

# Bureau Enquêtes Accidents pour la Sécurité de l'Aéronautique d'État (State Aviation Safety Investigation Bureau - BEA-É) Safety Investigation Report



T-2023-22-I

|                  |   |
|------------------|---|
| Event date:      | 20 December 2023                            |
| Place:           | Saint-Jacques-de-la-Lande (Ille-et-Vilaine) |
| Type of aircraft | TBM 700                                     |
| Organization     | French army                                 |

## NOTICE

### USE OF THE REPORT

In accordance with article L.1621-3 of the French Transport Code ("*Code des Transports*"), the sole purpose of this safety report is to prevent accidents and serious incidents without apportioning blame or liability.

The identification of causes does not imply apportioning administrative, civil or criminal liability.

Therefore, any use of the full or partial report for purposes other than its aim of improving safety is contrary to the international commitments of the French Republic and to the spirit of the relevant laws and regulations and is the sole responsibility of its user.

### REPORT CONTENT

The first chapter of the report presents the facts relevant to understanding the event. The second chapter identifies and analyzes the causes of the event. The third chapter draws the conclusions of this analysis and presents the identified causes.

In the fourth and last chapter, the BEA-É makes its safety recommendations.

Except where otherwise indicated, the times in this report are in French standard time.

This is a courtesy translation by the BEA-É of the final report on the safety investigation. As accurate as the translation may be, the original text in French is the work of reference.

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## CREDITS

|                   |  |                        |
|-------------------|--|------------------------|
| Figures 1 and 2   | French army<br>SIA ( <i>Service de l'information aéronautique</i> ) -<br>Aeronautical Information Services | Cover page<br>7 and 10 |
| Figures 3 to 5    | BEA-É  | 11 and 12              |
| Figure 6          | <i>Google Earth</i> and BEA-É  | 13                     |
| Figure 7          | BEA-É  | 13                     |
| Figure 8          | Bouygues   | 15                     |
| Figure 9          | <i>Google Earth</i> and BEA-É  | 15                     |
| Figures 10 to 13  | BEA-É  | 17 and 19              |
| Figures 14 and 15 | RESEDA and <i>Google Earth</i>   | 19 and 20              |
| Figure 16         | <i>Google Earth</i> and BEA-É  | 21                     |
| Figures 17 and 18 | BEA-É  | 22 and 23              |

## CONTENTS

|  |    |
|--|----|
| GLOSSARY .....   | 4  |
| SUMMARY .....  | 5  |
| 1. FACTUAL INFORMATION .....   | 7  |
| 1.1. History of the flight .....                                       | 7  |
| 1.2. Injuries to persons.....  | 8  |
| 1.3. Damage to aircraft .....  | 8  |
| 1.4. Other damage .....  | 8  |
| 1.5. Personnel information .....                                       | 8  |
| 1.6. Aircraft information .....  | 9  |
| 1.7. Meteorological information.....                                   | 10 |
| 1.8. Aids to navigation.....   | 10 |
| 1.9. Communications .....  | 10 |
| 1.10. Airport information .....  | 10 |
| 1.11. Flight recorders .....   | 11 |
| 1.12. Observations made about the aircraft and the incident area ..... | 11 |
| 1.13. Medical information.....   | 13 |
| 1.14. Fire .....   | 14 |
| 1.15. Emergency services aspects.....                                  | 14 |
| 1.16. Tests and research .....   | 14 |
| 1.17. Organizational information.....                                  | 14 |
| 1.18. Additional information.....                                      | 14 |
| 2. ANALYSIS .....  | 17 |
| 2.1. Technical examinations.....                                       | 17 |
| 2.2. Similar events.....   | 23 |
| 2.3. Event sequence .....  | 23 |
| 2.4. Investigation of the causes of the event.....                     | 24 |
| 3. CONCLUSION .....  | 27 |
| 3.1. Identified factors useful to understanding the event.....         | 27 |
| 3.2. Causes of the event.....  | 27 |
| 4. SAFETY RECOMMENDATIONS .....  | 29 |
| 4.1. Preventive measures directly related to the event .....           | 29 |
| 4.2. Measures not directly related to the event.....                   | 29 |
| APPENDIX I.....  | 30 |

## GLOSSARY

|         |   |
|---------|---|
| AAIB    | Air Accidents Investigation Branch  |
| BFU     | <i>Bundesstelle für Flugunfalluntersuchung</i> - German air accident investigation authority      |
| COMALAT | <i>Commandant de l'aviation légère de l'armée de Terre</i> (French army light aviation commander) |
| CVFDR   | Cockpit voice and flight data recorder  |
| DAAT    | <i>Détachement avions de l'armée de Terre</i> (French army air detachment)                        |
| DGA     | <i>Direction générale de l'armement</i> (French Defence Procurement Agency)                       |
| EAAT    | <i>Escadrille avions de l'armée de Terre</i> (French army air squadron)                           |
| ft      | Feet – (1 foot = 30.48 cm)  |
| IFR     | Instrument flight rules   |
| kt      | Knots – (1 knot = 1.852 km/h)   |
| ICAO    | International Civil Aviation Organisation   |
| RESEDA  | <i>Restitution des enregistreurs d'accidents</i> (Accident Recorder Analysis Department)          |
| UTC     | Coordinated universal time  |

## SUMMARY

Date and time of event: 20 December 2023 at 07:20 (06:20 UTC<sup>1</sup>)

Place of event: Rennes Saint-Jacques airport (LFRN)

Organization: French army

Organizational command: French army light aviation command (COMALAT)

Unit: French army air detachment (DAAT)

Aircraft: TBM 700 no. 80 registered F-MABY

Type of flight: authority transport

Number of people on board: 2

### Summary of the event

On the morning of 20 December, departing from Rennes Saint-Jacques airport (LFRN), the TBM 700 registered F-MABY requested clearance to line up for take-off to Clermont-Ferrand (LFLC). It was dark, visibility was greater than 10 km and the runway was wet. Upon receiving clearance, the aircraft backtracked runway 28, turned around in the turn pad and lined up using the lights for guidance. During the take-off run, the crew felt vibrations coming from the auxiliary landing gear. Suspecting a puncture, the crew decided to abort take-off and informed the airport's control tower. The fire brigade arrived at the site immediately.

The aeroplane's four propeller blades were damaged and the auxiliary landing gear tyre was punctured. Five runway lights were destroyed. The crew were unharmed.

### Composition of the safety investigation group

- a BEA-É-appointed chief safety investigator (investigator in charge);
- a technical investigator (BEA-É);
- a pilot with experience flying the TBM 700;
- an expert in organizational and human factors (IRBA<sup>2</sup>);
- a senior licensed doctor of aeronautical medicine.

### Other experts consulted

- French Defence Procurement Agency - Propulsion Tests (DGA EP)/Accident Recorder Analysis Department (RESEDA);
- European Union Aviation Safety Agency.

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<sup>1</sup> *Coordinated universal time*

<sup>2</sup> French armed forces biomedical research institute.

PAS DE TEXTE

## 1. FACTUAL INFORMATION

### 1.1. History of the flight

#### 1.1.1. Mission

Type of flight: CAG IFR<sup>3</sup>

Type of mission: authority transport

Last point of departure: Rennes Saint-Jacques (LFRN)

Departure time: 07:14 (from parking area)

Point of intended landing: Clermont-Ferrand (LFLC)

#### 1.1.2. History

##### 1.1.2.1. Flight preparation

On December 20 2023, the TBM 700 registered F-MABY of the French army air detachment (DAAT) was scheduled to take off from Rennes Saint-Jacques airport at 07:20 to carry out a deployment mission to Clermont-Ferrand. The crew were made up of a pilot-in-command, who was sat in the right seat, and a pilot flying, who was sat in the left seat. At the time of the event, it was still dark. The parking area, taxiways and runway were wet.

##### 1.1.2.2. Description of the flight and the factors that led to the event

At around 07:10, the TBM 700 started taxiing to runway 28 in use. The lights were on. Having received clearance from the airport's control tower, the aeroplane backtracked the runway and entered the turning area<sup>4</sup> following the taxiway marked by lights on the ground. To avoid lining up on the slippery runway threshold markings, the crew anticipated their U-turn to line up on the runway by moving away from the lit path. Coming out of the turn, identifying a marking on the ground they took to be that of the runway centreline, the crew lined up using the white lights to help them. After checking the heading, the crew were ready for take-off.

##### 1.1.2.3. Reconstruction of the portion of interest of the flight path

Several meters after brake release, the aeroplane struck a first elevated light<sup>5</sup> located close to the taxiways. The aircraft's path resulted in it striking four other runway edge lights. Feeling an unusual vibration from the auxiliary landing gear that they equated with a puncture, the crew decided to abort take-off and inform the airport's control tower.

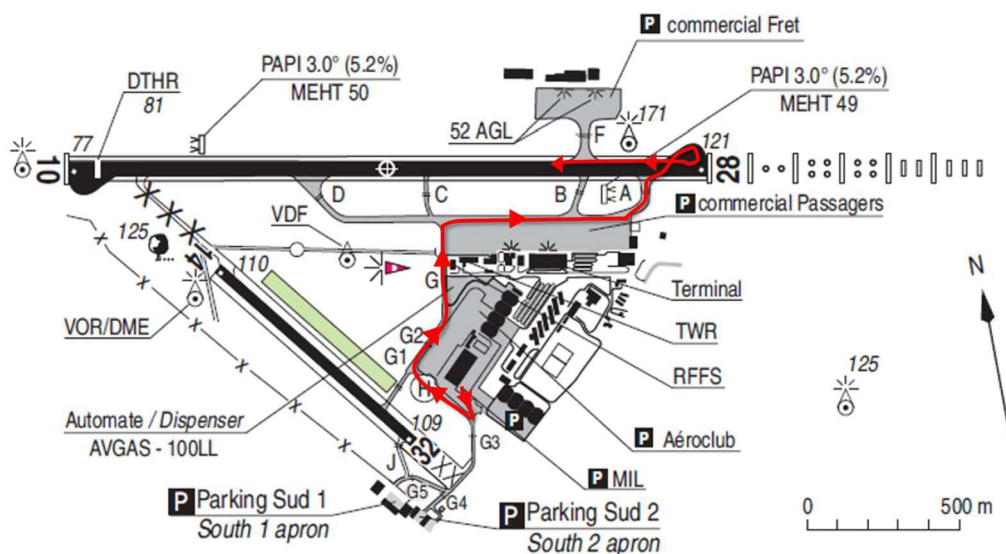


Figure 1: reconstruction of the portion of interest of the flight path

<sup>3</sup> General air traffic – *instrument flight rules*.

<sup>4</sup> Also known as the turn-around bay.

<sup>5</sup> Light that is not inset in the ground but that is elevated by several tens of centimetres in relation to the runway surface.

### 1.1.3. Location

- Place:
  - country: France
  - department: Ille-et-Vilaine (35)
  - commune: Saint-Jacques-de-la-Lande
  - geographical coordinates: N 48°04'14" / W 001°43'13"
  - height of the event location: on the ground
- Time: at night
- Closest airport at the time of the event: Rennes Saint-Jacques (LFRN)

### 1.2. Injuries to persons

The crew were unharmed.

### 1.3. Damage to aircraft

The aircraft was damaged.

### 1.4. Other damage

Some of the runway and taxiway lights were destroyed.

### 1.5. Crew information

#### 1.5.1. Flight crew members

##### 1.5.1.1. Pilot-in-command

- Age: 39 years old
- Unit of assignment: DAAT
- Training:
  - qualification: pilot-in-command
  - specialised school: école nationale de l'aviation civile (French school of civil aviation (2014))
  - CPL (A)<sup>6</sup> IR<sup>7</sup> SET<sup>8</sup> revalidated on 15 June 2023
- Flight hours as a pilot:

|                   | Total        |                     | In the last six months |                     | In the last 30 days |                     |
|-------------------|--------------|---------------------|------------------------|---------------------|---------------------|---------------------|
|                   | on all types | of which TBM<br>700 | on all types           | of which TBM<br>700 | on all types        | of which TBM<br>700 |
| Total (h)         | 5,330        | 3,300               | 187                    | 187                 | 30                  | 30                  |
| of which at night | 764          | 335                 | 19                     | 19                  | 4                   | 4                   |

- Date of previous flight: 19 December 2023

##### 1.5.1.2. Pilot flying

- Age: 36 years old
- Unit of assignment: DAAT
- Training:
  - qualification: pilot-in-command
  - specialised school: école nationale de l'aviation civile (French school of civil aviation (2016))
  - CPL (A) IR SET revalidated on 02 March 2023

<sup>6</sup> Commercial pilot licence (aeroplane).

<sup>7</sup> Instruments rating.

<sup>8</sup> Single engine turbine.

- Flight hours as a pilot:

|                   | Total        |                  | In the last six months |                  | In the last 30 days |                  |
|-------------------|--------------|------------------|------------------------|------------------|---------------------|------------------|
|                   | on all types | of which TBM 700 | on all types           | of which TBM 700 | on all types        | of which TBM 700 |
| Total (h)         | 3,860        | 2,096            | 126                    | 126              | 30                  | 30               |
| of which at night | 313          | 219              | 11                     | 11               | 8                   | 8                |

- Date of previous flight: 18 December 2023

#### 1.6. Aircraft information

- Organization: French army
- Parent command: COMALAT
- Base aerodrome: Rennes Saint-Jacques (LFRN)
- Unit of assignment: DAAT
- Type of aircraft: TBM 700 version A

|          | Type-series | Number | Total flight hours (h) | Flight hours (h) at last intermediate inspection |
|----------|-------------|--------|------------------------|--|
| Airframe | TBM 700 A   | 80     | 9,410                  | 9,337  |
| Engine   | PT6-A64     | PM0007 | 2,666                  | 2,593  |

##### 1.6.1. Maintenance and airworthiness

Examination of the documentation showed that maintenance was conducted in accordance with the directives and frequencies defined by the type certificate holder and the continuing airworthiness rules.

##### 1.6.2. Performance

The performance calculated for the aircraft's configuration and the meteorological conditions of the day was compatible with the mission.

##### 1.6.3. Weight and balance

At the time of the event, the weight was estimated to be 2,964 kg for a MTOW<sup>9</sup> of 2,984 kg. The balance was compliant with the standards.

##### 1.6.4. Fuel

- Type of fuel used: F-34
- Quantity of fuel at take-off and at the time of the event: 270 gal US<sup>10</sup>

##### 1.6.5. Other fluids

- Auxiliary landing gear damper oil: H-515
- Engine oil: O-156

<sup>9</sup> Maximum take-off weight.

<sup>10</sup> Gallon US: 1 gal US equals 3.785 litres.

## 1.7. Meteorological information

### 1.7.1. Forecasts

The forecast meteorological conditions at Rennes Saint-Jacques airport were compatible with the mission: a moderate north-westerly wind of 10 kt, visibility greater than 10 km, and a ceiling at 1,600 ft with, temporarily, rain showers reducing visibility.

### 1.7.2. Observations

At the time of the event, the meteorological conditions were better than those forecast with a westerly wind of 8 kt and a ceiling higher than 3,300 ft.

The runway was wet.

## 1.8. Aids to navigation

The aeroplane was equipped with two VOR<sup>11</sup>, a radiocompass, two GPS receivers, an autopilot, two transponders, a radio-altimeter and a weather radar.

The flight control and aircraft information was shown on three screens. The crew could see in particular the position of the aeroplane, the paths and the aeronautical charts.

## 1.9. Communications

The aeroplane was equipped with three VHF<sup>12</sup> radio stations. The crew were in radio contact with the tower at Rennes Saint-Jacques airport during line-up and take-off.

## 1.10. Airport information

Rennes Saint-Jacques airport is an international airport located in the commune of Saint-Jacques-de-la-Lande in the south-west of Rennes. It is open to national and international traffic, to private aeroplanes, and to IFR and VFR flights. In 2010, Société d'Exploitation des Aéroports de Rennes et Dinard (SEARD) received authorisation to operate the airport in compliance with (EC) regulation No. 2018/1139 dated 04 July 2018.

The airport has two paved runways: one main runway 10/28 that is 2,102 m long and 45 m wide, and a second runway 14/32 that is 850 m long and 30 m wide. Only the main runway has lights. Major works completed on the main runway in 2020 involved enlarging the turn pad and installing runway centreline lights.

DAAT aeroplanes, hangars and personnel are located in the airport's military area. The pilots are very familiar with the airport facilities and procedures.



Figure 2: Rennes Saint-Jacques airport facilities

<sup>11</sup> VHF Omnidirectional Range.

<sup>12</sup> Very High Frequency.

### 1.11. Flight recorders

Two flight recorders were present on board:

- the avionics system recording the flight parameters;
- a flight and voice data recording system (CVFDR<sup>13</sup>).

Due to the malfunction of the avionics system, only data from the CVFDR could be used.

### 1.12. Observations made about the aircraft and the incident area

#### 1.12.1. Examination of the aircraft

Most of the damage to the four propeller blades was at their tips and included notches, deformation and loss of material.



Figure 3: view of the damaged propeller

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<sup>13</sup> Cockpit voice and flight data recorder.

Four pieces of blade, corresponding to the pieces missing from the propeller, were found on the runway.



Figure 4: propeller pieces

The auxiliary landing gear was damaged in three ways:

- The tyre was deflated and had a 5 cm hole on one of its flanks
- The rim had several scratches and a considerable deformation over a length of 9 cm
- Scratches were visible over the entire inside of the landing gear strut below the damper.

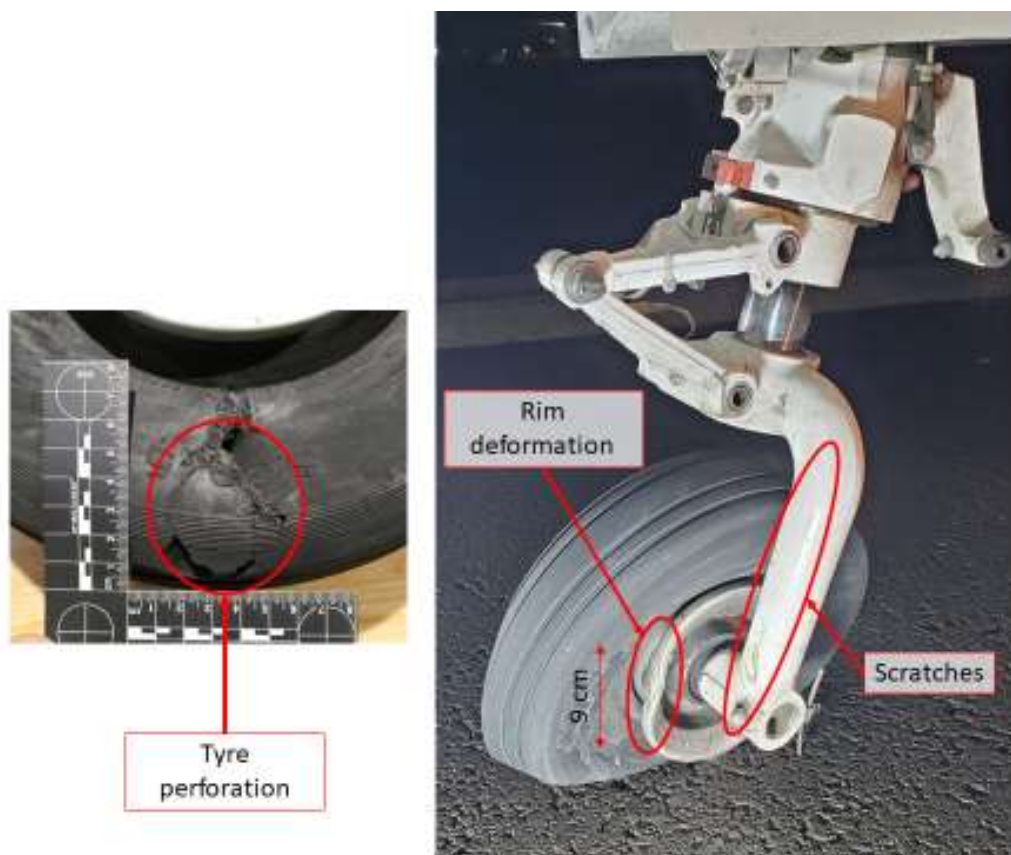


Figure 5: damaged auxiliary landing gear

### 1.12.2. Examination of incident area

On the north side of the main runway, close to the threshold of runway 28, three elevated runway edge lights and two elevated taxiway edge lights were destroyed.

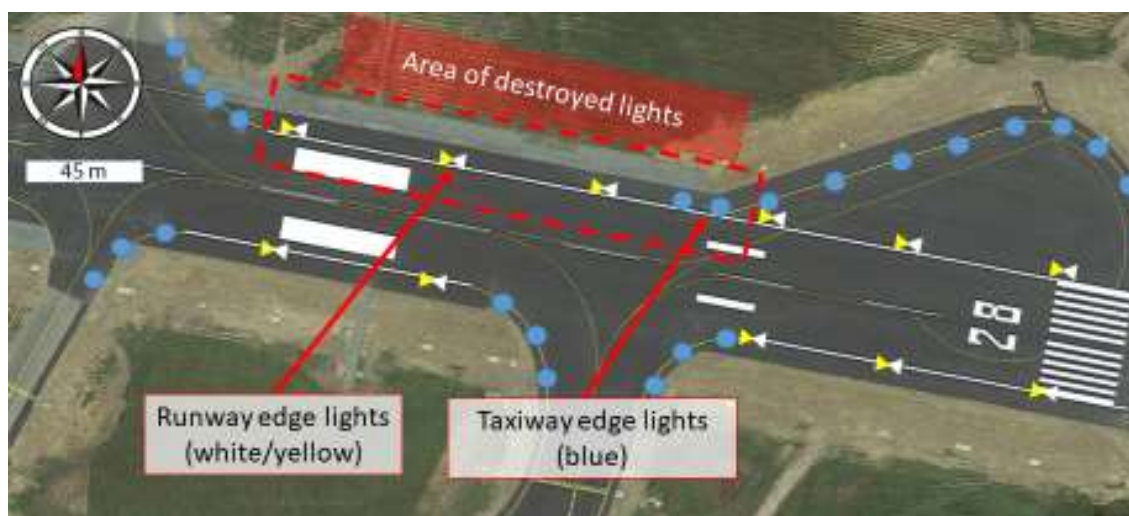


Figure 6: schematic diagram of the incident area



Figure 7: elevated runway edge lights (white/yellow) and elevated taxiway lights (blue)

### 1.13. Medical information

#### 1.13.1. Crew members

##### 1.13.1.1. Pilot-in-command

- Last medical examination:
  - type: examination at the flight crew medical test centre (CEMPN<sup>14</sup>) on 12 October 2023
  - result: fit
- Biological examinations: conducted

<sup>14</sup> Flight crew medical test centre - Reference to Instruction No. 812/ARM/RH-AT/PRH/LEG dated 16 February 2018 pertaining to medical fitness standards applicable to French army military personnel.

#### 1.13.2. Pilot flying

- Last medical examination:
  - type: six-monthly examination at the unit on 19 July 2023 (with reference to the class 1 test by the CEMPN on 24 January 2023)
  - result: fit
- Biological examinations: conducted

#### 1.14. Fire

Not applicable.

#### 1.15. Emergency services aspects

When the alarm was raised by the airport's control tower, the fire brigade took less than two minutes to arrive at the incident site.

#### 1.16. Tests and research

Flight recorder data was analysed by RESEDA.

Organizational and human factors were analysed by the French Armed Forces Biomedical Research Institute (IRBA).

#### 1.17. Organizational information

The DAAT comprises the EAAT whose activity is focused fully on the command aid mission (transport authorities), by the operation of a fleet of eight TBM 700s and the assignment of around 20 pilots.

#### 1.18. Additional information

##### 1.18.1. Runway lights

Airport lights serve as one of the airport's visual aids in the manoeuvring areas and on the runways to guide crews during different flight phases (taxiing, take-off, approach and landing) in the dark and in poor visibility conditions.

The lights in the vicinity of the threshold of runway 28 at Rennes Saint-Jacques airport notably include:

- two white and yellow runway edge lights installed 60 m apart;
- two white runway centreline lights installed 15 m apart;
- two blue taxiway edge lights;
- two green taxiway centreline lights.

Depending on their type and their position, these lights can be elevated (several tens of centimetres above ground level) or inset into the runway and the taxiways.

This light complies with the applicable regulation<sup>15</sup>.

##### 1.18.2. Runway layout

Main runway 02/28 has a slope change in its middle section that gives it a slightly convex shape. Due to this, the second half of the runway cannot be seen from a cockpit of a TBM 700 when the aeroplane is at the threshold of runway 28.

This runway marking complies with the applicable regulation<sup>15</sup>.

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<sup>15</sup> *Certification specifications for the design of aerodromes (CS-ADR-DSN)*, which is the EASA's transposition of ICAO Annex 14 *Aerodrome design and operation*.



Figure 8: view of Rennes Saint-Jacques runway 28 on final

### 1.18.3. Turn pad

The turn pad is a construction at the end of the airport's runway that enables aircraft to turn around. This space is essentially intended for large aeroplanes to taxi and move off to a manoeuvring area or to line up at the end of the runway before take-off. The turn pad marking complies with the applicable regulation<sup>15</sup>.

Due to its small size, the TBM 700 is not obliged to use this type of area when the runway is wide enough for it to turn around. This is the case of the 45 m-wide runway at Rennes Saint-Jacques.

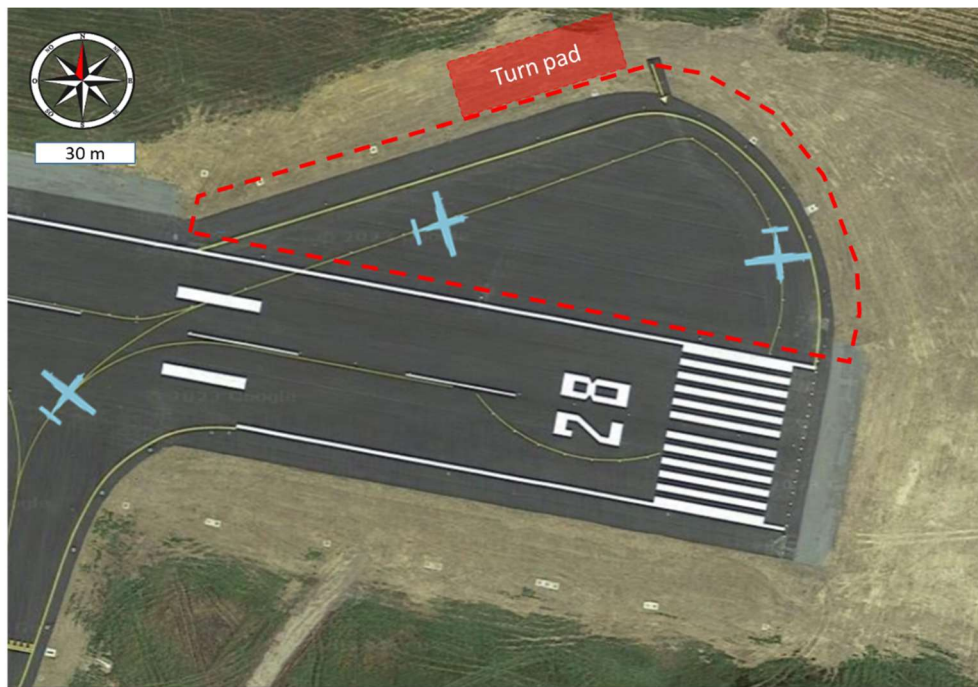


Figure 9: turn pad at the threshold of runway 28

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## 2. ANALYSIS

### 2.1. Technical examinations

#### 2.1.1. Analysis of the propeller and destroyed lights

The damages visible on the propeller were concentrated at the end of each blade in the final quarter, less than 20 cm from the blade tip. The remainder of the propeller was intact. At least four pieces were torn off due to the violent impact with an obstacle that must have been located at a height, considering the propeller's ground clearance<sup>16</sup> (20 cm), of between 30 and 40 cm.

The analysis of the damage revealed the presence of yellow and blue marks on the blades and on some debris.

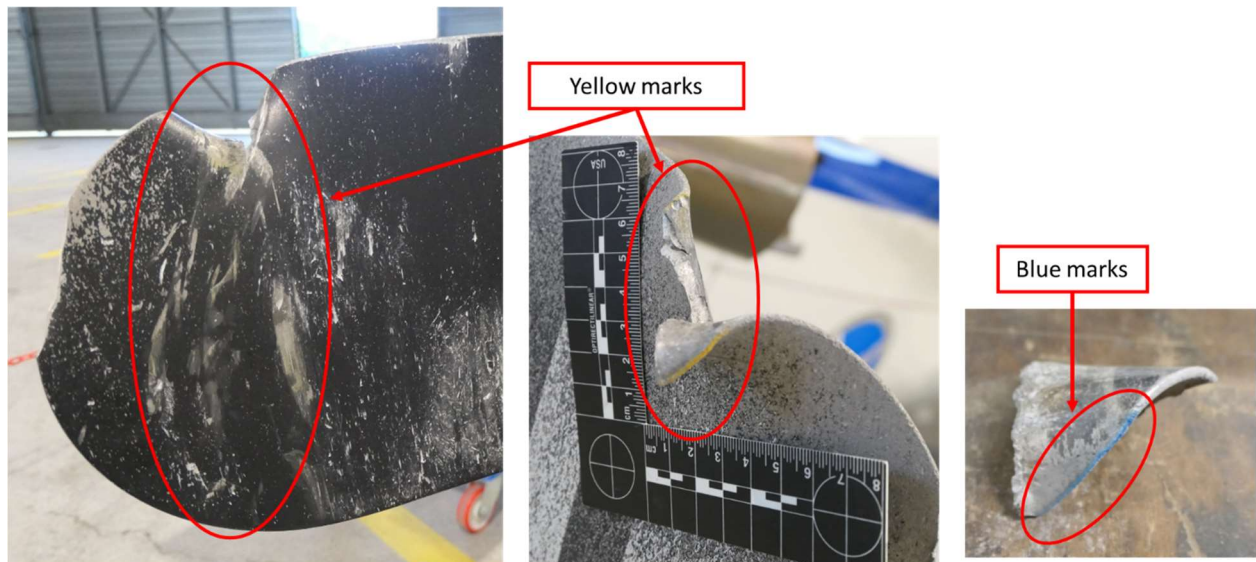


Figure 10: visible marks on the propeller blades and debris

The five lights destroyed were elevated lights located at a height of 35 cm (runway edge lights) and 29 cm (taxiway edge lights). The metal parts of these lights were covered with a yellow coating. The taxiway edge lights were fitted with a blue metal ring. The examination of the debris showed that the damage was caused by violent impact with the metal sections. This damage was consistent with the findings on the propeller (colour marks and location of deformation).

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<sup>16</sup> Clearance between the ground and the end of the lowest blade in normal operating conditions.



Figure 11: debris from the destroyed lights

During the take-off run, the propeller blades struck five lights located along the north edge of the runway.

#### 2.1.2. Analysis of damage to the auxiliary landing gear

The main damage was visible on the tyre, which was perforated, and on the rim, of which one part was distorted by an impact that left a yellow mark. Yellow friction marks were also visible on the auxiliary landing gear strut.

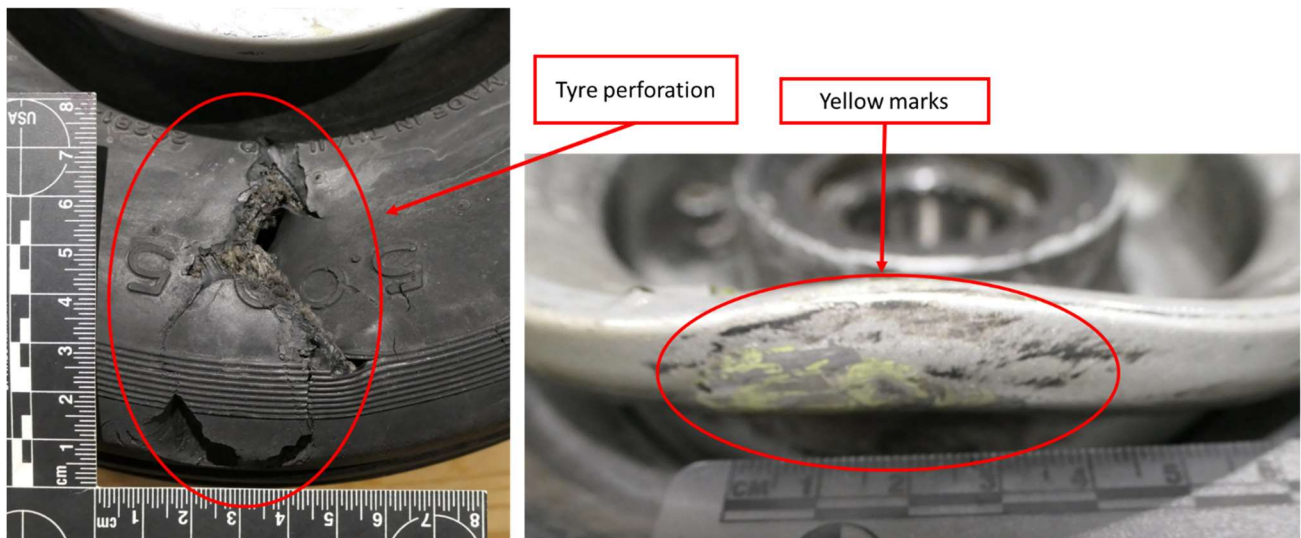


Figure 12: damage to the auxiliary landing gear

On the runway, near the location of one of the destroyed lights, the marks of a tyre similar to an auxiliary landing gear tyre were visible and showed a path deviated due to the struck light. This observation fits with the crew's statement that described vibrations from the auxiliary landing gear.

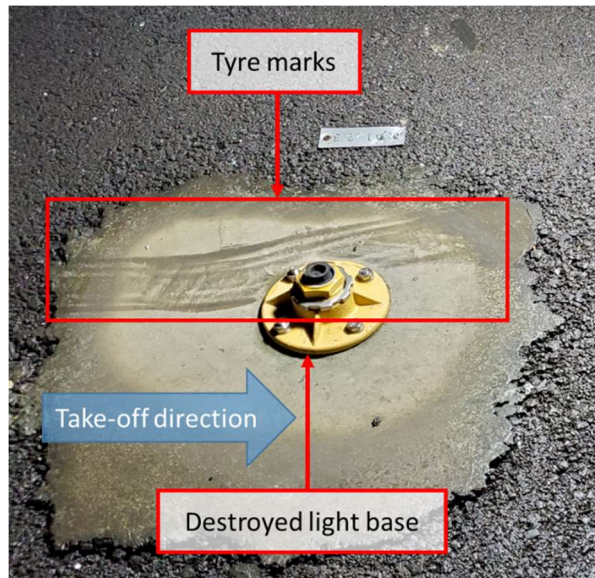


Figure 13: tyre marks

**The tyre puncture and damage to the auxiliary landing gear strut resulted from the impact with one or more lights.**

### 2.1.3. Flight recorder analysis

The analysis of data from the flight recorder confirmed that the TBM 700 was lined up on the north edge of the runway after partially following the path to the turn pad. When it received clearance for take-off, the TBM 700 was positioned 67 m from the threshold of runway 28 with an offset to the north by 22 m in relation to the centreline.

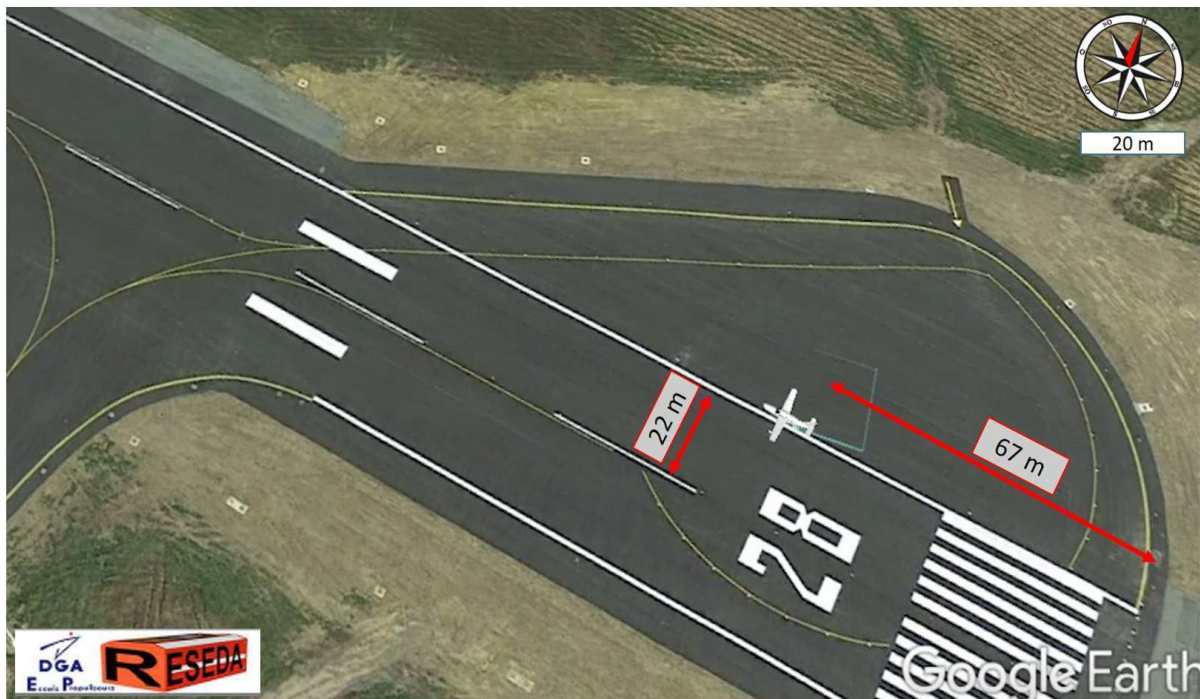


Figure 14: position of the TBM 700 at the start of the take-off

Impact noises could be clearly heard on the read-out of the cockpit voice recorder. Synchronisation of the path with the sound revealed that these impacts corresponded to the position of the damaged lights. Only the impact with the last light was not clearly picked up due to a louder ambient noise probably generated by the damaged propeller.

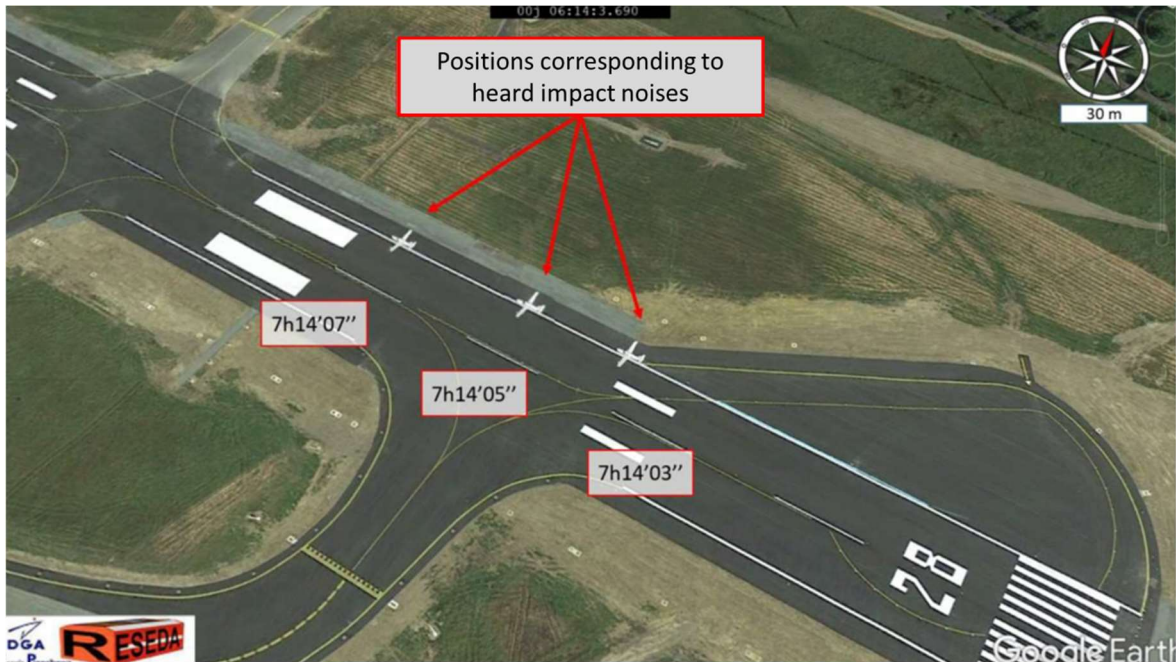


Figure 15: positions of the TBM 700 during impacts with the lights

**The TBM 700 performed a take-off run identifying the north edge of the runway as the centreline and struck lights with the propeller and the auxiliary landing gear.**

#### 2.1.4. Analysis of the lights and markings at Rennes Saint-Jacques airport

##### 2.1.4.1. View from the cockpit of the TBM 700

The runway centreline lights are white directional lights inset into the centreline of runway 28 at the threshold. The runway edge lights distanced from the taxiways comprise white and yellow elevated lights. At the boundary of the runway and the turning area, the lighting is similar to that of the runway centreline: inset white lights and white ground markings (area demarcated by yellow dots on the figure below).

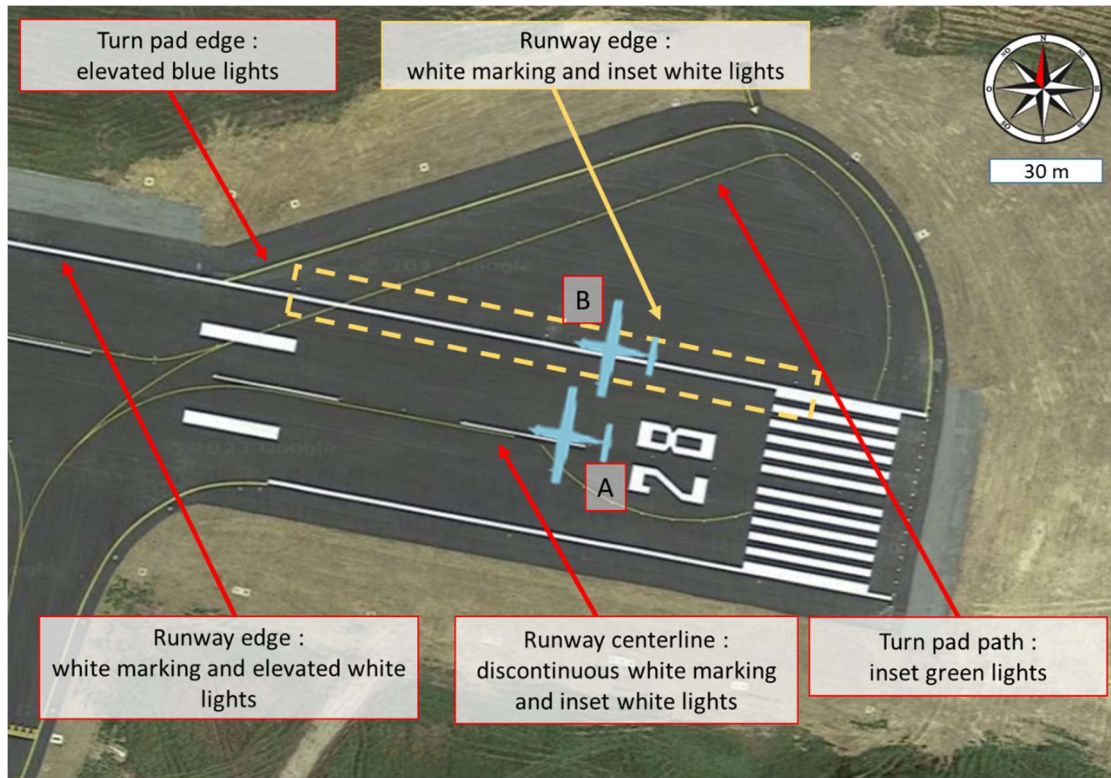


Figure 16: marking and lights in the runway 28 threshold area

The observation of the lights in the dark from on board the TBM 700 successively occupying positions A and B identified the following points:

- Marking: despite the width being different, it is difficult to differentiate the white runway centreline markings and the runway edge markings. In addition, the limited range of the TBM 700 taxi light makes it impossible to distinguish the discontinuous nature of the runway centreline marking, rendering it very similar to the runway edge marking.
- Lights: it is difficult to differentiate the runway centreline lights from the runway edge lights from positions A and B due to the following reasons:
  - the white colour and the brightness are identical;
  - the elevated and inset characteristics are impossible to differentiate between visually;
  - the longitudinal spacing of the centreline lights (15 m) and the runway edge lights (60 m) is difficult to estimate due to the low cockpit height;
  - as the runway centreline and edge lights are directional, it is impossible to visualise those located immediately to the left and to the right of the aircraft;
  - due to the slope change, the runway edge and centreline lights on the downslope of the runway are not visible to crew members.

Only the double convergence of the runway edge lights enables a differentiation to be made between the two positions.

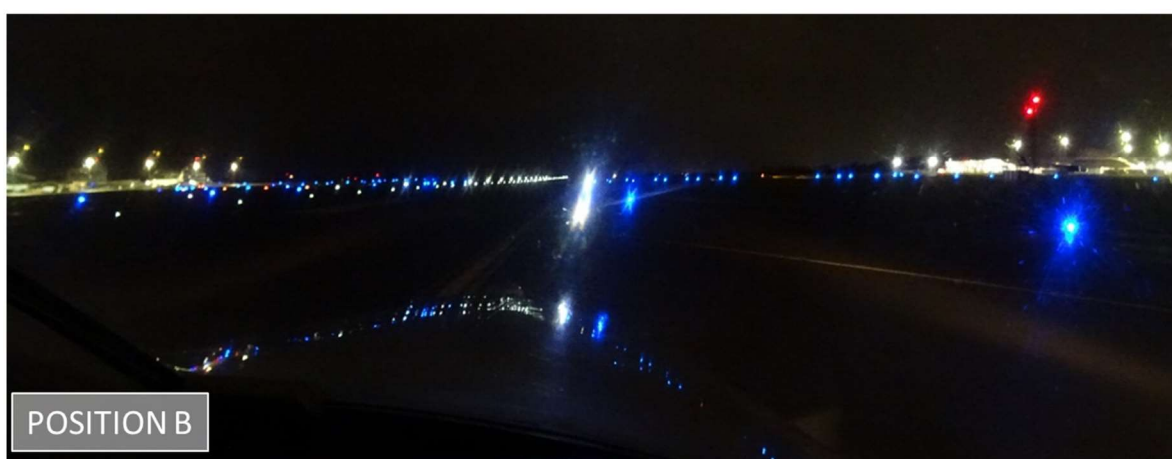


Figure 17: views from the cockpit of the TBM 700 located at positions A and B

**Viewed from the cockpit of the TBM 700 located at the threshold of runway 28, in the dark, it is difficult for the crew to differentiate a line-up on the runway centreline from a line-up on the north edge of the runway.**

#### 2.1.4.2. View from the control tower

Regulation<sup>17</sup> does not require the air traffic controller to check the correct positioning of an aircraft prior to issuing clearance for take-off. Indeed, depending on the visibility conditions and the location of the control tower, it is not always possible to detect an aircraft that is incorrectly lined up or off-centre.

At Rennes airport, although the positioning of the control tower enables the duty controller to have sight of a TBM 700 located in the threshold area of runway 28, the latter is unable to see the runway centreline and edge lights due to their bidirectional nature.

<sup>17</sup>SERA (Standardised European Rules of the Air) pertaining to air traffic services.

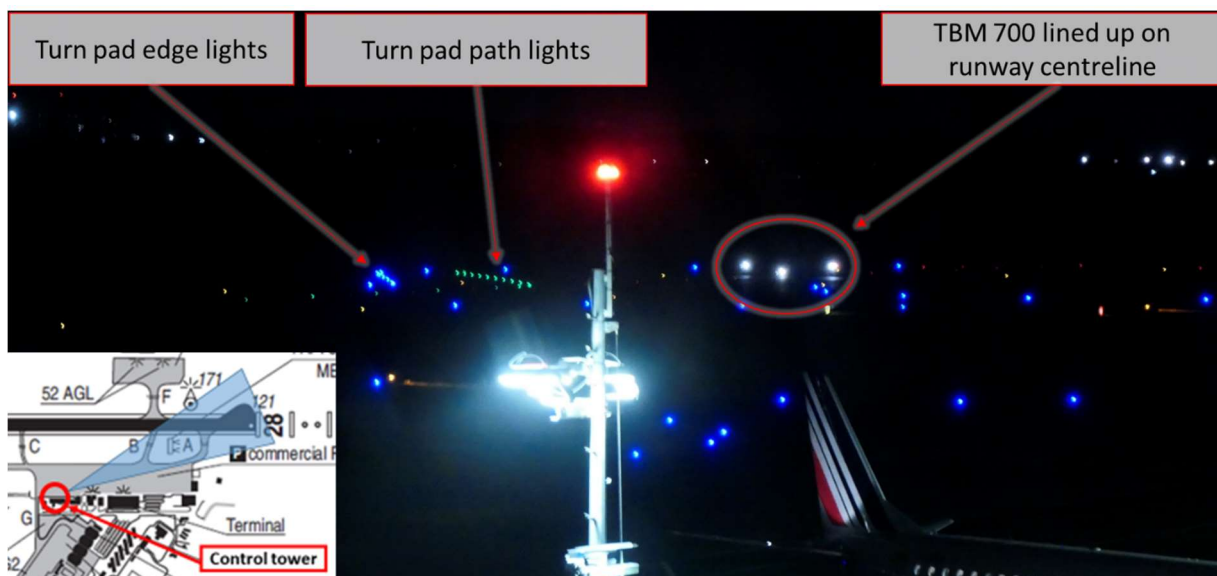


Figure 18: TBM 700 lined up on the centreline of runway 28 as seen from the control tower

**From the Rennes control tower, in the dark, it is not possible to see whether a TBM 700 is correctly lined up on the centreline of runway 28.**

#### 2.1.5. Similar events

Several European air safety investigation authorities reported accidents and serious incidents with runway excursion due to errors lining up on the runway edge lights before take-off (source: ECCAIRS<sup>18</sup> database):

- an ATR 72-212 on 05 March 2002 at Dresden (BFU 5X005-0/02),
- an ATR 42-300 on 20 January 2006 at Glasgow Prestwick (AAIB EW/G2006/01/16),
- an Embraer 145 on 16 November 2007 at Lyon Saint- Exupéry (BEA F-ZX071116),
- a Gulfstream III on 24 November 2014 at Biggin Hill (AAIB EW/C2014/10/01),
- an ATR 72-200 on 25 February 2016 at Karup (AIB DK HCL510-2016-299)
- and an ATR 72-212 at Cologne on 27 April 2020 (BFU 20-0251-EX).

At other locations in France, at least four public transport events were reported between 2014 and 2018. These four events were analysed internally by the airlines but did not give rise to the drafting of reports. The analysis of these events identified that the crew had confused the runway centreline lights and the runway edge lights. In several of these events, crew fatigue was considered to be a contributing factor.

**Over the last 12 years in Europe, several events resulting in runway excursions due to confusion of lights at take-off were reported. Crew fatigue was often identified as a risk factor.**

#### 2.2. Event sequence

The event sequence was established through technical examinations:

- 07:08:28: start of taxiing to the runway 28 holding point;
- 07:12:15: clearance to backtrack runway 28 and to line up. The TBM 700 turned around on the turn pad by shortening the path marked by the lights;
- 07:13:42: line-up on the north edge of the runway and engine power-up;
- 07:14:03: striking of first light. The other four lights were then struck in succession approximately two seconds apart;
- 07:14:11: decision to abort take-off;
- 07:14:27: engine shut-down.

<sup>18</sup> *European Coordination Centre for Accident and Incident Reporting Systems.*

## 2.3. Investigation of the causes of the event

### 2.3.1. Lack of knowledge of the risk by the crew

In civil aviation, several events caused by a confusion between the centreline and edge lights during a line-up in the dark had already occurred in similar circumstances. Aware of this risk, the operator of Rennes Saint-Jacques airport produced and circulated a safety memo in May 2020 after carrying out work aimed in particular at enlarging the turn pads and adding a centreline light. This memo advises crews to follow the taxiway until fully lined up on the runway. Knowing that DAAT aeroplanes did not use the turn pad due to the small size of the TBM 700, the airport operator did not distribute this safety memo to the DAAT.

Moreover, the DAAT document watch prevents some of its crews from knowing about incidents encountered in civil aviation.

**The pilot flying had no knowledge of incidents caused by line-up errors occurring in civil aviation and was unaware of the risk of confusion of lit centrelines in the dark.**

### 2.3.2. Choice of the line-up path

Before a take-off from runway 28, the crew can line up directly on the runway at the taxiway. This option is frequently used by DAAT crews. The crew can also line up by backtracking the runway via the turn pad. This option can increase the take-off distance available and the safety margins.

The crew's decision to line up via the turn pad was not discussed during the pre-flight briefing, this point not usually being discussed at this stage of the mission. The decision was made, as proposed by the air traffic controller, upon entering the runway. The aeroplane's path initially followed the green lights, then the pilot flying decided to make a tighter turn on the turn pad to line up. This decision was accepted by the pilot-in-command. In taking this path, the aeroplane was no longer using the lights for guidance. This choice could be explained by the small size of the aeroplane that did not require it to follow all lit paths, given that there is no documentary requirement to do so. This is also a common practice of DAAT crews as it allows them to both reduce runway occupancy time and to avoid lining up on the runway threshold markings that can be slippery, as was the case on the day of the event.

In addition, with the risk of a line-up error not being shared within the unit, this practice had not been the subject of a risk assessment.

**The path adopted in the turn pad did not completely follow the turn pad path. This choice of the DAAT crews was the result of a voluntary practice that was not prohibited. This manoeuvre was not risk-assessed by the DAAT before the occurrence of the incident.**

### 2.3.3. Erroneous situational awareness

During taxiing, believing he could see the figure 8 of the threshold of runway 28 to his right, the pilot flying tightened his turn thinking he was lining up on the runway centreline between the figure 2 and the figure 8, opposite a white light that he thought was the runway centreline light. The pilot was therefore the victim of a misperception that led him to make a turn that was too tight.

The pilot-in-command performed his usual supervision tasks, including verification of the aeroplane's position and line-up. However, these tasks did not enable him to detect the abnormal situation.

The confusion of centrelines was a misperception error as the crew were not aware that they were lined up on the lights of the right edge of the runway. Prior to the renovation work, the runway had no centreline lights. To check their line-up, pilots used the runway edge lights and central centreline markings on the ground lit up by the aircraft's lights. The visual references marking the centre and edges of the runway were therefore different, rendering the occurrence of an alignment error less likely. Since the renovation of the

runway, both pilots had changed their night practices and used the centreline lights to check that the aeroplane was on the runway centreline. Relying solely on the search for the centreline, this practice was reported by other DAAT pilots.

**Due to a misperception error, both the pilot flying and the pilot-in-command thought that the aeroplane was correctly lined up on the runway.**

#### 2.3.4. Non-detection of the line-up error

##### 2.3.4.1. Non-error-tolerant situation

The analysis of the views of the air traffic controller and crew showed that when the aeroplane was positioned on the right edge of the runway, neither the controller nor the crew seemed to have information that was prominent enough to detect and correct the error in a timely manner. In effect, seen from the cockpit, only the double convergence of the runway edge lights could help to confirm the position, but this criterion does not appear to be sufficiently clear to alert the crew to a line-up error.

**The lights did not appear to be clear enough to help the crew to detect a line-up error. This situation can be qualified as non-error-tolerant.**

##### 2.3.4.2. Crew's overconfidence

The crew comprised two experienced pilots, qualified as pilots-in-command and who had flown with the DAAT for a number of years. These two pilots, recruited at the same time and of the same grade, knew each other and regularly flew together. There were no known grievances between them. They were familiar with Rennes Saint-Jacques airport. This latest mission of the year was considered usual and did not present any particular difficulty from a technical or operational point of view. The composition of the crew and the carrying out of a mission that was routine in nature on a known runway in favourable meteorological and operational conditions may have contributed to an overconfidence in the cockpit and the subsequent occurrence of the line-up error and its non-detection. In this context, it is likely that the crew's actions essentially relied on automatic reflexes. The pilots had a tendency to look for information based on their expectations of the situation and on their understanding. Therefore, with no perceptible indication of the lights and ground marking to make them aware that the actual situation did not correspond to the expected situation, it was difficult for the crew to question their situational awareness.

**The composition of the crew exposed them to the risk of overconfidence, especially when the mission was deemed to be usual and was being performed at a known location. This overconfidence possibly contributed to the crew not actively seeking other information that could have helped them to detect the error, such as the double convergence of runway edge lights.**

##### 2.3.4.3. Crew's fatigue levels

During the six days prior to the incident, the activity of the two crew members was regular and more or less sustained, without exceeding the maximum levels specified in the operating manual. The analysis of their sleep log<sup>19</sup> revealed no major sleep deficit<sup>20</sup>.

However, on the day of the event, there were a number of factors likely to cause hypovigilance: a short night (less than six hours of sleep for the pilot flying) and a mission that started in the 06:00 – 07:30 timeslot, which is considered to be a hypovigilance risk factor.

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<sup>19</sup> The sleep log records quality and amount of sleep over several days.

<sup>20</sup> Sleep deficit is the total number of hours of lost sleep in relation to individual needs. Sleep deficit is deemed to be major when the individual has slept for less than four hours over two consecutive nights or for less than three hours during one night.

Indeed, the pilot flying had been experiencing disturbed and poor quality sleep for several months due to non work-related troubles. During the week preceding the event, the average duration of his sleep was six hours and 30 minutes. The night before the event, this duration was even shorter (five hours of effective sleep) with his sleep considered to be of poor quality and several periods of wakefulness. The pilot stated that he was tired when he woke up. It is likely that this situation contributed to him suffering from chronic fatigue.

Within the DAAT, within the context of operational risk management, the preparation file for each mission incorporates a risk self-assessment section. This tool, known as “Check your mission” must be completed by the crew prior to each mission. Fatigue risk is assessed subjectively via a single item. In compliance with operational risk management factors, the pilot flying, who knew he was tired, reported this to the pilot-in-command during the briefing. However, this perception did not result in the crew questioning the mission as it was perceived to be usual and without any particular difficulty. The routine nature of the flight may have resulted in the crew underestimating the risks associated with the pilot’s tiredness levels. In addition, due to the early morning take-off time, it was difficult for the crew to report the situation to the commander at the time of the briefing and to find an alternative solution.

The analysis of the fatigue risk self-assessment questionnaire, still not commonly used in French state aviation, nevertheless revealed the lack of objective criteria that would help with decision-making and the implementing of counter-measures when a high risk is identified, such as those proposed by the *Australian Defense Flight Safety Bureau* (see Appendix).

**On the day of the event, the crew presented several fatigue risk factors that they did not consider to be of sufficient concern. The chronic fatigue of the pilot flying was a potential contributing factor in the non detection of the line-up error and the erroneous situational awareness.**

#### 2.3.4.4. Management of fatigue by the DAAT

The scale of the activity of DAAT pilots complies with the recommendations of STANAG 3527 “*Fatigue management in air operations*” (2021 issue) and recovery times comply with the recommendations of STANAG 3474 “*Temporary flying restrictions due to exogenous factors affecting aircrew efficiency*”. The management of annual air activity by the commander is based on an even distribution of flight hours to each pilot to avoid individual overload. Yet, in 2023, the air activity of the pilot flying was 50 hours less than the average, i.e. around 300 flight hours on the TBM 700. In accordance with the unit’s principles, its flight scheduling was optimised to make up part of the pilot’s deficit and to take pressure off the remainder of the squadron pilots who had to absorb an increase in activity. Thus, the flight schedule of the pilot flying was not adapted to his state of chronic fatigue.

**The strategy of balancing the air activity and distributing the operational load of the squadron resulted in the management scheduling more flights for the pilot flying, which was not conducive with his state of chronic fatigue.**

### 3. CONCLUSION

The event was an aborted take-off at night due to a line-up error leading to a runway excursion (#RE<sup>21</sup>).

#### 3.1. Identified factors useful to understand the event

During a turnaround manoeuvre at night on the turn pad of runway 28 at Rennes Saint-Jacques airport, the crew lined up in error on the north edge of the runway. During the take-off run, the propeller struck five elevated lights and the auxiliary landing gear wheel was damaged resulting in it puncturing. The crew aborted the take-off, switched off the engine on the runway and informed the airport control tower, which alerted the emergency services.

The aircraft was damaged and the crew members were unharmed.

#### 3.2. Causes of the event

The event was caused by organizational and human factors. In particular, the incident was caused by a misperception that was likely the result of:

- a lack of knowledge of the risk of confusion of the lit ways at night;
- the difficulty for the crew and the impossibility for the air traffic controller, once the aeroplane was lined up, to detect and correct the error due to the nature of the airport's infrastructure;
- a state of chronic fatigue of the pilot flying and an overconfidence, in particular on the part of the pilot-in-command;
- an air activity balancing strategy that was not conducive to the state of fatigue of the pilot flying.

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<sup>21</sup> *Runway excursion* – based on the taxonomy of the air accident and incident data reporting system of the ICAO.

PAS DE TEXTE

#### 4. SAFETY RECOMMENDATIONS

##### 4.1. Preventive measures directly related to the event

Further to the serious incidents of 2014 at Biggin Hill and 2020 at Cologne, the AAIB and the BFU each drafted a recommendation pertaining to lighting standards. The recommendation did not result in an update of international practices. However, a selective use of the brightness level between runway centreline lighting and runway edge lighting appears to be technically practicable but is still not underpinned by the regulation. This could help crews to better identify the runway limits, including in the dark and in poor visibility conditions. Lastly, despite the conformity of the markings and lights on the runway at Rennes, the event showed that it is possible to confuse the white runway edge markings on the turn pad side and the white dashed markings along the runway centreline.

Consequently, the BEA-É recommends that:

**the ICAO looks into amending the standards and recommended practices pertaining to:**

- **ground runway edge markings in the vicinity of the turn pad;**
- **runway centreline and edge lights to make them more distinctive by considering the use of a differential brightness level for example.**

R1 – [T-2023-22-I] *Recipient: ICAO*

##### 4.2. Measures not directly related to the event

To take into account the risk associated with state of fatigue, the DAAT is one of the only state units to use a self-assessment tool. However, this could be improved by including more objective criteria. Within the context of the sharing of best practices with a view to collectively improving aviation safety, this self-assessment principle could be shared with operating authorities that do not yet have such a tool.

With regards to the application of STANAG 3527 in state aviation, the BEA-É recommends:

**that the NATO Aeromedical Working Group (AMDWG) assesses the relevance of including a fatigue risk self-assessment tool incorporating objective criteria in aviation safety documentation.**

R2 – [T-2023-22-I] *Recipient: AMDWG*

Without waiting for the potential integration of a fatigue risk self-assessment tool in STANAG 3527, the BEA-É recommends:

**that operating authorities, if they have not already done so, include a fatigue risk self-assessment tool based on objective criteria in their operating documentation.**




R3 – [T-2023-22-I] *Recipients: CEMAAE, CEMAT, CEMM, DGA, DGDDI, DGGN, DGPN, DGSCGC*

APPENDIX I

AVIATION FATIGUE RISK SELF-ASSESSMENT QUESTIONNAIRE

Source: Australian Defence Flight Safety Bureau (2021), Aviation Fatigue Management, Guidebook Version 1. The original document is available at the following web address:

<https://dasa.defence.gov.au/sites/default/files/DFSBAviationFatigueManagementGuidebook.pdf>

|   | <br><b>MONITOR</b>  | <br><b>ACTIVELY MANAGE</b>                      | <br><b>CAUTION!</b>   |
|---|--|---|--|
| <p><b>At the START of duty, how many hours of sleep have you had in the past 24 hours?</b></p> <p><small>(Note: The figures used in this question can be tailored to account for individual sleep needs. It is important to understand how much sleep you need to feel well rested. The average sleep needed is 7–8 hours to consistently feel well rested; however, some people may require only 6 hours and some 10 hours.)</small></p> | <input type="radio"/><br><b>&gt;7 Hours</b>  | <input type="radio"/><br><b>6–7 Hours</b>   | <input type="radio"/><br><b>&lt;6 Hours</b>  |
| <p><b>At the START of duty, how many hours of sleep have you had in the past 48 hours?</b></p> <p><small>(Note: The figures used in this question can be tailored to account for individual sleep needs. It is important to understand how much sleep you need to feel well rested. The average sleep needed is 7–8 hours to consistently feel well rested; however, some people may require only 6 hours and some 10 hours.)</small></p> | <input type="radio"/><br><b>&gt;14 Hours</b>   | <input type="radio"/><br><b>12–14 Hours</b>   | <input type="radio"/><br><b>&lt;12 Hours</b>   |
| <p><b>How many hours will you have been awake at the end of planned duty?</b></p> <p><small>(Note: The timings in this question are based on the acclimatised circadian rhythm of an individual, their 'body-clock time'. Further consideration is required for transmeridian travel.)</small></p>  | <input type="radio"/><br><b>&lt;16 Hours</b>   | <input type="radio"/><br><b>16–18 Hours</b>   | <input type="radio"/><br><b>&gt;18 Hours</b>   |
| <p><b>When will you be performing safety-critical tasks during the duty period?</b></p>   | <input type="radio"/><br><b>0730–2200</b>  | <input type="radio"/><br><b>0600–0730 or<br/>2200–0200</b>  | <input type="radio"/><br><b>0200–0600</b>  |
| <p><b>How ALERT are you feeling?</b></p>  | <input type="radio"/> <ul style="list-style-type: none"> <li>Fully alert, wide awake</li> <li>Very lively, responsive but not at peak</li> <li>Okay, somewhat fresh</li> </ul> | <input type="radio"/> <ul style="list-style-type: none"> <li>A little tired, less than fresh</li> <li>Moderately tired</li> </ul> | <input type="radio"/> <ul style="list-style-type: none"> <li>Extremely tired, very difficult to concentrate</li> <li>Completely exhausted, unable to function effectively</li> </ul> |

A single occurrence of an amber or red should initiate the corresponding amber or red actions below. Multiple occurrences of amber and/or red increase the potential fatigue risk level and due consideration should be given during the risk-management process. Apply the principles of **Rule of Three** to any identified ambers, that is, **three or more ambers** is a **red** and should be managed in-line with the **CAUTION** response.

**CONTINUE  
TO MONITOR  
ALERTNESS**



Continue to monitor your alertness and fatigue levels throughout duty. Consider asking a team member to monitor you for any observed decline in alertness.

Implement lifestyle factors that will help you to manage your alertness on an ongoing basis e.g. nutrition, sleep, stress, et cetera.

**ACTIVELY  
MANAGE  
FATIGUE &  
ALERTNESS**



Advise your supervisor of your heightened fatigue risk and ask team members to monitor you. Consider adjusting tasks. Increase team communication and task cross-checking.

Consider taking a break or accessing controlled rest/napping. Consider strategic use of caffeine and food intake.

**CONSIDER  
FITNESS FOR  
DUTY.  
GET HELP  
TO MANAGE  
FATIGUE  
LEVELS**



Pre-duty, inform your supervisor of your heightened fatigue risk. Discuss with them your fitness for duty and ability to safely operate.

If mid-duty, inform your supervisor and team members of your heightened fatigue risk. Discuss with them your continued fitness for duty, ability to safely operate or how to safely manage your ongoing performance.