio beacon (DME) and the radio beacon landing system (RBLS) SP-

200, issued by the State Aviation Administration of Ukraine, valid at the time of the accident. According to the acts of annual flight inspections of DME RMD-90NP and RBLIS SP-200 system with two landing courses, conducted in June 2019, it was established that their parameters meet the requirements of the operational and technical documentation for the RBLIS II Category, and the RBLIS is suitable for supporting aircraft flights. In the period from 19.10.2019 to 20.10.2019, a semi-annual flight inspection of the DME RMD-90NP and RBLIS SP-200 with two landing courses was carried out. In Tables 12.6 of the Flight inspection certificate of DME RMD-90NP MSN 1158, issued on August 24, 2011, installed at the Lviv aerodrome with MH = 310° and the DME Flight Test Certificate for RMD-90NP MSN 1157, issued on August 24, 2011, installed at the Lviv aerodrome with MH = 130°, approved by the General Director of State Enterprise Lviv Danylo Halytskyi International Airport on 15.06.2019, the altitude at which the overflight was carried out is not indicated, the field strength parameters in the DME coverage area are not clearly indicated, reports based on the results of flight inspections of ground-based radio technical support are not attached, printouts of the measurement results tables are not attached; some graphs on results of flight inspections indicate incorrectly SP-200 serial number and name of the Kharkiv aerodrome and the like.

According to the conclusions of the Flight Inspection Acts, it was established that the parameters of the specified equipment comply with the requirements of the operational and technical documentation for Category II RBLIS, and RBLIS is suitable for flight support operations.

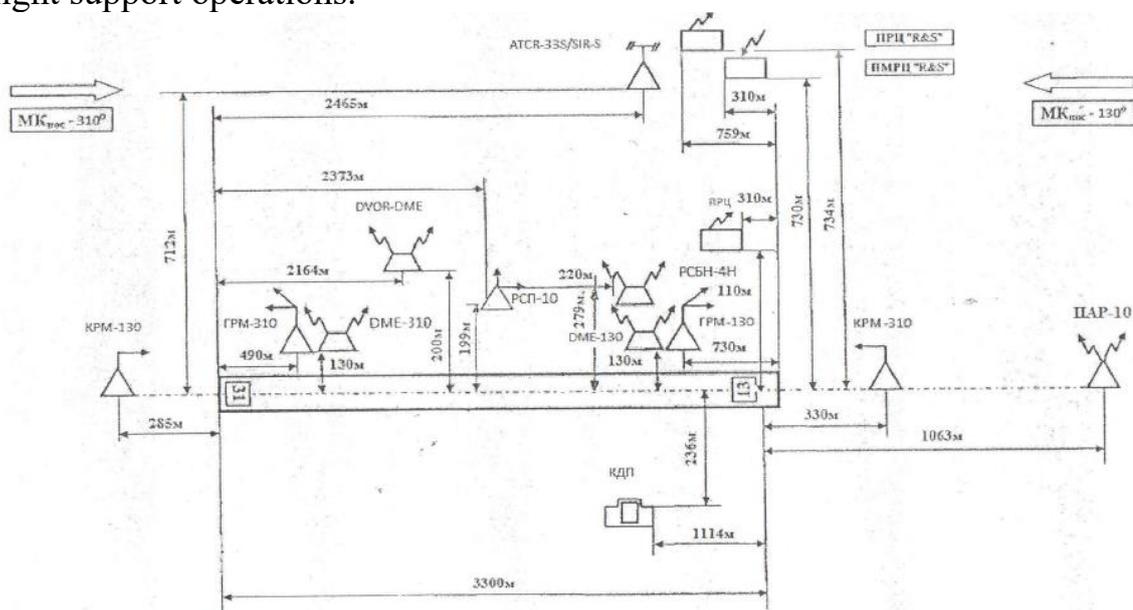


Fig. 5. Layout of radio equipment of the Lviv aerodrome relative to the runway

According to the Information on Operation of the landing system (SP-200) and DME (RMD-90np) with MH310° dated 25.10.2019, prepared by the department of radio navigation and electrical support of the State Enterprise Lviv Danylo Halytskyi International Airport, according to the statistics of the status of radio beacons and their parameters for the period from 03:00 to 04:00, the landing system and the radio

beacon of the rangefinder with MH310° operated in the normal mode, the parameters correspond to the requirements of the operational and technical documentation.

In the area of responsibility of the Lviv ACC, the following means of monitoring the air situation were used to provide the ATS:

- AORL ATCR-33S/SIR-S at the Lviv aerodrome;
- AMVORL SIR-S on TRLK-1 (Zhydachiv)
- TRLK-10 in PORL mode on TRLK-1 (Zhydachiv)
- TRLK-10 on TRLK-2 (Dubno)
- AMVORL SIR-S on TRLK-2 (Dubno)
- TRLK-10 on TRLK-3 (Bar)
- TRLK-10 on TRLK-4 (Zhytomyr)
- AMVORL SIR-S at the Boryspil aerodrome;
- AMVORL SIR-S at the Odesa aerodrome;
- Radar Complex STAR-2000/RSM970S, Chisinau.

In the area of the Tower Lviv responsibility is:

- - automated air traffic control system "Roksolana" used only as an aid in the ATS.

Air traffic service using ATS surveillance systems within CTR Lviv is not provided.

INSTRUMENT APPROACH CHART (IAC)-ICAO

AD ELEV 328 M

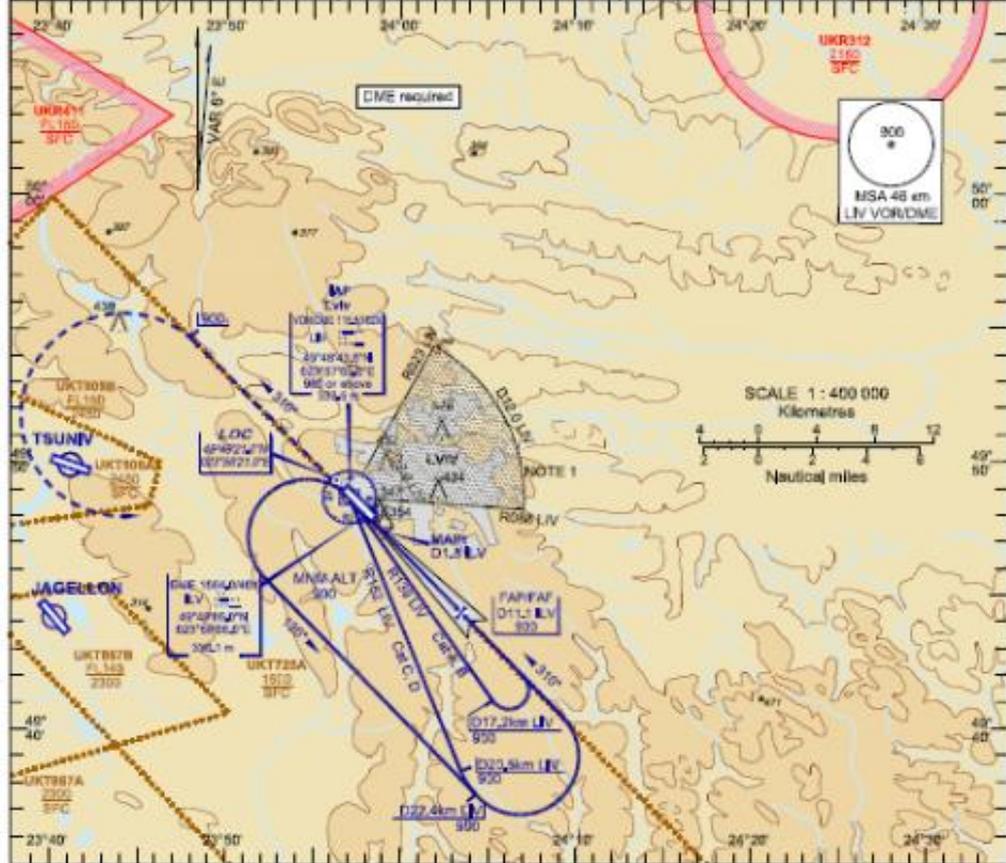
LVIV ILS or LOC RWY 31

BEARINGS AND TRACKS ARE MAGNETIC ALT, HGT AND ELEV ARE IN METRES DISTANCES ARE IN KILOMETRES

TRANSITION LEVEL: by ATC
TRANSITION ALT: 3050

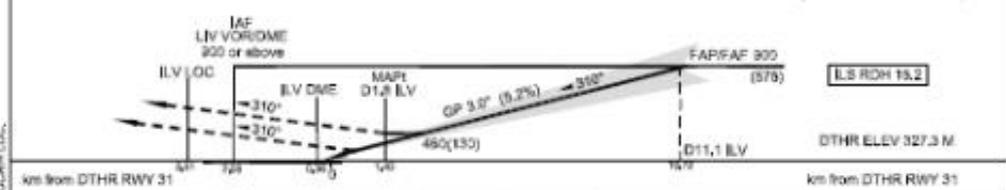
LOC 110,300
ILV ---

Radar 120,525
TWR 125,000



ILV DME, km	10,0	8,0	5,0	4,0
DIST DTHR, km	8,66	7,64	5,64	3,54
ALTHGT, m	844(817)	740(413)	636(309)	532(205)

MISSED APPROACH:
Climb on track 310° to 800(575), turn LEFT to LVV VOR/DME, then according to chart or as directed by ATC.



OCA/H	A				B				C				D			
	ILS CAT I		ILS CAT II		ILS CAT I		ILS CAT II		ILS CAT I		ILS CAT II		ILS CAT I		ILS CAT II	
Straight-in Approach	387(50)		360(33)		350(53)		365(38)		390(86)		360(42)		373(46)		460(130)	
Circling	525(196)		525(196)		525(196)		700(370)		700(370)		700(370)		700(370)		700(370)	
GROUND SPEED	knots		150		180		210		240		270		300		350	
FAFAP • DTHR 10719 m	mins		4:17		3:54		3:04		2:41		2:23		2:08		1:57	
RATE OF DESCENT	m/s		2,2		2,6		3,1		3,5		3,9		4,4		4,8	

State Aviation Administration © UKSATSE, 2017 [AIRAC AMDT 02/19]

Fig. 6. Excerpt from the Aeronautical Information Publication of Ukraine (RW-31 instrument approach procedure)

1.9. Communication

Aeronautical telecommunication facilities:

When performing the descent and landing approach, the aircraft crew conducted radio communications with the LVE + LVW sector controller of the Lviv ACC at a frequency of 118.675 MHz, the LVT sector controller of the Lviv ACC at a frequency of 120.525 MHz and with Lviv Tower controller at a frequency of 128.0 MHz. The air traffic controller-crew communication was stable.

Aeronautical air telecommunication was provided by ROHDE&SCHWARZ radio transmitters and receivers from the transmitting and receiving radio centers at the Lviv aerodrome, ROHDE & SCHWARZ radio stations at Chernivtsi aerodrome and TRLK-2 (Dubno), including at the frequency of the emergency channel (121.5 MHz), as well as LRS radio stations by ROHDE & SCHWARZ at Lviv Tower.

1.10. Aerodrome Information

The Lviv aerodrome, in the area of responsibility of which the accident occurred, is a certified civil aviation aerodrome entered into the state register of civil aerodromes in Ukraine. The Aerodrome Registration Certificate No. AR 13-01 was issued by the State Aviation Administration of Ukraine on December 15, 2015. The Aerodrome Certificate No. AP 13-01, issued by the State Aviation Administration of Ukraine on February 28, 2017, is valid until February 28, 2020. The owner and operator of the aerodrome is the State Enterprise (SE) Lviv Danylo Halytskyi International Airport.

The aerodrome has one paved runway with the landing magnetic heading MHlanding 130°/310°.

The runway has dimensions of 3305 x 45 m, type of pavement – concrete, PCN 70/R/C/X/T, equipped for a precision landing approach according to ICAO Category II. With MHlanding 310°, the runway threshold is displaced by 120 m, the end of the runway for take-off is displaced by 140 m from RW13 end. Along MHlanding 130°, the threshold is displaced by 410 m.

The dimensions of the runway are 3425 x 180 m.

Aerodrome class - B (4D).

The aerodrome is operational day and night.

The aerodrome is equipped with landing systems – DVOR/DME, RBLs of SP-200 type, and high-intensity lighting (HIL).

Aerodrome category for firefighting - 8.

Coordinates of the aerodrome reference point: 494835N; 0235730E.

Aerodrome elevation - 328.4 m.

Magnetic variation - 6°E.

According to clause 9 of the certificate annex, the aerodrome is suitable for receiving the aircraft of index 6 (code 4D).

The runway threshold elevations:

Runway 31 – 328.25 m; Runway 13 – 326.32 m.

The displaced runway threshold elevations:

Runway 31 - 327.3 m; Runway 13 - 325.7 m.

1.11. Flight Recorders

Flight Recorder

An-12BK aircraft, registration number UR-CAH, is equipped with a combined flight recorder CFDR-42-12.

Serial number: K7081

Individual number: URA.12.142.000.000

The number of channels for recording voice information: 4 for the whole duration of recording via each channel (at An-12, two channels of voice information are used.)

Number of recording channels for parametric information: 12 recording channels according to the standard MSRP-12-96 system and an additional block of information containing information from GPS receiver built-in sensors, accelerometers, and magnetometer.

Decoding of recorder records

Voice information recording is legible via each of the recording channels. An extract from the cockpit communication is provided in the attachments.

Start of recording according to GPS data: 22 hours 09 min 01 sec.

End of recording according to GPS data: 03 hours 43 min 38 sec.

Duration of the recording according to GPS data: 05 hours 34 min 37 sec.

The duration of the recording, which was recorded by the recorder, is 05 hours 32 min 07 sec. Thus, the difference in the duration of the recording and according to GPS data is 2 minutes 30 seconds, which corresponds to an error of about 0.75%. The standard aircraft registration system of An-12 type (MSRP-12-96) and CFDR-42-12 recorder do not have a built-in timer and recording of the astronomical or relative time, therefore, it is impossible to establish the reason for difference in duration of the recording and GPS data.

Since it is impossible to establish the time points of disappearance of individual recording frames of the recorder, the continuous time (start of flight) is set in such a way that the recording end time corresponds to the time recorded by the recorder according to GPS data.

The decoding description indicates the time that corresponds to the recorded UTC time according to GPS data. Considering the above, the time on continuous time scales on the parameter decoding graphs and in the parameter tables may differ from the time in the decoding description, which is indicated in UTC according to GPS data – the closer to the beginning of the recording, the greater the difference is.

Based on the results of comparing the recorded geographical coordinates in the last recorded flight data frame with the sketch of the accident site, it was found that the recording on the recorder stopped at the moment of collision with trees, at a height of 5-7 meters above the ground surface. The probable cause of the recording stop was damage to electrical lines and/or communication lines.

FDR/CVR recording starts after auxiliary power unit starts up.

1.12. Wreckage and Impact Data

According to the FDR, the engines were running until the aircraft came to rest, propellers # 1 and # 2 had minor damage, and propellers # 3 and # 4 were damaged as a result of coming off the shafts of engines # 3 and # 4.

1.13. Medical and Post Mortem Information

All crew members had valid medical certificates and were allowed to perform their functional duties.

The examination of the bodies of the dead and those injured during the accident was carried out by forensic experts from the Lviv Regional Bureau of Forensic Medicine of the Lviv Regional Council.

According to the Experts' Opinion No. 944/2019, 945/2019, 946/2019, 947/2019 and 950/2019, the cause of death of five crew members (PIC, co-pilot, navigator, flight engineer and flight radio operator) was blunt concomitant body injuries as a result of shock-inertial impact from contact with blunt objects and blunt instruments with a limited surface resulted from the destructive action at the time of the aircraft impact.

According to the Experts' Opinion No. 962 and No. 963, the flight engineer and aviation technician for the operation of the An-12 aircraft (airframe and engine), who were in the aircraft escorting staff cabin, received moderate bodily injuries as a result of the accident. According to Experts' Opinion No. 965, an aviation technician for the An-12 aircraft operation, who was also in the aircraft escorting staff cabin, received serious injuries as a result of the accident.

According to the results of a toxicological study in the blood of the crew members and other persons on board the aircraft, ethyl, other alcohols and narcotic substances were not found.

There is no evidence in the conclusions of the forensic experts that physiological factors or disability affected the crew members performance.

1.14. Fire

There was no fire during the accident.

1.15. Survival Factors

The accident with the An-12 UR-CAH aircraft took place on 04.10.2019 at 03:43, at a distance of 1117 m from RW-31 threshold on the outskirts of the Sokilnyky village, Pustomyivsky district, Lviv region, in the area of the emergency rescue operations responsibility of the SE Lviv Danylo Halytskyi International Airport.

The last time the crew contacted the air traffic controller at 03:42:06, confirming the receipt of an ATC clearance for landing.

During the period from 03:45:30 to 03:52:44, the air traffic controller made 9 attempts to establish communication with the aircraft crew.

At 03:48:33, the Tower controller informed the CDA about the disappearance of communication with the An-12 aircraft and of its intention to call the rescue team.

At 03:49:03, the Tower controller announced «Emergency» via the loudspeaker, informing that during the landing approach with MH310°, communication with the An-12 aircraft was lost between the second kilometer and the runway threshold.

***Note:** the investigation found that the decision to announce the “Emergency” was agreed by the Tower controller with the Tower command center according to the requirements of clause 6.2.2 of the Rules for Rescue and Fire Safety of Flights in Civil Aviation, approved by order of the Ministry of Infrastructure of Ukraine dated 07.05.2013 No. 286 and registered with the Ministry of Justice on May 24, 2013 under No. 809/23341.*

At 03:49:22, rescue teams began to confirm the “Emergency”.

***Note:** Tower controller’s actions regarding announcement of the Emergency signal comply with the requirements of subparagraph 3 of paragraph 2 of Section V of the Aviation Regulations of Ukraine "Air Traffic Services", approved by Order of the State Aviation Administration of Ukraine dated 04.16.2019 No. 475 and registered with the Ministry of Justice on 04.07.2019 No. 727/33698, according to which the ATS units should declare the Alarm stage, in particular, in the case when the aircraft, which was granted clearance to land, did not carry out it within 5 minutes after the end of the estimated landing time, and communication with the aircraft failed.*

At 03:51:11, the CDA controller established communication with the Tower controller and asked if the "Emergency" signal was announced and whether the rescue teams should be gathered, to which she received an affirmative answer.

***Note:** according to the Annunciation Scheme for rescue teams, airport officials and interacting organizations at accident in the territory of the SE Lviv Danylo Halytskyi International Airport and in the area of airport responsibility, the Tower shall announce the Alarm to the rescue teams and CDA. According to clause 3.10 of the Emergency Plan, the CDA, having received the “Emergency” signal, duplicates the signal through portable radio stations and receives confirmation from the structural divisions of the rescue teams about the receipt of the signal and records the time of receipt. In the Report on performance of rescue operations of the emergency rescue and fire-fighting service of the SE Lviv Danylo Halytskyi International Airport, it is indicated that the Alert signal was received from the CDA via the airport's selector and radio communication at 03:50. During the search and rescue operations, the head of the rescue operations maintained contact with the CDA via the rescue teams channel, as provided for in paragraphs 3.23 and 3.24 of the Emergency Plan. Also, the controller of the CDA shall report of the accident, in particular, to the State Emergency Service of Ukraine in the Lviv region, the Lviv regional center for emergency medical aid and accident medicine, the Western Aviation Support Center for Search and Rescue and other interested organizations.*

At 03:51:17 AM, the Tower controller re-announced the "Emergency" signal: "To emergency rescue team – “Emergency” for aerodrome, to emergency rescue team "Emergency, Emergency", An-12 disappeared at a distance between the second and the first kilometer, at 03:47...3:45 pm, communication was cut off, heading 310."

***Note:** during announcement of the Alert signal, the Tower controller did not have information regarding the place of the occurrence and, accordingly, did not indicate the number of the square, in which the event occurred, and the place of gathering of the rescue teams according to the graphic plan of the airport (data that should be indicated in the text of the Annunciation, defined by the requirements p. 6.2.2 of Order No. 286). The aerodrome control tower Lviv did not have information about the number of crew members and passengers on board the aircraft, the presence of dangerous goods (this information was not in the presented flight plan), therefore, when the “Emergency” signal was announced, the air traffic controller did not indicate the number of crew members and passengers on board the aircraft, information on the presence of dangerous goods. At the same time, according to clause 3.8 of the Action Plan, in case of accident emergencies at the Lviv Danylo Halytskyi International Airport dated June 14, 2017, No. 213, approved by the General Director of the airport (hereinafter referred to as the Emergency Plan), the absence of all information about the aircraft is not a reason to postpone the announcement of the “Emergency” signal. According to clause 3.21 of the Emergency Plan, the place of arrival of the rescue teams can be directly the location of the accident. If the place of the accident is unknown at the time of Annunciation, the rescue teams shall arrive at the specified meeting point (square 8Zh of the aerodrome graphic map), if the meeting point is not indicated when reporting. However, the rescue teams meeting was organized in square 8L, which is confirmed by an extract of talks between the Tower controller and the CDA official (at 04:06:55 UTC, the Tower controller asked the CDA official, whether the aircraft was being searched, to which she received the answer that the rescue teams were being collected in area of B1 parking place). B1 is within the 8L square. In addition, the shift supervisor – head of the rescue operations of the fire department of the rescue and fire-fighting support of the airport flights – notes in his explanatory note about the rescue teams meeting in square 8L.*

At 04:25:02 UTC, the Tower controller contacted the CDA and indicated the search squares for the possible location of the aircraft - 19-C-C and 20-T-T.

***Note:** according to the shift supervisor - the head of the rescue operations, the plane was found within square 18-P-P, from which, according to his decision, the search for the accident site started.*

According to clause 4.1.2 of the Emergency Plan, the head of the aviation enterprise, without delay, no later than 15 minutes after receiving the information about the incident, should report to the Coordination Center for Search and Rescue of Civil Aviation and the NBAAI on the measures taken in response to the occurrence. However, the airport management failed to report to the NBAAI about the accident

(accident information was received by the NBAAI from the mass media and from the National Police.)

The Rules for Rescue and Fire Safety of Flights in Civil Aviation, approved by order of the Ministry of Infrastructure of Ukraine dated 07.05.2013 No. 286 and registered with the Ministry of Justice on May 24, 2013 under No. 809/23341 stipulate that the area of responsibility of the aerodrome for conducting search and rescue operations, within which the aerodrome operator ensures the organization and conduct of search and rescue operations, as a rule, has the shape of a circle with a center at the aerodrome reference point and radius of up to 10 km, which is indicated in the instructions for performing flights (use of airspace) in the area of the Lviv aerodrome.

According to the required fire protection level, the Runway has Category 8.

For the timely conduct of rescue and fire-fighting operations at the airport, a rescue and fire-fighting service has been created. The fire and rescue teams of the service are on duty around the clock with 12 people shift. In the territory of the airport near the runway at a distance from the runway threshold of 1250 m (MH 130°) and 2055 m (MH 310°), there is an emergency rescue station (ERS) of the rescue and fire support service, the combat unit of which uses AA 12-100 fire trucks on the KAMAZ 63501 chassis - 3 units, and reserve fire vehicle ATs 12-70 on the KamAZ 63501 chassis - 1 unit. The distance from ERS to the most remote places of the airport is 1.5 - 2.1 km. The control time for approaching them is 3 - 4 minutes. Distance from the airport to the nearest fire and rescue units of the State Emergency Service and Lviv medical institutions is 3.5 km and 13 km respectively.

Note:

- number of fire trucks that were on duty met the requirements of Table. 3.2 of Appendix 3 to the Rules for Rescue and Fire Safety of Flights in Civil Aviation, approved by order of the Ministry of Infrastructure of Ukraine dated 07.05.2013 No. 286 and registered with the Ministry of Justice on 24.05.2013;

- number of the duty shift staff of the rescue team met the requirements of Table. 4.1 Appendix 4 to the Rules for Rescue and Fire Safety of Flights in Civil Aviation, approved by order of the Ministry of Infrastructure of Ukraine No. 286 dated 07.05.2013 and registered with the Ministry of Justice on 24.05.2013.

Organization and conduct of search and rescue operations on 04.10.2019 was carried out by the rescue and fire-fighting service of the SE Lviv Danylo Halytskyi International Airport together with the Main Department of State Emergency Service in the Lviv region.

From the personnel of the rescue teams airport "Lviv" crews, the head of the rescue operations formed the Ground Search and Rescue Group (hereinafter referred to as the GSRG), which involved 4 units, technicians and personnel in the amount of 22 people.

In addition, the following units were involved in the search and rescue operations:

- mobile operational group of the Main Department of the State Emergency Service of Ukraine in the Lviv region. - 1 vehicle and personnel in the amount of 4 people;

- subdivisions of the State Directorate of the State Emergency Service of Ukraine in Lviv region - 15 vehicles and personnel in the amount of 68 people;

- brigades of emergency medical aid and accident medicine in the Lviv region. - 5 vehicles and personnel in the amount of 15 people.

According to the Report on performance of rescue operations of the rescue and fire-fighting support of flights of SE Lviv Danylo Halytskyi International Airport, the departure of the GSRG from the airport was at 4:16. To the gathering place of the rescue team, 1 vehicle (a fire truck) and 4 people arrived as a mobile operational group of the Main Department of the State Emergency Service in the Lviv region, which, in a formed column, as part of the GSRG, departed to search the aircraft. Another part of the fire-and-rescue crew of the Main Department of the State Emergency Service in the Lviv region. immediately departed to search the accident site, being in constant communication with the head of the rescue operations.

The location of the accident was determined visually, by means of a ground search on the map of the airport's area of responsibility. During the search, 0.4 km² of the area was surveyed. The search for the accident site was complicated due to the hard access to the site (the presence of dense bushes, trees and bushes on the way to the likely location of the aircraft, which prevented passage of special vehicles), as well as due to difficult meteorological conditions – thick fog, which limited visibility and interfered with orientation on the ground.

The plane was found at 4:41 in a forest belt near the village of Sokilnyky, Pustomyty district, Lviv region. The casualties, who were in the part of the cockpit for the accompanying personnel, were found at 04:42 (by voices.) Also at the site, five dead crew members were found – two bodies were in the cockpit, remains of three bodies were scattered near the plane.

In parallel with the search for the injured by the GSRG and State Emergency Service unit, priority measures were taken to prevent fire occurrence – a main hose line was laid, and a foam concentrate covered plots of land outside the aircraft, which were filled with fuel; this corresponded to the requirements of clause 6 of the Operational plan for fire extinguishing at the aircraft at the SE Lviv Danylo Halytskyi International Airport, approved by the Order of the SE Lviv Danylo Halytskyi International Airport dated 17.11.2016 No. 502 and clause 3 of Procedure B1 of the Emergency Plan.

The evacuation of the victims lasted from 6:22 to 07:00. To evacuate the victims, it was necessary to cut and cut through the fuselage skin (cutting was carried out in the place where the victims' voices came from) and unloading part of the cargo.

During the work, electric circular saws were used for cutting metal and emergency axes. After cutting the fuselage skin and unloading several elements of the cargo, two people were found, who were in the part of the cockpit for the accompanying personnel closer to the cockpit and were clamped by the cargo elements and aircraft equipment. The affected individuals were conscious but unable to move independently and asked for help. After gaining direct access to the victims, they were injected with an anesthetic injection, after which, with the help of special tools, by the forces of the emergency rescue and firefighting service of flights, they were unblocked from the plane and handed over to doctors. After that, the employees of the airport rescue and fire-fighting service, together with representatives of the State Emergency Service, proceeded to unblock the third victim and, after he was released from the plane, they took him to the ambulance. After all the people on the plane were evacuated and handed over to doctors, rescuers proceeded to unload the plane.

All victims were provided with medical assistance according to the protocols of the Ministry of Health – by the medical staff of the airport medical center, emergency medical aid and accident medicine teams.

After evacuation and first aid, all the victims were taken to a specialized medical facility. As a result of the accident, one aviation technician (on the airframe and engine operation) and one service passenger (airline flight engineer) suffered moderate injuries. Another victim – an aviation technician for avionics, suffered severe injuries.

According to the flight engineer, at about 03:00 in the morning, he was in the cockpit section for the accompanying personnel on the left of the flight course, sitting with his back to the nose of the aircraft, opposite the table. There was another person in the seat facing him. At the time of the plane's impact, as a result of the impact, the abdomen, lower chest and both legs were pressed by another person and table. At this time, he leaned his right hand on the table, as a result of which, he suffered a fracture of his right arm. He did not lose consciousness. An ambulance took him to the 8th Lviv City Clinical Hospital. He complained of pain in his right arm at areas of his injuries. As a result of the accident, he received moderate bodily injuries.

According to the avionics maintenance technician, during the flight he was in the cockpit part for the accompanying personnel in the seat to the right of the flight direction. As a result of the plane crash, perhaps (he cannot say for sure), he could have been pressed between the seat, which could have been torn out, and the kitchen panel. An ambulance took him and hospitalized in the 8th Lviv City Clinical Hospital. He complained of headache, pain at fractures and injuries. As a result of the accident, he received serious injuries.

According to the aviation technician for the glider and engine operation, at about 03:00 in the morning, he was in the cockpit part for the accompanying personnel, to the left of the flight direction, sitting in a seat facing the nose of the aircraft. There was a table in front of him. At the moment the plane crashed as a result of the movement of the chair, in which he was located and the table, which was twisted into

a vertical position, he was sandwiched between the chair and the table. Due to the compression of the torso, it was difficult for him to inhale air. He did not lose consciousness. His legs were twisted by the table. An ambulance delivered and hospitalized him at the 8th Lviv City Clinical Hospital. He complained of pains in the chest on the right and on the left, at the thigh injury and in the right ulnocarpal joint. As a result of the accident, he suffered injuries of medium severity.

All persons, who were in the part of the cockpit for the accompanying personnel, according to them, at the time of the occurrence were fixed in their seats with the help of seat belts.

1.16. Tests and Research

Tests and experiments were not carried out.

1.17. Information on Organizations and Administrative Activities Related to Accident

SE Lviv Danylo Halytskyi International Airport

The owner and operator of the aerodrome is the State Enterprise Lviv Danylo Halytskyi International Airport. Located on the southwestern outskirts of Lviv. The airport includes an aerodrome, terminals, a complex of ground facilities, airport services for receiving and releasing aircraft, passengers, baggage, mail and cargo, aircraft service. The airport operates around the clock and has an international status.

Ukrainian State Air Traffic Service Enterprise (UkSATSE)

Air Navigation Service Provider: State Air Traffic Service Enterprise of Ukraine (UkSATSE). State regulation of UkSATSE activities according to the Charter is carried out by the Ministry of Infrastructure of Ukraine.

Certificate for Air Navigation Services Provision was issued by the State Aviation Administration of Ukraine on December 22, 2017.

State Aviation Administration of Ukraine

The State Aviation Administration is a central executive body, whose activities are directed and coordinated by the Cabinet of Ministers of Ukraine through the Minister of Infrastructure, which implements the state policy for civil aviation and use of the airspace of Ukraine, and it is a civil aviation authority.

According to the Regulation on the State Aviation Administration, the State Aviation Administration shall adopt and implement the aviation regulations of Ukraine, supervise and monitor the observance by aviation activities entities the requirements of the legislation, aviation regulations of Ukraine.

Aerodrome Meteorological Station Civil "Lviv"

The civil aviation meteorological station of the first category (Aerodrome Meteorological Station Civil) is a structural subdivision of the Lviv Regional Center for Hydrometeorology (LRCHM). The activities of the Aerodrome Meteorological Station Civil are directed, coordinated and controlled by the LRCHM on the organization of meteorological services for aviation – by the Aviation Meteorology Division of the Ukrainian Hydrometeorological Center, and on methodological issues - by the State Enterprise "Ukrainian Aviation Meteorological Center" (SE "UAMC").

The main tasks of the Aerodrome Meteorological Station Civil are:

- meteorological services for operators, flight crew members;
- meteorological services during the flight planning phase;
- meteorological service at aerodromes, air strips;
- meteorological service for takeoffs and landings of aircraft at controlled aerodromes;
- meteorological services for airport services;
- pre-flight information service for crews;
- flight information services for aircraft in the terminal area (through approach control units)
- meteorological service for the search and rescue service;
- forecast service at the AFIS Ternopil uncontrolled aerodrome;
- carrying out a complex of observations: meteorological aviation, meteorological surface – according to the program of the basic network, meteorological and other observations provided for by the work plans, their timely processing and transmission of information to consumers, including about dangerous and natural hydrometeorological phenomena.

1.18. Additional Information

a) according to clause 12.12 of the Rules for Rescue and Firefighting Support of Flights in Civil Aviation of Ukraine, approved by the Order of the Ministry of Infrastructure No. 286 dated 07.05.2013, registered with the Ministry of Justice of Ukraine on May 24, 2013 under No. 809/23341, the ATS unit shall provide initial reports of an accident to the NBAAI. UkSATSE did not send any reports about the crash of the An-12 UR-CAH aircraft to the NBAAI. A report of the accident was provided to the State Aviation Administration of Ukraine by the ATS provider at the Lviv aerodrome according to the national mandatory reporting system in force at the time of the accident.

b) according to clause 6.3.1 of the Rules for Rescue and Firefighting Support of Flights in Civil Aviation of Ukraine, having received information about the occurrence of an accident, the head of the airport, aerodrome, air strip, in whose area of responsibility for conducting search and rescue operations – the accident took place, and the head of the operator, with whose aircraft the accident took place – should immediately begin to implement the measures provided for by the relevant plans. Without delay, no later than 15 minutes after receiving the information about

the accident, it is necessary to report to the NBAAI on the actions taken in response to the accident. According to the requirements of clause 6.3.2 of these Rules, the head of the airport, aerodrome, air strip, in whose area of responsibility for conducting search, rescue operations, an accident occurred, and the head of the operator, whose aircraft suffered the accident – within no more than two hours shall collect the operational information and transmit the initial report, in particular, to the NBAAI. However, no information about the aircraft fatal accident was reported to the NBAAI from the State Enterprise Lviv Danylo Halytskyi International Airport, nor from PJSC «AIRLINE «UKRAINE-AIR ALLIANCE». PJSC «AIRLINE «UKRAINE-AIR ALLIANCE» sent a report of the accident only at 08:05 on 04.10.2019, after an official written request from the NBAAI.

c) Tower of the Lviv aerodrome did not inform the Lviv Aerodrome Meteorological Station Civil about the accident, and, in such a way, no unscheduled meteorological observations after the An-12 plane crash were carried out.

According to the Annunciation Scheme for rescue teams, airport officials and cooperating organizations at the accident on the territory of the State Enterprise "IA "Lviv" and in the area of the airport, approved by the General Director of the State Enterprise "IA "Lviv" on 08.08.2019 and agreed by the director of the Lviv Regional Subdivision of UkSATSE, the Aerodrome Meteorological Station Civil "Lviv" is not included in the circular communication correspondents to receive the “Emergency” signal.

1.19 Useful or Effective Techniques Used in Investigation

The standard methods were applied during the investigation.

2. Analysis

According to the certificate of PJSC «AIRLINE «UKRAINE-AIR ALLIANCE», all crew members had experience in flying at the Lviv aerodrome and were familiar with the irregularities of this aerodrome, and the PIC, in addition, served there as a PIC of the An-12 military transport aircraft of the Armed Forces of Ukraine.

According to a certificate signed by an aviation medicine doctor of PJSC «AIRLINE «UKRAINE-AIR ALLIANCE», during flights over the past three hours, all crew members underwent medical certification on time, were not on sick leave certificates, they did not receive any complaints about health problems and annually used their vacations. All crew members held acting Class 1 medical certificates.

The flight assignment was not preserved, therefore, the actual composition of the crew for flight UKL4050 was not established. In the declared composition, the crew performed flights for a month of 04.09.2019 to 03.10.2019, when the flight engineer was replaced at Toulouse airport.

On 03.10.2019, the crew performed a flight en-route Toulouse (France) - Vigo (Spain) for 2 hours 04 minutes. The departure of the flight from Vigo UKL4050 was scheduled for 20.00 and according to the information received from the airport Vigo (Spain), the crew did not leave the airport territory, that is, the crew did not rest between flights.

In the course of the investigation, the daily working hours and rest times of the aircraft crew were reviewed in the period from 27.09.2019 to 04.10.2019, and non-compliance with the requirements of the Order of the Ministry of Transport of Ukraine, dated 02.04.2002 No.219.

During the flight 4050 Vigo (Spain) - Lviv (Ukraine), the crew of the An-12 UR-CAH aircraft could have over-fatigue.

In the course of the investigation, the correctness of the crew's decision to take off was analyzed and it was found that, according to the daily weather forecast for the Lviv aerodrome, issued at 17:03 on October 3, 2019 for 10:00 03.10.2019 to 18:00 04.10.2019, and was used by the crew during pre-flight briefing, at the time of the estimated time of arrival at the Lviv aerodrome, a temporary (TEMRO) deterioration in visibility up to 500 meters, heavy rain, fog was forecasted. By coincidence, at the time of the arrival of the An-12 aircraft at the Lviv aerodrome, there was indeed a forecasted deterioration in visibility up to 150-300 meters, fog.

According to the Astronomical Observatory of T. Shevchenko Kyiv National University, 04.10.2019 in the area of Lviv aerodrome, civil twilight came at 03:51, that is, 7 minutes after the estimated time of arrival of the aircraft. According to local regular reports on the Lviv aerodrome, after dusk, the runway visual range (RVR) deteriorated even more (by an average of 250 meters.)

Guided by the requirements of national regulations and the airline's operating manual, the crew and the flight controller failed to take into account the temporary deterioration of visibility and the occurrence of fog at the destination aerodrome.

At the time of taking the decision on departure, the PIC did not take into account the temporary deterioration of weather conditions at the time of landing (TEMRO), which corresponds to the requirements of the Order of the State Aviation Administration dated 08.04.2005 No. 295, registered with the Ministry of Justice on 27.05.2005 under No. 577/10857 (hereinafter - the Procedure for Taking Decision), airline's Operations Manual and contradicts the requirements of JAR OPS 1, approved by the State Aviation Administration Order dated February 21, 2006, No. 137 "On Application in Civil Aviation of Ukraine of Common Aviation Requirements JAR OPS 1 "Commercial Air Transportation (Airplanes)", registered with the Ministry of Justice on 07.03.2006 under No. 245/12119 (hereinafter - JAR OPS 1 Regulations) and contradicting Table 4-4 of ICAO Doc 9976: Flight Planning and Fuel Management Manual.

According to the letter of the airline PJSC «AIRLINE «UKRAINE-AIR ALLIANCE», the risk assessment in case the crews had not taken into account the temporary deterioration of visibility in fog at the destination aerodromes to values below the corresponding minima of the aircraft PIC and aircraft, in particular, at the time of arrival at the destination aerodrome at the time of dusk, was not carried out.

The investigation established that the PIC had a valid commercial pilot's license issued by the State Aviation Administration, which specified PIC's meteorological minimum of 200 ft x (RVR = 550), and clearance for landing approach by CAT I.

In October 2019, at the request of the State Aviation Administration, the airline returned the acting Air Operator's Certificate No. UK023 dated 09.11.2017. and Operations Specifications dated 09.11.2017. These Operations Specifications indicated that the airline could operate CAT 1 landing flights with a minimum of DH 200 ft and RVR 550 m, and for takeoff – RVR 400m.

Subsequently, the State Aviation Administration issued the Air Operator's Certificate and Operations Specifications (OS) to the airline dated 31.01.2020, replacing the OS with OS 2 dated 28.02.2020, and later replacing OS 2 with OS 3 dated 16.06.2020. At that, the OS dated 09.11.2017 and OS dated 31.01.2020 contained the information on the minima for landing and take-off under CAT 1, and OS 2 dated 28.02.2020 and OS 3 dated 16.06.2020 contained no minima for landing and take-off.

According to paragraph 2.5 of the An-12 Aircraft Flight Operation Manual, and the information provided by Antonov State Enterprise by the letter of 21.02.2021 No. 724/2318-20, the lowest meteorological minimum for the instrument landing as of the accident date was: in the director mode of the landing approach – decision height – 60 meters, runway visual range – 800 meters (attached.)

After the fatal accident, the Antonov State Enterprise clarified the existing minimum for An-12 aircraft and entered into the Flight Operation Manual an amendment dated 15.07.2021 No. 2/2021 regarding the minima for takeoff and landing. According to the amendment, An-12 aircraft can perform an ILS approach and landing by CAT I ICAO minimum. Under the Flight Operation Manual amendment, the aircraft received the following minimum for landing: decision height (DH) for precision landing approach – 60 meters (200 feet), runway visual range (RVR) – 550 meters, meteorological range of visibility (MRV) – 800 meters. Landing Minimum shall be applied at aerodromes with High Intensity Approach Lighting System (HIALS) and High Intensity Runway Landing Lights (HIRL).

According to OFP received from the operator's flight controller, the total take-off weight of the aircraft was to be 61,000 kg.

Due to the absence of the flight assignment, logbook, calculations of take-off weight and aircraft CG, performed by the crew before departure, the Investigation Team could not accurately establish the aircraft take-off weight and CG. But taking into account the information received from the Vigo airport about the commercial cargo weight, documents on the cargo, the amount of fuel filled, and information received from the cockpit crew communication, the Investigation Team calculated that the take-off weight of the aircraft during departure could make 66,400 kg.

M empty aircraft	36,240 kg
M fuel	14,050 kg (according to the records of the crew's communication after 14-minute flight in the takeoff mode)
M crew	640 kg
M cargo	14,078* kg
M service load	850 kg (approximately, minimum)
M of service equipment	390 kg (Flight Operation Manual, par 3.2, 3 of Art. 24)
M of personal crew baggage	160 kg (approximately, minimum)
M takeoff	66,408 kg

According to the calculation presented in Appendix 1, the take-off weight of the aircraft could be 65,500-67,500 kg, i.e. by 6.5 tons higher than the maximum established by the Flight Operation Manual.

***Note:** this calculation of the take-off weight approximately corresponds to the calculation made on the basis of the aerodynamic parameters of the flight by the specialists of the Antonov State Enterprise (66,700 kg.). The calculations by the NBAAI and Antonov State Enterprise were made on the basis of the aerodynamic parameters of the flight, they are attached to the materials of the investigation.*

***Note:** according to the An-12BK Aircraft Flight Operation Manual, par 2.2, the maximum take-off weight shall be 61,000 kg.*

*According to the Charter Cargo Manifest, the gross weight of the aircraft cargo was 13,000 kg. According to another consignment note (Carta de Porte Transporte Nacional de Mercancías por Carretera), the gross weight of the cargo was 14,078 kg. On the NBAAI's request to clarify the actual weight of the cargo loaded at the plane, the Vigo airport handling company reported that it did not have documents on the actual cargo.

Upon analysis of the information received from the CVR, the Investigation Team found that at 02:01:43, in the aircraft cockpit, the onboard EGPWS system was activated for a short time: "50 ... 30 ... MINIMUMS, MINIMUMS." At that time, the aircraft was at FL 250 and performed a level flight.

Further on, during the entire flight until the moment, when the aircraft collided with obstacles on the ground, the onboard EGPWS system did not operate.

2.1. Aircraft Engine Start-Up, Taxiing and Take-Off

- FDR/CVR recording starts after the auxiliary power unit start-up.
- According to CVR, the engine start began at 22:09:27.
- At 22:13:30, the crew requested a taxi clearance from the controller, and having received a taxi clearance to RWY 01, they confirmed it and began taxiing. Before taxiing began, the flaps were extended to 15 degrees for takeoff.
- At 22:18:08, the crew reported to the controller about their readiness for takeoff.
- At 22:18:26, having received a take-off clearance from the controller, the crew reported the start of take-off.

Attention is drawn to the non-conformity with the aircraft takeoff characteristics. The An-12 aircraft manual (Table 7, page 46) provides the following data for take-off:

For takeoff weight of 61,000 kg:

- Take-off conditions: $W=0, \theta=0, H_{rw} = 220\text{m}, \delta_{flaps} = 15^\circ$;
- Engine operating mode - takeoff;
- Unstick speed = 240 km/h;
- Take-off distance = 1230 m -;
- Climb speed = 3.2-3.3 m/s;
- Instrument climb speed = 360 km/h;
- Flaps should retract immediately after unstick, at an altitude of at least 150 meters and a speed of 310 km/h.

The actual data under the same conditions were as follows:

- Unstick speed = 272.3 km/h. (Exceeding by 32.3 km/h)
- Take-off distance = 1600 m (Exceeding by 380 m);
- Climb speed = 2.76 m/s (Less by about 0.5 m/s);
- Instrument climb speed = 372 km/h (Exceeding by 12 km/h)
- Flaps were retracted gradually during the climb to 5-6 degrees and were completely retracted at the altitude of flight level of 6600 m at 23:00:30.

These figures indicate that the plane could be overloaded.

At 23:54:13, after 1 hour and 36 minutes of flight, the aircraft reached an altitude of 7200m (FL240.)

At 01:20:54, the aircraft entered the flight altitude 7400 m (FL250). The flight at this altitude continued until the start of the descent.

2.2. Landing Approach

At 03:22:25, the crew requested clearance from the controller of the Lviv ACC to descend to FL120, and, having received clearance at 03:22:40, began the descent and landing approach using the radar vectoring method as instructed by the controller.

There were no deviations in the operation of the engines based on the results of FDR decoding, and according to the crew reports based on the results of CVR decoding.

***Note:** The flight path was calculated at the landing approach stage according to the recorded parameters of the aircraft movement with account of the correction of the coordinates recorded by the GPS unit.*

***Note:** The movement of the aircraft after the end of the recording on the recorder (after collision with trees) is restored approximately according to the sketch of the accident site.*

***Note:** All distances on the diagrams and graphs are indicated counting from the aircraft CG and may differ from the distances indicated in the sketch by the aircraft geometric dimensions.*

At 03:40:00 UTC, the height over the RW-31 threshold was 1170 m, descent rate -4 ... -4.5 m/s, flight speed 352 km/h, distance 15.70 km;

At 03:40:20 UTC, at a distance of 16.1 ... 14.7 km, the aircraft, in the process of descent, completes the turn and enters the final;

At 03:41:10 UTC, at a distance of 11 km, the aircraft is 70 m above the glide path. The estimated height of the point of entry into the glide path is 590 m, the actual height is 660 m. The indicated speed was recorded at 320 km/h. The vertical rate of descent was -6.5 m/s. The aircraft decreases and approaches the glide path;

At 03:40:01 UTC, the crew reported on the localizer capture beam for the ILS approach to Runway 31. The controller instructed to continue the ILS approach to Runway 31. The mean vertical descent rate was 4 ... 4.5 m/s.

At 03:40:30 UTC, the crew extended the landing gear at a distance of 13.9 km (according to recorders).

***Note:** according to the Aircraft Flight Manual, the landing gear shall be extended before flaps are extended by 15° at a distance of at least 18 km. Thus, the crew released the landing gear with a 4 km delay.*

At 03:41:16 UTC, at a distance of 11.6 km, the crew began to deploy the flaps to 15 degrees. The instrument speed was 326 km/h.

***Note:** according to the Flight Operation Manual, when approaching the landing, the flaps shall be deployed in three stages: at 15°, at 25°, at 35°. The maximum flight speed with flaps at 15° shall be 340 km/h. Thus, the flaps were extended at a lower speed than established by the Flight Operation Manual.*

After the flaps were deployed by 15 degrees, one of the crew members (flight engineer) reported of the aircraft configuration: "**15, landing gear extended, landing weight 53**".

At 03:41:36 UTC, at a distance of 10.64 km to the glide slope beacon, additionally flaps were extended by 20 degrees, the flight speed was 316 km/h.

***Note:** according to the Flight Operation Manual, the maximum flight speed with flaps extended at 25° shall be 340 km/h.*

At 03:42:24 UTC, at a distance of 8.0 km from the glide slope beacon, the aircraft reaches the glide path. At a distance of 7.9 km, the aircraft crosses the glide path and continues to gradually descend below the glide path.

At that time, the internal engines were operating in the IKM2 – 10, IKM3 - 12 modes, the external engines were operating in the IKM1 – 19, IKM4 - 12 modes.

***Note:** during the descent, it is necessary to balance the aircraft with the trims so that the aircraft steadily maintains the specified flight mode.*

In the time interval 03:42:55 ... 03:43:00 at a distance of 4.7 ... 4.4 km, the crew extended the flaps to 35 degrees. The aircraft was below the glide path and continued to descend. 3-4 seconds after the flaps were extended, the thrust of the external engines increased and the vertical rate of descent began to increase.

***Note:** according to the Flight Operation Manual, flaps shall be extended to 35° before entrance to the glide path at a speed of 280-300 km/h. Thus, flaps at 35° were extended much later, when there were 4 km to the runway.*

According to the Flight Operation Manual, the extension of the flaps from 15° to 35° is accompanied by the aircraft's tendency to pitch up (an increase in the pitch angle) and a noticeable decrease in the gliding speed. Therefore, this desire should be countered by a smooth movement of the steering wheel away from a pilot and, if necessary, increase the engine thrust mode. Despite the fact that the plane was below the glide path, the situation became dangerous.

At 03:43:24 UTC, at a distance of 2.86 km from the runway threshold, the crew increased the thrust mode of the external engines to 42-43 by the engine torquemeter, while the vertical descent rate was 4-5 m/s, which exceeds the rate established for the Lviv aerodrome. The aircraft moved below the glide path by 65 m. The actual altitude was 105 m. After 7-8 seconds, the vertical descent rate increases again, the aircraft descended further below the glide path, the operating mode of the external engines increased to 55 by the engine torquemeter.

At 03:43:32 UTC, at an altitude of 60 m, at a distance of 1980 m from the runway threshold, the radio altimeter alarm "Decision Altitude" was triggered, but none of the crew members responded to it and the aircraft continued to descend.

***Note:** according to the Flight Operation Manual par 4.7.1, if a radio altimeter alarm is triggered to establish a reliable visual contact with the lights of the aerodrome lighting equipment or other landmarks along the landing course, an urgent go-around maneuver should be started.*

At 03:43:34 UTC, at a distance of 1.67 km from the displaced threshold of the runway, the mode of the internal engines for a short time, for 3-4 seconds, increased and then decreased to 22-30, the vertical speed was 4 m/s, the height was 48 m (40m below the glide path), the speed was 244 km/h.

***Note:** according to the Flight Operation Manual Table 4.6, rate of descent with a landing weight of 50 - 55 t and flaps 35° should be 270 km/h. Thus, the crew did not control the speed and flew at a speed that was 26 km/h less than those established in the flight manual.*

At an height of about 30 m over the runway threshold (20 m over the ground surface), 2-3 seconds before collision with trees, the elevator deviates to pitching-up by about 75% of the maximum value, but these actions were not enough to reduce the vertical speed and the aircraft continued descend with a vertical speed of 6 m/s and at a height of 5-7 m from the ground surface (15-17 m from the threshold of the runway) at a distance of 1500-1600 m from the threshold of the runway collided with trees. After a collision with trees, the recording on the recorder discontinued.

During the flight along the glide path (navigator) provides commands to correct the direction of movement along the course, however, none of the crew members reported about the position of the aircraft relative to the glide path.

During the flight along the glide path (navigator) reports the distance to the runway threshold (according to the extract of the crew's communication), which corresponds within an error of 150-200 m to the calculated distance according to the recorded coordinates of the aircraft.

From an altitude of 100 m until the moment of collision with obstacles (flight engineer) reports the altitude by radio altimeters every 10 meters.

Analysis of the aircraft landing approach parameters at a distance of 11,000 meters, obtained from the recorders data, shows that the crew increased the instrument speed three times by increasing the vertical speed. So, at a distance of 8000 meters from the displaced threshold of the runway, the crew, after a slight loss of the indicated speed, increased the vertical speed to 6 m/s (established as 4 m/s), at a distance of 4200 meters from the displaced threshold of the runway, the crew, after losing the indicated speed, increased the vertical speed up to 5.5 m/s, with its subsequent decrease to 3 m/s, at a distance of 2000 meters from the displaced threshold of the runway and Habsolute=48 m, after the loss of the indicated speed to 237 km/h, the crew made a third attempt to increase the indicated speed for by increasing the vertical speed.

This approach procedure indicates inadequate actions of the PIC.

When inspecting the accident site, the Investigation Team found devices of the aircraft instrument landing system, and found that the glide slope and heading alarm flags were turned off.



Fig.7 Pointer of the flight control and navigation instrument

*Note: according to the Flight Operation Manual p.4.7.1, “**warning:** while maintaining the target rate of descent, the speed should be increased only by increasing the engine operating mode. It is **forbidden** to increase the speed at the expense of descent.”*

In the course of the investigation, the calculation of the amount of fuel on board the aircraft during the approach to the Lviv aerodrome was made.

According to the calculation, taking into account the actual take-off weight of the aircraft, the tendency to climb and occupy target flight levels by the aircraft, approximately 600 - 650 kg of fuel could remain on board the aircraft,

Calculation of the approximate fuel amount on board An-12 UR-CAH aircraft during the landing approach to the Lviv aerodrome on 04.10.2019. (Variant 1)

The amount of fuel on board the aircraft during departure (obtained from the report of the flight engineer to PIC at 14th minute of flight) 14050 kg

Fuel consumption for the first 2 hours of flight 2 x 2700 kg = 5400 kg;

Fuel consumption for second 2 hours of flight 2 x 2500 kg = 5000 kg;

Fuel consumption for the last 1.5 hours of flight 1.5 x 2000 kg = 3000 kg;

The approximate remaining fuel on board the aircraft during the landing approach on 04.10.2019 at the Lviv aerodrome was 650 kg.

Calculation of the approximate amount of fuel on board An-12 UR-CAH aircraft during the landing approach to the Lviv aerodrome on 04.10.2019. (Variant 2)

The amount of fuel on board the aircraft during departure (obtained by the PIC from the flight engineer's report for 14 minutes of flight) was 14050 kg.

The estimated take-off weight of the aircraft at the time of departure was 66400 kg.

(This take-off weight roughly corresponds to the calculations of the Antonov State Enterprise specialists (66.5 - 67.5 tons).

The aircraft weight during descent for landing (obtained by the PIC from the report of the flight engineer) was 53,000 kg.

Having made the calculation ($66,400 - 53,000 = 13,400$), $14,050 - 13,400 = 650$ kg. That is, this calculation corresponds to the previous ones.

During the draining of the remaining fuel from the aircraft, it was found that the fuel remained only in the wing root tanks. The tanks were not destroyed. About 170 liters of fuel were drained from the tanks.

According to the Section "Criterion of Stabilized Approach. Execution of Pre-Landing Checklist", part A of the Operation Manual of PJSC «AIRLINE «UKRAINE-AIR ALLIANCE» (OM-A), Revision 8 dated 10.08.2016, which was in effect at the time of the accident, the crew should calculate the approach so that by the time of crossing altitude 500 feet above aerodrome elevation the aircraft should be in the landing configuration, balanced, at a stabilized approach speed, and the

Checklist should be fully completed, except for specific items such as landing lights, windshield wipers, etc. Compliance with this rule is essential for careful and adequate flight control during the final approach and landing phase.

According to paragraph 7.9 of Chapter 8 of OM-A, at flight on final, the aircraft PIC should stop the descent and perform the procedure in case of an unsuccessful landing approach (hereinafter referred to as the go-around), if, in particular, the flight is not stabilized till reaching the altitude of 150 meters (500 feet) to the runway threshold (unless it is provided by the flight operation manual for this aircraft type.) Despite the fact that the flight was not stabilized, and the plane was significantly below the glide path, the decision to stop the descent and to go around was not complied with.

2.3. Operation of Lighting System at Lviv Aerodrome

In the course of the investigation, the Investigation Team analyzed the work of the electrical and lighting support of flights at the Lviv airport, and found that, according to the Archive of the lighting control system and Information on the operation of the HIL-II IDMAN-type lighting equipment, dated 25.10.2019, prepared by the Division for lighting support for flights of the airport "Lviv", starting from 03:13:35 to 03:25:15, the aerodrome lighting system with MKland310° was switched on, in particular, runway edge lights, runway centre line lights, taxiway lights, stop bar lights, approach lights, stopway lights, threshold lights, light units – at 30%, and touchdown area zone lights – at 10%, which met the requirements of the Certification Requirements for Civil Aerodromes of Ukraine (hereinafter - CRCAU).

***Note:** The requirements for the regulation of the luminous intensity of high-intensity lights were determined by clause 8.2.6.1 and table D.11.2 of the CRCAU*

The HIL-II lighting equipment with MKland310° was turned off at 5:26:25. During the specified period, according to the Archive of the electrical and lighting support of flights, there were no critical comments on the operation of the lighting equipment.

The last flight check of the HIL-II IDMAN-type system before the accident, with MKland310°/130°, was carried out in the period from 12.06.2019 to 13.06.2019. According to the conclusions of the inspection, the parameters of HIL-II IDMAN-type system with MKland310°/130° met the requirements of the operational and technical documentation. The HIL-II IDMAN-type system is suitable for aircraft flights.

2.4. Functioning of Landing Systems at Lviv Aerodrome

In the course of the investigation, the landing systems at the Lviv airport were analyzed and it was found that the aerodrome is equipped with DVOR/DME landing systems and SP-200 type radio beacon system (certificate of serviceability of the RMD-90NP rangefinder radio beacon (DME) and SP-200 radio beacon landing system (RBLS), which were issued by the State Aviation Administration of Ukraine, were valid at the time of the accident). According to the acts of annual flight inspections of the DME RMD-90NP and RBLS SP-200 system with two landing courses, which were conducted in June 2019, it was established that their parameters meet the requirements of the RBLS II category operational and technical documentation, and the RBLS is suitable for flights.

After the accident, in the period from 19.10.2019 to 20.10.2019, a semi-annual flight check of the DME RMD-90NP and RBLS SP-200 was carried out with two landing courses. According to the conclusions of the Flight Inspection Acts, it was established that the parameters of the specified equipment comply with the requirements of the operational and technical documentation for Category II RBLS, and RBLS is suitable for flight operations.

As part of the investigation, under instruction of the Deputy Minister of Infrastructure, with the involvement of specialists from the State Aviation Administration and UkSATSE airline, the issues of compliance with the performance of flight checks of ground-based radio communication facilities at the Lviv aerodrome with Da-42 aircraft of SkyKGAirlines (Kyrgyzstan), equipped with the AT-940 system, were additionally investigated in 2019 at the Lviv airport vs. requirements of the Ukrainian legislation. In particular, materials on the flight over ground-based radio communication facilities at the Lviv aerodrome in 2019 were analyzed. According to the results of the study, numerous inconsistencies in the results of the checks performed with the requirements of the Rules for organizing and conducting ground and flight checks of ground facilities of the radio communication of flights, aviation telecommunication and lighting equipment of aerodromes of the Civil Aviation of Ukraine, approved by DASU order dated 23.03.2005 No. 210 and registered in the Ministry of Justice on 07.04.2005 No.374/10654 and Appendix 10 to the Convention on International Civil Aviation "Aeronautical Telecommunications", Volume 1 "Radio Navigation Aids", in particular:

in tables 12.6 of the Flight Inspection Certificate of DME RMD-90NP serial No. 1158, issued on August 24, 2011, installed at the Lviv aerodrome with MH=310° and DME RMD-90NP Flight Test Certificate serial No.1157, issued on August 24, 2011, installed at the Lviv aerodrome with MH=130°, approved by the General Director of Lviv Airport on 15.06.2019, the altitude at which the overflight was carried out, is not indicated, the field strength parameters in the DME coverage area are not clearly indicated, reports based on the results of flight checks of ground-based radio technical support are not attached, printouts of the measurement result tables are not attached, on separate charts based on the results of flight checks, the serial

number of SP-200 and name of the Kharkiv aerodrome and the like are incorrectly indicated.

The identified shortcomings and inconsistencies in the performance of flight checks of ground aids of the radio communication at the Lviv aerodrome in 2019 were reported to the State Enterprise Lviv Danylo Halytskyi International Airport and Civil Aviation Agency under the Ministry of Transport and Roads of the Kyrgyz Republic, which, in turn, agreed that the operator of the aircraft, which was flying over the radio communication facilities, committed some violations and informed the NBAAI of its intentions to conduct an inspection of the operator's activities and draw attention to the quality of aviation work performed by the airline.

In addition, in order to clarify the question of whether the AT-940 equipment (made in the USA) can be used for flight checks of ground-based radio communication facilities at aerodromes equipped according to ICAO Category II, and whether this equipment meets the requirements of ICAO Doc 8071 "Manual for Testing Radio Navigation Aids "Volume 1" Testing of Ground-Based Radio Navigation Systems", NBAAI contacted the US Transportation Safety Board (NTSB). Upon request from the NBAAI, the NTSB advised that the AT-940 flight inspection system meets the requirements of ICAO Doc 8071 1 as regards performance of flight inspections of ILS Instrument Landing Systems (CAT I, II and III) and DME Rangefinder Ground Stations.

According to the Information Certificate on operation of the landing system (SP-200) and DME (RMD-90np) with MH310° dated 25.10.2019, provided by the department of radio navigation and electrical support of airport "Lviv", according to the statistics of the state of radio beacons and their parameters for the period from 03:00 to 04:00, the landing system and radio beacon of the rangefinder with MH310° operated in the normal mode, the parameters corresponded to the requirements of the operational and technical documentation.

2.5. Meteorological Information Provision

Meteorological services at the Lviv aerodrome were provided by the Lviv Aerodrome Meteorological Station Civil. The daily weather forecast for the Lviv aerodrome (TAF) with a period of validity from 18:00 03.10.2019 to 18:00 04.10.2019, which was used by the crew during the pre-flight briefing, was compiled on 03.10.2019 at 17:03. The crew received the weather forecast and other meteorological information as part of the OFP at the Vigo aerodrome at 18:51. Besides the forecast for the Lviv aerodrome, the crew received as part of OFP the regular information (METAR) on the Lviv aerodrome for 18:30 03.10.2019, as well as TAF and METAR on the Boryspil alternate aerodrome. According to METAR for the Lviv aerodrome, visual meteorological conditions were observed at the Lviv aerodrome, in particular, wind 280°, 1 m/s, CAVOK, air temperature +6°, dew point temperature +5°, QNH 1012 hPa. According to TAF, a wind of 270°, 4 m/s was forecasted for the Lviv aerodrome, visibility 3000 m, mist, broken clouds 210 m

high; time (TEMRO) from 18:00 03.10 to 06:00 04.10 visibility was forecasted 500 m, mist, fog, broken clouds with a height of 60 m, broken cumulonimbus clouds with a height of 540 m; gradually (BECMG) from 6:00 to 08:00 04.10: wind of variable directions 1 m/s, visibility 10 km or more, no special weather phenomena, broken clouds with a height of 450 meters; time between 8:00 and 15:00 04.10: light shower rain, broken cumulonimbus clouds 600 meters high.

According to paragraph 6 of clause 5.4 of the Decision-Making Procedure, when departing outside the destination aerodrome under IFR, the temporary (TEMRO) deterioration in visibility forecasted before the arrival time is not taken into account. At the same time, if the estimated time of arrival coincides with the BECMG forecast period of change in visibility, its lowest value is taken into account when making a decision under IFR. According to paragraph 3.1 of the Decision Procedure, the TEMPO change index is used in weather forecasts to describe the expected temporal changes in meteorological conditions reached or that have passed the established values, and in each individual case persist over time lasting less than one hour, and in general - less than half the forecast period, during which changes are forecasted. During the descent and approach period at the Lviv aerodrome, actually for 03:20 (ATIS information used by the crew during pre-landing preparation), fog was observed, visibility 150 m, vertical visibility 50 m. The duration of the fog phenomenon with visibility of 500 m and less was 1 hour 17 min, which indicates an error in determining the index of duration of change (TEMPO) and need to use the BECMG index of changes in this case.

2.6. Rescue and Fire Fighting Support

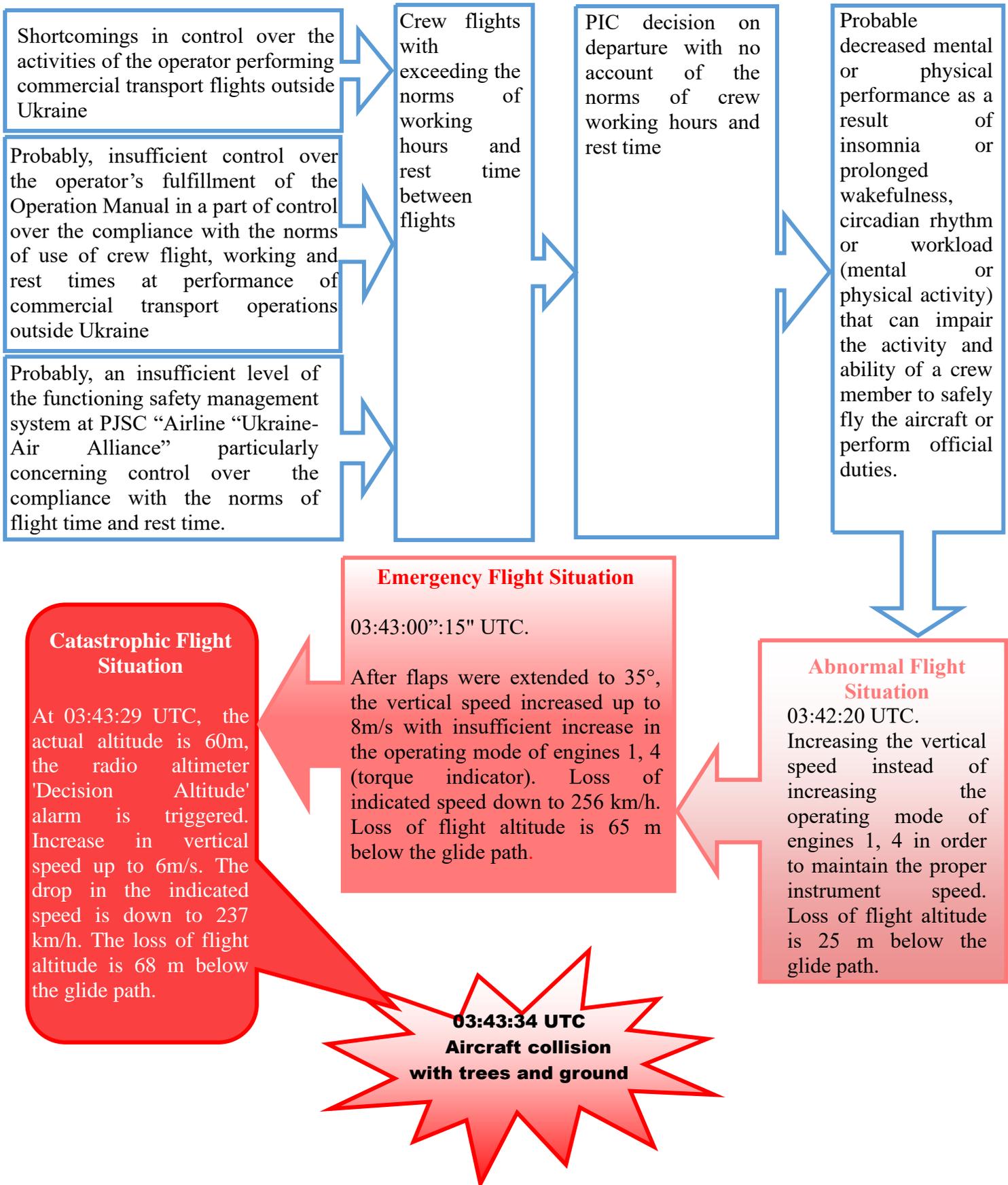
The investigation analyzed operation of the rescue and fire-fighting support at the Lviv airport during the accident and established that the organization and conduct of search and rescue operations on 04.10.2019 were carried out by the rescue and fire-fighting service of the State Enterprise Lviv Danylo Halytskyi International Airport together with the Main Department of the State Emergence Service in the Lviv region.

The number of fire trucks that were on duty met the requirements of Table. 3.2 of Appendix 3 to the Rules for Rescue and Fire Safety of Flights in Civil Aviation, approved by order of the Ministry of Infrastructure of Ukraine dated 07.05.2013 No.286 and registered with the Ministry of Justice on 24.05.2013;

The number of the duty shift of the rescue team met the requirements of Table. 4.1 of Appendix 4 to the Rules for Rescue and Fire Safety of Flights in Civil Aviation, approved by order of the Ministry of Infrastructure of Ukraine dated 07.05.2013 No.286 and registered with the Ministry of Justice on 24.05.2013.

The plane was found 52 minutes after the Tower controller announced the “Emergency” signal. The search for the accident site was complicated due to the inaccessibility of the approach to the accident site and adverse weather conditions.

Diagram of Accident Causal Relationship



3. Conclusions:

1. The analysis of the technical documentation on operation of engines AI-20M Series 6A Nos.: 1; 2; 3, 4 indicates that the engines were operated according to the Technical Operations Manual and maintenance schedule and were serviceable at the time of the accident.

2. The propellers were fully maintained and were serviceable at the time of the accident.

3. According to the decoded flight parameters en-route Vigo (Spain) – Lviv (Ukraine) of An-12BK UR-CAH aircraft, before the collision with obstacles, the engine parameters corresponded to the operating modes set by the crew.

4. Based on the on-board recorders data analysis results, it was established that the fuel system of the An-12BK UR-CAH aircraft was serviceable at the time of the accident and provided engine operation in the takeoff mode until the aircraft came to rest.

5. All crew members had significant work experience and valid licenses of aviation personnel.

6. An-12BK UR-CAH aircraft had the airworthiness certificate. The aircraft was operated according to the airworthiness directives and manufacturer's operating bulletins.

7. The aircraft was fully operational and controllable until the moment of collision with obstacles on the ground.

8. No defects or technical malfunctions of the aircraft, engine, auxiliary units or systems of the aircraft were found.

9. During take-off from Vigo airport, the estimated take-off weight of the aircraft could exceed the maximum take-off weight by more than 5400 kg.

10. The estimated remaining fuel on board the aircraft during the landing approach to the Lviv aerodrome could not allow the crew to perform a flight to the alternate Boryspil airport.

11. During the flight along the glide path, the engine operating mode was set lower than that provided for by the Flight Operation Manual p. 4.7.1.

12. PIC had considerable experience in performing flights to the Lviv aerodrome.

13. PIC has repeatedly tried to increase the indicated speed of the aircraft by increasing the vertical speed, contrary to the requirements of the An-12 Flight Operation Manual.

14. PIC made a decision to take off from Vigo airport without the necessary rest of the crew.

15. On the eve of the accident, the crew did not comply with the working hours and rest time between flights.

16. Control over the performance of flights did not allow to reveal non-compliance by the crew with the norms of crew working hours and rest time.

3.1. Causes

3.1.1. The most probable cause of the accident, collision of a serviceable aircraft with the ground during the landing approach in a dense fog, was the crew's failure to perform the flight in the instrument conditions due to the probable physical excessive fatigue, which led to an unconscious descent of the aircraft below the glide path and ground impact.

3.2. Contributing Factors

3.2.1. Probable exceeding the aircraft takeoff weight during departure from the Vigo Airport, which could result in increase in consumption of the fuel, the remainder of which did not allow to perform the flight to the alternate Boryspil aerodrome.

Category: CFIT.

4. Safety Recommendations

4.1. To: State Air Traffic Service Enterprise (UkSATSE)

4.1.1. Initiate together with the SE Lviv Danylo Halytskyi International Airport inclusion of "Lviv" Aviation Meteorological Station Civil into the Annunciation Scheme for Rescue Teams, Airport Officials and Cooperating Organizations at Accident in Territory of SE Lviv Danylo Halytskyi International Airport and Airport Area, to the conference communication correspondents in order to receive the Alert.

4.2. To: State Aviation Administration of Ukraine:

4.2.1. Urgently suspend the effect of paragraph 6 of clause 5.4 of the Procedure for Making Decision on Departure and Arrival of Civil Aircraft of Ukraine under Instrument Flight Rules, which was approved by the Order of the State Aviation Administration of 28.04.2005 No.295.

4.2.2. Eliminate differences in regulatory legal acts (the Procedure for Making Decision on Departure and Arrival of Civil Aircraft of Ukraine under Instrument

Flight Rules, which was approved by the Order of the State Aviation Administration of 28.04.2005 No.295 and registered with the Ministry of Justice on 27.05.2005 under No.577/10857 and Order of the State Aviation Administration of 21.02.2006 No.137 "On Application in Civil Aviation of Ukraine of General Aviation Requirements JAR OPS 1 "Commercial Air Transportation" (Airplanes), registered with the Ministry of Justice on 07.03.2006 under No.245/12119) in a part of taking into account by an aircraft PIC of the forecasted temporary (TEMRO) change in weather conditions at taking decision on departure.

4.2.3. In order to establish an effective control over the fulfillment of the requirements of Regulations on Determination of Working Time and Rest Time of Civil Aviation Crews of Ukraine, approved by the Order of the Ministry of Transport of Ukraine dated 02.04.2002. No. 219 and registered with the Ministry of Justice on 24.04.2002 under No.390/6678 – organize and conduct systematic inspections of aircraft operators for compliance with the norms of crew working and rest hours.

4.2.4. Organize the development of a new redaction of the Regulations on Organization and Conduct of Ground and Flight Checks of Ground-Based Facilities of Radio Communication Flights, Aviation Telecommunication and Lighting Equipment of Aerodromes of Civil Aviation of Ukraine, approved by Order of the State Aviation Administration dated 23.03.2005 No. 210 and registered with the Ministry of Justice on 07.04.2005 No. 374/10654, taking into account of the current edition of ICAO Doc 8071 "Manual for Testing of Radio Navigation Aids", Volume I "Testing of Ground-Based Radio Navigation Systems".

4.2.5. Check the ratings indicated in the pilot licenses for compliance with the landing permissions under the minima corresponding to the Aircraft Flight Operation Manual.

4.2.6. Take actions for the proper functioning of the Fatigue Risk Management System (FRBLS) for operators, and establish an appropriate control system according to the Manual on Control of Fatigue Management Activities (ICAO Doc 9966).

4.2.7. Resolve the issue of ensuring the reporting to the NBAAI of occurrences by the relevant aviation entities according to the Order of the Ministry of Infrastructure of Ukraine dated 07.05.2013 No. 286 and registered with the Ministry of Justice on 24.05.2013 under No. 809/23341. Introduce alterations/amendments to the civil aviation regulations for the purpose of reporting safety-related occurrences to the NBAAI.

4.3. To: Operator, PJSC “AIRLINE “UKRAINE-AIR ALLIANCE”

4.3.1. Take additional actions to ensure aircraft crew compliance with the norms of working hours and rest hours, according to the requirements of the Regulations on Determination of Working Time and Rest Time of Civil Aviation Crews of Ukraine, approved by the Order of the Ministry of Transport of Ukraine dated 02.04.2002. No. 219 and registered with the Ministry of Justice on 24.04.2002 under No.390/6678 and constantly monitor the crew rest time and working hours at flight operation with account of trans-meridian flights.

4.3.2. Develop a procedure for monitoring aircraft loading, taking into account its tactical-and-technical characteristics and flight conditions at operational flight plan development.

4.3.3. Ensure the safety of originals (copies) of aircraft on-board documentation according to the requirements of the Aviation Regulations on “Continuing Airworthiness of Aircraft and Aeronautical Products, Parts and Appliances, and on the Approval of Organizations and Personnel Involved in These Tasks,” — as approved by State Aviation Administration (Order No. 286 dated 6 March 2019) and registered with the Ministry of Justice on March 28, 2019 under No. 316/33287.

4.3.4. Conduct simulator training with flight crews on performance of the landing approach and landing procedure in compliance with the requirements of the An-12 Aircraft Flight Operation Manual.