MINISTRY OF CONSTRUCTION AND TRANSPORT

TRANSPORTATION SAFETY BUREAU

FINAL REPORT

Fly-Coop Kft., Beechjet 400A, HA-YFJ

Budapest Ferenc Liszt International Airport (LHBP)

1 March, 2021

Incident

2021-0040-4

Introduction

Synopsis

Occurrence class		Incident
Aircraft	Manufacturer	Raytheon Aircraft Co.
	Model	Beechjet 400A
	Registration	HA-YFJ
	Operator	Fly-Coop Kft.
Occurrence	Date and Time	1 March, 2021, 22:43 LT
	Location	Budapest Ferenc Liszt International Airport (LHBP)
Fatalities / Severe Injuries		none
Damage to Aircraft		none

On March 2, 2021, in the early afternoon hours, the Duty Airside Manager (DAM) of Ferenc Liszt International Airport reported that between 08:00 and 12:30, the ES-LSG registered Saab 340 aircraft knocked down four edge lights at intersection J4 of Runway 31L/13R.

Subsequent investigations revealed that contrary to initial assumptions[1], the incident actually occurred on March 1 at 22:43. At this time the pilots of a Beechjet 400A registered as HA-YFJ damaged the first, second, and fourth runway edge lights to the southeast of the intersection J4, while taxiing SE from holding point B1 on the runway for takeoff from 31L *(Figure 3).*

Figure 1. The affected aircraft *(Source: jetphotos.com)*

[1] The reasons and circumstances behind the misidentification of the event's timing are detailed in sections 1.10.1, 1.16.1 and 3.1.5.

The crew likely did not notice the damage to the edge lights and proceeded with takeoff from Runway 31L.

According to the findings of the Investigation Committee (IC), the primary cause of the damage to the edge lights was attributed to human factors, particularly the crew's insufficient attention during taxiing. As a result, while backtracking to threshold 31L, the crew mistakenly identified the runway's left-side edge lights lining beyond intersection J4 as centerline lights.

In addition to the causes of both the event and the failure to recognize the misidentification, the IC ascertained further contributing factors as well.

Considering the safety risks identified during the investigation, the IC outlined a safety recommendation addressed to HungaroControl in order for them to develop procedures that assure crews backtracking to threshold 31L to be informed about the absence of visible centerline lights during taxi. However, due to the interim corrective measures implemented by HungaroControl subsequent to the coordination meetings with TSB, the issuance of this safety recommendation did not eventually occur.

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Definitions and Abbreviations

(A)	*Airplane* (Aircrew License Rating)
AAIB	The *Air Accidents Investigation Branch* investigates civil aircraft accidents and serious incidents within the United Kingdom, its overseas territories and crown dependencies.
Aerodrome	A defined area (including any buildings, installations and equipment) on land or water or on a fixed offshore or floating structure intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.
AFM	*Aircraft Flight Manual*
AGL	*Above Ground Level*
AIP	*Aeronautical Information Publication* is defined by the International Civil Aviation Organization as a publication issued by or with the authority of a state and containing aeronautical information of a lasting character essential to air navigation. It is designed to be a manual containing thorough details of regulations, procedures and other information pertinent to flying aircraft in the particular country to which it relates. It is usually issued by or on behalf of the respective civil aviation administration.
ARP	*Aerodrome Reference Point*
A-SMGCS	The *Advanced Surface Movement Guidance and Control System* provides routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the aerodrome visibility operational level (AVOL) while maintaining the required level of safety. It consists of a Non-Cooperative Surveillance (e.g. SMR, Microwave Sensors, Optical Sensors etc.) and Cooperative Surveillance (e.g. Multilateration [MLAT] systems).
ATO	*Approved Training Organization*
ATPL	*Airline Transport Pilot License*
ATS	*Air Traffic Services*
BUD	IATA coding for Budapest Ferenc Liszt International Airport.
CM1	*Crew Member 1:* the pilot occupying the left-side seat.
CM2	*Crew Member 2:* the pilot occupying the right-side seat.
Commercial Single Pilot with Pax	A class rating that allows single pilot commercial operation while carrying passengers.
CPL	*Commercial Pilot License*
CRI	*Class Rating Instructor*
CRM	*Crew Resource Management* is a management system which makes optimum use of all available resources (equipment, procedures and people) to promote safety and enhance the efficiency of flight operations.
CVR	*Cockpit Voice Recorder*
dual time	Flight time under instruction that is received and logged as training time before obtaining a sought license, rating or endorsement.

EASA *European Union Aviation Safety Agency*

FDR *Flight Data Recorder*

FFS A *Full Flight Simulator* is a highly sophisticated flight simulator that is classified into four technical levels, from A through D, with level D being the highest standard and being eligible for zero flight time (ZFT) training of civil pilots when converting from one airliner type to another.

FO *First Officer*

FOD *Foreign Object Damage* or *Foreign Object Debris*

GAT *General Aviation Terminal*

HC *HungaroControl Zrt.* is the primary Air Traffic Service Provider in the Hungarian FIR.

HIEL *High Intensity Edge Light*

ICAO *International Civil Aviation Organization*

IR *Instrument Rating (A)* (A for Aircraft Class)

IRI *Instrument Rating Instructor*

KBSZ *Közlekedésbiztonsági Szervezet* (Transportation Safety Bureau of Hungary)

Kbvt. *Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents and other transportation occurrences*

LHBP ICAO coding for Budapest Ferenc Liszt International Airport.

LAPL *Light Aircraft Pilot License*

LT *Local Time*

ME *Multi Engine Rating*

MLAT *Multilateration* or *Pseudo-range Multilateration* is a surveillance technique for determining the position of an unknown point, such as an aircraft, based on measurement of the times of arrival (TOAs) of energy waves traveling between the unknown point and multiple stations at known locations. Airport ground services utilize the waves transmitted by the aircraft's transponders, which will also transmit additional information, such as – among others – callsign.

MTOM *Maximum Take-Off Mass*

NFM *Nemzeti Fejlesztési Minisztérium* (Ministry of National Development, Hungary – abolished in May 2018).

NKH LH *Nemzeti Közlekedési Hatóság, Légügyi Hatóság* (National Transport Authority Aviation Authority, Hungary – abolished on 31 December, 2016)

NOTAM *Notice(s) to Airmen* is an advisory notice filed with an aviation authority to alert aircraft pilots of potential hazards along a flight route or at a location that could affect the flight, containing information concerning the establishment, conditions or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which may be essential to personnel and systems concerned with flight operations.

NVFR *Night VFR (Visual Flight Rules)* are night flight conditions, and also a pilot rating enabling holders to operate under such conditions.

OCM	*Other Crew Member* is an abbreviation used in the Aircraft Flight Log for denoting a third person on duty on the flight deck beside the operating pilots.
PIC	*Pilot-in-Command*
PICUS	A *Pilot-in-Command Under Supervision* is a copilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command.
PPL	*Private Pilot License*
RETIL	*Rapid Exit Taxiway Indicator Light*
RHS	*Right Hand Seat Authorization*
RWY	*Runway*
SE	*Single Engine (rating)*
SEP(Land)	*Single Engine Piston (Land)*
SMR	*Surface Movement Radar*
SPIC	A *Student Pilot in Command* is a student pilot acting as pilot-in-command on a flight with an instructor where the latter will only observe the student pilot and shall not influence or control the flight of the aircraft.
TMG	*Touring Motor Glider* (rating or endorsement)
Towing (S+B)	*Towing (Sailplane and Banner)* (endorsement)
TRI	*Type Rating Instructor*
UPRT	*Upset Prevention and Recovery Training*
UTC	*Coordinated Universal Time*
VFR	*Visual Flight Rules*

General information

All times indicated in this report are in local time (LT), which at the time of the occurrence was UTC+1 hour.

Geographic locations throughout this document are provided by WGS-84 standard.

Capitalized references used throughout this document (e.g. Captain, Pilot, etc.) denote particular persons concerned in the event investigated.

The format and content of this report is in harmony with Chapter 6 of Annex 13 of Act XLVI of 2007 promulgating the Appendices to the Convention on International Civil Aviation, signed in Chicago on 7 December 1944. Appendix, as well as with the requirements set out in ICAO Doc 9756 Part IV.

Reports and Notifications

The DAM of LHBP reported the occurrence to TSB's call center at 11:38 on 2 March, 2021, specifically identifying a Saab 430 registered as ES-LSG as the aircraft causing the damage.

In line with Article 9, Section (2) of Regulation (EU) No 996/2010 of the European Parliament and of the Council, TSB of Hungary notified the following organizations.

- Accident Investigation Authority of the State of Registry (Sweden) on 3 March, 2021 at 16:17.
- Accident Investigation Authority of the State of Operator (Estonia) on 3 March, 2021 at 16:17.
- Accident Investigation Authority of the State of Manufacture (Sweden) on 3 March, 2021 at 16:18.
- ICAO on 3 March, 2021 at 16:21.
- EASA on 3 March, 2021 at 16:28.
- NTSB, the Accident Investigation Authority of the State Manufacture (USA) for Beechjet 400 Aircraft on 28 April, 2021 at 09:04.

None of the notified organizations appointed an accredited representative for the investigation.

Investigation Committee

The Head of TSB appointed the following persons to the investigating committee (hereinafter: IC).

Investigator-in-Charge	Mr. Akos Hanczar	investigator
Member	Ms. Klementina Joó	investigator

Overview of the Investigation Process

Receiving event notification, the on-duty TSB supervisor mandated an immediate dispatch to the site.

Pursuant to Article 5 of REGULATION (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/ECA the TSB is required to initiate an investigation in the following circumstances.

1. *Every accident or serious incident involving aircraft to which Regulation (EU) 2018/1139 of the European Parliament and of the Council applies shall be the subject of a safety investigation in the Member State in which the accident or serious incident occurred.*
2. *Where an aircraft to which Regulation (EU) 2018/1139 applies and which is registered in a Member State is involved in an accident or a serious incident the location of which*

cannot be definitely established as being in the territory of any State, a safety investigation shall be conducted by the safety investigation authority of the Member State of registration.

3. *The extent of safety investigations referred to in paragraphs 1, 2 and 4 and the procedure to be followed in conducting such safety investigations shall be determined by the safety investigation authority, taking into account the consequences of the accident or serious incident and the lessons it expects to draw from such investigations for the improvement of aviation safety.*

4. *Safety investigation authorities may decide to investigate incidents other than those referred to in paragraphs 1 and 2, as well as accidents or serious incidents to other types of aircraft, in accordance with the national legislation of the Member States, when they expect to draw safety lessons from them.*

5. *By way of derogation from paragraphs 1 and 2 of this Article, the responsible safety investigation authority may decide, taking into account the expected lessons to be drawn for the improvement of aviation safety, not to initiate a safety investigation when an accident or serious incident concerns an unmanned aircraft for which a certificate or declaration is not required pursuant to Article 56 (1) and (5) of Regulation (EU) 2018/1139, or concerns a manned aircraft with a maximum take-off mass less than or equal to 2 250 kg, and where no person has been fatally or seriously injured.*

Based on the findings of the site inspection and with regard to Article 5 (4) of Regulation (EU) No 996/2010 of the European Parliament and of the Council, the head of the TSB decided that an investigation is required and will be launched.

In the course of the investigation the IC has taken the following measures.

1. Actions taken prior to discovering the error in the reported time of occurrence

- Conducted a site survey, collected and secured the tire marks left on the damaged lights and on their base plates. The affected lighting fixtures were seized.
- Interviewed the DAM who was on duty at the time of discovering the damage.
- Obtained airport movement radar screen footage and radio transmission recordings from HungaroControl for the initially reported time of occurrence.
- Inspected the returning Saab 340 (ES-LSG) and interviewed its crew members. The Flight Data Recorder and Cockpit Voice Recorder of the aircraft were seized for readout and further analysis.
- Inspected each aircraft that entered RWY 31L during the initially investigated time period for fuselage and landing gear damage. Due to lack of involvement, the registrations of these aircraft (later on referred to as *Aircraft 1* to *3*) have been redacted for data protection reasons. Tire marks from each landing gear tire of these aircraft were sampled and compared with the tire marks secured at the scene. Since no match was found, the investigation was extended to earlier time periods.

2. Actions taken following the error in the reported time of occurrence was revealed

- Secured and examined footage and radio transmissions of the preceding runway maintenance period to determine the correct time of occurrence.
- Positively identified a Beechjet 400A (HA-YFJ) as the aircraft that caused the damage a few hours prior to the initially reported time. The aircraft was inspected, and its crew and passengers were interviewed.
- Interviewed the DAM who was on duty at the actual time of occurrence.
- Conducted follow-up inspections on HA-YFJ, modeled and replicated its taxi route in similar circumstances, which was video recorded from the cockpit point of view.

- Consulted with CAA regarding the non-compliances exposed concerning the flight in question.
- Obtained the AIP valid at the time of the occurrence.
- Contacted the UK Air Accidents Investigation Branch (AAIB) regarding the context and impact of the Safety Recommendation #GB-SIA-2015-0038 issued by them earlier, addressing the potential need for distinctive runway edge lights.
- Held discussions and meetings with representatives of HungaroControl, resulting in proposing the issuance of a Safety Recommendation.
- Examined and analyzed all data and information obtained throughout the investigation formulate a Final Report.

Investigation Principles

This investigation is being carried out by Transportation Safety Bureau on the basis of the following disciplines.

- Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC,
- Act XCVII of 1995 on aviation,
- Annex 13 identified in the Appendix of Act XLVI. of 2007 on the declaration of the annexes to the Convention on International Civil Aviation signed in Chicago on 7th December 1944,
- Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents (referred to as Kbvt. throughout the document),
- NFM (Ministry for National Development) Regulation 70/2015 (XII.1) on safety investigation of aviation accidents and incidents, as well as on detailed investigation for operators,
- In matters not covered by Kbvt., Act CL of 2016 on General Public Administration Procedures prevails.

The competence of the Transportation Safety Bureau of Hungary is based on Government Regulation № 230/2016. (VII.29.) on the assignment of a transportation safety body and on the dissolution of Transportation Safety Bureau with legal succession.

Pursuant to the aforesaid legislation,

- Transportation Safety Bureau of Hungary shall investigate aviation accidents and serious incidents.
- Transportation Safety Bureau of Hungary may investigate aviation and incidents which – in its judgement – could have led to accidents of more severe consequences in different circumstances.
- Transportation Safety Bureau of Hungary is independent of any person or entity that may have interests in conflict with the objectives of the investigating body.
- In addition to the aforementioned legislation, TSB of Hungary shall conduct safety investigations in line with ICAO Docs 9756 and 6920 Manual of Aircraft Accident Investigation.
- This Report shall not be binding, nor shall an appeal be lodged against it.
- The original of this report was written in Hungarian.

No conflict of interest has been identified between safety investigators appointed to the IC. Investigators assigned to a safety investigation shall not be involved as experts in any other procedure pertaining to the same case and shall refrain from doing so in the future.

The IC shall retain all data and information having come to their knowledge in the course of the safety investigation. Furthermore, the IC shall not be obliged to make such data and information available to other authorities, if their original owner could have legally refused disclosure.

This Final Report is based on the Draft Report prepared by the IC that was sent to all involved parties for comments, as set forth by the relevant regulations.

Comments have been received within the legal deadline from Budapest Airport Zrt. and Hungarian CAA's Accident and Serious Incident Investigation Department, which the IC reviewed and incorporated into the Final Report.

The Operator involved in the incident (FlyCoop Kft.) presented differing views on the identification of the aircraft involved the incident. After reviewing the evidence and facts, the IC finds the Operator's claims unsubstantiated and upholds its original conclusions in the Final Report.

Copyright

Translation

This document has been translated from Hungarian. Although efforts have been made to provide a translation as accurate as possible, discrepancies between the versions might occur. In such eventuality, the Hungarian version shall prevail.

1. Factual information

1.1 Flight History

With four persons on board, the affected flight blocked off from their stand on Apron 1 at 22:40 on 1 March, 2021. The pilot occupying the left seat (CM1), serving as Pilot Flying (PF) taxied to holding point B1 via taxiway B1. He was assisted by CM2, seated on the right and serving as Pilot Monitoring (PM), holding company PIC and RHS authorization.

Behind them in the passenger compartment, separated by the cockpit partition bulkhead, a company TRI (PAX1) was seated on an aft-facing passenger seat that could rotate 90 degrees inboard. According to his statement, he was conducting CM1's type rating training.

The fourth person in the passenger cabin was a positioning company pilot.

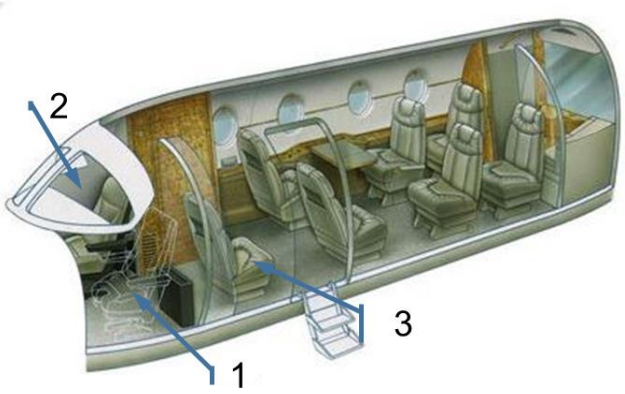


Figure 2. Position of the affected pilots in the aircraft
***1.** CM1: non-type rated student pilot; **2.** CM2: pilot with PIC authorization; **3.** PAX1: TRI rated pilot*

According to the crew's report, the pre-takeoff checks were completed before reaching the holding point. They then entered the runway via holding point B1, turned southeast, and taxied to the threshold of Runway 31L. Their movement was tracked and recorded by the airport ground service A-SMGCS system, which uses autonomous data sources both from the primary radar system and secondary transponder data. Registered paths from both data sources showed identical tracks along the entire taxi route *(Figure 3).* Review of the radar screen footage revealed that instead of following the centerline, the crew taxied the aircraft along the runway edge line marking on the northeastern side of the runway.

During taxi along the runway edge, the crew knocked down the first and second edge lights beyond intersection J4 with the aircraft's left main landing gear, and the fourth edge light with the nose gear *(Figure 14)*. Approaching the threshold, they executed a right-left turn maneuver to align with the centerline of Runway 31L and took off as per the takeoff clearance. The rest of the flight was not affected by the incident under investigation.

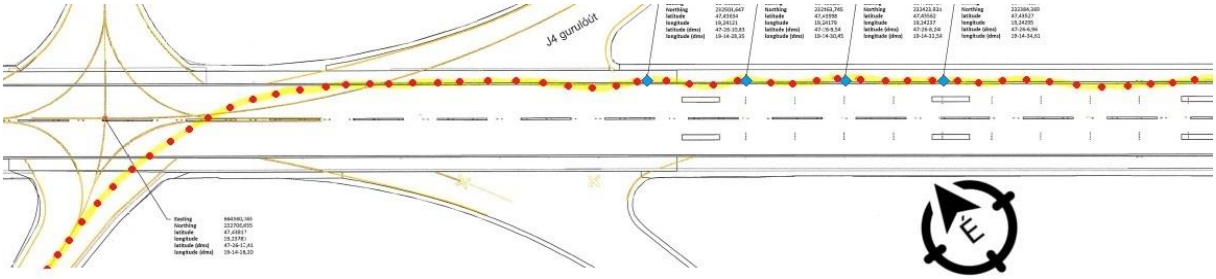


Figure 3: Registered taxi track line of HA-YFJ, with the coordinates of the four affected edge lights
***Yellow line:** secondary transponder data.*
***Red dotted line:** primary radar data.*
(Source: A-SMGCS)

1.2 Injury to Persons

No personal injury occurred in connection with the occurrence.

1.3 Aircraft Damage

The aircraft was not damaged in the incident. The investigation documented minor blemishes that can likely be associated with the incident, with no effect to the aircraft's airworthiness. The list of the mostly cosmetic damage, photographically documented during the on-site inspection in the presence of the operator, is as follows.

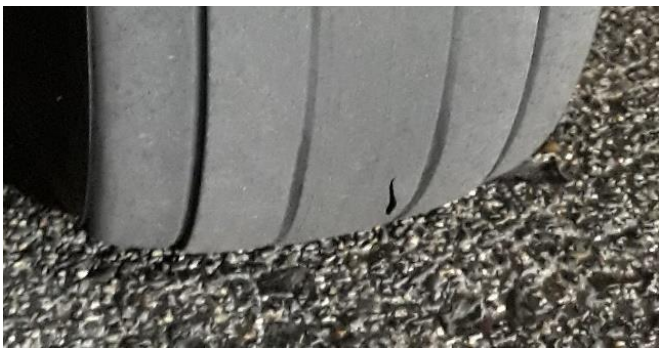
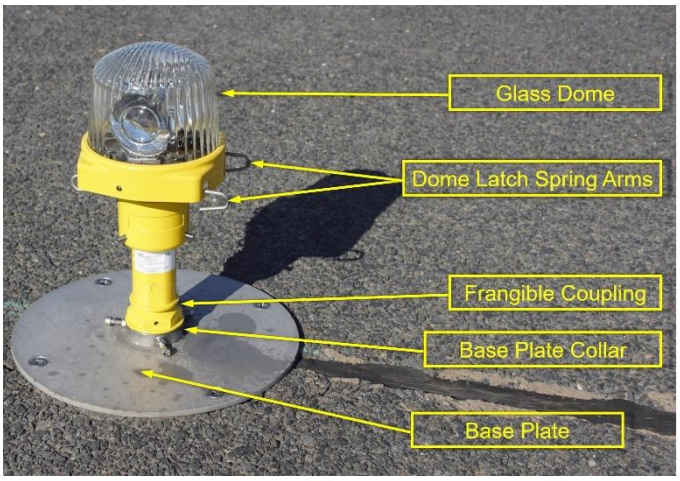


Figure 4. Incised damage on the left tire tread area

- Blunt impact marks on the corners of the left main gear oleo filling plug, which indicate a single frontal impact, rather than rotational, wrench-induced chipping. These impact marks, together with traces of yellow paint transfer, match the damage on light fixture No. 2 *(Figure 15)*.
- A fore-and-aft scratch on the underside of the left main oleo strut, corresponding to the position of the glass dome latch spring arm of light fixture No. 2 *(Figure 12)*.
- Two deep, sharp cuts about half an inch in length on the left tire tread surface. These cuts appear to be incised piercings, likely caused by rolling over broken glass *(Figure 4)*.

1.4 Other Damage



The frangible couplings of the first and fourth edge light fixtures gave way on impact with the tire. Further damage was caused when the lights landed on the runway surface. The second fixture broke off by its stump right below the frangible coupling *(Figure 5).*

The third fixture was replaced as a precaution. A comparative analysis of damages of the aircraft and the fixtures is provided in *Section 1.16 Tests and Research.*

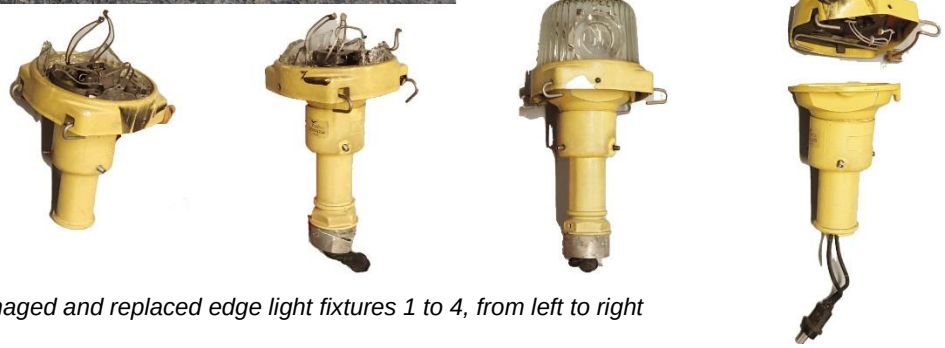


Figure 5. The damaged and replaced edge light fixtures 1 to 4, from left to right

1.5 Personnel Information

Commission Regulation (EU) No. 1178/2011 of 3 November 2011 laying down technical requirements and administrative procedures related to civil aviation aircrew pursuant to Regulation (EC) No. 216/2008 of the European Parliament and of the Council FCL.050 *Recording of flight time*, along with FCL.010 *Definitions* and AMC1.FCL.050 General (b) (1) stipulate that on aircraft on which more than one pilot is required under the type certification of the aircraft only one pilot can ultimately be in command and charged with the safe conduct of the flight.

Through the crew interviews it became evident that the crew members considered CM1's type rating training complete, and they regarded the flight's training status as perfunctory. This is reflected in the instructor's note in CM1's training log saying "*Released for exam*" dated on the morning of 1 March, prior to the occurrence flight *(1.17; 2.1.4)*. PAX1 stated in his interview that CM1 had significantly more extensive aviation experience compared to his own and checking him out for this type was a mere formality.

1.5.1 Pilot-in-Command

Age, nationality, gender		42, Hungarian, male
FD position		CM2
Flight License	Type	ATPL(A)
	valid until	does not expire
	ratings and endorsements	A320, Beech400/MJ30, IRI(A)/ME, SEP(Land)
Medical class and valid until		Class 1: 27-JUN-2021 Commercial Single Pilot with Pax: 27-DEC-2020 Class 2/LAPL: 2022-JUN-27
Flight hours / take-offs	in the preceding 24 hours	00:00 / 0
	in the preceding 7 days	10:51 / 2
	in the preceding 90 days	148:27 / 44
	total:	11 748 / 3 006
	total on this type:	N/A
Aircraft types flown:		A320, Beechjet400
Pilot function at the time of the occurrence		Pilot Monitoring (PM) – logged as PIC in the AFL and Pilot Logbook
Rest and duty time in the preceding 48 hours		not on duty
Date of most recent training		N/A
Results of most recent training, mandatory and periodic checks		N/A
Familiarity with the affected airport		Experienced at LHBP

1.5.2 Co-pilot

Age, nationality, gender		42, Hungarian, male
FD position		CM1
Flight License	Type	ATPL(A)
	valid until	does not expire

	ratings and endorsements	B737, IR(A)ME, IR(A)SE, NVFR, SEP(Land), TOWING / S+B Instructor ratings: CRI(A)/ME, CRI(A)/SE, FI(A): CPL(A), FI(A), LAPL(A), NVFR, PPL(A); IRI(A)
Medical class and valid until		Class 1: 20-JUN-2021 Commercial Single Pilot with Pax: 20-DEC-2020 Class 2/LAPL: 2022-JUN-20
Flight hours / take-offs	in the preceding 24 hours	02:00 / 2
	in the preceding 7 days	16:11 / 17
	in the preceding 90 days	45:53 / 136
	total:	11 161:59 / 9 951
	total on this type:	12:53 / 13
Aircraft types flown:		B737
Pilot function at the time of the occurrence		Pilot Flying (PF) – logged as FO in the AFL and as DUAL in his Pilot Logbook
Rest and duty time in the preceding 48 hours		Rest: 12:20 Duty: 4:16 under training
Date of most recent training		Type Rating conversion in progress, not yet type rated
Results of most recent training, mandatory and periodic checks		N/A
Familiarity with the affected airport		Experienced at LHBP

1.5.3 TRI-Rated Pilot Occupying a Passenger Seat

Age, nationality, gender		34, Hungarian, male
FD position		PAX1 (not present on Flight Deck)
Flight License	type	ATPL(A)
	valid until	does not expire
	ratings and endorsements	BE90/99/100/200, Beech400/MU300, HS125, IR(A)/ME, IR(A)/SE, MEP(land), NVFR, PA31T/42, SEP(Land), TMG, TOWING /S+B, Instructor ratings: CRI(A)/ME, CRI(A)/SE, FI(A): CPL(A), FI(A), LAPL(A), NVFR, PPL(A); IRI(A), TRI(A): Beech400/MU300, PA31T/42
Medical class and valid until		Class 1: 22-JUL-2021 Commercial Single Pilot with Pax: 22-JUL-2020 Class 2: 2022-JUL-22 LAPL: 2025-JUL-22
Flight hours / take-offs	in the preceding 24 hours	02:16 / 1
	in the preceding 7 days	19:18 / 19
	in the preceding 90 days	95:00 / 92
	total:	3 610:13 / 4 755
	total on this type:	N/A

Pilot function at the time of the occurrence	According to his statement, he was conducting CM1's training from the passenger compartment as an instructor, occupying a passenger seat. Logged as OCM in the AFL and PIC in his Pilot Logbook
Date of most recent training	N/A
Results of most recent training, mandatory and periodic checks	N/A
Familiarity with the affected airport	Based at LHBP

1.6 Aircraft Information

1.6.1 General Information

Class	Fixed Wing Aircraft (MTOM > 5 700 kg)
Manufacturer	Raytheon Aircraft Co.
Model	Beechjet 400A
Year of manufacture	1999
Serial number	RK-254
Registration	HA-YFJ
State of registry	Hungary
Date of registry	2-SEP-2016
Owner	GEKOQ S.A.
Operator	Fly-Coop Kft.

As set forth in the operating manual, this aircraft must be operated in a minimum configuration of one pilot and one co-pilot (multi-crew configuration). According to the relevant regulations, the crew required for multi-crew operations must consist of either two type-rated pilots or one trainee pilot and one type rating instructor or examiner *(1.17).*

	Flight Hours	No. of Takeoffs
Since New	5 825,7	4 536
Since Last Overhaul	47,9	64
Since Last Periodic Maintenance/Inspection	47,9	64

1.6.2 Airworthiness Certificate

Airworthiness Certificate	Number	8 320
	Date of Issue	17-JUN-2008
	Valid Until	Until Withdrawn
	Restrictions	none

	Number	35 212
	Date of Issue	6-JUL-2020

Airworthiness Review Certificate	Valid Until	6-JUL-2021
	Date of Latest Review	6-JUL-2020

1.6.3 Engines

Category	Turbofan	
Manufacturer	Pratt & Whitney	
Type	JT15D-5	
Position on the aircraft	Engine 1	Engine 2
	Hours / cycles flown	
Total	4 391	4 433

The engines did not impact the course of the incident, further engine data are not provided.

1.6.4 Aircraft Loading Data

Empty Weight (kg)	4 718.3
Fuel on board (kg)	4 500
Maximum take-off weight (kg)	7 303
Maximum landing weight (kg)	7 121

Weight and balance had no effect on the course of the incident, further loading data are not provided.

The aircraft carried no dangerous goods.

1.6.5 Malfunctioning Systems or Equipment

In the course of the investigation, no information emerged indicating any structural failure or system malfunction of the aircraft that contributed to or influenced the occurrence of the incident.

1.6.6 On-board Warning Systems

The systems operated in compliance with the requirements, and the IC did not make or receive any comments regarding any irregularities in their operation.

1.7 Weather Information

The occurrence took place at nighttime, in clear visibility. Wind was light and south-easterly.

1.8 Aids to Navigation

Navigation equipment, on-board or ground based, had no influence on the course of events.

1.9 Communication

Communication equipment had no influence on the course of events.

1.10 Aerodrome Information

The crew entered Runway 31L at 22:43 on March 1, 2021 and performed takeoff at 22:46. The airport had a valid operating license.

Name of Aerodrome	Budapest Ferenc Liszt International Airport
Airport Codes	LHBP (ICAO); BUD (IATA)
Airport Operator	Budapest Airport Zrt.
Reference Point (ARP)	472622N 0191543E
Elevation	151.3 m (495 ft.)
Affected Runway	13R/31L
Runway Dimensions	L 3 009 m; W 45 m
Runway Surface	Concrete
Runway Conditions	Clear and Dry
Other Information	Runway Light Configuration was set according to the runway in use (31L). Edge lights and centerline lights of runways B1, B2 and J4 were on and operational.

At the time of the incident, the runway lights were operating in a configuration for direction 31. Unlike on the other runway at the airport (Runway 13L/31R), the centerline lights only illuminate in the southeast direction and are not visible from the opposite runway direction. The centerline lights are therefore hidden for aircrews backtracking on the runway (facing SE).

In compliance with relevant rules and regulations, the runway edge line is marked with a solid white line, and the centerline with a dashed white line. Where the shoulder's load bearing capability is lower than that of the runway (such as on the runway section between intersections J4 and A1), an additional, thinner white line, painted next to the edge line on the outside, indicates the partition between the load-bearing pavement and the shoulder. Along such runway sections, runway edges are therefore marked by a double line.

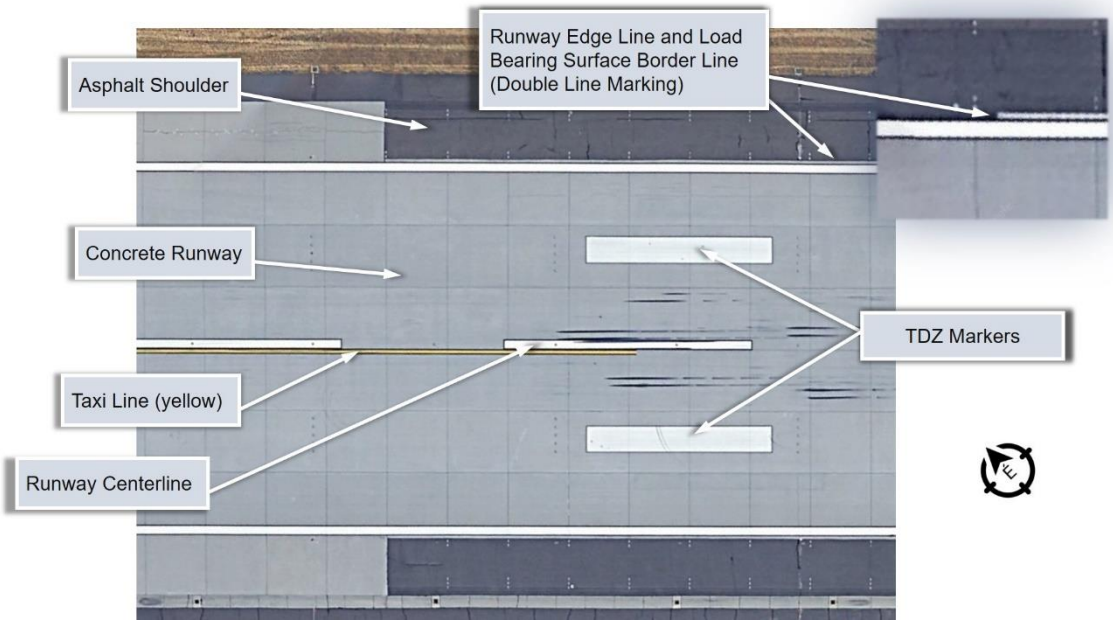


Figure 6. Runway Surface Markings (Source: Google Earth)

On aprons and taxiways, a solid yellow taxi line (with or without a thin black border) marks the path that ensures obstacle-free taxiing when followed. It may originate on the runway surface, connecting the runway centerline with the taxiway axis in a curve, to facilitate runway vacation for landing traffic. Besides its primary function of providing guidance from the runway to the appropriate taxiways centerline, the yellow taxi line also connects opposing taxiways to assist efficient runway crossing *(Figure 19)*.

The attributes of runway lights around intersection J4 *(1.16.2)* and the context regarding their potential effect on the occurrence are explored in detail in section *1.18.1 Similar Cases, ATSB Study and AAIB Safety Recommendation*.

In the Aerodrome Chart's *Lights* section, the centerline lights are marked bidirectional (illuminating in both directions) for both runways. This information is misleading, inasmuch as the centerline lights on Runway 13R/31L, although capable of emitting light both ways, will only operate unidirectionally at a time: the direction of the lights will change in function of the runway direction in use. The Aerodrome Chart version in effect at the time provided no information of this feature, nor did it say that the centerline lights on the airport's other runway (RWY 13L/31R) were permanently bidirectional.

Similarly, the AIP valid at the time of the incident also did not provide information on this, nor did it include graphic representations of the taxiway centerline markings at the intersections. Flight crews entering the runway at B1 for threshold 31L would therefore not expect the taxi line to first curve left, before turning right towards the southeastern end of the runway *(Figure 9)*.

1.10.1 Scheduled Runway Inspections

The schedule and detailed procedures of daily runway inspections were outlined and published in the airport operator's "Management Directives". This publication describes two types of inspection procedures (Types A and B), both of which require the inspection of lighting equipment, with detailed instructions regarding the scheduling of each inspection.

Between the time of the incident and the discovery of the broken edge lights, three scheduled runway inspections were planned. However, during the first inspection, the lighting equipment check was omitted and the inspection personnel did not notice the broken lighting fixtures on the runway in the darkness. The internal investigation of Budapest Airport Zrt *(Figure 7)* also revealed that the subsequent, second runway inspection, scheduled for 07:50 and recorded in the Work Log as "performed from 07:50 to 08:20" did not actually take place, contrary to the Work Log entry made of it.

Tényleges Zárás kezdete:	Tényleges Zárás vége:	Naplózva:	Előírt 03./2020. REFÜ:	Pontos helyszínek
2021.03.02. 05:12(LT) *Nincs Fénytechnikai ellenőrzés*	2021.03.02. 05:20(LT) *Nincs Fénytechnikai ellenőrzés*	2021.03.02. 4:50- 05:20(LT)	*A típusú ellenőrzés (Reggeli)* 05:00(LT)-kor a tárgynap forgalmának megkezdése előtt.	Általános, teljes forgalmi területet érintő ellenőrzés
2021.03.02. 7:50(LT) (RWYI pálya ellenőrzés elmaradt.)	2021.03.02. 8:20(LT) RWYI pálya ellenőrzés elmaradt.)	2021.03.02. 07:50-08:20(LT)	*B típusú ellenőrzés) (Délelőtti)* 09:00-10:00 (LT) között a forgalomtól függően.	Általános, teljes forgalmi területet érintő ellenőrzés (Lásd a 3.sz.Mellékleteket DRR rádió TWR forgalmazást és az A-SMGCS felvételt.)
2021.03.02. 12:31 LT	2021.03.02. 12:38(LT)	2021.03.02. 12:20-12:35(LT)	*(B típusú ellenőrzés (Déli)* 12:00-13:00(LT)	13L/31R RWY ellenőrzése (e közben fedezte fel a DAM a törött szegélyfényeket)

Figure 7. Runway inspections scheduled for the period following the occurrence (Source: BUD Internal Investigation and Analysis)[2]

[2] *Annex 3* of the *BUD Internal Investigation Report* cited in the chart does not provide relevant information regarding this incident, it is therefore not attached to this report.

At the time of the omitted runway inspection, inspection personnel drove the vehicle marked 'AIRSIDE1' from the tower to Apron 1 via taxiway B2, which was partially closed and being used as a long-term aircraft parking area. Without stopping on Apron 1, the vehicle turned around and returned to taxiway B5 via the same route *(Figure 8)*. The only time the vehicle spent on the runway was during runway crossing. No runway inspection was performed.

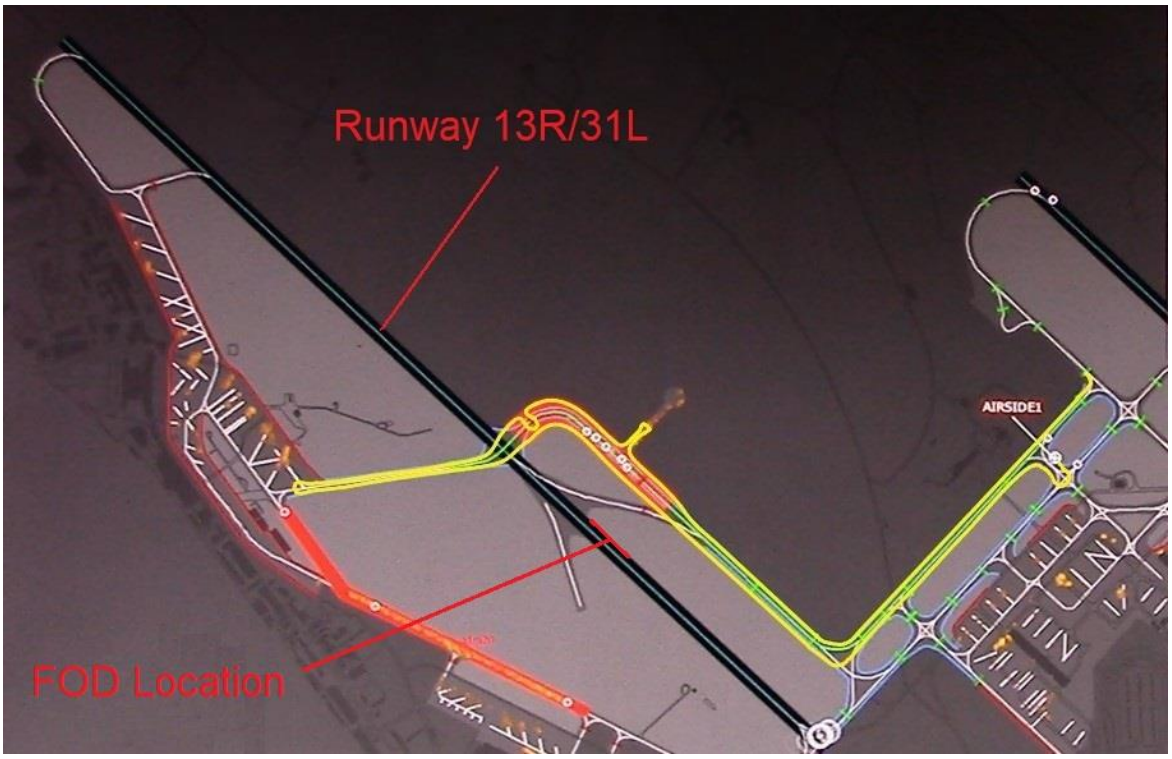


Figure 8. Track of the inspection vehicle (AIRSIDE1) during the time of the omitted runway inspection

Since the runway crossing was about 300 meters away from the damage site and the debris scattered on the runway was out of sight in the dark, the broken edge lights were not discovered – again. It took another four and a half hours before the DAM found the debris during the third runway inspection carried out under daylight conditions.

The airport operator's subsequent internal investigation revealed that the runway lights were not checked during the first runway inspection, and the second one, although logged and reported as completed, never actually happened *(Figure 7)*. The internal investigation did not find any reasonably acceptable explanations for the omission. The impact of the missed check and inspection on airport traffic and how the deliberate avoidance of divulging this information affected the TSB investigation are discussed further in section *2.2*.

1.11 Data Recorders

The ATS data recording systems were operational and provided serviceable data for the event analysis.

The incident aircraft was equipped with a model F-1000 onboard data recorder. This unit does not offer features in line with the latest technology, and its low sample rate and geolocation resolution precludes the provision of accurate data that could be used in the investigation. For this reason, the IC did not seize this unit or download its content.

As there was no regulatory requirement for a cockpit voice recorder, HA-YFJ was not equipped with such a unit.

The IC obtained and made use of the recorded radio communications and the synchronized primary and secondary radar data recorded by the A-SMGCS system of the airport ground service.

According to HungaroControl, accuracy checks performed on March 19, 2021, indicated that the accuracy of the SMR (primary) radar was better than 3 meters, and the accuracy of the M-LAT (secondary) system was better than 5 meters.

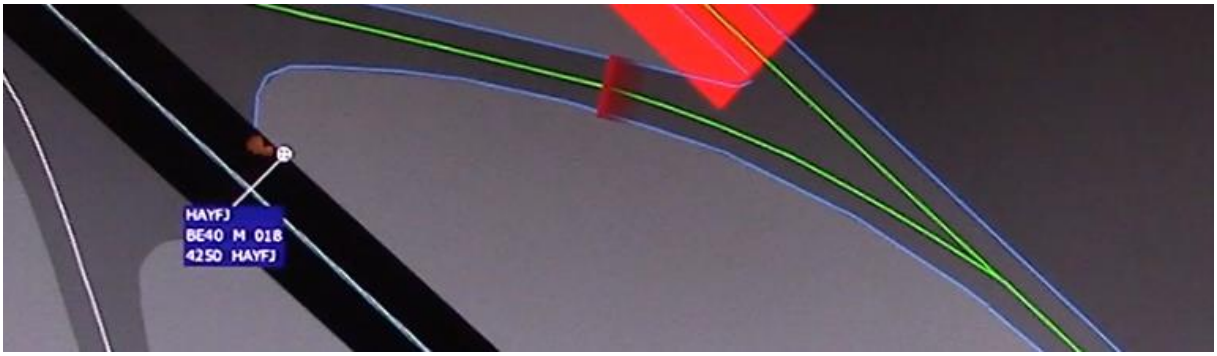


Figure 9. An ATS radar display image of HA-YFJ taxiing on the runway edge at the damage site. (Source: HungaroControl A-SMGCS data)

1.12 Wreckage and Impact Information

There was no wreckage caused by the occurrence.

1.13 Medical and Pathological Information

There was no indication of any physiological factor or other impediments affecting the Pilot's capacity or capabilities.

1.14 Fire

There was no fire.

1.15 Survival Aspects

No personal injuries occurred; the risk of such was not significant due to the relatively low speed during taxiing.

1.16 Tests and Research

1.16.1 Identification of the Aircraft that Damaged the Edge Lights

The event was reported to have occurred between 08:00 and 13:30 in the DAM's occurrence report submitted to the TSB, positively identifying a Saab 340 cargo aircraft as the culprit. The airport operator based this finding on the fact that, during the specified period, the Saab 340 was the only aircraft whose recorded track played back from A-SMGCS went through the damage area during its takeoff run. The investigation started with this information and focused on the Saab 340. The aircraft's cockpit voice recorder and flight data recorder were seized when the aircraft returned a few hours later. The units were dispatched to their respective manufacturers for data download.

To ensure certainty and eliminate all doubts, the IC inspected each aircraft that passed near the damage site during the specified period (ES LSG, "Aircraft 1", "Aircraft 2", "Aircraft 3") and collected prints of all their tires to record tread patterns *(Figure 10)*.

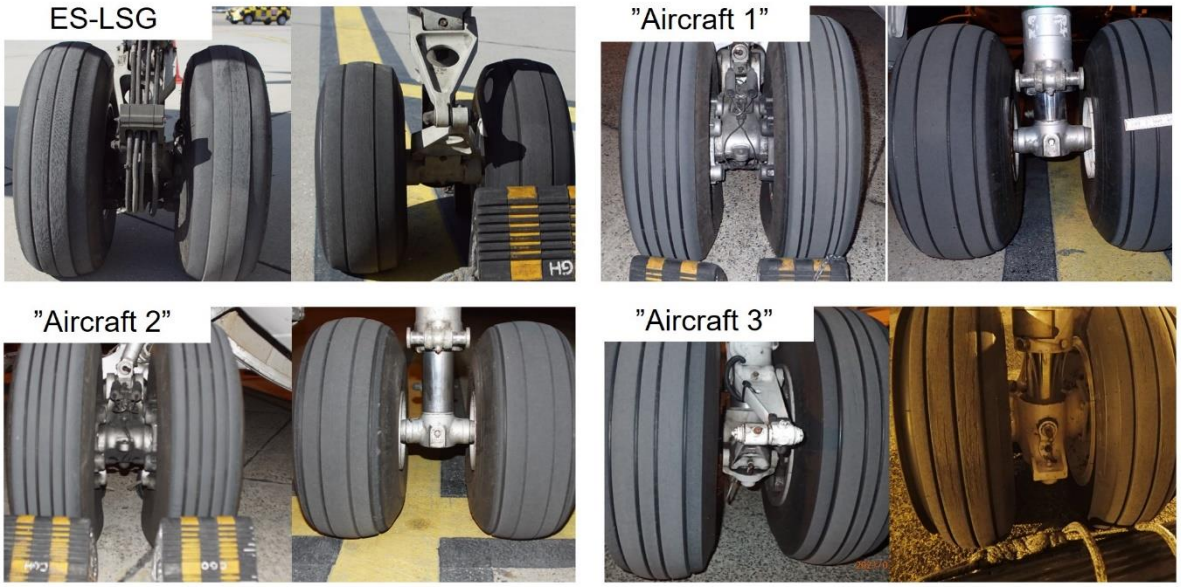


Figure 10. Tread patterns of the aircraft passing by intersection J4 on RWY 13R/31L between 08:00 and 13:30. (left: main gear, right: nose gear on each pair of photos)

These patterns were compared with the tread marks found on the steel base plates of the damaged edge lights *(Figure 11)*, but no matches were found. Furthermore, the data from the Saab 340's FDR, processed in the meantime, confirmed that this aircraft (ES-LSG) was already airborne before reaching the location of the affected edge lights, and passed 150 feet above the first one. Additionally, its tire tread patterns were markedly dissimilar from the recorded tread marks. Consequently, this aircraft was excluded from further investigation.

The absence of any similarity in the tire tread patterns of any aircraft near the incident site during the specified period with the tread marks found on the damaged edge lights made it clear that the incident must have occurred outside the timeframe reported by the airport operator. The IC then shifted focus to the preceding period, going back to the last comprehensive lighting inspection conducted between 21:17 and 21:35 on March 1, when the edge lights were last checked and confirmed to be fully operational. (The circumstances and impact of the event time misidentification are discussed in section *2.2*).

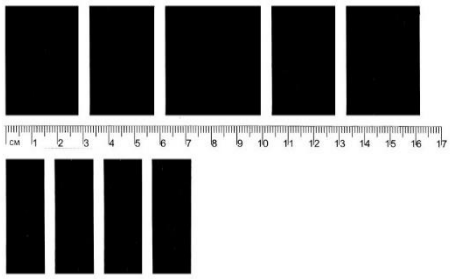


Figure 11. Tire tread patterns reconstructed from the tread marks found on the base plates of the damaged edge lights.
*(**Upper image:** main gear; **lower image:** nose gear)*

Figure 12. Main and nose gear treads of HA-YFJ.
*(**Left:** main gear, **right:** nose gear)*

During the period from 21:00 to 08:00, no service road vehicles entered the runway, and only one aircraft (HA-YFJ) had a ground track that passed precisely through the incident site *(Figure 3).* A site inspection of this aircraft revealed that the tread patterns of its main and nose landing

gear tires both show an exact match to the tire marks collected from the base plates *(Figure 11; Figure 12; Figure 16; Figure 17 and Figure 14)*. Additionally, a minor scratch on the left main oleo strut corresponded to the type of damage that could be caused by a dome latch spring arm of HIEL No. 2 *(Figure 13)*.

Figure 13. Scratch on the underside of HA-YFJ's left main oleo strut.

The angles and directions of the tread marks found on the base plates also aligned with the corresponding segments of HA-YFJ's recorded ground track *(Figure 3 and Figure 14)*.

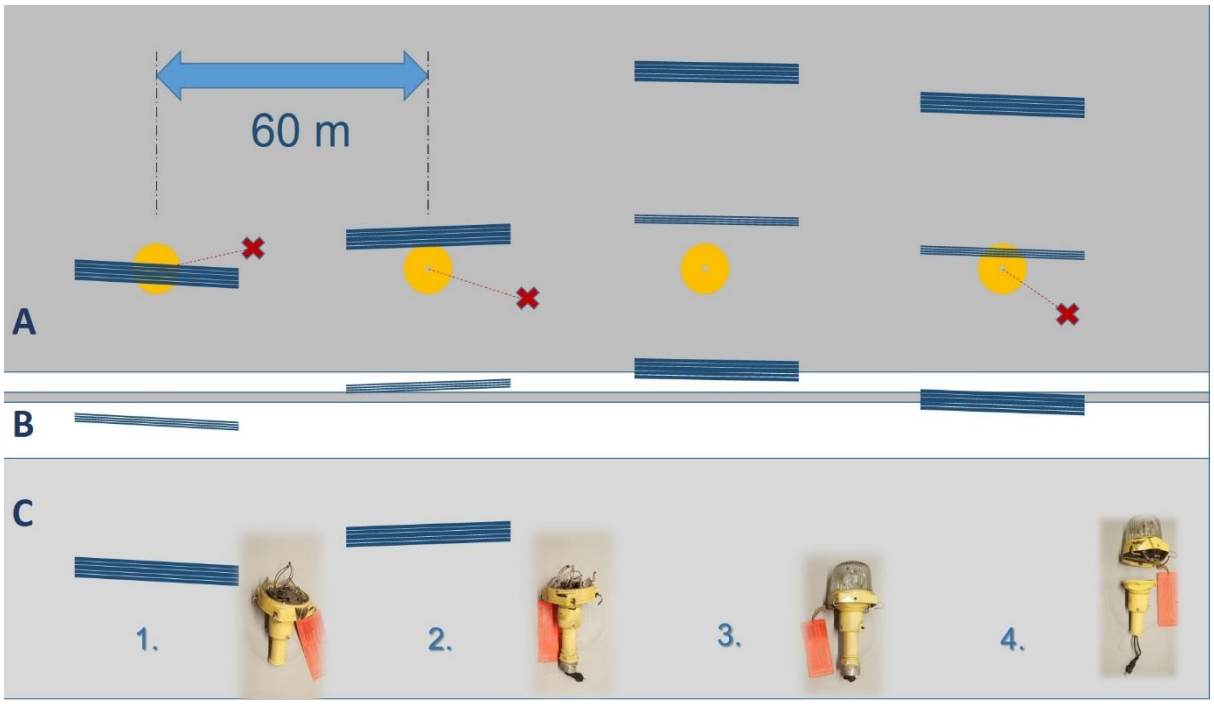


Figure 14. Aircraft heading angles at the affected edge lights.
Note: distance intervals between the lights are not to scale. Taxi direction: left to right.
***A**: Shoulder Surface; **B**: Runway Edge Line; **C**: Runway Load Bearing Surface*

Figure 14 demonstrates the direction of each taxi path segments at the affected edge light locations. These track segments are recreated from A-SMGCS data *(Figure 3)* and the angles of tread marks found on the base plates. The red '**X**' marks indicate where the knocked-down light fixtures ended up following the impact, and the red dashed lines, originating from their installed positions, indicate impact vectors.

HIEL No. 1 was hit by the left main landing gear tire *(Figure 17)* going across the middle of the base plate. HIEL No. 2 was impacted by the left oleo strut *(Figure 15),* with the tire rolling over the last few inches at the edge of the base plate. HIEL No. 3 went between the nose gear and the right main gear, sustaining no damage. HIEL No. 4 was knocked over by the nose wheel tire *(Figure 17)*.

The wavering directional angles of the recorded tread marks on each base plate, along with the fact that the knocked-down fixtures remained near their stubs indicated that the edge lights were knocked down by an aircraft taxiing at low speed rather than during a straight and high-speed takeoff or landing run. These track characteristics are explained by the aircraft's low speed. How straight and unwavering an aircraft rolls on the ground is proportional to its speed: aircraft taxiing at low speed are kept on track by many small directional corrections, which typically produce a wavier track compared to the straight line an accelerating or decelerating aircraft follows at higher speeds.

The damage to the aluminum side skirt of HIEL No. 2 showed a distinct and exactly matching impression from a protrusion on the left main oleo strut, with details corresponding down to the tightening angle of the oil filling plug *(Figure 15)*.

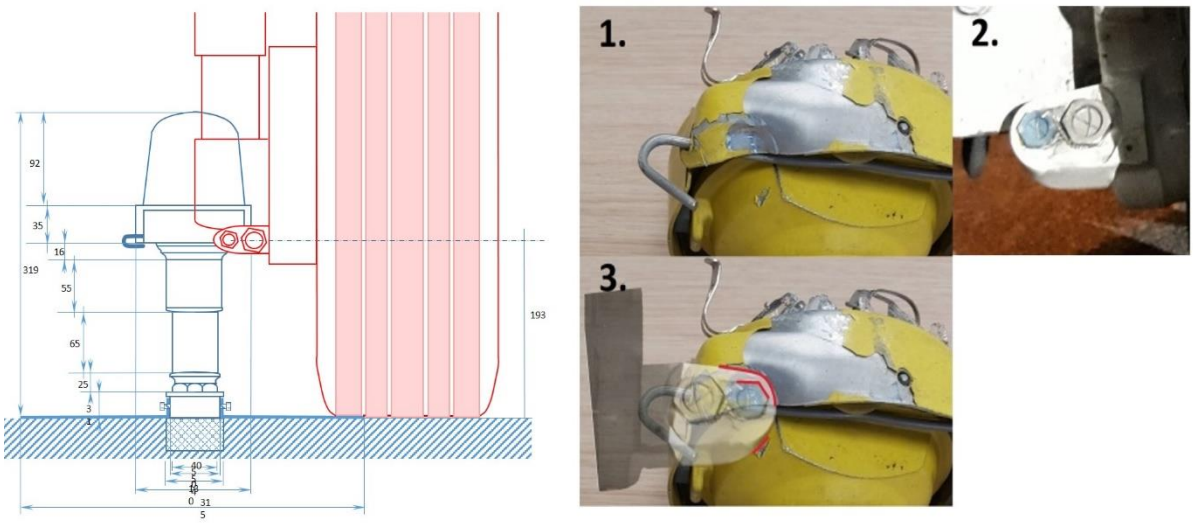


Figure 15. Correspondence of damage on the left main oleo strut and HIEL No. 2.
***Left side:** identical heights of the left gear's oil filler plug and the damage on the light.*
***Right side: 1.** Damage on the fixture; **2.** Strut protrusion with the filler plug; **3.** Overlay of 1. and 2. – imprint characteristics of the oleo strut parts left on the fixture highlighted in red.*
(Image enlarged in Appendix 1.)

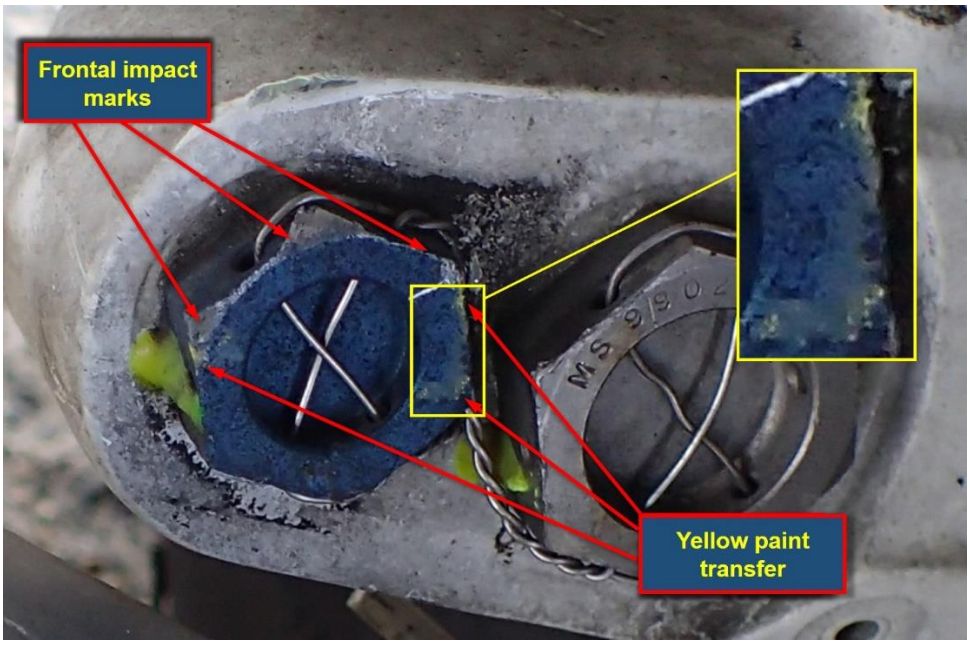


Figure 16. Frontal impact marks on the oil filling plug and paint transfer from the light fixture. (Image enlarged in Appendix 1.)

Yellow paint transfer from the edge light was also located on the impacted face of the oil filling plug *(Figure 16)*.

The tire track across base plate No. 4 was a precise match for HA-YFJ's nose gear, and for this single gear only, of every aircraft entering the runway during the scrutinized period. The rubber scuff mark left on the light fixture's side skirt when it was knocked down also matched the height and flanged design of this nose wheel *(Figure 17)*.

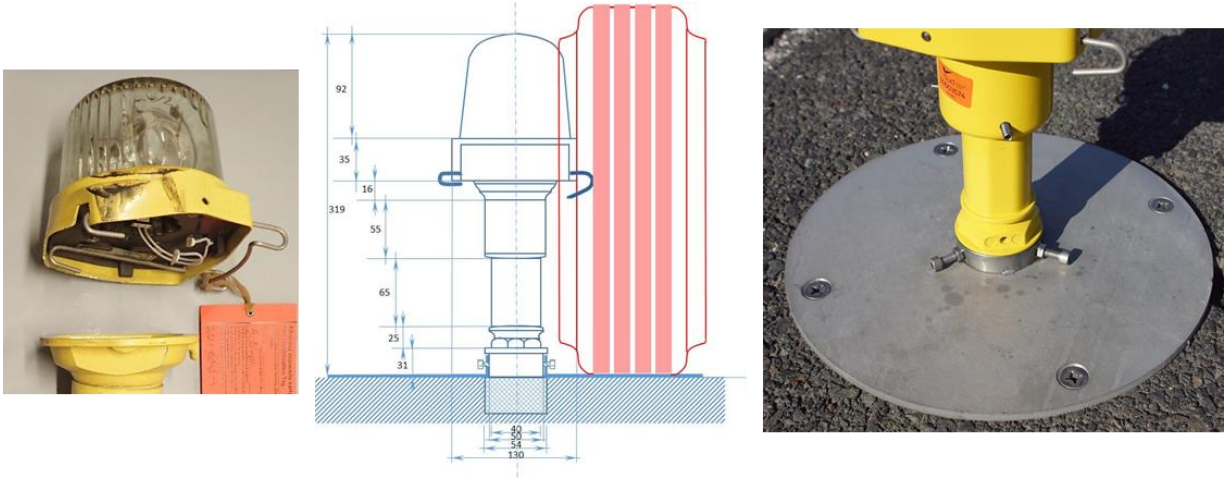


Figure 17. HA-YFJ nose wheel and tread marks found on HIEL No. 4. (The right side image shows the tire track across the base plate and a fixture that has been restored following the incident. Image enlarged in Appendix 1.)

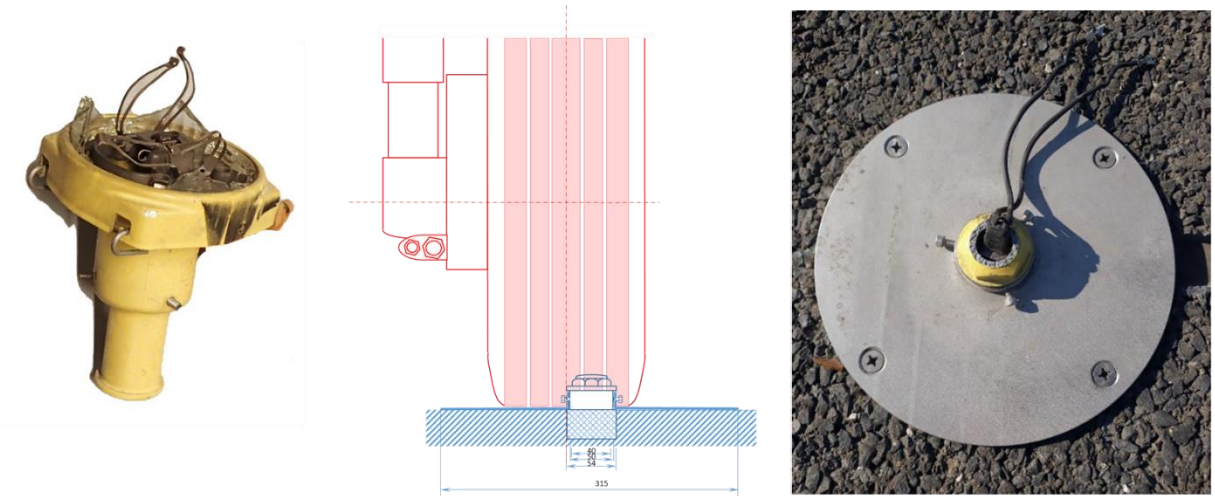


Figure 18. Tread marks on the HIEL No. 1 base plate matching HA-YFJ's left main gear tire. (Image enlarged in Appendix 1.)

1.16.2 Event Reconstruction

In order to gain an authentic understanding of what the pilots of HA-YFJ could have seen during their taxiing, the same exact taxi path reconstructed from A-SMGCS data was replicated a few days later under similar visibility and weather conditions, tracking the same taxi path at its recorded speeds. The event was documented using a camera positioned at the pilots' eye level.

The key insights from the event reconstruction are as follows.

Visual Perception

- The active runway lighting system set up for 31 configuration, which it was at the time of the occurrence, the centerline lights on Runway 13R/313L only illuminate the southeast and are not visible from the opposite direction, i.e. for aircrew taxiing southeast on the runway.
- The centerline lights do not cast light onto the runway surface, so they are not visible from the opposite direction.
- Unless a left-seat pilot consciously and deliberately looks back outside to the left when entering the runway at B1 for backtrack, the crew will never see the centerline lights throughout the backtrack, until after lined up for takeoff from 31L.
- The low-laying domes of the centerline light fixtures are not visible from the runway edge after dark.
- In contrast to the symmetric geometry of turnoffs branching out of Taxiway B2 in a single point, taxi lines branching out of Taxiway B1 towards NE and SW separate consecutively, with each turnoff initially starting to the left *(Figure 19).*

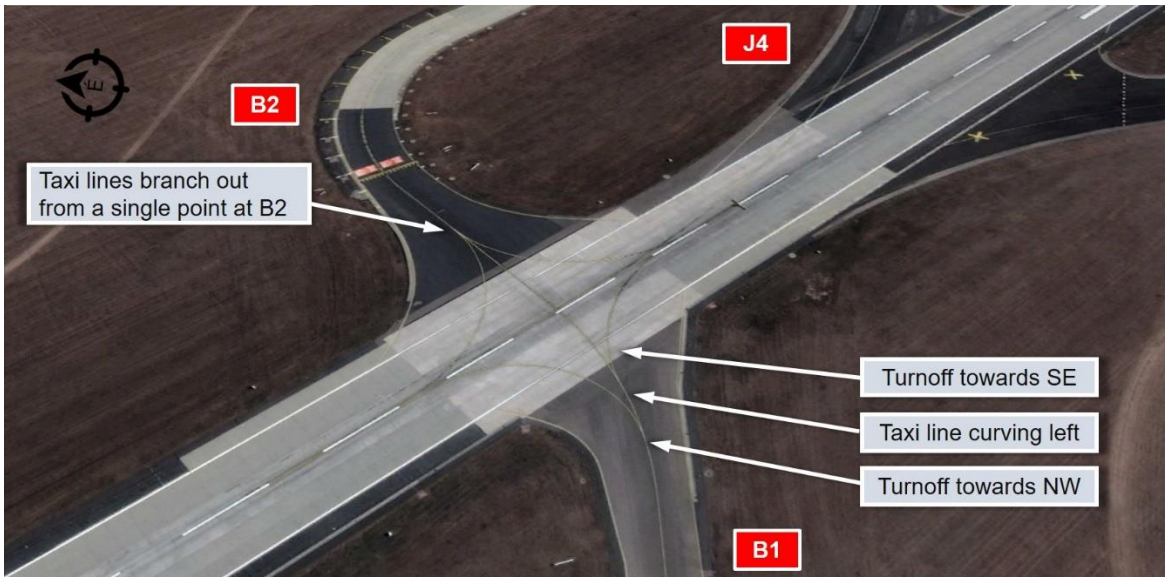


Figure 19*. Aerial view of intersections B1, B2 and J4. (Source: Google Earth)*

- Of the three diverging taxi lines after B1, only the middle one, leading across the runway to B2, is illuminated, and it begins with a wide left turn. The taxi line branching off to the right towards threshold 31L can only be glimpsed after initially following the lights turning left *(Figure 20)*.

Figure 20. Taxi line turnoffs from Taxiway B1 towards NW and SE, all starting to the left. (Source: TSB Taxi Reconstruction. Image enlarged in Appendix 1.)

- If pilots headed for threshold 31L ignore the left turning yellow line beyond holding point B1 and continue straight or turn right at once in the intended direction, departing from the line, they will have a relatively large, poorly lit area with no surface markings ahead to navigate through. Upon exiting this dark zone beyond J4, the left-side edge lights become visible, coinciding with the intended taxi direction.
- The path of a right turn started immediately after holding point B1 departs from the yellow line to intersect it again at the runway centerline, but with a significant angular difference *(Figure 3).*
- The alternating yellow and green lights of Rapid Exit Taxiway J4 provide guidance for aircraft vacating the runway, leading them from the runway centerline to the centerline of Taxiway J4. From a pilot's perspective while taxiing along the runway heading southeast, this yellow and green line of lights can only be on the left side of the runway and cannot be located right of the runway centerline.
- From a relatively low-built cockpit, such as HA-YFJ's, the edge lights or centerline lights only appear aligned when viewed from a relatively slight lateral angle (e.g., when the crew

closely follows or does not deviate significantly from the centerline). However, from a lateral angle of more than about 30 degrees (e.g. when a pilot departs from the centerline), the linear characteristics of the lights break down and the lights become a cluster of separate, individual points of light.

- With regard to this particular event it was observed that while the linear alignment of the HIELs during taxi is clear from a two-meter high cockpit, the edge lights 45 meters away on the other side of the runway appear as fragmented points of light, blending into the nighttime environment.
- In nighttime conditions it might escape the observer's notice that, in contrast to in-pavement centerline lights that are almost flush with the runway surface, runway edge lights are elevated 27 cm above the runway surface.
- The 7.5-meter-wide asphalt shoulder outside the runway edge line is of a darker color compared to the concrete load bearing runway surface. However, this difference is not as conspicuous in the dark though as it is in daylight conditions *(Figure 21)*.
- The concentrated, narrower beam of a business-size aircraft's taxi lights may not illuminate the entire width of the asphalt shoulder to reveal its actual size.
- The color of the last 10 edge lights installed along the last 540 meters of the runway between Intersection J4 and the 31L threshold changes from warm white to yellow, which may not appear obviously different in dark conditions.
- Six pairs of sizable white bars (Touchdown Zone Markers) are painted on the runway surface from Intersection J4 to the threshold. One pair, the TD aiming point, is even larger than the rest of the TDZ markers. These runway markings are clearly visible from the runway edge with taxi lights, even under nighttime conditions.

1.17 Organizational and Management Information

The company operating the aircraft, referred to as Training Organization or ATO, is an approved pilot training organization and also engages in commercial business activities. At the time of the incident, the ATO was legally authorized to conduct type rating trainings for Beechjet 400. However, their *Approved Training Organization Certificate, Training Course Approval* document, sanctioned by the supervisory authority, did not list any flight simulation training devices for the Beechjet 400 type courses. Thus, this document did not provide legal grounds for the Training Organization to use a flight simulation training device in their Beechjet 400 type rating courses.

According to its Flight Manual, HA-YFJ can only be operated as a multi-pilot aircraft *(1.6.1)*. FCL.010 defines multi-pilot aircraft as "*aeroplanes certificated for operation with a minimum crew of at least two pilots"*. FCL.700 M5 (a) and the ATO's approved Beechjet 400 Type Training Manual stipulate that holders of a pilot license shall not act in any capacity as pilots of an aircraft unless they have a valid and appropriate class or type rating, with the exception of cases including undergoing skill tests, or proficiency checks for renewal of class or type ratings; when receiving flight instruction; and when they hold a flight test rating issued in accordance with FCL.820. In all other cases, a type rating is required to operate the aircraft.

ORA.ATO.135 mandates that simulators and aircraft used for training must be *fitted with primary flight controls that are instantly accessible by both the student and the instructor*. During the incident flight, CM1 was seated on the left and CM2 on the right, both having access to their respective primary flight controls. According to all three pilots' pilot log entries, PAX1, a TRI-rated pilot, was acting as a flight instructor but was seated outside the two-seat cockpit in the passenger compartment, separated from the cockpit by a partition bulkhead. Although his seat could be rotated 90 degrees inboard, he had no access to the primary flight controls and limited visual access through the cockpit entrance to the flight instruments and the activity of CM1, a non-type-rated student pilot under instruction.

Preamble Part 7 of the ATO's Training Program requires type trainings to include a minimum of 10 hours of flight training under normal conditions and no less than 10 hours of training for engine failure and asymmetric flight practice. The ATO's Training Manual for Beechjet 400 type training, approved by the supervisory authority, lists 12 hours of mandatory flight training, 4 hours of simulator training, and an additional 2 hours of check flight before the final release check. Simulator sessions are listed as 'Task 6'.

According to CM1's training log, seven flights (Tasks 1 through 8, except for Task 6) out of the nine required for type training were completed by the time of the incident. Task 8 was logged on March 1, 2021, with the remark "*Released for exam*". The occurrence flight was performed subsequently, marked in CM1's training log as an unspecified "Additional Task" of 1 hour 35 minutes, without any explanation concerning the necessity or grounds for this assignment. Four hours of the still-uncompleted simulator sessions ("Task 6") were logged the following day. The simulator used for this purpose, certified by the supervisory authority as HU.FSTD.0018, was an FNPT II MCC "Large Generic Jet" simulator device, which, according to its type certificate dated May 17, 2019, was not approved for type rating training.

Since a modification of relevant regulations in December 2019, type-specific UPRT trainings must be included in type ratings. The ATO's Training Folder version *Rev. 01*, issued and approved for use on 19 December, 2019, had been amended with the required type-specific UPRT training. However, CM1's type rating training was recorded in the old, outdated format without the type-specific UPRT training.

Supervising compliance with relevant regulations regarding completed type rating training documentation submitted to CAA is the responsibility of the type rating examiner. The CAA had no way of detecting this compliance deficiency and issued CM1's type rating certifications based on the examiner's report, which marked the training documentation as complete and compliant. As a result, CM1's license was issued without fulfilling UPRT requirements.

Flight times of the occurrence flight were logged by three pilots: CM2 in the right seat as "PIC" (without instructor rating); CM1 in the left seat as "DUAL"; and TRI-rated PAX1 in a passenger seat also as "PIC". This practice is not compliant with regulations cited in section *1.5*. Logged take-offs and landings in each pilots' flight log also shows significant overlaps. The IC found a marked tendency for such time building reflected by a number of similar administrative discrepancies in other probed records and training documentation of the Training Organization.

Despite obvious evidence uncovered during the investigation, the ATO did not change its position, denying any involvement of HA-YFJ and its crew in the occurrence. Consequently, they refused to conduct the legally required risk assessment and the mandatory internal investigation as defined by the 376/2014/EU regulation.

Following the incident, the supervisory authority suspended the Training Organization's authorization for Beechjet 400 series type training. Concerning the necessity to review the validity of type ratings issued without meeting the required standards, the supervisory authority decided that in light of the COVID-19 pandemic, the simulator mandatory exercises were to be considered completed by the actual flight hours performed since released for line flying by the affected crews. The supervisory authority determined that this decision provided compliance with the provisions of Regulation (EU) No 1178/2011, ARA.GEN.355 Findings and corrective actions, paragraphs (a) and (b),

The ATO's compliance monitoring manager appointed according to ORA.GEN.210, is responsible for ensuring regulatory compliance through audits and internal investigations.

1.18 Additional Information

1.18.1 Similar Cases, ATSB Study and AAIB Safety Recommendation

Mistaking the runway edge lights for the centerline lights is not uncommon for aircraft entering the runway. Below are some examples, without aiming for completeness, where this error led to incidents or accidents.

- 5 March, 2002, Dresden, ATR-72: In the dark, the PIC mistook the left edge lights of Runway 22 for the centerline lights. The first officer did not trap the error either.
- 20 January, 2006, Glasgow Prestwick, ATR-42: The PIC started a night takeoff rolling on the left runway edge lights.
- 23 October, 2010, Oslo-Gardermoen, EMB-190: The crew commenced takeoff from the left edge lights of runway 01L, mistaking them for the centerline. Contributing factors included night conditions; peculiar characteristics of the taxiways, the runway and the runway edge; as well as CRM and radio communication deficiencies.
- 30 January, 2012, Abu Dhabi, Airbus A330: In poor visibility, the pilots mistook the left edge lights of the runway for the centerline. They aborted the takeoff, prompted by the thumping noise of the aircraft striking edge light fixtures at high speed.
- 24 November, 2014, Biggin Hill, Gulfstream III: The crew began taking off from the runway edge lights, thinking it was the runway centerline. The nose gear collapsed and the fuselage sustained significant damage.
- 25 February, 2016, Karup, ATR-72: In hazy conditions after dark in limited visibility, the crew commenced takeoff from the right edge lights of Runway 27L.
- 18 January, 2016, Amsterdam, EMB-120ER: The crew took off from the edge lights in the dark.
- 27 April, 2020, Cologne-Bonn, ATR-72: After backtracking on the runway at night, the PIC lined up for takeoff on the left side edge lights of Runway 06. Neither crew member noticed the error, and they started their takeoff roll along the runway edge.

According to a 2009 analysis by the Australian Transport Safety Bureau (ATSB), mistaking the runway edge lights for the centerline during nighttime takeoffs becomes a significant risk factor if any of the following conditions are present:

- Nighttime operations
- Ambiguous or complex runway markings and lighting elements
- Large areas outside the edge line (turning bay or wider runway shoulder)
- Absence of centerline lights
- Discontinuous runway edge lights (e.g., at taxiway intersections)
- Distractions in the cockpit or pilot attention lapses
- Reduced visibility
- Displaced threshold or intersection takeoff
- ATC clearances issued during taxi or on runway entry
- Pilot fatigue or exhaustion

Due to the unreasonably high number of occurrences of this nature, the UK Air Accidents Investigation Branch (AAIB) issued a safety recommendation on 3 December, 2015[3]. AAIB proposed that the International Civil Aviation Organization initiate the process to develop within

[3] GB-SIA-2015-0038

Annex 14 Volume 1, '*Aerodrome Design and Operations*', a standard for runway edge lights that would allow pilots to identify them specifically, without reference to other lights or other airfield features. This would enable aircrews to distinguish edge lights from centerline lights without external reference, based solely on their distinctive light characteristics. The AAIB noted that in the cases studied, pilots mistook the well-visible edge lights for the centerline because edge lights viewed along their axis do not have distinctive features to differentiate them from centerline lights. The main difference lies in their spacing, which is noticeable only when compared with other lighting elements also simultaneously visible for the crew. If the visual cues are incomplete or misinterpreted, pilots' situational awareness can be compromised, leading to the misidentification of edge lights as centerline lights. This error could be avoided if edge lights were distinguishable beyond doubt from all other runway lighting elements in their nature and light emission, without pilots needing to interpret their spatial arrangement and spacing. Modern lighting technology offers significantly broader and more advanced solutions than those available when ICAO's guidelines were established.

In response to the recommendation ICAO stated that Safety Recommendation 2015-038 would be referred to the Aerodrome Design and Operations Panel (ADOP) within ICAO for further study. In reviewing the recommendation, the ADOP, including its various specialized working groups, would take into account possible contributing factors such as additional pavement width at the beginning of the runway and the need for appropriate fog dispersal at aerodromes. A final resolution in this petition is still pending.

1.19 Useful or Effective Investigation Techniques

The investigation did not require techniques differing from the conventional approach.

2. Analysis

2.1 Flight Operation Aspects

2.1.1 Factors Affecting Nighttime Operation

In their 2009 analysis cited in section *1.18.1*, the Australian Transport Safety Bureau (ATSB) identified ten distinctive factors that increase the risk of even experienced crews mistaking the runway edge lights for the centerline lights if as few as one of these factors is present. The more of these factors are involved, the higher the risk of oversight on each taxi event.

In the current incident six of these factors were identified as contributing to the oversight.

- *Nighttime operations*
- *Ambiguous or distracting runway light elements* – a single and conspicuous row of lights leading out of a poorly lit area, concurring with the direction of the intended taxi
- *Large paved areas outside the edge line* – a 7.5 m wide runway shoulder of similar color
- *Absence of centerline lights* – neither centerline lights, nor light fixture domes were visible from the taxi direction
- *Discontinuous runway edge lights* – at the contiguous intersection of taxiways B2 and J4, there is an unusually long hiatus of runway edge lights
- *Distractions in the cockpit or pilot attention lapses* – evidenced by the crew's inadvertence in identifying the error of mistaking the continuous double edge line for the dashed centerline throughout the entire duration of taxiing; aggravated by poorly defined and overlapping roles in the cockpit (detailed in sections *2.1.3* and *3.2*)

Beyond the ATSB's general factors, additional elements specific to this incident and influential to safe operation have been identified.

- Although both pilots were experienced at LHBP airport, their situational awareness may have been influenced by their prior experience on larger aircraft with higher cockpits providing better view. From an A320 or a B737 cockpit, runway edge lights look different and may be easier to identify compared to HA-YFJ (Beechjet 400), in which they both had limited experience.
- Additionally, medium-range passenger airliner pilots operating at LHBP would practically never need to backtrack from holding point B1 for a RWY 31L takeoff. This backtrack procedure is characteristic of light traffic operating from Apron 1, which typically includes business jets, other private aircraft and occasionally cargo jets.

2.1.2 Situational Awareness in Intersection B1-B2-J4

The B1-B2-J4 intersection is a relatively large, poorly lit area with an extended runway edge segment without edge lights at the contiguous intersection of B2 and J4 taxiways on one side and the slant intersection of taxiway B1 on the other. As the crew traversed this area turning southeast onto the runway, they very likely expected to see centerline lights. However, the first continuous line of lights they saw in front of them, pointing in their intended direction was the runway edge lights.

In fact, regular runway edge lights at most airports are the same color as the centerline lights, with a marked difference manifested in their spacing. The edge lights are spaced 60 meters apart, whereas the centerline lights are spaced at either 15 or 30 meters – in this case, at 15 meters, the centerline lights were installed four times denser than the runway edge lights.

Another feature on Runway 13R/31L is the runway edge lights changing from warm white to yellow along the last 540 meters (last 10 lights) to the runway threshold. While the difference in hue is clearly present, it may still slip the attention of a pilot focused elsewhere during taxi *(Figure 21)*.

The 22-centimeter shafts the runway edge lights are mounted on may also blend in the night environment, masking the difference between runway edge lights and centerline lights.

The information about centerline light characteristics were misleading in the then-current AIP, defining these lights on Runway 13R/31L as "*bidirectional*", while in fact these centerline lights only work in one direction at a time, according to the runway direction in use. Since airport charts are based on the AIP, these charts also displayed 13R/13L centerline lights as "*bidirectional*", without reference to their sequential operation.

Whether or not backtracking crew, especially in a low-built cockpit, is aware of this feature may decisively influence their consideration of inadvertently searching for centerline lights when none are available.

It should be noted that from the left runway edge the opposite side edge lights appear as single lights, and only start visually forming a line at a considerable distance up ahead.

Figure 21. Nighttime visual difference in the color of the concrete runway surface and the asphalt. (Source: TSB Taxi Reconstruction)

The surface of the concrete runway is of a lighter shade than the asphalt shoulder, which is quite visible in daylight conditions, but it is not as noticeable after dark.

In consequence of the details in section *1.16.2 Event Reconstruction* and the analysis by the ATSB, the IC expresses support concerning the safety recommendation set forth by the UK Aircraft Accident Investigation Branch (AAIB), which suggests a physical distinction of runway edge lights to enhance pilots' situational awareness on the runway.

In light of the above the IC decided to propose a safety recommendation and initiated consultative meetings with the representatives of Budapest Airport Zrt. and HungaroControl *(4.1)*.

2.1.3 Crew Situational Awareness during the Incident

Maintaining a high level of situational awareness during ground movements is essential in aviation, particularly in commercial aviation, to prevent misidentification of the centerline. The solid double runway edge marking is fundamentally different in character from the dashed centerline. Additionally, the different colors of the shoulder pavement and the runway surface at the incident location serve as visual cues to enhance situational awareness. Missing these indicators suggests insufficient or divided attention on the part of the operating crew.

When the crew's attention during taxiing declines and their focus waivers, they are generally more prone to instinctively align with the lights ahead and follow along, driven by ingrained

habits and everyday routine. This phenomenon, known as “confirmation bias”, might have been further influenced by the pilots’ prior experience in larger aircraft with significantly higher flight decks that offer very different outside view during taxiing.

Upon entering the runway at B1 and making a right turn towards the 31L threshold, the crew deviated from the left-turning yellow taxi line. Although strict adherence to these taxi line markings on the runway is optional, deviating from the solid yellow line means forfeiting a layer of safety provided by direct visual reference to the taxi line. While not inherently unsafe in this case, the new and more complex situation the crew now faced called for acute situational awareness, which they did not have at that moment. Instead, the pilots were navigating a rather complex intersection at night at their own terms, continuing without a taxi line to follow, and without clearly understanding the context of the various lights surrounding them. Prompt and accurate interpretation of these lights in pace with the progress of taxiing requires focused attention, which proved overwhelming for the crew in their state of reduced awareness.

The crew’s compromised awareness while taxiing with their guard down is evidenced by the large number of visual cues they missed all the way to the threshold, never realizing they were tracking the edge lights rather than the centerline. The first of these clues for the crew was their convergence with the same yellow taxi line they had left behind a short while ago, upon turning right after entering the runway. Next, they missed to recognize that together with crossing this yellow line they also crossed the dashed white centerline and the alternating green and amber rapid exit taxiway lights too. Then they did not acknowledge that this RETIL, providing guidance from the runway centerline to Taxiway J4, belonged to the farther side of the runway, across the centerline. Comprehending the significance of this relation could have alerted them to the fact that having already crossed the runway centerline, they were proceeding towards the further edge of the runway. The next clue they missed was at J4, where they crossed this RETIL for the second time, which meant they were now tracking the edge lights along the northeastern side of Runway 13R/31L.

Before reaching the threshold along the runway edge, the crew missed several more signs, which is indicative of their disorientation. They took no notice of the solid nature of the double edge line they were tracking (in contrast to the dashed centerline), and did not detect the differing surfaces on either side of it. They also missed the large TDZ markings appearing on their right (and right only) as they passed them and apparently did not observe the color of the last ten edge lights changing from warm white to yellow.

Kinetic Perception

- The physical impact of a tire knocking down an edge light at taxi speed was too small for the crew to notice, due to the low-energy yield resistance of each edge light’s frangible coupling against the moving aircraft’s momentum.
- After HIEL No. 1 was hit by the left main gear, its tire rolled over the pointed, 43-mm stump that remained attached to the base plate *(Figure 18)*. The relatively small area of the stump digging into the tire and the tire’s flexible deformation, potentially assisted by the left oleo, was likely enough to effectively compensate for the bump as the tire rolled over the stump. Similarly, rolling over the shards from the shattered glass dome – though leaving cut marks on the tread later discovered – went undetected by the crew for the same reasons.
- When the left main gear strut hit HIEL No. 2, the deformation of its aluminum skirt softened the blow, so the impact did not even break the frangible coupling. The light fixture’s stem cracked at its base as it was wrenched out of the base plate’s mounting ring *(Figure 5).* Any conceivable impact noise was very likely drowned out by the engines.
- HIEL No. 4 was knocked down by the rubber flange of the nose gear tire *(Figure 17)*, also without a noticeable change in momentum.

In summary, the energy and impact intensity of the breakages were too insignificant to bring about a noticeable change in the aircraft’s momentum, and remained below the occupants’ perception threshold. The impact noise of each fixture being hit was also negligible amid the

airport's ambient noise and the aircraft's engines, making the collisions practically undetectable from inside the taxiing aircraft.

2.1.4 Compliance Issues Regarding Crew Training and the Incident Flight

The Training Organization's approved training syllabus included the legally required type-specific Upset Prevention and Recovery Training (UPRT). However, CM1's type rating training was based on an outdated program, which did not include UPRT training, as reflected in CM1's training folder. His type rating application was submitted to the CAA and his license eventually issued without completing the mandatory type-specific UPRT training required by law.

Testimonies from the crew and training documentation indicate that the flight in question was labelled an "*Additional Flight Requirement*" conducted within CM1's type rating training. However, no training record entry was made to authorize the assignment or to warrant the necessity of this additional exercise.

The incident flight was performed with CM1, a non-type-rated pilot, in the left seat, assisted by CM2 on the right, who was not a type rating instructor or examiner. Since CM1 had not completed his type rating training, he was not legally entitled to fly this aircraft without a type rating instructor in the other seat. Additionally, CM2, holding captain and first officer authorization from the operating company, was not legal to conduct flights with a non-type-rated pilot.

The pilot with type instructor qualifications (PAX1) was seated in the passenger compartment, separated from the flight deck by a partition bulkhead. From a passenger seat, PAX1 had no access to the primary flight controls, he could not intervene when necessary, and had very limited view over the instruments through the cockpit door. His supervisory role from the cabin was contrary to reason and did not comply with legal pilot training requirements.

As PAX1 suggested in his interview, he did not feel he had much to teach to CM1, as the latter had more extensive experience in aviation and significantly more flight hours. This lenient approach suggested that PAX1 did not maintain a professional oversight of the training aspects of the flight, potentially resulting in a lax atmosphere on the flight deck during operation.

Concerning the entry made in CM1's training log on the morning of the incident "*Released for exam*", the IC found no answers to explain how CM1 could be checked out for a type rating examination flight with a pending simulator session *(Task No. 6)* yet to be done and an unspecified "*Additional Flight Requirement*" scheduled for 1 March for him.

The training folder submitted to the type rating examiner for CM1's final check, along with CM1's and PAX1's flight logs indicate that the two of them performed the training flights, included the incident flight, without mentioning CM2, who actually flew as commander. This untruthful paperwork about the flights and fulfilled requirements was misleading for both the type rating examiner and the CAA, who eventually issued a valid type rating based on this information.

Three pilots logging flight times for flights conducted in a two-pilot aircraft, with two of them as PIC, is not compliant with current international and state regulations.

Oblique and incoherent interpretation of duties and responsibilities on the flight deck, such as in the incident flight, can lead to decision-making conflicts, as the acting "captain" in the cockpit might feel subordinate to the instructor, who, seated in the passenger cabin, is not in a valid decision-making position. This "shared" responsibility setup can negatively impact focus and delay or impede efficient decision-making, resulting suboptimal decisions.

2.2 Airport Operation Issues

2.2.1 The Impact of the Documented but Unperformed Runway Inspection

The Airport Operator's Internal Investigation Report revealed that during the early morning runway inspection logged as "*Morning Check 1, performed from 05:12 to 05:20"*, the DAM did not request the runway lights to be turned on for inspection. During this check the DAM drove along the runway, but in the dark overlooked the broken light fixtures scattered on the runway near the edge line. The next scheduled runway surface inspection and light check *("Morning Check 2")* planned for 07:50 to 08:20, was completely omitted, although it was logged and reported as performed. These deviations from the Operator's Inspection Directives resulted in the runway's prolonged FOD contamination, lasting for a total of 13 hours and 53 minutes. Furthermore, the inaccurate and misleading information about the runway inspections in the Airport Operator's initial report to the TSB delayed the identification of the aircraft causing the damage, and also disadvantaged the initially – wrongfully – investigated airline.

3. Conclusions

3.1 Findings

3.1.1 Aircraft

The aircraft was airworthy *(1.6.2)*.

It had a valid airworthiness certificate *(1.6.2)*.

No material damage occurred to the aircraft due to the incident *(1.3)*.

The aircraft was equipped and maintained according to current regulations and approved procedures *(1.6.2)*.

No faults relating to the airframe, flight controls or systems were identified before the incident in direct relation to the event *(1.6.5)*.

The aircraft was equipped with devices listed in the type certification, and no issues were found or reported regarding their operation (*1.6.6*).

3.1.2 Flight Crew

None of the flight crew members possessed the required licenses and/or qualifications to legally operate in their respective positions during the occurrence flight *(1.1; 1.5; 2.1.4)*.

3.1.3 Flight Operation

The flight was not conducted in compliance with the prevailing regulations: the aircraft should have been operated either by two type rated pilots, or in this case, the non-type-rated student pilot should have been supervised by a type rating instructor or examiner seated in the other seat a *(1.1; 1.6.1; 1.17; 1.5; 2.1.4)*.

The aircraft's weight and balance were within prescribed limits *(1.6.4)*.

Fuel on board was not related to the occurrence *(1.6.4)*.

The flight took place under night conditions with good visibility *(1.7)*.

3.1.4 Training Organization

The ATO's Beechjet 400 type rating training program was approved with the use of a non-type-specific flight simulator, which did not align with the prevailing legal regulations. In addition, no approved flight simulation device was listed in the "*Approved Training Organization Certificate Course Approval*" suitable for the training *(1.17; 2.1.4)*.

For CM1's type rating program an outdated training folder was used from before UPRT training had been made mandatory for type rating trainings. Consequently, his type rating training was incomplete and his Beechjet 400 qualification was eventually issued for him without completing the mandated type-specific UPRT training *(1.17; 2.1.4)*.

Without UPRT training and a missing flight simulator session the "*Released for exam*" approval note in CM1's training log was erroneous as the type training was not yet complete *(1.17; 2.1.4)*.

HA-YFJ is certified as a multi-pilot aircraft, requiring an operating crew of either two type-rated pilots or a student pilot with a type rating instructor or examiner. The flight did not meet the regulatory flight training requirements, which mandate that both the student and instructor must have unobstructed access to the aircraft's primary flight controls. During the flight, the seat next to the pilot without type rating was occupied by a pilot without instructor qualification, thus failing to meet either condition *(1.6; 1.17; 2.1.4)*.

The Operator and ATO refused to conduct the required risk assessment analysis and organizational investigation *(1.17)*.

3.1.5 ATS and Airport Services

The runway inspection as part of airport operations at the time of the incident did not comply with regulations, resulting in debris (FOD) posing a hazard to traffic for 13 hours and 53 minutes *(1.10.1; 2.2.1).*

3.1.6 Data Recorders

The required ATS data recording systems were operational and provided usable data *(1.11)*.

The flight data recorder on the aircraft was operational, but the data recorded was not accurate enough to be useful for the investigation *(1.6.6; 1.11)*.

3.1.7 Flight Safety Assurance

The supervising authority did not comply with relevant regulations when it granted type rating authorization to the ATO without the appropriate flight simulator device. Furthermore, the supervising authority did not take corrective measures and revoke the ATO's type rating authorization during its ongoing supervision over the ATO's professional activities *(1.17)*.

The safety and compliance manager of the training organization did not perform adequately, as mandatory audits and internal investigations failed to uncover training deficiencies and flaws in operations, leading to the ATO's regulatory non-compliance *(1.17)*.

3.2 Determining the Causes

The TSB safety investigation concluded that the direct cause of the event was human error, causing the crew to mistake the runway edge lights for centerline lights while backtracking to the runway threshold. This error was attributed to a deviation from professional standards and the crew's lack of required focus during taxi. Due to reduced situational awareness, the crew let their expectations and preconceived mental model to prevail over the surrounding visual cues. This resulted in the misidentification of the runway edge lights and additionally prevented them from spotting and understanding the numerous clues indicating their incorrect position throughout the entire taxi to the runway threshold. During this time, the pilots did not consciously cross-check their actions or challenge their assumptions, and let these visual cues pass by without triggering a response in them to trap the error concerning their visual perception and actual position.

The pilots' initial misconception was likely influenced by their prior experience in larger aircraft with higher cockpits. They were probably accustomed to seeing centerline lights on runways similar in size to 13R/31L (as it is the case on LHBP's other runway, 13L/31R), and therefore likely expected a similar visual scenario. Such an engraved mental model might have led them to identify the continuous line of the runway edge lights beyond intersection J4 as the runway centerline. Contributing to this error was the fact that neither the AIP, nor their AIP-based airport charts did point out the absence of centerline lights, depicted as "bidirectional", in an opposite runway configuration.

The pilots' declined state of situational awareness was likely further influenced by the friendly nature of their interpersonal relationship and the confusion and anomalies regarding instructor roles and crew dynamics in the cockpit. Consequently, they not only made an initial mistake but also overlooked a significant number of clues that could have alerted them to the position error before reaching the runway threshold. The list of signs the crew missed to spot or did not correctly interpret comprises the following elements.

- The reappearance of the yellow taxi line the crew had departed from, and crossing it a second time.
- Reaching and crossing the dashed white centerline markings.
- Simultaneously crossing the alternating green-and-yellow line of the J4 RETIL, and then crossing it again at J4.
- The significance of the RETIL's location on the runway.
- The solid state of the white runway edge line the crew were following, as opposed to the dashed nature of the runway centerline marking they were supposed to track. They also missed to spot and interpret the second solid line appearing from J4, running parallel to the runway edge line, marking the load bearing surface limit all the way to A1 towards the 31L threshold.
- The different shades of gray on either side of the edge marking, characterizing the different surfaces of the shoulder and the runway.
- The color change from warm white to yellow of the last ten edge lights.
- The large white TDZ markings, clearly visible from the taxiing aircraft, passing by only on the right instead of both sides of the aircraft.

The unusually large number of overlooked cues (which, when acknowledged and properly interpreted, should have incited the pilots' action to revise their initial assumptions and realign their position) substantiates the crew's compromised SA during taxi.

3.2.1 Root Causes

The root cause of taxiing on the runway edge and knocking down the edge lights was identified as human error, where the crew's lapse in focus and attention attested during taxiing led to a compromised situational awareness, causing them to misidentify the edge lights as centerline lights while backtracking to threshold 31L.

3.2.2 Contributing Factors

The safety investigation identified the following contributing factors that influenced the runway centerline misidentification and why the crew never identified the error.

Factors influencing the misidentification:

- The AIP did not provide comprehensive information regarding the difference in the operation of the centerline lighting system of Runway 13R/31L compared to Runway 13L/31R; and marked both runway's centerline lights "bidirectional". Additionally, the AIP did not include a visual representation of the taxiway centerlines continuing as taxi lines crossing the runways, to help pilots understand in advance the complexities of the area around intersection J4 and prepare them for the initial left turn of the taxi line leading right from B2.
- Inadequate execution of flight training procedures (PAX1, acting as instructor, was seated in the passenger compartment).
- PAX1's lacking pre-flight briefing, without highlights regarding the expected difficulties during taxi, such as an unexpected initial turn of the yellow taxi line after B2, the visual differences out of a low-built cockpit and peculiarities of runway lights and markings at the J4 area).
- Undefined and overlapping responsibilities regarding pilot roles: two PIC's on board (CM2 and PAX1) will in all likelihood undermine flight deck synergy (CRM) and erode decision making efficiency.

- Relatively little experience of both pilots in this aircraft with a low-built cockpit and at this particular intersection at night. With the AIP deficiencies referred to earlier, familiarity with this runway's peculiarities, particularly in the B2-B1-J4 area is crucial for processing and properly interpreting the complex visual pattern at this intersection at night. Regretfully, the pilot with local knowledge and experience with this intersection was seated in the passenger compartment.
- The deterioration of the crew's situational awareness could be fostered by pilots' personal relationship and their relatively high flight experience, where none of them regarded each other as 'novice' or 'trainee'. Their high overall familiarity with the airport also likely reduced their attention during taxi.
- The crew's compromised situational awareness likely triggered an automatic response known as *confirmation bias*. Influenced by their prior experience, they inadvertently searched for centerline lights and took the first opportunity to find them in the runway edge lights.
- As inferred from their interviews, the pilots regarded this flight as a mere formality to conclude CM1's type rating, which probably contributed to letting their guard down during taxiing.
- The corporate culture observed at the operator and ATO, as detailed in section *2.1.4*, reflects a more lenient approach to regulations. This leniency directly contributed to none of the crew members being legally qualified for their assigned roles in the incident flight. Specifically, CM1, without a valid type rating, should only have flown with an instructor in the other seat; CM2, as PIC, should have refused to fly with a non-type-rated co-pilot; and PAX1 should have occupied a pilot seat to operate as an instructor).

Factors contributing to the crew not recognizing their oversight throughout the backtrack to threshold 31L:

- The centerline lights in their current northwesterly configuration were not visible to the crew taxiing southeast.
- Information about the above fact was not available in the AIP or taxi charts.
- The outer edge of the shoulder was outside the main beam of the aircraft's taxi lights.
- The different shades of grey between the shoulder and runway were perceptible but not obvious.
- With the frangible couplings' low yield force and the engine noise drowning out the tires impacting the lights at low speed made the impacts' physical perception from the cockpit practically undetectable.

4. Safety Recommendations

4.1 Actions Taken by the Operator/Authority during the Investigation

The Supervisory Authority's CAA Licensing Department initiated proceedings to investigate non-compliance issues related to the ATO's training activities. As a result, the ATO was found in breach of relevant legislative regulations and was fined for the exposed violations. The ATO's 'Beechjet 400 series' type rating trainings in progress were suspended, and its type rating training authorization was revoked until the referenced deficiencies would be rectified. However, the validity of the type ratings already issued without meeting the requirements was not revoked for reasons detailed in section *1.17 Organizational and Management Information*.

The airport operator, Budapest Airport Zrt. conducted an internal investigation related to the incident. Their findings led to an update of inspection activities in their operator's manual, issued by the BUD Air Traffic Organization. All affected personnel received specialized training on the updated procedures. Additionally, during the quarterly meetings addressing aviation safety issues between HungaroControl and the BUD Air Traffic Organization, the updated inspection instructions were included on the agenda and discussed with the participation of HungaroControl's senior tower controllers and BUD DAMs. Since then, Budapest Airport Zrt. has repeatedly reviewed the improved inspection system in operation and has not identified any related deficiencies since the incident. In conclusion of the observations made by service providers working for BUD Aviation Safety and Air Traffic Organization, Budapest Airport Zrt. determined that the missed inspection was an isolated incident.

Following the consultations between TSB and HungaroControl Zrt. regarding the planned safety recommendation, HungaroControl implemented the following measures.

- Issued an internal Safety Bulletin to inform tower service personnel about the unidirectional operation of the 13R/31L runway centerline lights.
- In cooperation with the airport operator, amended the AIP effective from 16 May, 2024, including a warning printed in bold on the airport layout chart about the centerline lights illuminating only in a single direction at a time, corresponding to the runway direction in use.
- Notified users (air personnel and aviation service entities) through a NOTAM entry maintained in effect until the AIP amendment became effective.

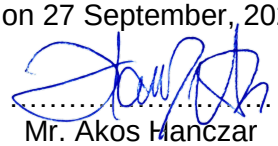
4.2 Interim Safety Recommendation(s)

Based on the safety hazards identified in course of the investigation, the Investigation Committee proposed a safety recommendation for HungaroControl to work out procedures to inform crews performing backtrack on LHBP runway 31L/13R that centerline lights are not visible to them during backtrack. Following a series of consultation sessions on the proposed safety recommendation, HungaroControl implemented the safety measures detailed in section *4.1.* The Investigation Committee believes that the implemented safety measures will achieve the intended goals, hence the originally proposed safety recommendation will not be issued.

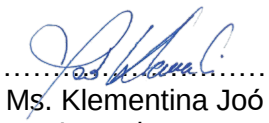
4.3 Concluding Safety Recommendation(s)

The Investigation Committee of TSB Hungary will not issue a new safety recommendation but concurs with the UK Air Accidents Investigation Branch (AAIB) 2015 safety recommendation (GB-SIA-2015-0038), which proposes a change in the design of the runway edge lights in order to distinguish them from centerline lights by physical characteristics.

Dated in Budapest, on 27 September, 2024.



Mr. Ákos Hanczár
Investigator-in-Charge



Ms. Klementina Joó
Investigator

APPENDICES

Appendix 1: Enlarged Images

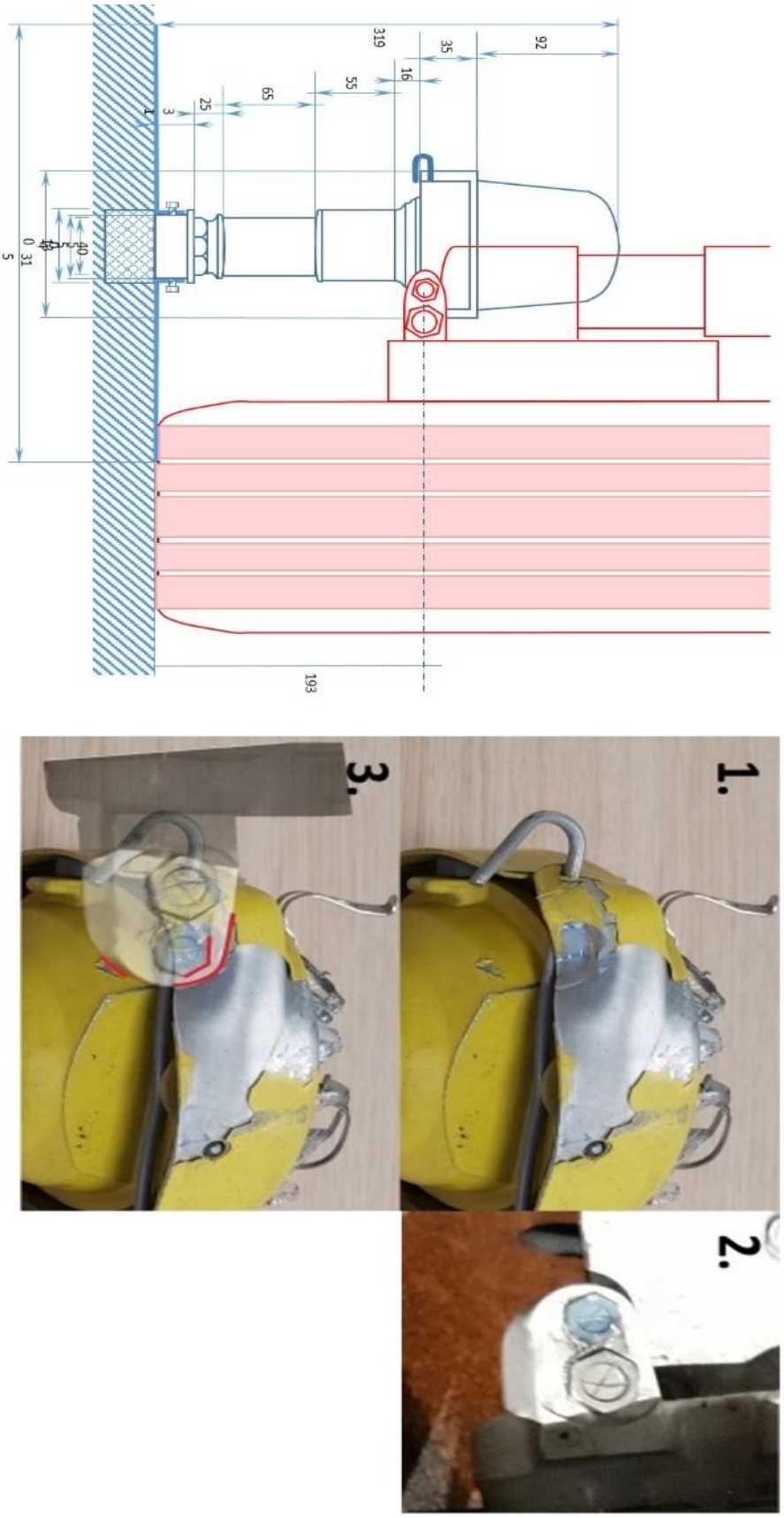


*Figure 15. Correspondence of damage on the left main oleo strut and HIEL No. 2. **Left side:** identical heights of the left gear's oil filler plug and the damage on the light. **Right side: 1.** Damage on the fixture; **2.** Strut protrusion with the filler plug; **3.** Overlay of 1. and 2. – imprint characteristics of the oleo strut parts left on the fixture highlighted in red.*

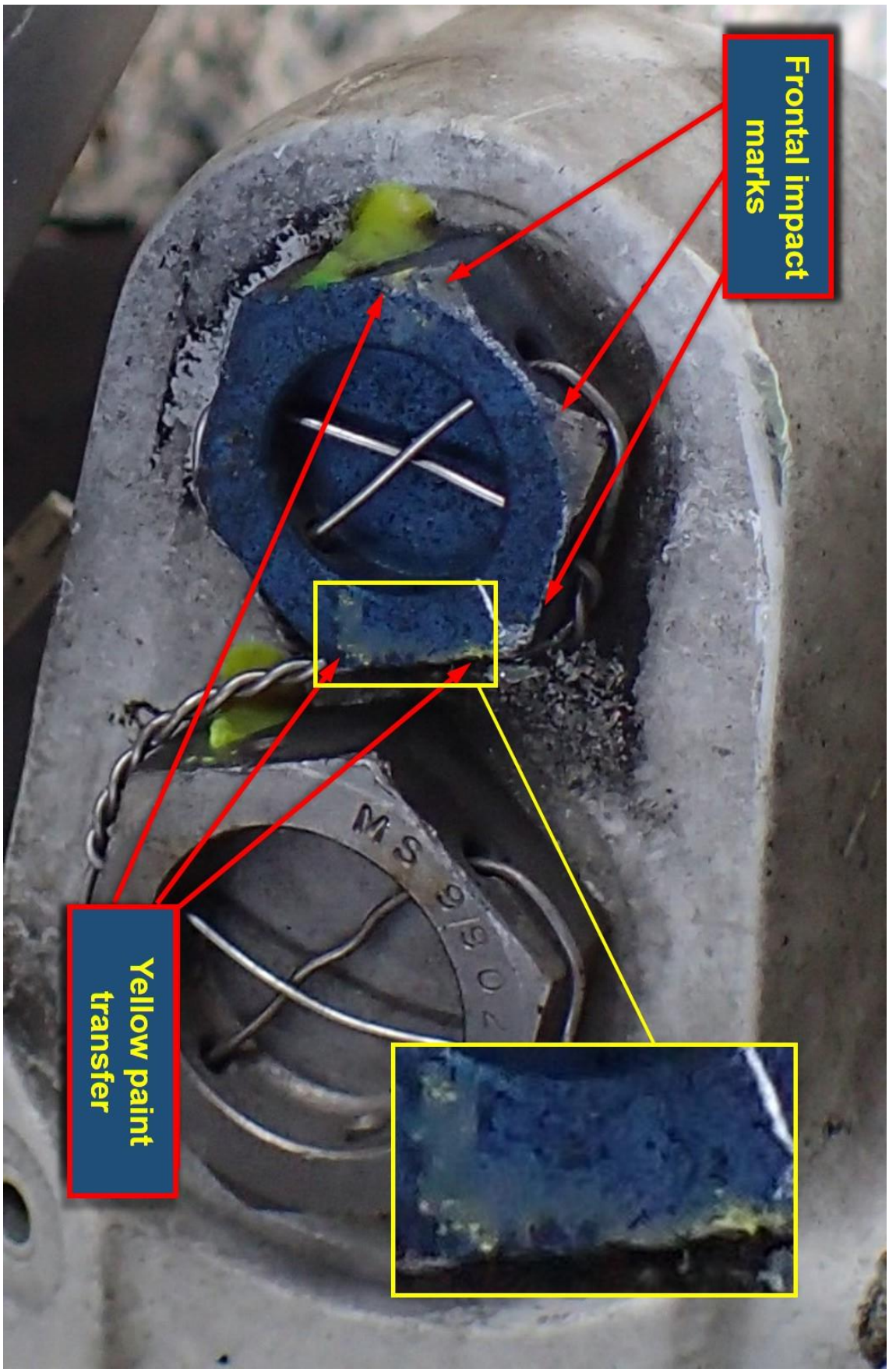


Figure 16. Frontal impact marks on the oil filling plug and paint transfer from the light fixture. (Image enlarged in Appendix 1.)

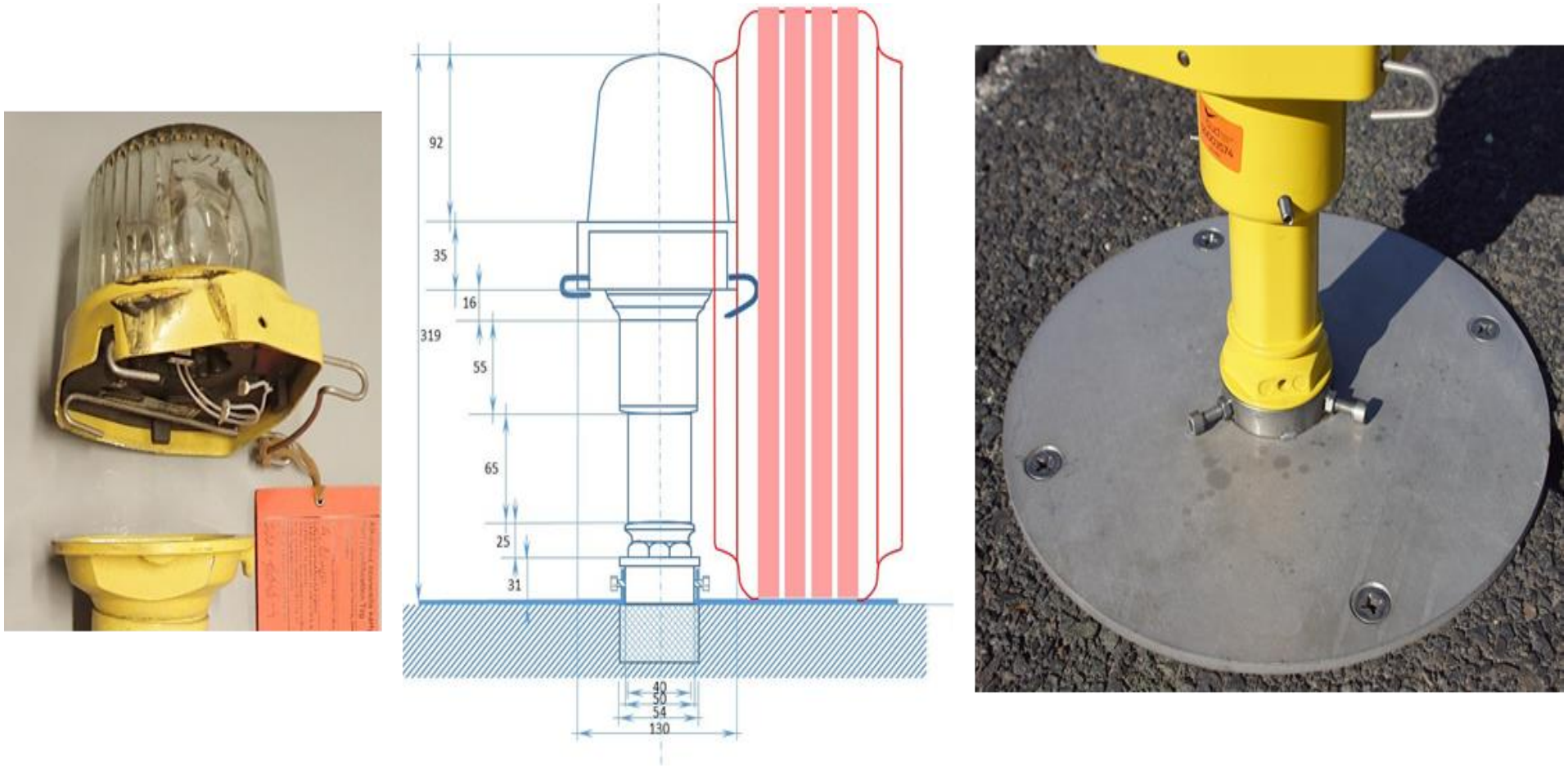


Figure 17. HA-YFJ nose wheel and tread marks found on HIEL No. 4.
(The right side image shows the tire track across the base plate and a fixture that has been restored following the incident)

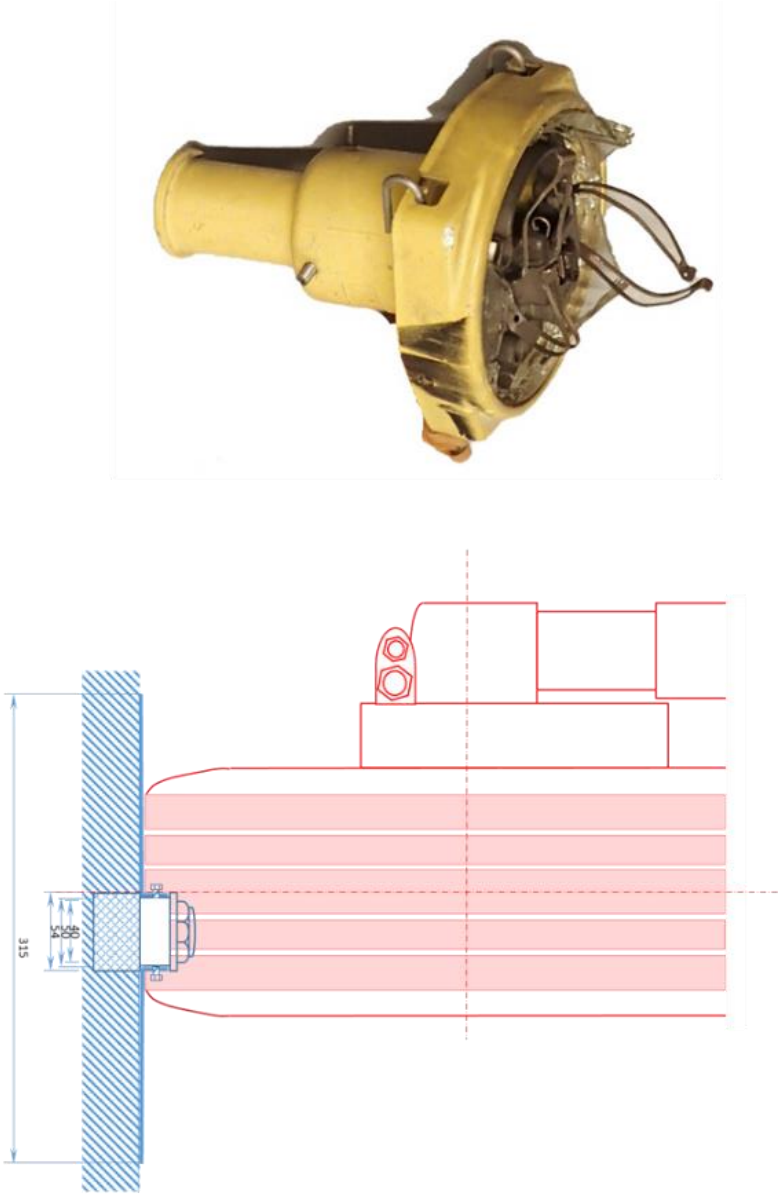


Figure 18. Tread marks on No. 1 fixture and base plate matching HA-YFJ's left main gear tire.

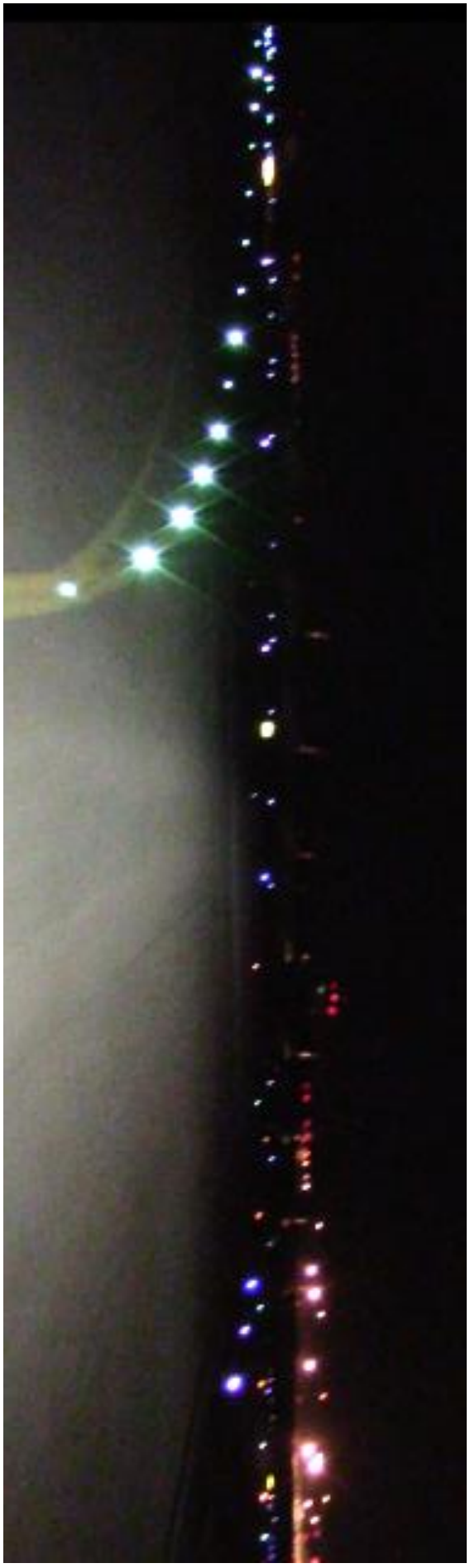


Figure 20. Taxi line turnoffs from Taxiway B1 towards NW and SE, all starting to the left (Source: TSB Taxi Reconstruction)