NATIONAL BUREAU OF AIR ACCIDENTS INVESTIGATION

SERIOUS INCIDENT

FINAL REPORT

RUNWAY EXCURSION DURING LANDING AT KYIV (ZHULIANY) AERODROME

AIRCRAFT OPERATOR:	ARROW AVIATION
AIRCRAFT TYPE:	H25B
REGISTRATION NUMBER:	4X-CUZ
OCCURRENCE PLACE:	"Kyiv" (Zhuliany) Aerodrome
STATE OF OCCURRENCE:	UKRAINE
OCCURRENCE DATE:	21.05.2021

APPROVED BY
Acting Director
of the National Bureau of
Air Accidents Investigation
_____Igor MISHARIN
"___" _____ 2021

FINAL REPORT

on Technical Investigation of Serious Incident (Runway Excursion) With H25B 4X-CUZ Aircraft, Which Took Place on 21.05.2021 During Landing At "Kyiv" (Zhuliany) Aerodrome

Kyiv City

The Investigation Team of the National Bureau of Air Accidents Investigation (hereinafter referred to as NBAAI), appointed by the NBAAI Acting Director's Order dated 21.05.2021 No. 27 and Order dated 02.08.2021 No. 51, has conducted an investigation into the serious incident that occurred on 21.05.2021 with H25B 4X-CUZ aircraft during landing at the "Kyiv" (Zhuliany) Aerodrome.

The Final Report is to be sent to the following addressees:
- National Bureau of Air Accidents Investigation of Ukraine;
- State Aviation Administration of Ukraine;
- SE ATS "UkSATSE";
- Office of the Chief Investigator (AIAI) of the Ministry of Transport of Israel;
- International Civil Aviation Organization (ICAO).

Investigation was initiated on 21.05.2021.

Investigation was completed on 20.12.2021.

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

Brief Description of Occurrence (SI)

Aircraft Operator: Arrow Aviation

Aircraft Type and Registration Number: H25B 4X-CUZ

Number and Type of Engines: 2, -

Occurrence Date and Time: 21.05.2021, 01:17 UTC

On May 21, 2021, at 01:17 UTC, in the course of landing on wet RW 26 covered with 1 mm layer of water (according to the aerodrome service) at the Kyiv (Zhuliany) aerodrome, H25B 4X-CUZ aircraft operated by Arrow Aviation, which performed flight 4X-CUZ en-route Ben Gurion (Tel Aviv) – Kyiv (Zhuliany), suffered a runway excursion to the left. Having failed to report to the ATS unit, the aircraft crew continued taxiing along the runway lights outside the runway for about 40 meters; the aircraft returned to the runway before the runway end and vacated the runway, headed along TW1, continued taxiing to Stand 24 behind a follow-me car. After shutting down the aircraft engines, the aircraft inspection revealed damage to the right tire of the right main landing gear.

Note: hereinafter, the Universal Time Coordinated (UTC) is indicated. The difference between the local time and UTC time is +3 hours.

On May 21, 2021, NBAAI received report about the occurrence from the Central Dispatch Service of the State Aviation Administration of Ukraine and Kyiv (Zhuliany) International Airport. The incident report **was not received** by NBAAI from the Arrow Aviation and SE ATS UkSATSE. NBAAI sent the Notification to:

- State Air Traffic Service Enterprise of Ukraine (copy);
- International Civil Aviation Organization (copy);
- U.S. National Transportation Safety Board (NTSB) (copy).

List of Abbreviations Used in This Report

.

AMSC	-	Aviation Meteorological Station Civilian;
ARTFL	-	Available Rejected Takeoff Field Length;
ATS	-	Air Traffic Service;
AMM	-	Aircraft Maintenance Manual
ATIS	-	Automatic Terminal Information Service
CVR	-	Cockpit Voice Recorder
CTR	-	Control Traffic Zone
FCOM	-	Flight Crew Operation Manual
FIR	-	Flight Information Region;
FDR	-	Flight Data Recorder
FL	-	Flight Level;
FPL	-	Flight Plan;
HIL	-	High-Intensity Lighting;
ICAO	-	International Civil Aviation Organization
ILS	-	Instrument Landing System;
Kfriction	-	Friction Coefficient;
LDA	-	Landing Distance Available;
MH	-	Magnetic Heading;
MHlanding	-	Magnetic Heading for Landing;
METAR	-	Meteorological Aerodrome Report;
NDB	-	Non-directional beacon;
NOTAM	-	Notice to Airmen;
OM	-	Operation Manual;

PCN	- Pavement Classification Number;
PIC	- Aircraft Pilot-in-Command;
P/N	- Part Number;
RBLS	- Radio Beacon Landing System;
S/N	- Serial Number;
SPECI	- Aviation Selected Special Weather Report;
TAF	- Terminal Aerodrome Forecast;
TDA	- Takeoff Distance Available;
TRA	- Takeoff Run Available;
TMA	- Terminal Maneuvering (Control) Area;
TW	- Taxiway;
QFE	- Q-code Field Elevation – atmospheric pressure at aerodrome elevation (at runway threshold);
QNH	- Q-code Nautical Height - Altitude above Mean Sea Level, local station pressure;
RVR	- Runway Visual Range;
UTC	- Universal Time Coordinated.

Contents

1. Factual Information

1.1 Flight History

On 21.05.2021, according to the flight assignment, the private flight 4XCUZ was scheduled for patient transportation en-route Ben Gurion (Tel-Aviv) – Kyiv (Zhuliany) by a private Arrow Aviation airline with the crew consisting of PIC, first officer and one flight attendant.

According to the PIC, the flight was performed with a delay of 2 hours. The airport departure time was 22:44. The flight was delayed due to loading of a sick patient with assistance of the crew members.

Arrow Aviation is the operator of the aircraft and is responsible for the aircraft flight and technical operation, continued airworthiness and flight safety.

The duties of the Pilot Flying of the aircraft were performed by the PIC, the Pilot Monitoring was the first officer.

The flight preparation of the crew, according to his explanations, was carried out 2 hours prior to the actual departure at the airport (the PIC received the aeronautical and meteorological information from the company representative.)

The PIC stated: “after a day of work (personal, not in aviation) I was called to an ambulance flight to Kyiv.” During the flight preparation, the PIC noted that the right wheel on the right main landing gear had a scuffed tire.

The aircraft cabin was in an ambulance configuration. According to the report received from the airline, the airplane was checked, the documents were signed and release to flight was granted. The aircraft was released to fly by the airline’s mechanic/inspector.

The climb and level flight were performed in the normal operation.

Landing approach was performed to RW 26 using the ILS system. During landing at Kyiv (Zhuliany) Aerodrome, at the landing run, the plane veered off the left edge lights onto the soil and stopped at a distance of 2070 m from the threshold of RW 26 and 15 m from the left edge lights. 12 seconds later, having increased the thrust of both engines, the airplane moved away from the stopping point and returned to the runway concrete.

None of the passengers or crew members were seriously injured.

1.2 Injuries

There were 3 medical crew and 2 aircraft crew members on board the aircraft.

Injuries	Crew	Pax	Others
Fatal	0/0	0/0	0/0
Serious	0/0	0/0	0/0
Minor/None	0/0	9/0	

1.3 Aircraft Damage

According to the Arrow Aviation Act of H25B 4X-CUZ Inspection, the aircraft was not damaged.

1.4 Other Damage

Not found.

1.5 Personnel Information

a) Information on Crew:

Position	**Pilot-in-Command**
Gender	Male
Date of birth	1957, 64 years old.
Education	---
Total flight hours	5,500 hours
Flight hours as a PIC	1,300 hours
Flight hours on this aircraft type	600 hours
Flight hours on 21.05.2021	2 hours 46 min
Pilot Licence number and expiration date	14.12.2021
Medical certificate	Valid until 23.06.2021

Position	**First Officer**
Gender	Male
Date of birth	1980, 41 years old
Education	---
Total flight hours	1800 hours
Flight hours on this aircraft type	1100 hours
Flights hours on the day of the incident: 21.05.2021.	2 hours 46 minutes
Flight hours for the last 90 days	---
Pilot Licence number and expiration date	Transport Pilot Licence valid until 27.09.2022
Medical certificate	Valid until 11.12.2021

b) Information on ATS personnel of Zhuliany Tower:

Flight Supervisor – works in a position of the ATC Senior Controller at the Kyiv Tower workplace, performed the duties of the Flight Supervisor.

He has the specialized secondary education (Riga Civil Aviation Technical School) and complete higher specialized education (State Flight Academy of Ukraine).

He is a holder of:

air traffic controller certificate – valid until 09.07.2023;

sector/workplace permit – TWR/KK1 rating/ADI/AIR supplement valid until 09.07.2023;

sector/workplace permit – TWR/KK2 rating/ADI/GMC supplement valid until 09.07.2023;

medical certificate – valid until 09.08.2021;

ICAO Level 4 English language proficiency certificate – valid until 21.07.2023;

admission to work as a Tower flight supervisor – valid until 18.01.2024.

TWR Controller – works in a position of the ATC Controller at the Kyiv Tower workplace.

He has a complete higher special education (State Flight Academy of Ukraine) (specialist).

He is a holder of:

air traffic controller certificate – valid until 03.03.2024;

sector/workplace permit – TWR/KK1 rating/ADI/AIR supplement valid until 03.03.2024;

medical certificate – valid until 18.03.2023;

ICAO Level 4 English language proficiency certificate – valid until 12.06.2023.

GND Controller – works in a position of ATC Controller at the Kyiv Tower workplace, performed the duties of the Senior Controller.

She has a complete higher special education (State Flight Academy of Ukraine) (specialist).

She is a holder of:

air traffic controller certificate – valid until 15.03.2023;

sector/workplace permit – TWR/KK1 rating/ADI/AIR supplement valid until 15.03.2023;

sector/workplace permit – TWR/KK2 rating/ADI/GMC supplement valid until 15.03.2023;

medical certificate – valid until 12.07.2021;

ICAO Level 4 English language proficiency certificate – valid until 22.10.2022;

admission to work as a Tower Flight Supervisor – valid until 18.02.2022;

admission to work as a ATC instructor – valid till 29.01.2024.

Note: TWR Controller has a sector/workplace permit – TWR/KK1. After the aircraft landing, before runway vacating, she instructed the crew to contact the ATC controller of the sector/workplace – TWR/KK2 (taxiing). She used no surveillance cameras.

1.6 Aircraft Data

Aircraft type	HAWKER 800XP
State and registration number	4X-CUZ
MSN	258514
Manufacturing plant	HAWKER BEECHCRAFT CO.
Date of manufacture	2000
Aircraft owner	ARROW AVIATION LTD
Aircraft operator	ARROW AVIATION LTD

Aircraft Registration Certificate	1857/1 12.08.2016
Airworthiness Certificate	Till 11.08.2021
Airworthiness Review Certificate	---
Flight hours since new	8370 hours
Number of cycles since new	5695
Last Base Maintenance according to Form 1A	20.05.2021

On Thursday (20.05.2021) evening, the crew arrived at the aircraft for flight preparation. The aircraft was in the ambulance configuration, it was checked, the documents were signed, and the aircraft was released to fly by the airline's mechanic/inspector. The tire pressure in the main wheels was checked to 135 PSI and the nose wheels 100 PSI. The pressure gage was calibrated and certified according to the regulations.

After the incident, at Zhuliany Airport Stand No. 24, the crew went out to inspect the aircraft and found that the plane had flaps extended, tire No. 4 was completely flat and damaged, and grass and mud were found on all wheels. No other visible damage besides tire No. 4 was found.

1.7. Meteorological Information

TAF weather forecast for Kyiv (Zhuliany) Aerodrome, issued by the meteorological unit at 23.17 UTC 20.05.2021, valid from 00.00 UTC 21.05 to 24.00 UTC 21.05, was as follows:

wind 310 degrees 03 m/s, gusts 8 m/s, visibility 6000 meters, considerable cloudiness with 600-meter cloud base. Occasionally, from 00 to 06 UTC, May 21, wind of unstable direction, 1m/s; visibility 400 meters fog; vertical visibility 60 m. Gradually, from 06 to 08 UTC, May 21, wind 330 degrees, 05 m/s, gusts 11 m/s; visibility 10 km and more; considerable cloudiness with 1200-meter cloud base. Gradually, from 15 to 17 UTC, May 21, the wind is 250 degrees, 3 m/s, gusts 8 m/s.

According to the actual weather reports (MET REPORT) provided by AMSC Kyiv, the weather at the "Kyiv" (Zhuliany) Aerodrome at the time of the occurrence was as follows:

for 1:00 UTC: wind in the RW26 landing zone: 320º 3 m/s, variable 290º to 350º, at the end of the runway: 330º 2 m/s; good weather conditions; air temperature +11ºC, dew point temperature + 08ºC; atmospheric pressure reduced to mean sea level by standard atmosphere: 1011 GPa, air pressure at runway threshold level: 990 GPa; forecast for landing: with no significant changes; additional information: forecast wind at 500 m height - 330º 4 m/s.

for 1:30 UTC: wind in the RW26 landing zone: 340º 4 m/s, at the end of the runway: 330º 3 m/s, maximum wind speed 6 m/s, minimum wind speed 2 m/s; good weather conditions; air temperature +10ºC, dew point temperature + 08ºC; air pressure reduced to mean sea level by standard atmosphere 1011 GPa, air pressure at runway threshold level: 990 GPa; forecast for landing: with no significant changes; additional information: forecast wind at 500 m - 330º 4 m/s.

1.8. Navigation Aids

The list of radio navigation aids in service of the area of responsibility of Kyiv (Zhuliany) Tower and their technical specifications are set out in Section AD 2.19 of the Aeronautical Information Publication of Ukraine.

According to paragraph 8 of the Attachment to Certificate of Kyiv (Zhuliany) Aerodrome No. AP 09-02, Kyiv (Zhuliany) Aerodrome is equipped with “OPRS-A” standalone non-directional beacon, “SP-90”-type RBLS landing systems.

1.9. Communication

The crew’s radio communication with ATS controllers was performed on Kyiv (Zhuliany) Aerodrome Tower’s operating frequencies: with TWR Controller – on 120.7 MHz, with GND Controller – on 119.0 MHz.

There are no critical remarks to operation of the communication means.

The investigation analyzed the following transcripts of the communication of the Kyiv ATS service, which were provided by SE ATS "UkSATSE":

1) transcript of communication between the aircraft crew and Kyiv (Zhuliany) Tower Controller on the frequency 120.7 MHz; with the GND Controller on the frequency 119.0 MHz.

1.10. Aerodrome Information

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

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

The owner of the aerodrome is the Kyiv City State Administration, the operator is the Municipal Enterprise “Kyiv” (Zhuliany) International Airport.”

The paved runway has the dimensions of 2310x45m (with two take-off and landing headings – MH 79º/MH 259º), pavement type – mixed, PCN 46/R/C/X/T, equipped for I

category precision approach. On MHlanding259º, the runway threshold is displaced by 48m, on MHlanding79º it is displaced by 150 m.

The aerodrome class is B (4C).

The aerodrome is suitable for day and night operations all year round.

The aerodrome is equipped with "OPRS-A" standalone non-directional beacon, "SP-90"-type RBLS, 2 DME-415 landing systems and lighting of high intensity lights (HIL.)

The level of the necessary fire protection is Category 7.

The coordinates of the Aerodrome Reference Point are 50º24'07"N and 30º27'07"E.

There are reinforced airstrip parts with a width of 45 m and a length of 50 m in front of both ends of the runway.

At the end of the declared available take-off distances with both headings, there are obstacle-free strips.

The obstacle-free strip with MHlanding79º is 150 m long and extends for 75 m in each direction from the continued runway centerline.

The obstacle-free strip with MHlanding259º is 60 m long and extends 75 m in each direction from the continued runway centerline.

At the end of the runway (threshold 26), there is an aircraft turnaround area, which makes the runway width with the turning area equal to 75 m. The presence of the runway turnaround area is caused by the absence of TW adjacent to the end of the runway (threshold 26.) The runway shoulders for turnaround on the runway make 3 m.

The airstrip extends from the end of RW 08 to the point located at 60 m behind the end of RW 26 and has a total length of 2370 m. The end safety areas are at the ends of the runway, which have the dimensions of 90x90 m. The airstrip extends in a transverse direction on both sides of the runway axis and extended centerline along the entire length of the runway for a distance of 140 m (the total width of the runway is 280 m.)

Aerodrome elevation is 179 m.

Magnetic dip is 7ºE.

Available Distances:

MH79:

Takeoff Run Available = 2310 m;

Takeoff Distance Available = 2460 m;

Available Rejected Takeoff Field Length = 2310 m;

Landing Distance Available = 2160 m.

MH259:

Takeoff Run Available = 2250 m;

Takeoff Distance Available = 2310 m;

Available Rejected Takeoff Field Length = 2310 m;

Landing Distance Available = 2262 m.

According to paragraph 9 of the Appendix to the Certificate, the aerodrome is fit to receive aircraft of index 4 (code 4C with limitations), helicopters of all types and lighter aircraft.

Runway Status Information

Date	Runway Inspection Time (UTC)	Airfield Status Log Records
20.05.2021	23:25	Paved Runway MH259 is wet, water layer is up to 2 mm, Kfriction = 0.54/0.54/0.54, the braking action was assessed as "Good", R26/290254. No foreign objects found. TW 1, 2, 4 are wet, water layer is up to 2 mm.
21.05.2021	01:58	Paved Runway MH259 is wet, water layer is up to 1 mm, Kfriction = 0.56/0.56/0.56, the braking action was assessed as "Good", R26/290156. No foreign objects found. TW 1, 2, 4 are wet, water layer is up to 1 mm. Aprons, Stands – the artificial pavements are wet, covered with a layer of water up to 1 mm, separate areas are covered with water in some places. Closed Stands "L": 19, 21, 22, 23, 24. At Stands "L": 26/27, it is allowed to park An-24/26/72/74 aircraft. Paved Runway, air taxiing taxiways and taxi-route are marked with signs. The strength of aerodrome soil components is 4 kgf/cm², difference in the strength is > 20%. Stands "Z" 6-15 are wet, water layer is up to 1 mm.
21.05.2021	02:20	Paved Runway MH259 is wet, water layer is up to 1 mm, Kfriction = 0.56/0.56/0.56, the braking action was assessed as "Good", R26/190058. No foreign objects found. Traces of aircraft veering off the runway to the south were found.
21.05.2021	02:50	Paved Runway MH259 is wet, water layer is up to 1 mm, Kfriction = 0.56/0.56/0.56, the braking action was assessed as "Good", R26/190058. No foreign objects found. Fragments of aircraft gear rubber and traces of the aircraft veering off the runway were found. Taxiways 1, 2, 4 are wet, water layer is up to 1 mm, in separate places some areas are covered with water.

		Aprons, Stands – the artificial pavements are wet, covered with a layer of water up to 1 mm, separate areas are covered with water in some places. Closed Stands "L": 19, 21, 22, 23, 24. At Stands "L": 26/27, it is allowed to park An-24/26/72/74 aircraft. Paved Runway, air taxiing taxiways and taxi-route are marked with signs. The strength of aerodrome soil components is 4 kgf/cm², difference in the strength is > 20%. Stands "Z" 6-15 are wet.

Note:

- from the Statement of the chief of the aerodrome service shift, on 21.05.2021, at 01:50 UTC, he entered the runway for inspection

The apron and runway video surveillance monitor displays the information from 4 video cameras: cameras No. 1 and No. 2 – reflect the situation on the M apron, cameras No. 3 and No. 4 – on the runway. The cameras operated in the normal mode, according to the "Instruction on the use of CCTV at the TOWER workplace at the Kyiv (Zhuliany) Aerodrome Control Tower." However, with the runway surveillance cameras at Zhuliany Airport, it is impossible to observe the final part of the landing run on RW 26.

1.11. Flight Recorders

Due to the absence of Hawker-800XR aircraft operation in Ukraine, the National Bureau is unable to read out and decode the FDR and CVR information, therefore, according to paragraph 5.8 of Annex 13 to the ICAO Convention, the Investigation Team requested the Accredited Representative of Israel to read out and decode the FDR and CVR data. On July 1, 2021, a notice was received that the FDR information had been read out and sent to Flight Data System (UK) for decoding.

On July 23, 2021, the Accredited Representative of Israel provided to NBAAI the results in the form of a raw data binary file, two CSV-format text files and two pdf-format graphic files.

The CVR information was not received while the aircraft was at the airport of the occurrence (UKKK) due to a lack of technical means to read out it, and the small size of the long-term memory capacity of the CVR drive did not allow the incident data to be stored. When the aircraft arrived at the location, where the CVR could be read out, the UKKK incident data had already been deleted from the drive in the process of its normal operation.

Unfortunately, the flight time data in the materials , which were provided by the Accredited Representative of Israel, does not match the actual time of the flight. According to the materials, the recording of the flight started at 4:35 and ended at 7:23, while the actual take-off took place at 22:44 and landing took place at 1:27 the next day. In addition, there are contradictions between the text and graphic data on

the flap extension value – for example, in the text material, the flaps have three fixed positions: 0, 15 and 45, while in the graphic material they have 0.2 and 8, respectively.

In order to eliminate the contradiction with the FDR time scale given in the materials provided, a transcript of the crew's radio communication with the UKKK Tower was used. Due to the presence of radio contact signals in the FDR record, it was possible to compare the recording time of these signals with the time set out in the radio exchange transcript, and thus, to correct the time scale in the materials of the FDR decoding. Text files with the corrected time scale were converted into Microsoft Excel format.

In the course of the recorder data analysis, the calculation of the distance to the landing runway threshold was performed. The calculation was performed by the method of inverse integration of the instrument airspeed with consideration of the data on wind, temperature and atmospheric pressure on the runway. The integration was carried out since the moment of the aircraft veering off the runway concrete, which can be determined from the normal overload signals. The lateral deviation from the runway centerline was also calculated by the same method plus taking into account the values of aircraft lateral overload and magnetic heading, as well as the magnetic dip in the area of the landing runway.

1.11.1 Flight Analysis According to Data of Recorders

Take-off took place at 22:44, on 20.05.2021, from RW 03 LLBG with flaps in position 15°, rotation speed of 137 kts, unstick speed of 157 kts. Flaps were retracted at 177 kts at the altitude of 3100 feet. The engine mode averaged 96-97% from the take-off run start – till flap retraction. The left engine thrust reverser readiness signal was recorded during taxiing before the take-off, before the take-off run start. The right engine thrust reverser readiness signal was not recorded at all throughout the flight, which confirms the fact that the right engine thrust reverser was deactivated.

The route was flown at FL 340 and 360 with average instrument speeds of 270 and 260 kts, respectively. The autopilot was engaged at 1000 feet at takeoff and operated throughout the flight until the altitude of 400 feet during the glide path flight.

The descent from FL 360 to an altitude of 2400 feet took place at a vertical rate of 2300 to 2400 feet per minute. The approach to RW 26 of UKKK and glide path flight were performed with the ILS system in the automatic mode down to an altitude of 400 feet and then visually. No flaps were released or retracted at approach, glide path flight, crossing the runway threshold and further until touchdown – all the time the flaps were in position 0° (retracted.) The glide path flight was at an average instrument speed of 145 kts; the instrument speed of runway threshold crossing was 140 kts, instrument touchdown speed – 131 kts. The touchdown occurred at 330 meters after the runway threshold, the front gear touchdown occurred 4 seconds after the main gear touchdown, and, one second later, the air brakes were released and 15-degree flap extension started. The 45-degree flap extension was conducted at 101 kts – 16 seconds following the main landing gear touchdown.

During the landing run, the aircraft heading angle fluctuated more to the left side, so probably, the aircraft began to deviate to the left of the runway centerline. And when the airplane was 1600 meters from the RW 26 threshold at 80 kts, the heading deviation to the left accelerated and reached an angular velocity of 2 degrees per second, the aircraft veered off the left edge lights to the soil and stopped at the distance of 2070 meters from RW 26 threshold and 15 meters from the left edge lights. 12 seconds later, due to an increase in thrust of both engines, the airplane moved away from the stopping point and returned to the runway concrete, after which, the flaps were retracted to position 15° and then to position 0°.

The left engine thrust reverser readiness signal was recorded from the moment of the front landing gear touchdown till the aircraft taxiing start after stopping by using the engine power more than the idle one. No signals of right engine thrust reverser readiness were recorded throughout the flight. This is the evidence that the right reverser was deactivated, and the left reverser was operational. But not a single signal of left or right engine thrust reverser operation was recorded, indicating that the reverse thrust was not used after landing.

1.12. Wreckage and Impact Information

Not relevant.

1.13 Medical Information and Brief Post Mortem Examination Results.

The medical examination of the crew was performed with no critical notes.

1.14 Fire.

There was no fire during the serious incident.

1.15 Survival Factors

Not relevant.

1.16. Tests and Research

Not conducted

1.17 Information on Organizations and Administrative Activities Relevant to Occurrence

Not relevant.

1.18 Additional information

None.

1.19 Useful or Effective Methods Used In Investigation

Standard methods were used in the investigation.

2. Analysis

Due to the absence of Hawker-800XR aircraft operation in Ukraine, the National Bureau is unable to read out and decode the FDR and CVR data, therefore, according to paragraph 5.8 of Annex 13 to the ICAO Convention, the Investigation Team requested the Accredited Representative of Israel to read out and decode the FDR and CVR data. On July 1, 2021, a notice was received that the FDR information had been read out and sent to Flight Data System (UK) for decoding.

On July 23, 2021, the Accredited Representative of Israel provided to NBAAI the results in the form of a raw data binary file, two CSV-format text files and two pdf-format graphic files.

The plane departed from the Ben Gurion Aerodrome at 22:44 UTC and landed in 2 hours 46 minutes at Zhuliany Airport at 01:30 UTC on RW 26. At the Ben Gurion Airport, on Thursday (20.05.21), in the evening, the crew arrived at the plane for carrying out the flight preparation.

The PIC stated: “after a day of work (personal, not in aviation) I was called to an ambulance flight to Kyiv.” During the flight preparation, the PIC noted that the right wheel on the right main landing gear had a scuffed tire.

The aircraft cabin was in an ambulance configuration. According to the report received from the airline, the airplane was checked, the documents were signed and release to flight was granted. The aircraft was released to fly by the airline’s mechanic/inspector.

Take-off took place at 22:44, on 20.05.2021, from RW 03 LLBG with flaps in position 15°, rotation speed of 137 kts, unstick speed of 157 kts. Flaps were retracted at 177 kts at the altitude of 3100 feet. The engine mode averaged 96-97% from the take-off run start till flap retraction. The left engine thrust reverser readiness signal was recorded during taxiing before the take-off, before the take-off run start. The right engine thrust reverser readiness signal was not recorded at all throughout the flight, which confirms the fact that the right engine thrust reverser was deactivated.

The PIC confirmed with the signature that the right reverser was deactivated (technical act.) **Although the report sent by the company stated:**

“Airplane: HS-125 with 8370 Total Hours and 5695 Cycles.

Last DI: 20/5/2021 **with MEL of Left Thrust Reverser Deactivated**.”

The route was flown at FL 340 and 360 with average instrument speeds of 270 and 260 kts, respectively. The autopilot was engaged at 1000 feet at take-off and operated throughout the flight until the altitude of 400 feet during the glide path flight.

The landing approach to RW 26 at Zhuliany Airport was carried out using the ILS system. When the aircraft reached the ILS of RW 26, the PIC gave the command to extend the landing gear and flaps. The landing gear were extended, however:
"I felt that the flaps didn't respond, we recycled the flaps with no success so I decided to approach at speed of 140 (REF+ 15)."

The descent from FL 360 to an altitude of 2400 feet took place at a vertical rate of 2300 to 2400 feet per minute. The approach to RW 26 of UKKK and glide path flight were performed with the ILS system in the automatic mode down to an altitude of 400 feet, and then – visually. **No flaps were released or retracted at approach, glide path flight, crossing the runway threshold and further until touchdown** – all the time the flaps were in position 0° (retracted.) The glide path flight was performed at an average instrument speed of 145 kts (the standard is 140 kts); the instrument speed of runway threshold crossing was 140 kts (the standard is 125-120 kts), instrument touchdown speed – 131 kts (the norm is 120 kts). The main gear touchdown occurred at the distance of 330 meters after the RW 26 threshold. **The front gear touchdown occurred 4 seconds after the main gear touchdown, and, one second later, the air brakes were released, and 15-degree flap extension started. The 45-degree flap extension was conducted at 101 kts – 16 seconds after the main landing gear touchdown.**

At the same time, the Investigation Team did not find the flaps release and retraction signals at the pre-landing stage of the flight in the decoded records of the recorders. Further, the Investigation Team analyzed the following stages:

1. Aircraft departure from the Ben Gurion Aerodrome;

- flaps extension to 15º;

- rotation;

- aircraft unstick;

- turn and flaps retraction from 15° to 0º.

2. Flight before the landing approach at Zhuliany Airport was performed with no deviations.

3. Landing approach and landing before flaps retraction to 0º at Zhuliany Airport:

- airplane flight with the runway heading;

- runway threshold;

- runway touchdown;

- front gear touchdown, flaps 15º;

- flaps 45º;

- landing run speed on the runway – 80 knots;

- jerk braking of the wheels of the left and right main landing gears, rupture of the right wheel tire of the right landing gear;
- aircraft veering off the runway;
- aircraft stopping;
- moving on;
- return of the aircraft to RW 26;
- flaps retraction to 0º.

The graphic pattern of these stages was analyzed by the Investigation Team and attached below.

H-800XR 4X-CUZ Tel Aviv - Zhuliany 2021-05-20 Flight Stages According to Recorders

Analog parameters:

Tag	Name
FLAP	Flap Position
ACCY	Acceleration Vrt
ACCX	Acceleration Lng
ACCZ	Lateral Acceler.
HDG	Heading
ATTP	Pitch Attitude
ATTR	Roll Attitude
N1L	N1 RPM Engine LH
N1R	N1 RPM Engine RH
IAS	Airspeed
ALTP	Altitude Press
L	Distance from Threshold (- before, + after)

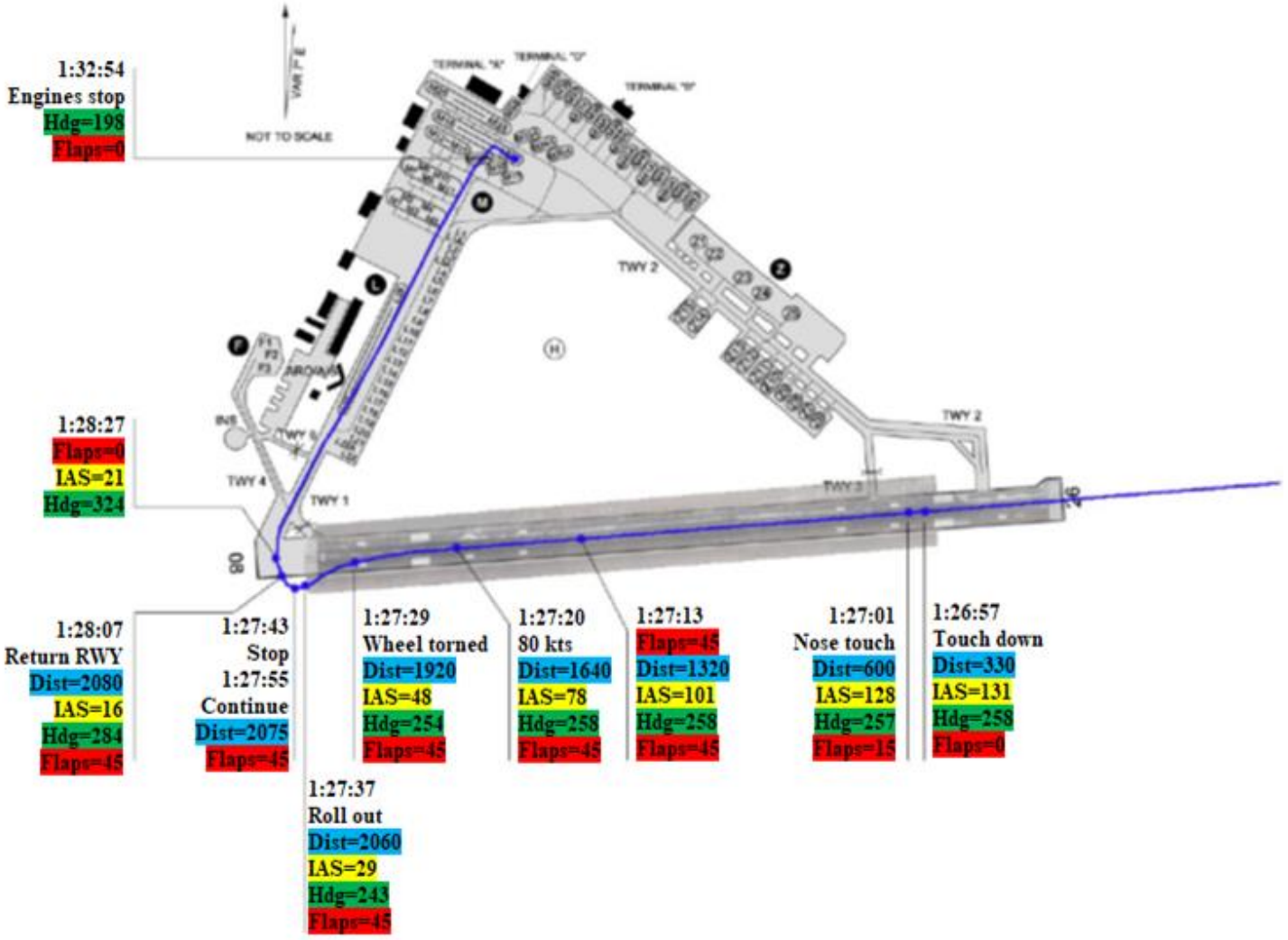
Binary signals:

Tag	Name
VHF2	VHF - 2 KEYING
TRAL	Thrust Rev Armed LH
TRAR	Thrust Rev Armed RH
ABO	Airbrake Open

Time	TRAL	TRAR	ABO	ACCY g	ACCX g	ACCZ g	FLAP	HDG deg	ATTP deg	ATTP deg	N1L %	N1R %	Deceleration	IAS kts	ALTP ft	L m	Marker
22:42:32	arm	.	.	0,9	-0,01		15	254	-1,5		27.9	27.3		19	230		Flaps 15°
22:44:15	.	.	.	0,95	-0,02		15	19	-1,4		36.6	36.9		13	230		Start
22:44:46	.	.	.	0,92	0,22		15	23	0,2		97.0	96.3		137	220		Rotation
22:44:52	.	.	.	1,12	0,33		15	22	13,1		96.8	95.9		157	270		Unstick
22:45:22	.	.	.	0,95	0,25		15	24	13,3		97.5	96.7		182	1360		Turn

22:45:57	.	.	.	0,85	0,27		0	77	13,6		97.8	97.0	177	3110		Flaps 0°
1:23:48	.	.	.	0,94	0,12	0	0	266	8,4	8,5	58.8	55.2	155	2350	-14210	RW Heading
1:26:52	.	.	.	1,06	0,13	-0	0	258	9	8,2	31.6	31.1	140	730	-20	RW Threshold
1:26:57	.	.	.	0,84	0,08	0,01	0	258	7,6	6,1	26.8	30.3	131	690	330	Touchdown
1:27:01	arm	.	.	0,86	-0,08	0,04	0	257	-0,9	-0,8	27.0	29.0	128	690	600	Front Gear Touchdown
1:27:02	arm	.	ext	0,8	-0,12	0,01	15	258	-1,1	-1,2	27.1	28.8	126	680	660	Flaps 15°
1:27:13	arm	.	ext	0,86	-0,16	0,03	45	258	-1,7	-1,8	27.1	27.6	101	680	1320	Flaps 45°
1:27:20	arm	.	ext	0,89	-0,26	0,04	45	258	-2	-2,3	27.3	27.4	78	670	1640	80 kts
1:27:29	arm	.	ext	0,97	-0,3	-0	45	254	-2,3	-2,5	27.4	27.4	48	660	1920	Wheel
1:27:37	arm	.	ext	0,88	-0,06	0,08	45	243	-2,5	-0,9	27.4	27.5	29	650	2060	Veering off
1:27:43	arm	.	ext	0,97	0,04	-0	45	262	-1,1	-1,3	31.3	31.6	16	650	2070	Stop
1:27:55	.	.	.	0,96	-0,02	0	45	266	-1,2	-1,3	71.6	60.9	12	650	2080	Moving on
1:28:07	.	.	.	1,21	0,2	0,02	45	284	-0,8	0	94.7	95.0	16	650	2170	Return to RW
1:28:27	arm	.	.	0,94	-0,01	-0	0	324	0	0,3	27.1	28.4	21	650	-	Flaps 0

4X-CUZ Aircraft Dynamics at UKKK on 21.05.2021, During Landing Run, Veering off Runway, Taxiing-in to Stand 24



According to the transcript of the Tower and crew communication provided by SE ATS "UkSATSE", at 01.23 UTC, the crew contacted Tower controller. **The controller provided the information about the runway status, wind direction and speed, and cleared landing on RW 26**. The crew readback the landing clearance. Three minutes later, the crew requested confirmation of the landing clearance, to which the controller once again gave the clearance for landing. **At 01.27.21 UTC, the controller instructed the aircraft crew to vacate the runway through TW 1 (Letter No. 1-14.1/4374/21 dated 04.06.2021 from SE ATS "UkSATSE".)**

During the landing run, the right wheel tire of the right main landing gear destructed, which resulted in the aircraft veering off RW 26 to the left and continuing movement along the runway edge lights outside the runway. The crew did not report this occurrence to the controller. At 01:28:26 UTC, the aircraft crew returned to the runway in front of the runway end, opposite to TW1, and reported a visual observation of the follow-me car. **Tower controller instructed to contact GND controller.** Then, the aircraft continued taxiing to the Stand behind the follow-me car.

The conducted analysis shows that the landing run on the runway took place with a slow decrease in speed, and the initial run speed was high, reversers were not used during landing, **and the aircraft reached 80 knots at the distance of 1640 m from the RW 26 threshold.** After the first officer reminding of 80 knots speed, the PIC jerkily braked both main landing gears and turned the rudder to the right. The right wheel tire, all its 10 layers destructed. The left landing gear and its 2 wheels had a greater braking action on the runway at two pedals pressed down, where the right wheel of the right landing gear was braked, with the destroyed right tire. **Therefore, a turning moment to the left appeared, and the aircraft turned to the left, to which the crew did not react, and the airplane veered off the runway.**

During the landing run, the aircraft heading angle fluctuated more to the left side, so, probably, the aircraft began to deviate to the left of the runway centerline. And when the airplane was 1600 meters from the RW 26 threshold at 80 kts, the heading deviation to the left accelerated and reached an angular velocity of 2 degrees per second, the aircraft veered off the left edge lights onto the soil and stopped at the distance of 2070 meters from RW 26 threshold and 15 meters from the left edge lights. 12 seconds later, due to an increase in thrust of both engines, the airplane moved away from the stopping point and returned to the runway concrete, after which, the flaps were retracted to position 15° and then to position 0°.

After exiting the runway, the PIC did not stop to check for any damage, which he could not see from the cockpit, and he did not report that to the controller.

The Tower controller did not visually observe that the aircraft had left the runway and was moving outside the runway, and could not monitor the aircraft movement due to the absence of cameras on that section of the runway. The controller did not pay attention to the aircraft slow movement after landing until vacating the runway.

Note. *According to paragraph 4 of the Kyiv/Zhuliany Aerodrome Control Tower Operating Instruction, the Tower ATC controller should constantly monitor all flights over and around the aerodrome, as well as the movement of vehicles and people in the aerodrome maneuvering zone:*

a) visually and/or by means of surveillance cameras;

b) in areas not observed visually and in low visibility conditions – by reports from the crew or vehicle driver.

The left engine thrust reverser readiness signal was recorded from the moment of the front landing gear touchdown till the aircraft taxiing start after stopping by using the engine power more than the idle one. **No signals of right engine thrust reverser readiness were recorded throughout the flight. This is the evidence that the right reverser was deactivated, and the left reverser was operational. But not a single signal of left or right engine thrust reverser operation was recorded, indicating that the reverse thrust was not used after landing.**

As regards the following remark in the airline report paragraph 9:

"The runway narrows toward the over-run and it's not shown on the charts !!! The plane rolled of the runway (forward, not sideway)",

then, this remark is incorrect, because:

At the Kyiv (Zhuliany) Aerodrome, the high intensity lighting system is installed and operated to ensure an accurate approach, landing, taxiing and take-off of ICAO category I aircraft with MHlanding259º/079º. The length of approach lights with MHlanding259º is 300 m. The system has been in operation since 2011. The manufacturer is IDMAN (Finland). Certification of Equipment Suitability for Operation No. AO 09-02-192 was issued by State Aviation Administration with validity period till 01.09.2023.

The lighting system includes the following light subsystems:

- with MH 259º: runway edge lights, runway end lights, runway threshold lights, PAPI-type glide path visual indication lights, simple runway touchdown zone lights, 300 m-long crossbar approach lighting system;

- with MH 079º: runway edge lights, runway end lights, runway threshold lights, PAPI-type glide path visual indication lights, simple runway touchdown zone lights, 900 m-long crossbar approach lighting system, pulsed approach lights;

- TW-1,2,4 taxiway edge lights; TW-4 centerline lights; TW-4 clearance bar; runway protection lights on TW-1 and TW-2, aerodrome signs, runway edge lights.

Runway edge lights

Runway edge lights are elevated-type, 360-deg visibility, lens, IDM 5848/150W-type lights.

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

The edge lights are permanent white color radiation lights, yellow color radiation is on the last 600 m of the paved runway in the direction of aircraft landing. The average value of light intensity for the paved runway lights is more than 10 kilo-Cd. On the section from the beginning of the runway to the displaced threshold with MHlanding79º, the lights emit red color in the direction of aircraft landing.

The edge lights are located along the entire runway length in two parallel lines at the same distance from the runway centerline and **at a distance of 1.75 m from its edge, which meets the requirements of paragraph 5.3.9.4 of Annex 13 to the Convention on International Civil Aviation, Vol. 1 "Aerodromes".** The interval between the lights is 60 m. The data from the Aeronautical Information Publication is in the investigation file.

By the letter dated September 5, 2021, the NBAAI asked the Accredited Representative of Israel for investigation of the serious incident to explain:

"due to what the flaps were extended to 15º and 45º during the aircraft landing run on RW 26 at Zhuliany airport."

On the same day, September 5, we received the reply:

“There were cases in hawkers that the flaps froze after a cold flight at altitude. Maybe that was the case and the flaps actually lowered on the ground because the handle remained in down position from lowering attempts. No pilot will “play” with the flaps handle at the ground roll.” In our opinion, this is not correct, as there were no conditions for the flaps to freeze in May, and, at the speed of about 130 knots with a flap extension to 15º, and even more to 45º, the pilot should feel an aerodynamic response of the aircraft.

3. Conclusions

- The aircraft departed from the Ben Gurion base aerodrome to perform the flight in an airworthy condition with the **right** thrust reverser deactivated, as it was confirmed by the Investigation Team:
  - ✓ based on the recorders data and
  - ✓ verified by the entry in the Technical Log Book at the Ben Gurion Airport,

  although the airline indicated in its report that the plane departed "with MEL release on Left thrust Reverser Deactivated."

The Investigation Team reviewed in detail the Arrow Aviation's report on the internal investigation into this serious incident and made the following conclusions:

- Crew was called in because of an unexpected emergency overnight flight in an ambulance configuration.
- PIC had a hard working day before the flight.
- Crew had a full hour of hard work before the flight to load a heavy 150-pound sick patient.
- At the time of reaching ILS, “the crew thought that the flaps didn’t work properly”, so, they took a decision to perform landing on RW 26 with the flaps not extended.
- The PIC believed that the flaps had not operated normally, but still continued the approach, not thinking about go-around and flaps re-extension and re-retraction according to the checklist.
- The PIC was in a state of fatigue:
  - ✓ Due to insufficient rest before the flight (the PIC had a hard working day before the flight), and
  - ✓ "The crew had a full hour of hard working prior to take off” to load a sick patient,

  and failed to correct the aircraft shift to the left.
- Jerk (unexpected) application of the two – left and right brakes simultaneously caused destruction of all ten layers of tire rubber and tire rupture, which contributed to the aircraft instant turn to the left and veering off the runway.
- Rupture of all ten plies of the right tire of the right main landing gear due to its scuffing mentioned by the aircraft PIC during the flight preparation.

  But despite these main factors, the aircraft was released to fly by the airline’s mechanic/inspector contrary to the requirements of the Hawker 800X Aircraft Maintenance Manual (AMM) 32-40-41.
- After veering off the runway, the PIC failed to stop to check for any damage that he could not see from the cockpit, and he failed to report that to the controller.

- The Tower controller failed to visually observe that the aircraft had left the runway and was moving outside the runway, and could not monitor the aircraft movement due to the absence of cameras on that section of the runway. The controller failed to pay attention to the aircraft slow movement after landing until vacating the runway.
- When the aircraft arrived at the Stand, the flaps were extended and a mechanical check showed that there were no problems with the flaps operation. Investigation Team has not established what caused the flaps to extend to 15° and 45° on the aircraft landing run.

3.1. Causes

3.1.1. The cause of the serious incident (the aircraft veering off RW 26 at the Zhuliany Airport during the landing run after touchdown):

was the destruction of the right wheel tire of the right main landing gear, which prompted onset of the turning moment to the left and the Pilot-in-Command's failure to keep the aircraft within the runway at this conjuncture.

3.2. Contributing Factors

3.2.1 The contributing factors of this serious incident comprise a professionally low-quality flight preparation on the part of the airline with regard to the aircraft release to the flight at the following factors:

- PIC's insufficient rest, fatigue prior to the flight, which contributed to the failure to follow established procedures in the course of the aircraft approach and landing, as it was stated by the PIC during the flight preparation, and as stated in the airline's report;
- Decision of the operator, Arrow Aviation, to perform the flight with a wheel, which condition required replacement according to the Maintenance Manual, which requires replacing not only the worn wheel, but also the second wheel on this landing gear (according to the PIC, he directed attention to a scuffed tire on the right wheel of the right main landing gear);
- Right thrust reverser deactivated, as stated in MEL;
- Non-use by the crew of the left thrust reverser during the landing run.

3.3. Shortcomings

3.3.1. The technical act on preparation of the aircraft to flight states that **the right** thrust reverser was deactivated, the airline report (signed by the same officials) states that **the left** thrust reverser was deactivated.

3.3.2. After veering off the runway, the PIC failed to stop to check for any damage, which he could not see from the cockpit, and he failed to report that to the controller.

3.3.3. The Zhuliany Tower controller failed to note the aircraft veering off the

runway, its movement parallel to the RW 26 edge lights with a lateral deviation of about 15 meters and about 40-meter longitudinal movement outside the runway, returning to the runway and its vacating, which made about 55 seconds. And due to the absence of cameras in this area to monitor this part of the runway, the controller failed to pay attention to the slow movement of the aircraft since touchdown till vacating the runway.

4. Safety Recommendations

4.1. To: Aircraft Operator

4.1.1. During the course of flights planning, organization and performance, strictly observe the requirements of regulatory documents as for monitoring and observing crew rest periods before and after the flight.

4.1.2. In case of MEL issue for an aircraft, take into account all risks, which arise, with the calculation of the aircraft landing distance on the runway.

4.2. To: SE "UkSATSE":

4.2.1. Ensure compliance with the requirements of the “Operating Instruction of Kyiv/Zhuliany Aerodrome Control Tower” as for the surveillance of the aircraft movement during the landing run and vacating the runway.

4.2.2. Install additional video surveillance cameras to monitor the following runway sections:

- Adjacent to TW 1;
- RW 08 touchdown zone.