European Union Aviation Safety Agency

Notice of Proposed Amendment 2025-01 (A)

issued in accordance with Article 6 of MB Decision 01-2022

Take-off performance parameters and position errors — large aeroplanes

RMT.0741

<table>
<tr><td colspan="3">WHAT THIS NPA IS ABOUT
This NPA proposes to require some large aeroplanes to be equipped with a take-off performance monitoring system (TOPMS). The proposal addresses new designs, with an amendment of the Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes (CS-25), and some already approved designs when the aeroplane is still in production and operated in commercial air transport, with an amendment of Part-26 (Annex I to Regulation (EU) 2015/640) and, subsequently, of the Certification Specifications and Guidance Material for Additional Airworthiness Specifications for Operations (CS-26).
The objective is to mitigate, using an on-board alerting system, the risk of large aeroplane accidents or incidents caused by the use of erroneous take-off performance parameters and erroneous take-off positions. Such errors have the potential to result in runway excursions and aeroplane upsets, with subsequent loss of control and collision with terrain or obstacles.
The proposed regulatory material is expected to improve safety while limiting manufacturers' efforts in the development and implementation of TOPMS functions to the most beneficial cases. Low- to very low-cost impact is expected. No environmental and social impacts have been identified.</td></tr>
<tr><td>REGULATION INTENDED TO BE AMENDED
— Commission Regulation (EU) 2015/640</td><td colspan="2">ED DECISIONS INTENDED TO BE AMENDED
— ED Decision 2003/002/RM (CS-25)
— ED Decision 2015/013/R (CS-26)</td></tr>
<tr><td colspan="3">AFFECTED STAKEHOLDERS
Design organisations dealing with large aeroplanes type design and installed equipment; operators of large aeroplanes</td></tr>
<tr><td colspan="3">WORKING METHODS</td></tr>
<tr><td>Development</td><td>Impact assessment(s)</td><td>Consultation</td></tr>
<tr><td>By EASA, with external support (workshops)</td><td>Detailed</td><td>Public – NPA</td></tr>
<tr><td colspan="3">RELATED DOCUMENTS / INFORMATION
— ToR RMT.0741, issued on 30 August 2023
— SIB 2016-02R1 (Use of Erroneous Parameters at Take-off), issued on 6 September 2021
— EASA website safety promotion related to 'Erroneous Take-Off Performance Data'</td></tr>
<tr><td colspan="3">PLANNING MILESTONES: Refer to the latest edition of the EPAS Volume II.</td></tr>
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1. About this NPA

1.1. How this regulatory material was developed

The European Union Aviation Safety Agency (EASA) identified the need to mitigate a safety risk (as described in Chapter 2), and, after having assessed the impacts of the possible intervention actions and having consulted those with the EASA Advisory Bodies, identified rulemaking as the necessary intervention action.

This rulemaking activity is included in the 2025 edition of Volume II of the European *Plan for Aviation Safety* (EPAS)[1] under Rulemaking Task (RMT).0741.

EASA developed the regulatory material in question in line with Regulation (EU) 2018/1139[2] (the Basic Regulation) and the Rulemaking Procedure[3], as well as in accordance with the objectives and working methods described in the Terms of Reference (ToR) for this RMT[4].

When developing the regulatory material, EASA received the advice of the industry (CS-25 large aeroplane manufacturers, avionics manufacturers) and partner foreign aviation authorities (the Brazilian National Civil Aviation Agency (ANAC), the Federal Aviation Administration (FAA) of the United States, Transport Canada Civil Aviation (TCCA)) during three workshops that were organised by EASA in November 2023, March 2024 and May 2024.

1.2. How to comment on this NPA

The draft regulatory material is hereby submitted for consultation with all interested parties.

NPA 2025-01 is divided into fours parts: (A), (B), (C) and (D). The present NPA 2025-01 (A) includes the background information pertaining to the regulatory proposal. NPAs 2025-01 (B), (C) and (D) include the proposed amendments.

Please submit your comments using the **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[5].

To facilitate the collection and technically support the subsequent review of comments by EASA in an efficient, controlled and structured manner, stakeholders are kindly requested to submit their

1 European Plan for Aviation Safety (EPAS) 2025 - 14th edition | EASA.

2 Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (OJ L 212, 22.8.2018, p. 1) (http://data.europa.eu/eli/reg/2018/1139/oj).

3 EASA is bound to follow a structured rulemaking process as required by Article 115(1) of Regulation (EU) 2018/1139. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 01-2022 of 2 May 2022 on the procedure to be applied by EASA for the issuing of opinions, certification specifications and other detailed specifications, acceptable means of compliance and guidance material ('Rulemaking Procedure'), and repealing MB Decision No 18-2015 (EASA MB Decision No 01-2022 on the Rulemaking Procedure, repealing MB Decision 18-2015 (by written procedure) | EASA (europa.eu)).

4 ToR RMT.0741 - Take-off performance parameters and position errors — large aeroplanes | EASA

5 In the event of technical problems, please send an email with a short description to crt@easa.europa.eu.

comments to the respective predefined segments of the NPA within the CRT and to refrain from submitting specific comments or all their comments to the 'General Comments' segment.

Further, once all comments have been submitted to the respective predefined segments, there is no need to submit them (as a pdf attachment) to the 'General Comments' segment.

The deadline for the submission of comments is **3 October 2025.**

1.3. The next steps

Following the consultation of the draft regulatory material, EASA will review all the comments received and will duly consider them in the subsequent phases of this rulemaking activity.

Considering the above, EASA may:

— issue a Decision amending CS-25;

— issue an Opinion proposing to amend Commission Regulation (EU) 2015/640[6]; the Opinion will be submitted to the European Commission, which shall consider its content and decide whether to issue amendments to that Regulation;

— following the amendment of Commission Regulation (EU) 2015/640, issue a Decision amending CS-26 to support the application of the Regulation.

When issuing the Opinion and/or Decision(s), EASA will also provide feedback to the commentators and information to the public on who engaged in the process and/or provided comments during the consultation of the draft regulatory material, which comments were received, how such engagement and/or consultation was used in rulemaking and how the comments were considered.

[6] Commission Regulation (EU) 2015/640 of 23 April 2015 on additional airworthiness specifications for a given type of operations and amending Regulation (EU) No 965/2012 (OJ L 106, 24.4.2015, p. 18) (http://data.europa.eu/eli/reg/2015/640/oj).

2. In summary — why and what

2.1. Why we need to act

2.1.1. Identified safety issue and priority

Incidents and accidents involving large aeroplanes used in commercial air transport (CAT), resulting from the use of erroneous take-off performance parameters or errors made during the positioning of the aeroplane for initiation of the take-off, are regularly reported.

This safety issue is considered one the highest safety risk priorities and one of the main common safety issues, contributing to runway excursions and aircraft upset key risk areas, as explained in more detail in the following section. In Volume I, Section 3.3.1.1, of the 2023–2025 EPAS, these two key risk areas are identified as strategic priorities.

In the EASA *2022 Annual Safety Review (ASR)*[7], the 'entry of aircraft performance data' was identified as a Priority 1 safety issue for large aeroplanes. It is one of the main common safety issues contributing to runway excursions and aircraft upset key risk areas.

In the EPAS 2023–2025 Volume III, the 'entry of aircraft performance data' (SI-0015) is recorded in the list of Commercial Air Transport – Aeroplanes (CAT A) safety issues per category and priority, and it is categorised as 'mitigate – implement', which means the implementation and follow-up of safety actions. 'To mitigate this safety issue, technical solutions are being considered for the long term; in the short to medium term, the focus will be on improvements to SOPs.' This safety issue is identified as a higher-risk safety issue in the EU aviation system (p. 13) as per the Safety Issue Priority Index (SIPI)[8].

This prioritisation considers the various incidents and accidents involving large aeroplanes that occurred in the past years as a result of:

— the use of erroneous data in aeroplane systems to set the take-off performance parameters;

— errors in the positioning of the aeroplane for initiation of take-off (e.g. incorrect runway intersection, incorrect runway, taxiway);

— errors in the configuration of the aeroplane for take-off (e.g. incorrect pitch trim setting due to erroneous determination of the centre of gravity (CG)).

Within the investigation reports of those incidents and accidents, a number of safety recommendations have been addressed to EASA by various safety investigation authorities.

2.1.2. EASA best intervention strategy development overview

A best intervention strategy (BIS) follows an impact assessment approach. The BIS is an assessment of an issue that presumably deserves the intervention of EASA, with the aim of determining which actions are the most appropriate to address the issue. It will define the alternative intervention strategies,

[7] Annual Safety Review 2022 | EASA

[8] A method to prioritise safety issues in the European safety risk management process by considering residual risk and other additional elements. For more information on the index, please read Volume III of the EPAS.

including a combination of actions (e.g. safety promotion, research/studies, rulemaking, evaluations, Member State actions or 'do nothing'). The conclusion is the selection of the BIS to address an issue.

EASA 2016 BIS

The 'entry of aircraft performance data' (SI-0015) was identified by EASA as a top safety issue in the *2016 EASA ASR*, and a BIS was developed in 2016 as per the EASA safety risk management process. The following safety actions were then initiated as the outcome of that BIS.

— In 2016, the EASA safety information bulletin (SIB) 2016-02 *Use of Erroneous Parameters at Take-off* was published with the purpose of:

  — raising flight crews, operators and competent authorities' awareness of the specific hazard;

  — providing recommendations to operators on the completion of a specific safety risk analysis and assessment related to this issue, in order to assess the effectiveness of mitigation measures in place and determine the need for additional or alternative action(s);

  — providing recommendations on training items to be emphasised during flight crew initial and recurrent training to increase awareness of the issue; and

  — providing recommendations on the use of the flight data monitoring (FDM) programme to identify precursor events.

— AMC 20-25A, 'Airworthiness considerations for Electronic Flight Bags (EFBs)' (subsequently published in 2019), and Commission Implementing Regulation (EU) 2018/1975[9] (published in 2018) (as regards air operations requirements for EFBs) and the related AMC & GM (published in 2019), were developed in order to adopt the related International Civil Aviation Organization (ICAO) EFBs Standards and Recommended Practices (SARPs).

The 'Minimum Operational Performance Standard (MOPS) for Onboard Weight and Balance Systems', EUROCAE Document ED-263, was developed as an outcome of the work of the EUROCAE WG-88, 'On-Board Weight and Balance System' with EASA participation. The MOPS was subsequently introduced in CS-25 in 2020 as an acceptable means of compliance (AMC) through the creation of AMC 25-1 'On-board weight and balance systems'.

Additionally, the EUROCAE WG-94, 'Take-Off Performance Monitoring System (TOPMS)', was launched and closed in 2015, with the conclusion that the development of standards to define performance requirements and operational conditions for TOPMS was not possible at that time, due to multiple factors, including the lack of maturity of the required technology. Therefore, no EUROCAE WG-94-related actions were retained in the 2016 BIS.

[9] Commission Implementing Regulation (EU) 2018/1975 of 14 December 2018 amending Regulation (EU) No 965/2012 as regards air operations requirements for sailplanes and electronic flight bags (OJ L 326, 20.12.2018, p. 53) (http://data.europa.eu/eli/reg_impl/2018/1975/oj).

EASA 2019 BIS

The BIS was updated in 2019 and concluded that further review of the effectiveness of the previously mentioned actions should be performed. As a result, the following actions were then initiated as the outcome of that BIS.

— SIB 2016-02 *Use of Erroneous Parameters at Take-off* was updated in 2021 (and renamed as 2016-02R1) to develop the recommendations on the use of the FDM programme. According to SIB 2016-02R1, the FDM programme can be used:
  - — to identify the precursors which the operator is recommended to monitor in order to detect possible events related to take-off performance;
  - — as a way to complement the occurrence reporting or detect those events that are not noticed by the flight crew;
  - — as a source of information for the operators on assessing the frequency and severity of these types of events.

— Safety promotion material was developed for a web page on the EASA website, including an 'erroneous data parameters' video made by Together4Safety, to illustrate this key aspect of flight safety and to outline five key practices that flight crews can follow to reduce the likelihood of using erroneous take-off data (https://www.easa.europa.eu/en/erroneous-take-performance-data).

EASA 2023 BIS

Since the 2019 BIS:

— additional incidents and accidents caused by the use of erroneous take-off performance parameters have occurred despite the actions taken. As a result, additional safety recommendations have been addressed to EASA, with some of them recommending to reassess the availability of potential design solutions to mitigate this safety issue;

— the technology required for the development of certain design solutions to mitigate the safety risk (e.g. TOPMS) has reached maturity, and several of those design solutions have been developed by the industry and certified by EASA.

The 2023 BIS was mainly focused on examining the effectiveness of the technological solutions available on the market that could mitigate the safety risk.

The conclusion of the review proposed a new action of 'new design specifications for the installation on large aeroplanes of mitigation means to protect against erroneous take-off performance parameters and position errors', focusing on design solutions. This new action will complement the existing actions from the previous versions of the BIS. The action consists of two sub-actions:

— for new type certificates (TCs) and certain Major Changes to TC (CS-25);

— for already type-certificated large aeroplanes (Part-26).

RMT.0741 was then created to initiate this action.

2.1.3. Description of the safety issue

2.1.3.1. Summary of causal factors involved and consequences

A variety of causal factors are involved in the above-mentioned reported occurrences, as summarised below.

The use of incorrect take-off performance parameters due to either errors made during the calculation of performance parameters or input errors made when entering correctly calculated performance parameters in aeroplane systems (e.g. flight management system (FMS)). The following errors have been encountered:

— incorrect weight values used, including use of an incorrect zero fuel weight (ZFW) value for take-off weight (TOW) calculation, use of the ZFW value or other value (e.g. empty weight) instead of TOW, use of a previous flight TOW, various errors made when using the EFBs, typing errors when entering weight values (e.g. ZFW) in the FMS, and errors in the load sheet provided to the flight crew;

— incorrect available runway length used, for example not taking into account a notice to airmen (NOTAM) (maintenance work), use of an incorrect runway chart or errors made during re-calculation after a runway/intersection change;

— incorrect assumed temperature used for thrust reduction calculation (e.g. incorrect entry in the FMS or other system);

— incorrect thrust selection in the FMS (e.g. fix derate);

— incorrect reference speeds entered in the FMS (calculation or typing errors) or no speeds entered;

— incorrect configuration (e.g. pitch trim setting) due to erroneous determination of the CG (e.g. in the load sheet) or changes in the actual passenger distribution compared with load sheet assumptions; and

— errors in the positioning of the aeroplane for initiation of take-off, for example take-off from a runway position providing a length shorter than that assumed for the calculation of take-off performance parameters (i.e. incorrect runway or incorrect runway intersection), or take-off from a taxiway.

These errors have resulted in various consequences and safety effects, including the following.

— A longer take-off roll, failure of the rotation or initial climb, collision with obstacles beyond the runway end (runway excursion), loss of control and fatal crash.

— A take-off performed without the flight crew noticing the abnormal situation and not taking any corrective action but with degraded performance and safety margins (e.g. longer take-off roll, slower rotation, decreased speed margins). In some cases, should an engine failure have occurred, the flight crew would either not have been able to stop the aeroplane on the runway after a rejected take-off or not have been able to clear obstacles during the continued take-off and climb, with potentially catastrophic consequences.

— A take-off performed but with a collision with runway end lights or antennas, and/or a tailstrike. A fatal accident (from a high-energy runway excursion or loss of control) has sometimes been avoided by pure luck. An engine failure during such a take-off could be catastrophic.

— A rejected take-off, sometimes preceded by a tailstrike.

— A rejected take-off and runway excursion with no fatal consequence.

2.1.3.2. Safety recommendations addressed to EASA

The following safety recommendations have been addressed to EASA in the domain of design mitigation means.

CAND-2006-007 (accident (fatal) to Boeing 747-244B (SF), registration 9G-MKJ, 14 October 2004, in Halifax International Airport, Canada, causal factor: use of previous flight TOW in the EFB): 'The Board recommends that the Department of Transport, in conjunction with the International Civil Aviation Organization, the Federal Aviation Administration, the European Aviation Safety Agency, and other regulatory organisations, establish a requirement for transport category aircraft to be equipped with a take-off performance monitoring system that would provide flight crews with an accurate and timely indication of inadequate take-off performance.'

FRAN-2005-001 (accident (fatal) to Boeing 727-223, registration 3X-GDO, 25 December 2003, in Cotonou Cadjèhoun Aerodrome, Republic of Benin, causal factor: overloaded aeroplane with forward CG (values unknown to the flight crew)): 'The BEA recommends that the Civil Aviation Authorities, in particular the FAA in the United States and the EASA in Europe, modify the certification requirements so as to ensure the presence, on new generation aeroplanes to be used for commercial flights, of on-board systems to determine weight and balance, as well as recording of the parameters supplied by these systems. The BEA recommends that the Civil Aviation Authorities put in place the necessary regulatory measures to require, where technically possible, retrofitting on aeroplanes used for commercial flights of such systems and the recording of the parameters supplied.'

FRAN-2008-328 (BEA France study on the *Use of Erroneous Parameters at Takeoff*, report dated May 2008): 'Improve the certification norms so that computers trigger crew warnings or activate protection systems when inconsistent data are inputted, obviously erroneous or far from usual values.'

FRAN-2018-022 (serious incident to Boeing 777-F, registration F-GUOC, 22 May 2015, in Paris Charles-de-Gaulle Airport, France, causal factor: error (100 t) in the weight used to calculate the take-off performance parameters): 'EASA, in the scope of an update of its impact assessment, assess the safety benefit of TOPMS-type systems, taking into account, in particular, the existing systems (Airbus TOM).'

FRAN-2018-023 (serious incident to Boeing 777-F, registration F-GUOC, 22 May 2015 in Paris Charles-de-Gaulle Airport, France, causal factor: error (100 t) in the weight used to calculate the take-off performance parameters): 'EASA, in the scope of an update of its impact assessment, assess the safety benefit of gross error detection / warning systems, taking into account, in particular, existing systems (Airbus TOS, Boeing FMS/EFB messages and protections, Lufthansa Systems LINTOP, etc.).'

FRAN-2018-024 (serious incident to Boeing 777-F, registration F-GUOC, 22 May 2015, in Paris Charles-de-Gaulle Airport, France, causal factor: error (100 t) in the weight used to calculate the take-off performance parameters): 'EASA, in coordination with the FAA, incite manufacturers to develop, for commercial aeroplanes which are the most prevalent and the most exposed to this risk, systems adapted to the characteristics of each aeroplane family, providing increased protection against the use of erroneous parameters at take-off.’

NETH-2007-004 (accident to Boeing McDonnell Douglas MD-88, registration TC-ONP, 17 June 2003, in Groningen Airport Eelde, the Netherlands, causal factor: inadequate pitch trim setting): ‘It is recommended to the Civil Aviation Authority, the Netherlands (IVW) to develop certification requirements for aircraft from the civil aviation category, to provide weight and CG measurements to the crew of new aircraft and to investigate the possibility to provide these data with existing aircraft.’

NETH-2018-001 (investigation of two serious incidents (September 2014 in Groningen Airport Eelde, the Netherlands (causal factor: incorrect TOW used for take-off performance calculation); September 2015 in Lisbon Airport, Portugal (causal factor: take-off performance calculated for an incorrect runway/take-off position combination due to an EFB input error) with the Boeing 737-800): ‘To prioritise the development of specifications and the establishment of requirements for Onboard Weight and Balance Systems (OWBS).’

NETH-2018-002 (investigation of two serious incidents (September 2014 in Groningen Airport Eelde, the Netherlands (causal factor: incorrect TOW used for take-off performance calculation), September 2015, in Lisbon Airport, Portugal (causal factor: take-off performance calculated for an incorrect runway/take-off position combination due to an EFB input error) with the Boeing 737-800): ‘To, in cooperation with other regulatory authorities, standardisation bodies, the aviation industry and airline operators, start the development of specifications and the establishment of requirements for Take-off Performance Monitoring Systems without further delay.’

NETH-2020-001 (serious incident to Boeing 777, registration VT-JEW, 21 April 2017, in Amsterdam Airport Schiphol, the Netherlands): ‘To European Union Aviation Safety Agency: To take the initiative in the development of specifications and, subsequently, develop requirements for an independent on board system that detects gross input errors in the process of take off performance calculations and/or alerts the flight crew during take off of abnormal low accelerations for the actual aeroplane configuration as well as insufficient runway length available in case of intersection take offs. Take this initiative in close consult with the aviation industry, including manufacturers of commercial jetliners amongst which in any case The Boeing Company.’

UNKG-2009-080 (serious incident to Airbus A330-243, registration G-OJMC, 28 October 2008, in Sangster International Airport, Montego Bay, Jamaica, causal factor: incorrect TOW used for take-off performance calculation): ‘It is recommended that the European Aviation Safety Agency develop a specification for an aircraft take-off performance monitoring system which provides a timely alert to flight crews when achieved take-off performance is inadequate for given aircraft configurations and airfield conditions.’

UNKG-2009-081 (serious incident to Airbus A330-243, registration G-OJMC, 28 October 2008, in Sangster International Airport, Montego Bay, Jamaica, causal factor: incorrect TOW used for take-off performance calculation): ‘It is recommended that the European Aviation Safety Agency establish a requirement for transport category aircraft to be equipped with a take-off performance monitoring system which provides a timely alert to flight crews when achieved take-off performance is inadequate for given aircraft configurations and airfield conditions.’

UNKG-2018-014 (serious incident to Boeing 737-800, registration C-FWGH, 21 July 2017, in Belfast International Airport, United Kingdom, causal factor: incorrect outside air temperature (OAT) value entered by the flight crew in the flight management computer (FMC)): 'It is recommended that the European Aviation Safety Agency, in conjunction with the Federal Aviation Administration, sponsor the development of technical specifications and, subsequently, develop certification standards for a Takeoff Acceleration Monitoring System which will alert the crew of an aircraft to abnormally low acceleration during takeoff.'

2.1.3.3. Analysis of the reported occurrences

(a) Analysed occurrences

EASA analysed the reported occurrences (accidents, serious incidents, incidents) involving the causal factors described in Section 2.1.1.1 (take-off performance parameters and position errors). The analysis gathered 118 occurrences worldwide between 1998 and 2023 (Figure 1) that were investigated by safety investigation authorities.

The breakdown of the 118 occurrences is as follows: 18 accidents (including 5 fatal), 74 serious incidents and 26 incidents (Figure 2).

The list of occurrences with the related descriptions is provided in Appendix 3 to this NPA.

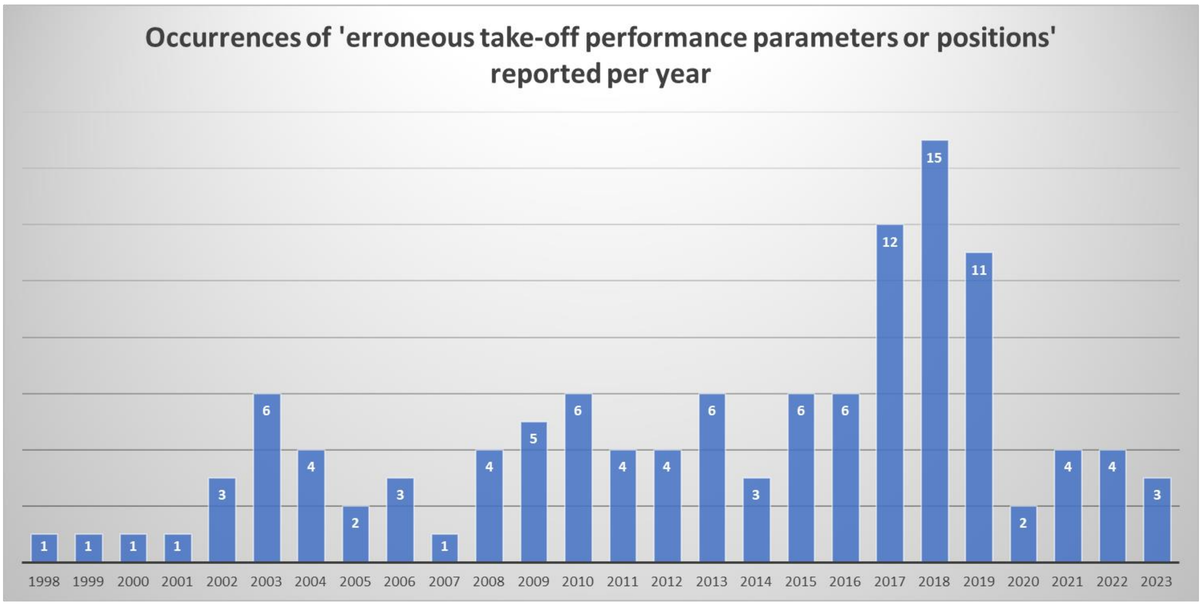

Figure 1. Yearly distribution of the reported occurrences (overall)

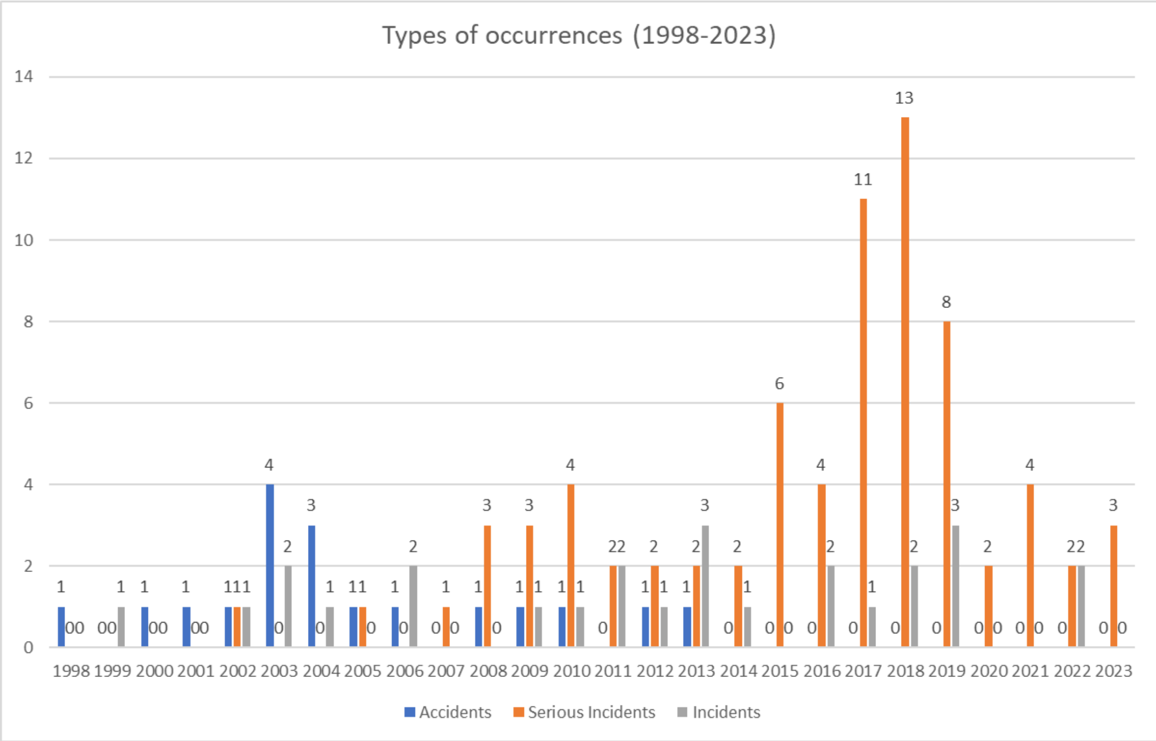

Figure 2. Yearly distribution of the reported occurrences (by type of occurrence)

These occurrences resulted in a total of 283 fatalities, 63 serious injuries and 39 minor injuries, distributed as shown in Figure 3.

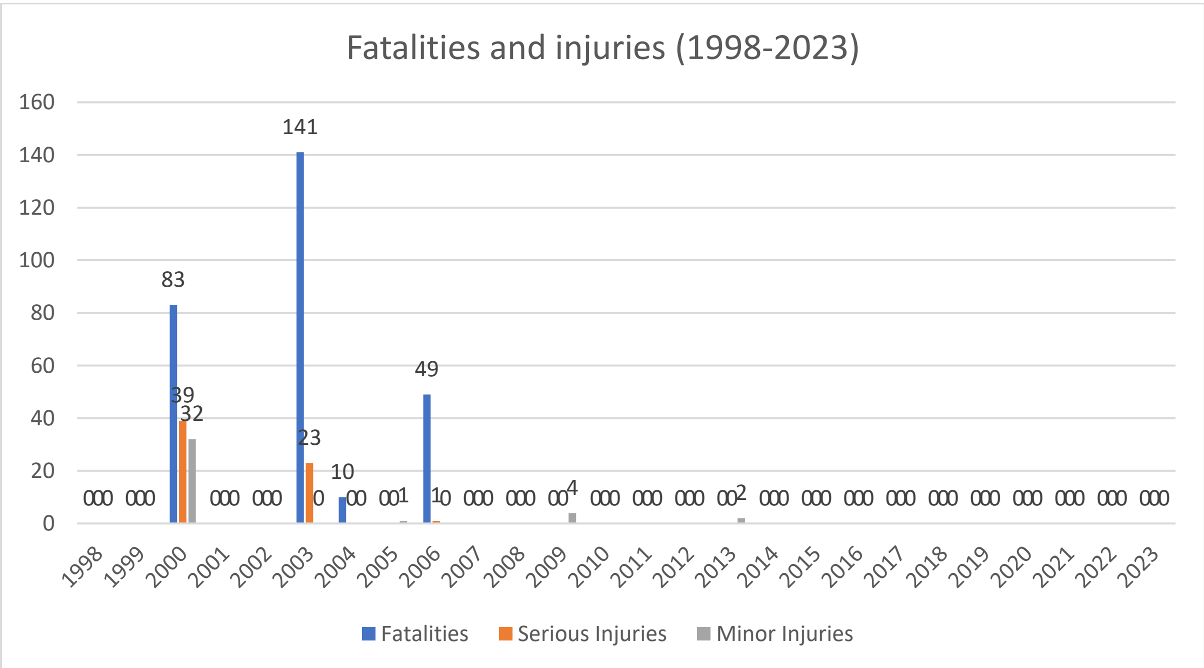

Figure 3. Yearly distribution of fatalities and injuries

(b) Types of errors

The following potential types of errors have been identified. Each analysed occurrence was allocated an error type. In the first column of Figure 4, the total number of occurrences actually involving each type of error is indicated.

Position	Error Type	Incorrect Position
23	POS_1	Wrong A/C position (T/O initiated from planned position (RUNWAY, INTERSECTION), **programmed position INCORRECT** (wrong value entered into FMS)
26	POS_2	Wrong A/C position (**T/O initiated from INCORRECT position (RUNWAY, INTERSECTION, TAXIWAY)**, programmed position CORRECT (correct value entered into FMS)
6	POS_3	Wrong A/C position (**NOTAM** not respected; e.g., displaced threshold)
0	POS_4	Wrong A/C position (**Threshold** not respected; e.g., poorly executed takeoff procedure, rolling takeoff)
0	POS_5	Inadequate available runway distance (distance of selected/used runway ≤ T/O distance needed based upon data entered in FMS (TOW, Thrust, OAT/FLEX, Vr/V2, displaced threshold)
0	POS_6	Inadequate RTO distance (distance remaining insufficient to stop)
Weight and Balance (load sheet, EFB,		**Incorrect Payload**
2	WB_1	**Computation error - manual calculation**
1	WB_2	Input error - Number of Passengers
0	WB_3	Input error - Average Weight of Passengers
5	WB_4	Input error - Distribution of Passengers/Fuel
0	WB_5	Dispatch error - Number of Passengers
1	WB_6	Dispatch error - Average Weight of Passengers
3	WB_7	Dispatch error - Distribution of Passengers/Fuel
		Incorrect Fuel On Board (less than actual)
1	WB_8	Input error - Total Fuel onboard
0	WB_9	Dispatch error - Total Fuel onboard
		Incorrect TOW (less than actual)
14	WB_10	Input error - ZFW used for TOW (TOW=ZFW)
17	WB_11	Input error - manual input error
		Incorrect ZFW
1	WB_12	Out of range **(ZFWMIN ≤ ZFW ≤ ZFWMAX)**
A/C Configuration		**Correct setting in entered in FMS, lever/control put in INCORRECT Position**
1	TRIM_01	Incorrect configuration (trim, slat, flap) for takeoff (based on takeoff phase of flight)
1	THRUST_01	Incorrect thrust selected
		INCORRECT setting in FMS, lever in CORRECT Position
0	TRIM_02	Incorrect configuration (trim, slat, flap) for takeoff (based on FMS values of weight/runway distance etc)
4	THRUST_02	Incorrect thrust selected
		Incorrect FMS T/O Speeds
1	SPEED_01	Input error - T/O Speeds out of range **(V1 ≤ VR ≤ V2)**
0	SPEED_02	Input error - T/O Speeds **(V1 ≤ VR ≤ V2) ≤ minimums**
1	SPEED_03	Input error - T/O Speeds not calculated/available in FMS
0	SPEED_04	Input error - T/O Speeds not available (e.g., not entered, after runway change in FMS)
		Incorrect FLEX Setting
7	TEMP_01	Incorrect OAT entered into FMS
0	TEMP_02	Incorrect Static Air Temp (SAT) entered in FMS
3	TEMP_03	Incorrect FLEX temp (SAT ≥ FLEX Temp)
0	OTHER_01	Residual braking
0	OTHER_02	Aerodynamic degradation
0	OTHER_03	Deflated Tyre
0	OTHER_04	Asymmetric Thrust
0	OTHER_05	Wind
Total		
118		

Figure 4. Types of errors

Figures 5–9 show the distribution of the types of errors.

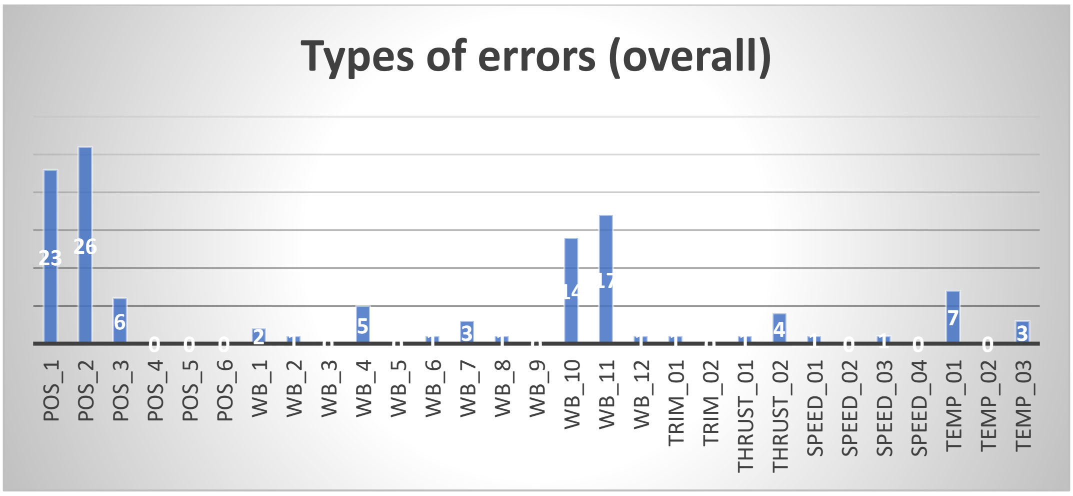

Figure 5. Overall distribution of the various types of errors

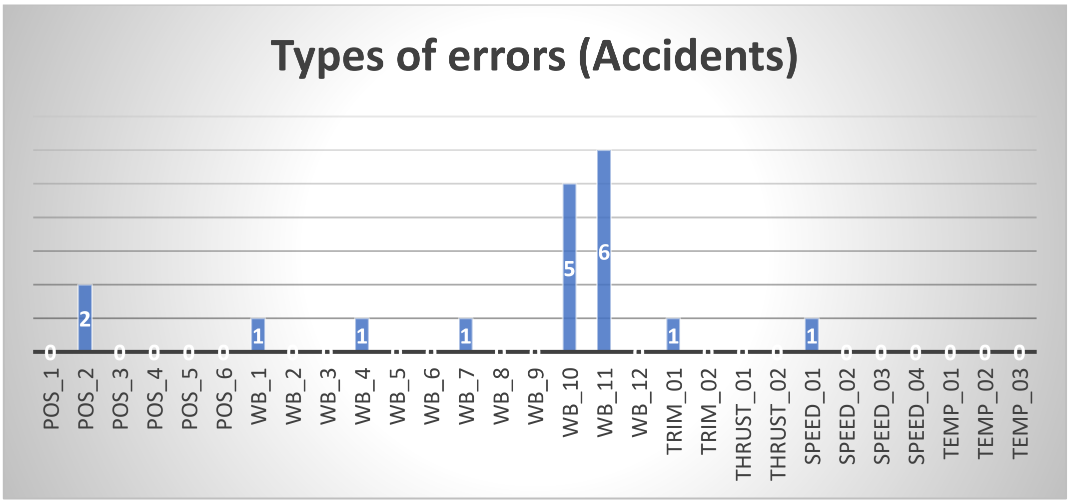

Figure 6. Distribution of the various types of errors for accidents

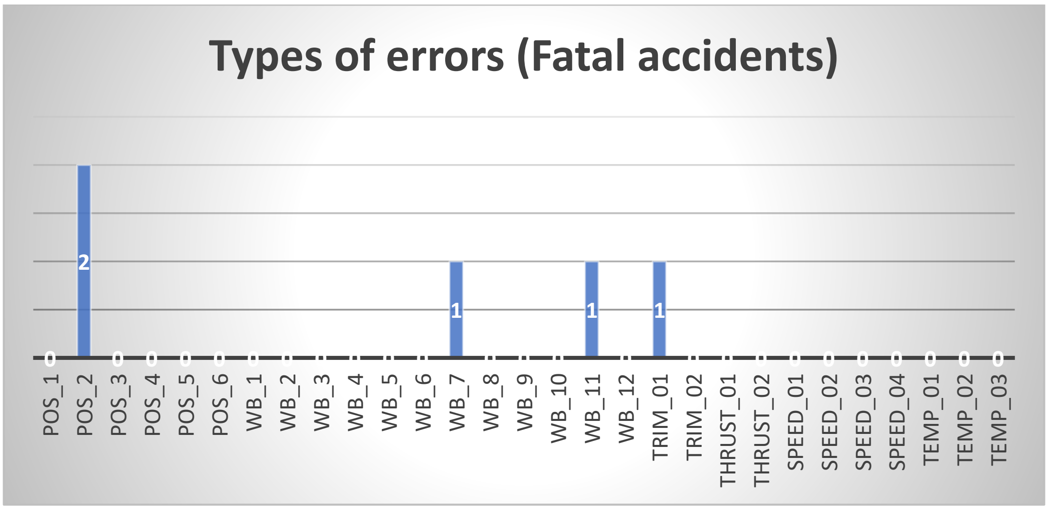

Figure 7. Distribution of the various types of errors for fatal accidents

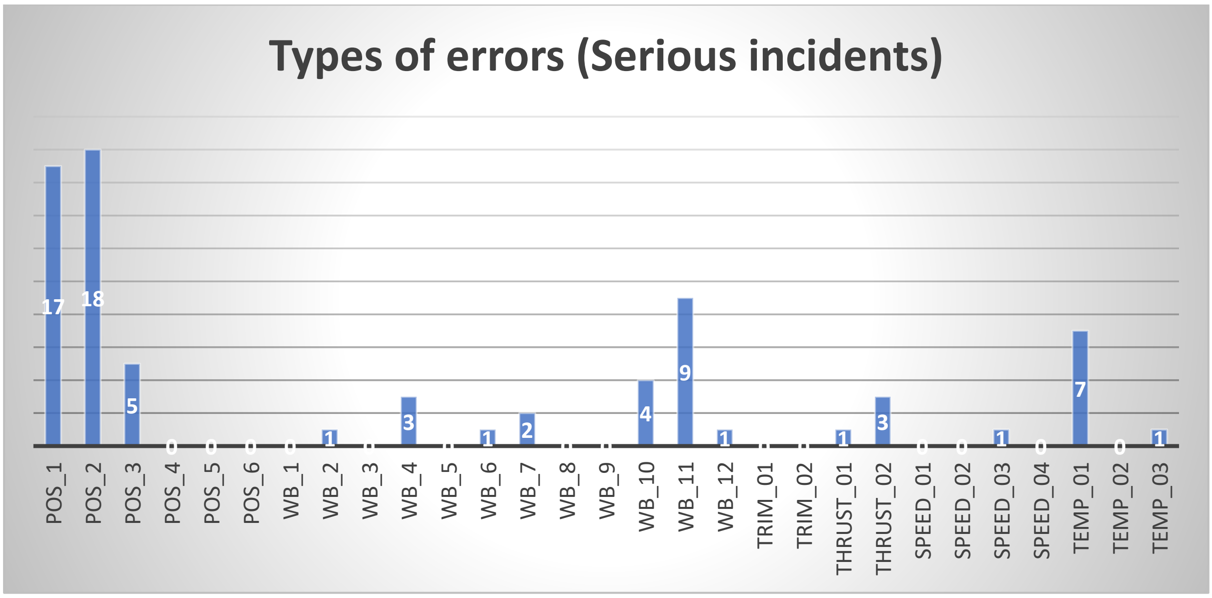

Figure 8. Distribution of the various types of errors for serious incidents

Occurrences per Manufacturer		**Accidents per Manufacturer**		**Fatal Accidents per Manufacturer**	
Airbus	42	Airbus	3	Airbus	0
ATR	1	ATR	0	ATR	0
Boeing	64	Boeing	10	Boeing	3
Bombardier	1	Bombardier	1	Bombardier	1
Dassault Aviation	1	Dassault Aviation	0	Dassault Aviation	0
Embraer	4	Embraer	0	Embraer	0
Gulfstream Aerospace	1	Gulfstream Aerospace	0	Gulfstream Aerospace	0
Ilyushin	1	Ilyushin	1	Ilyushin	1
McDonnell Douglas	3	McDonnell Douglas	3	McDonnell Douglas	0
Total	**118**	Total	**18**	Total	**5**

Figure 9. Distribution of the aeroplane manufacturers involved in occurrences

2.1.4. Who is affected by the issue

The domain affected by this safety issue is CAT by CS-25 large aeroplanes.

The main organisations affected by this safety issue are large aeroplane manufacturers, large aeroplane operators, aerodrome operators and air traffic management/air navigation service providers.

2.1.5. How could the issue evolve

EASA regularly receives reports of occurrences showing that the preventive actions taken so far (e.g. SIBs, safety promotion, FDM programmes, operator procedures and training upgrades, EFB upgrades) do not significantly change the trend. Often, various serious incidents did not develop into catastrophic accidents only as a matter of luck, thereby giving rise to concern for all stakeholders.

Meanwhile, some manufacturers have developed some promising on-board design solutions to alert pilots to errors, while others have not taken any action. Without a rulemaking action to mandate the installation and use of on-board design solutions, it is probable that their implementation will remain heterogeneous and the decrease in the safety risk will remain minimal. There will probably be significant differences in terms of protection between aeroplane manufacturers and types, ranging from well protected to not protected at all.

2.1.6. Conclusion on the need for rulemaking

EASA concluded, as explained further in Chapter 3, that an intervention was necessary and that non-regulatory actions cannot effectively mitigate the issue. Therefore, amendments to CS-25 and Commission Regulation (EU) 2015/640 are required. Following the amendments to Commission Regulation (EU) 2015/640, amendments to CS-26 will be required to support the application of the Regulation.

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 1 of the Basic Regulation. The regulatory material presented here is expected to contribute to achieving these overall objectives by addressing the issue described in Section 2.1.

More specifically, with the regulatory material presented here, EASA intends to mitigate, using on-board design means of protection, the risk of large aeroplane accidents or incidents caused by the use of erroneous take-off performance parameters and erroneous take-off positions.

2.3. How we want to achieve it — overview of the proposed amendments

It is envisaged that some large aeroplanes will require to be equipped with a TOPMS, incorporating the following functions that will be designed to detect and give timely alerts to the flight crew of some performance parameters or position errors.

— F1. Check and alert on errors in the aeroplane take-off performance parameters (input and selection in FMS or equivalent).

— F2. Check and alert on errors in the aeroplane position and heading at start of take-off.

— F3. Real-time take-off performance monitoring and alerting.

It is proposed to amend CS-25 to require that all new large aeroplane designs (i.e. new TCs and, if applicable, certain Major changes to TCs as determined by the Changed Product Rule of Commission Regulation (EU) No 748/2012[10]) are equipped with a TOPMS, including functions F1 and F2. In addition, some 'large transport aeroplane' designs (see explanation of this term below) would also have to be equipped with function F3. A new CS 25.704 'Take-off performance monitoring system' would be created, as well as the corresponding GM 25.704 and AMC 25.704.

In order to improve safety on already certified large aeroplane designs, it is proposed to amend Commission Regulation (EU) 2015/640 (including its Annex I (Part-26)) to require that large aeroplanes produced after a certain date (six years after entry into force of the amending regulation) and operated for CAT are equipped with a TOPMS, including functions F1 and F2. In addition, some large transport aeroplanes would also have to be equipped with function F3. A new point 26.204 'Take-off performance monitoring system' would be inserted in Part-26.

To support the demonstration of compliance with point 26.204 of Part-26, an amendment of CS-26 is proposed with the creation a new CS 26.204 'Take-off performance monitoring system' and a corresponding GM 26.204.

The term 'large transport aeroplane' is defined in this NPA such as to exclude business jets and regional turboprop aeroplanes. Large VIP business jets (e.g. the Airbus ACJ319/320 or similar types of aeroplane from other manufacturers) are not excluded.

The targeted applicability of the regulatory material is as follows.

— CS-25 amendment. It would enter into force the day following that of the publication of the ED Decision (anticipated to take place mid 2026).

— Amendment of Commission Regulation (EU) 2015/640 (Part-26): the amending regulation would enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union* (anticipated to happen end 2026). However, point 26.204 would

[10] Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (recast) (OJ L 224, 21.8.2012, p. 1) (http://data.europa.eu/eli/reg/2012/748/oj).

require new aeroplanes to be compliant from a date six years after the entry into force of the amending regulation (which would be early 2033).

Legal basis for the opinion proposing an amendment of Commission Regulation (EU) 2015/640 (Part-26):

Article 17(h) of the Basic Regulation reads: 'In order to ensure the uniform implementation of and compliance with the essential requirements referred to in Article 9, for the aircraft referred to in points (a) and (b) of Article 2(1), other than unmanned aircraft, and their engines, propellers, parts and non-installed equipment, the Commission shall, on the basis of the principles set out in Article 4 and with a view to achieving the objectives set out in Article 1, adopt implementing acts laying down detailed provisions concerning: …

(h) additional airworthiness requirements for products, parts and non-installed equipment, the design of which has already been certified, needed to support continuing airworthiness and safety improvements'.

2.4. What are the stakeholders' views

Stakeholders' views were gathered during three workshops held by EASA (refer to Section 1.1). During these workshops, EASA presented the CS-25 amendment concept (with the envisaged TOPMS functions) and initiated a discussion on a Part-26 rule.

Airbus, Boeing, Embraer and avionics suppliers were positive with regard to the objectives presented by EASA (i.e. mandating the above three functions in CS-25 and mandating their implementation in production). A retrofit is not supported due to technical show stoppers and the prohibitive costs for various old designs. Airbus has already begun developing and certifying these functions. Production implementation has been partially achieved, depending on the aeroplane type, and the possibility of retrofit is being proposed as far as possible to customers, as many have voiced an interest in that possibility. Boeing and Embraer are developing such functions with the intention of introducing them on newly produced aeroplanes.

ATR, Dassault Aviation, De Havilland (for the DHC-8) and Textron invited EASA to take into account the fact that their aeroplanes are less exposed to some of the errors, in particular the ones leading to insufficient take-off thrust/power, because the design either includes a fixed thrust/power derate selection device (DHC-8) or does not allow to select a thrust/power derate at all (ATR, Textron and some Dassault Aviation types); these aeroplanes are not equipped with flexible temperature thrust reduction systems (like turbofan-powered jets), which is a source of error when calculating/entering the flex temperature.

De Havilland considered that the data available does not justify a mandate for its aeroplane, and that, from its standpoint, it cannot make a business case owing to the anticipated costs of development of the functions. The production of the DHC-8 is paused right now. No system development has been planned, including a runway overrun awareness and alerting system (ROAAS).

ATR aeroplanes are equipped with a new avionics suite that would require further modification to obtain sufficient on-ground position precision (GPS data to be coupled with inertia data). The avionics capability will be close to its limit when a ROAAS will be implemented. The addition of take-off safety functions may require an expansion of the memory and processing capabilities. No technical show stoppers exist; however, costs will be generated.

ATR suggested considering setting up take-off safety function requirements as a function of aeroplane categories.

Dassault Aviation did not consider a retrofit requirement reasonable. A production cut-in is recommended; however, the rule should prioritise the 'static' functions (F1 and F2). The 'dynamic' function F3 may not be justified for aeroplanes that do not have a thrust/power derate function.

Garmin and Collins Aerospace mentioned that the function F3, which is dynamic, will be more difficult to develop, as it requires cooperation and data exchanges with the aeroplane manufacturers. However, no major technical issue is expected.

3. Expected benefits and drawbacks of the proposed regulatory material

EASA assessed that an intervention was required and that amendments to CS-25 and to Commission Regulation (EU) 2015/640 are necessary to effectively address the issue described in Section 2.1, as the objectives described in Section 2.2 cannot be achieved effectively by non-regulatory action.

When developing the proposed regulatory material, EASA identified different regulatory options on how to achieve the objectives and assess their impacts. Please refer to Appendix 1, Section 2.3.

The options selected for CS-25 and Part-26 are considered the optimal choice to guarantee an improvement in safety in the years to come while limiting manufacturers' efforts in the development and implementation of mitigation functions to the most beneficial cases. They include proportionality, as the effort demanded of the aeroplane manufacturers has been adapted to the level of risk identified by the analysis of occurrences: business jets and turboprop aeroplanes would not be required to implement a dynamic take-off performance monitoring function (F3) in their TOPMS.

The safety benefit analysis concluded that the combination of the proposed TOPMS functions (already certified and implemented by some stakeholders) is highly effective in mitigating the safety risk identified (erroneous take-off performance parameters and erroneous take-off positions). Almost 90 % of the occurrences analysed could have been prevented if the aeroplanes had been equipped with the design functions proposed to be mandated.

The combined amendments of CS-25 and of Commission Regulation (EU) 2015/640 (Annex I Part-26) could achieve a 92 % fleet implementation rate 25 years after entry into force of the amending decision/regulation.

The costs involved for aeroplane manufacturers are considered low to very low when compared with their annual turnover. Additional indirect costs arising for operators (e.g. crew training, procedures/checklists updates) are considered minimal and acceptable.

As the risk at stake involves the possibility of accidents, including fatal ones, an economic benefit is also expected from the prevention of such occurrences (the associated costs are set out in Appendix 1, Section 4.4).

The proposed regulatory material has hence been developed in view of the better regulation principles, and in particular the regulatory fitness principles.

4. Proposed regulatory material

Please refer to:

— NPA 2025-01 (B) Proposed amendment to CS-25;

— NPA 2025-01 (C) Proposed amendment to Commission Regulation (EU) 2015/640;

— NPA 2025-01 (D) Proposed amendment to CS-26.

5. Monitoring and evaluation

EASA plans to monitor as follows whether the objectives described in Section 2.2 will be achieved with the regulatory material:

(a) feedback from future large aeroplane certification projects; and

(b) in the long term, the trend in the number of accidents and incidents triggered by large aeroplane take-off performance parameters and take-off position errors.

Item (a) depends on the applications received after the amendment of CS-25 and Part-26/CS-26. A review may be carried out at the earliest five years after the CS-25 amendment in order to include feedback from new type certifications, in addition to certifications of changes to TCs.

Item (b) would be available once the aeroplanes equipped with a TOPMS have entered into service and have experienced sufficient flight time, which would require several years (at least five years to obtain relevant statistical information).

In addition, the changes made to CS-25 and Part-26/CS-26 might be subject to interim/ongoing/*ex post* evaluation that will show the outcome of the application of the new rules, taking into account the earlier predictions made in this impact assessment. The evaluation would provide an evidence-based judgement of the extent to which the proposal has been relevant (given the needs and its objectives), effective, efficient and coherent, and has achieved added value for the EU. The decision as to whether an evaluation will be necessary should also be taken based on the monitoring results.

6. Proposed actions to support implementation

In order to support affected stakeholders in the implementation of the new regulatory material, EASA plans to take the following actions:

— focused communication with Advisory Body meeting(s) (AG.005, AG.007, OPS.TeB, P&CA.TeB);

— if deemed necessary, a dedicated thematic workshop.

7. References

- ToR RMT.0741, issued on 30 August 2023.
- SIB 2016-02R1 (*Use of Erroneous Parameters at Take-off*), issued on 6 September 2021.
- EASA website safety promotion related to 'Erroneous Take-Off Performance Data'.

Appendix 1 — Impact assessment

1. Introduction

In CS-25 (certification specifications for large aeroplanes), CS 25.703 requires that a take-off configuration warning system be installed. This requirement was introduced in Europe with JAR-25 Amendment 5, effective on 1 January 1979. In the United States, this requirement was added to FAR Part 25 by Amendment 25-42, effective on 1 March 1978.

CS 25.703 requires that the take-off warning system provides an aural warning to the flight crew during the initial portion of the take-off roll, whenever the aeroplane is not in a configuration that would allow a safe take-off. The intent of this rule is to require that the take-off configuration warning system covers (a) only those configurations of the required systems that would be unsafe, and (b) the effects of system failures resulting in incorrect surface or system functions if there is no separate and adequate warning already provided. Conditions for which warnings are required include wing flaps or leading edge devices not within the approved range of take-off positions, and wing spoilers (except lateral control spoilers meeting the requirements of CS 25.671), speed brakes, parking brakes or longitudinal trim devices in a position that would not allow a safe take-off. Consideration should also be given to adding rudder trim and aileron (roll) trim if these devices can be placed in a position that would not allow a safe take-off.

The majority of currently in-service large aeroplanes are compliant with CS 25.703. Nevertheless, one isolated case of a non-compliant aeroplane is present in the occurrences reviewed, that is, the accident of the Ilyushin 76 registration UR-ZVA in Baku on 4 March 2004, which took off with retracted flaps and slats.

CS-25 does not require other systems or functions protecting the take-off from other errors affecting the performance and the safety of the aeroplane during this flight phase. Nevertheless, some design solutions have been or are being developed by the industry to mitigate the risk from these errors.

In order to improve safety, EASA developed this impact assessment to evaluate several options, envisaging mandating design functions in CS-25 (addressing new large aeroplane designs) and in Commission Regulation (EU) 2015/640 (addressing already type-certificated large aeroplanes).

2. What are the possible options

2.1. Systems that are available or being developed

Some design solutions that can mitigate the type of errors identified in the occurrences analysis (refer to Section 2.1.1 of this NPA) have been developed or are being developed, and some of them are already certified and installed on in-service aeroplanes.

2.1.1. Take-off parameters and configuration checking system

Such a system, in addition to ensuring compliance with CS 25.703 ('Take-off configuration warning system'), performs different checks throughout different phases, from the cockpit preparation to the take-off initiation, and provides an alert to the flight crew when an error is identified.

— During cockpit preparation, it is possible to detect gross errors made on weight and take-off speed values entered in the aeroplane FMS or other computers (e.g. out-of-range value, incoherent speeds, insufficient margins with minimum control or stall speeds, speeds not updated after a runway change). It is also possible to detect an inconsistency between a computed take-off distance and the available runway length (using the FMS input for performance parameters and runway selection).

— After engine start, it is possible to re-check the computed take-off distance, taking into account additional information that has become available, such as the actual fuel quantity on board.

— During the taxi phase, it is possible to check the actual positions of take-off critical surfaces, such as flaps and horizontal stabiliser (pitch trim), and compare them with the FMS take-off performance data. Regarding the pitch trim, the actual stabiliser trim position may also be compared with a computed value based on a CG value when available (e.g. calculated by taking into account the aeroplane weight and the fuel repartition). It is also possible to repeat the check of the take-off speeds and take-off distance as done in the previous steps to increase robustness.

For example, Airbus offers such functions as part of its take-off surveillance (TOS) system.

— TOS1. This function improves the checks performed on flaps and trim settings and adds a check of the performance parameters entered in the FMS (aircraft weight and take-off speeds).

— TOS2. This function checks that the aircraft is positioned on the intended runway and that the expected take-off performance — based on data entered in the FMS by the crew — is compatible with the runway distance available.

As of end 2024, the functions are available as follows.

— TOS1 is available on the A320, A330, A380 and A350. Depending on the sub-function, the fleet implementation rate ranges between 20 % and 100 %. All sub-functions are implemented in production and are being retrofitted.

— TOS2 is available on the A320, A330 and A350, with respective implementation rates of 4 %, 3 % and 100 %. It is under development for the A380.

Note that the A350 fleet is 100 % equipped with TOS with both TOS1 and TOS2 functions, as well as the take-off monitoring (TOM) function.

Information on Airbus take-off surveillance and monitoring functions is available here: https://safetyfirst.airbus.com/takeoff-surveillance-monitoring-functions/#:~:text=Airbus%20developed%20the%20Takeoff%20Surveillance,errors%20when%20entering%20takeoff%20data.

2.1.2. Take-off position checking system

Some existing systems check the actual position of the aeroplane at the time of take-off initiation and generate an alert under certain conditions.

Airbus, for instance, proposes such a function as part of TOS2 (see above). This function checks that, when take-off thrust is applied, the aeroplane is on the intended runway (as inserted in the FMS) and that the estimated lift-off distance is compatible with the available runway distance, taking into account the actual aeroplane position (using GNSS data). An alert is triggered to the flight crew in the event of error or insufficient lift-off distance. The system requires access to on-board runway characteristic databases. When the actual available runway length is reduced (e.g. runway length is shortened due to construction, as communicated by a NOTAM), this system is not able to alert the flight crew, as it does not take the length reduction into account.

Honeywell Aerospace Technologies proposes another system called the runway awareness and advisory system (RAAS), which has evolved and is now designated as SmartRunway and SmartLanding. It is available as a software option of the enhanced ground proximity warning system (EGPWS). The system aims to increase flight crew situational awareness during taxi, take-off and landing. Advisories/cautions are generated based on the current aeroplane position compared with the location of the airport runways, which are stored within the EGPWS Runway Database. The system can alert the pilots when a take-off is initiated on a non-runway location (e.g. taxiway). On-ground advisories provide the crew with awareness of which runway the aeroplane is lined up with, and if the runway length available for take-off is less than the defined minimum take-off runway length. If desired, an additional caution announcement can be enabled that provides the crew with awareness that the issue has not been resolved when the aeroplane is on the final stage of take-off. The system is compatible with various aeroplane types (transport short range and business category aeroplanes).

Similarly, Collins Aerospace proposes integrated avionics systems (e.g. Pro Line Fusion) with a surface management system (take-off and landing alerts). The system increases flight crew situational awareness and can alert the crew when unsafe ground operation is detected, such as runway incursion or confusion.

2.1.3. Take-off acceleration monitoring system

A take-off acceleration monitoring system is a system that monitors the performance (including, but not necessarily limited to, the acceleration) of the aeroplane during the take-off run and compares it with a predicted take-off distance. Such a system can generate an alert to the flight crew prior to reaching the V_1 speed (i.e. the take-off decision speed) if the performance is considered inadequate. The acceleration is a key parameter monitored by such a system.

Airbus developed such a system, called Take-Off Monitoring (TOM), that is certified by EASA. From 30 knots, it compares the expected acceleration with the real acceleration of the aircraft. If the difference between the real aircraft acceleration and its expected acceleration is more than 15 % when the aircraft reaches 90 knots, TOM will trigger the red ECAM[11] warning 'T.O ACCELERATION DEGRADED'. As of end 2024, TOM is available on the A380 and A350 aeroplanes (100 % of the fleets equipped). TOM is also under development for the A320 and under feasibility study for the A330.

Honeywell has been working on the development of a solution that would be part of its EGPWS, that is, the Honeywell Take-off Low Acceleration Monitor. The system is not yet certified by EASA, nor has Honeywell applied for certification.

Boeing and Embraer are currently developing TOPMSs with functions equivalent to the Airbus TOS2 and TOM functions.

[11] Electronic centralised aircraft monitor

SAE Aerospace Standard (AS) 8044A provides minimum performance standards for those sensors, computers, transponders and aeroplane flight deck controls/displays that together comprise a TOPMS. This AS was initially issued in 2007 and was confirmed in 2020.

More recently, in February 2024, EUROCAE created WG-129 on 'Take-off Performance Monitoring System'. This WG will continue the work previously carried out by WG-94, in view of facilitating the introduction and certifications of TOPMS, with the preparation of a MOPS and/or a minimum aviation system performance standard. WG-129 will jointly work with RTCA Special Committee (SC) 244, which was created concurrently. EASA closely follows this activity and has a member in WG-129.

2.1.4. On-board weight and balance system

An on-board weight and balance system (OBWBS) is a system installed on the aeroplane that determines and reports its actual gross weight and CG. The OBWBS typically requires the installation of sensors in the landing gear. The signals from these sensors (e.g. strut pressures or elongation) are converted to determine the weight and the CG of the aeroplane.

The information from the OBWBS is then available for checking the values used for the performance calculations (e.g. from a load sheet) and the ones entered in the FMS or other computers.

EUROCAE ED-263 provides MOPS for OBWBS and is mentioned in AMC 25-1 of CS-25 as an acceptable means of compliance for the certification of OBWBS. ED-263 initial issue, dated June 2019, envisages two kinds of usage (classes) of OBWBS: Class I (primary) and Class II (secondary). The data provided by a Class I system is considered to be the primary means to be used for dispatch of the aircraft, including the take-off performance calculation. When a Class II system is used, the crew uses the load manifest as the primary means and uses the OBWBS to verify the results of the data provided by the operations. Nevertheless, only the design and installation aspects of Class II (secondary) OBWBS is addressed in the initial issue of this MOPS. The guidelines for design and installation of Class I (primary) OBWBS may be defined at a later stage.

Historically attempts to develop an OBWBS started in the early 1940s, and since then many have failed to deliver a system that is accurate and reliable enough to be used as an operational system. Hence, a limited number of OBWBSs have been developed and put into service on large aeroplanes (e.g. Fairchild system in the 1960s, Honeywell system for the B747-400, MD-11 in the 1980s). The few operators who ordered and operated an OBWBS in the early stages (e.g. KLM, Lufthansa) typically reported issues regarding the reliability and accuracy of the system, leading to mistrust. The calibration was also an issue as it was a demanding and time-consuming task. This often led to operators removing or inhibiting the system. Over time, it appears that reliability and accuracy improved. Airbus developed a system for the A330/340 in the 1990s that was certified and positively evaluated in service, but did not convince customers, probably for cost-related concerns. Boeing proposes an optional system on the 747-8. Today, the number of aeroplanes equipped with an OBWBS (Class II) remains very small.

Avix Aero proposes a new kind of system, incorporating recent advancements in sensor technology and computing techniques seeking to overcome the concerns previously reported by operators. A strut data collection system (on-board system) collects landing gear strut pressures from each gear position along with other aircraft data. Through the Aero Source Data service, this data is communicated to a high-availability, secure off-site data centre managed by Satcom Direct, where algorithms provide pre-departure validation of primary load build-up methods, load manifest accuracy, touchdown load analysis and data analytics across all flight segments. Avix Aero holds a Supplemental Type Certificate for the strut data collection system approved by the FAA and validated by EASA on the Boeing 737NG family and the Boeing 777-200, 777-300 and 777-300ER aeroplanes.

2.2. Effectiveness of design solutions

For each of the occurrences analysed, EASA assessed the capability of the following functions to detect the type of error involved or its consequences, such as to prevent an unsafe take-off being made, with timely information or an alert being provided to the flight crew:

— checking of the take-off performance parameters input (before take-off)

  — validities (e.g. within an authorised range) and consistencies of the following parameters expected to be present in the FMS or equivalent: weight values (e.g. ZFW, GW), configuration (e.g. slat, flap, pitch trim), predicted take-off distance/run, thrust or power selection parameter and take-off speeds

— checking of the take-off (start) position

  — for instance, the available runway distance is compatible with the predicted take-off distance/run, and the actual position is on a runway (including heading) identical to the one selected in the FMS or another computer system

— monitoring the aeroplane's performance (including acceleration) during the take-off roll

  — no significant difference with planned/reference take-off performance;

— checking OBWBS data (weight and CG) against load sheet, EFB and FMS (or equivalent) data.

Figure 10 summarises the findings of this analysis.

		Percentage of all events			Percentage of all events
Number of events that could have been prevented by 'Error detection by system checking T/O performance parameters input'	35	29.66%	Number of events that could have been prevented by 'Error detection by system checking T/O performance parameters input' AND/OR by 'Error detection by system checking T/O position'	93	78.81%
Number of events that could have been prevented by 'Error detection by system checking T/O position'	61	51.69%			
Number of events that could have been prevented by 'Error detection by system monitoring the aeroplane performance during T/O roll acceleration'	50	42.37%	Number of events that could have been prevented by 'Error detection by system monitoring the aeroplane performance during T/O roll acceleration' AND NOT by 'System checking T/O performance parameters input' AND NOT by 'System checking T/O position'	12	10.17%
Number of events that could have been prevented by 'Error detection by system checking T/O performance parameters input' AND/OR by 'Error detection by system checking T/O position' AND/OR by 'Error detection by system monitoring the aeroplane performance during T/O acceleration'	105	**88.98%**			
Number of events that could have been prevented by 'System checking OBWBS data vs FMS (or equivalent) data'	17	14.41%	Number of events that could have been prevented by 'System checking OBWBS data vs FMS (or equivalent) data' AND NOT by 'System checking T/O performance parameters input' AND NOT by 'System checking T/O position' AND NOT by 'System monitoring the aeroplane performance during T/O acceleration'	8	6.78%

Figure 10. Efficiency of the potential design solutions.

This summary shows that around 90 % of the occurrences (green highlight on Figure 10) could have been prevented by one of the three following functions.

— F1. Checking of the take-off performance parameters input (before take-off)

— F2. Checking of the take-off (start) position

— F3. Monitoring the aeroplane performance (including acceleration) during the take-off roll

An additional 6.78 % (eight occurrences) could only have been prevented by the use of an OBWBS (yellow highlight on Figure 10). These occurrences involve errors in the actual CG compared with the one derived from the load sheet (e.g. different distribution of passengers and/or cargo loads). These occurrences mostly resulted in tailstrike during rotation and/or a rejected take-off (with no injury or fatality).

2.3. Options

2.3.1. List of options

EASA determined the options to be evaluated by considering:

— the availability of design solutions (see Section 2.1) and their effectiveness (see Section 2.2);

— the categories of large aeroplanes represented in the list of reported occurrences (see Figure 9);

— the statements expressed by stakeholders during the workshops mentioned in Section 1.1.

First, the options consider the creation of specifications in CS-25 to improve safety on new aeroplane designs. Second, as the number of new CS-25 designs is quite limited, in order to improve the overall safety of the large aeroplane fleet in service, the options also consider the creation of requirements in Part-26 (Annex I to Commission Regulation (EU) 2015/640) to address already type-certificated aeroplanes that are in operation.

The following function coding is used in Table 1 (CS-25 options) and Table 2 (Part-26 options).

— F1. Check and alert on errors in the aeroplane take-off performance parameters (input and selection in FMS or equivalent).

— F2. Check and alert on errors in the aeroplane position and heading at start of take-off.

— F3. Real-time take-off performance monitoring and alerting.

Also, the term 'large transport aeroplane' is used in this explanatory note when considering different applicability options. The term is defined as a CS-25 aeroplane with maximum take-off mass (MTOM) ≥ 35 t AND certified for transport of:

— passengers with a maximum passenger seating configuration (MPSC) > 19, OR

— cargo only, OR

— passengers and cargo on the main deck(s).

This definition is set up to exclude business jets (but not large VIP ones) and turboprop regional transport aeroplanes.

Two sets of options are evaluated: one set of CS-25 options (Table 1) and one set of Part-26 options (Table 2).

Table 1. Selected policy options for CS-25 (new certification specifications)

Option no	*Short title*	*Description*
0a	CS-25 — Do nothing	No policy change (rules remain unchanged and risks remain as outlined in the issue analysis)
1a	CS-25 — Mandate F1, F2 and F3 for all aeroplanes	Create a new CS 25.704 requiring a TOPMS that includes functions F1, F2 and F3. GM and AMC 25.704 are also included to support the demonstration of compliance.
2a	CS-25 — Mandate F1 and F2 for all aeroplanes, and F3 for 'large transport aeroplanes'	Same as Option 1a, but function F3 is required only for large transport aeroplanes

Table 2. Selected policy options for Part-26 (requirements for CS-25 large aeroplanes of already certified designs in operation)

Option no	*Short title*	*Description*
0b	Part-26 — Do nothing	No policy change (rules remain unchanged and risks remain as outlined in the issue analysis)
1b	Part-26 — Mandate F1, F2 and F3 for all CS-25 aeroplanes used in CAT after a 'production cut-in' date	Create a new rule in Part-26 requiring a TOPMS that includes functions F1, F2 and F3 for all CS-25 aeroplanes used in CAT that received their first certificate of airworthiness (CofA) on or after (*date six years after entry into force (EIF) of the regulation amending Part-26*) ('production cut-in') CS-26 is also amended to support the demonstration of compliance with the new Part-26 rule
2b	Part-26 — Mandate F1 and F2 for all CS-25 aeroplanes, and F3 for 'large transport aeroplanes' used in CAT after a 'production cut-in' date	Create a new rule in Part-26 requiring a TOPMS that includes functions F1 and F2 for all CS-25 aeroplanes, and an F3 function for large transport aeroplanes, used in CAT that received their first CofA on or after (*date six years after EIF of the regulation amending Part-26*) ('production cut-in') CS-26 is also amended to support the demonstration of compliance with the new Part-26 rule

3b	Part-26 — Mandate F1, F2 and F3 for ‘large transport aeroplanes’ used in CAT after a ‘production cut-in’ date	Create a new rule in Part-26 requiring a TOPMS that includes functions F1, F2 and F3 for all large transport aeroplanes used in CAT that received their first CofA on or after (*date six years after EIF of the regulation amending Part-26*) (‘production cut-in’) CS-26 is also amended to support the demonstration of compliance with the new Part-26 rule

2.3.2. Fleet evolution

CS-25 large aeroplane fleet evolution (EASA Member States): implementation of a TOPMS via CS-25 new certification specifications

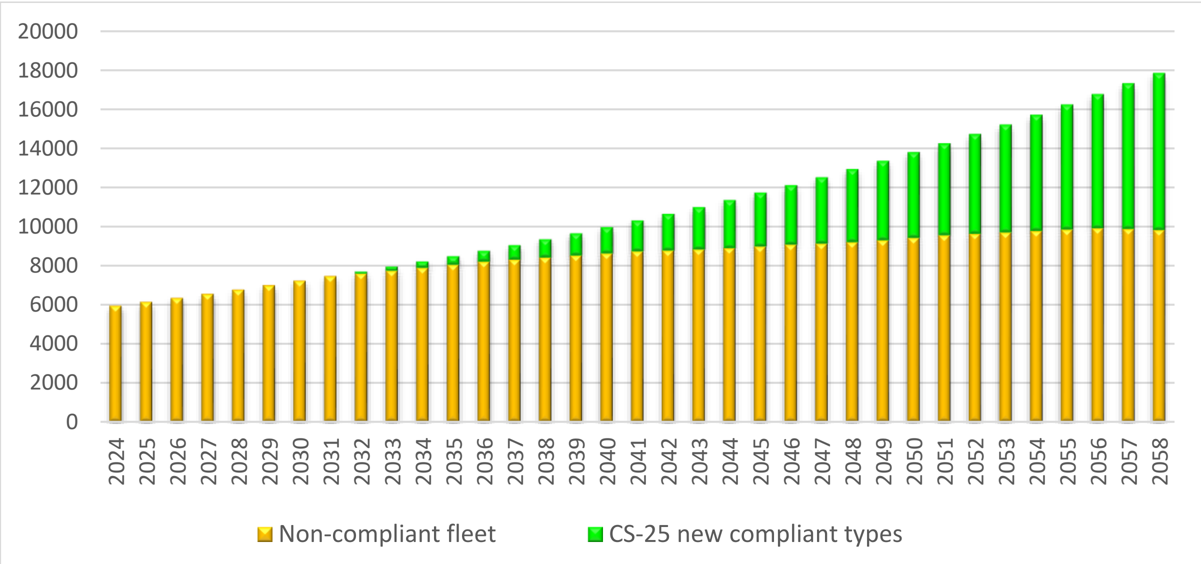

Figure 11. CS-25 large aeroplane fleet evolution (EASA Member States) — CS-25

Figure 11 illustrates the fleet evolution when mandating a TOPMS via CS-25 new certification specifications. A mandate for Part-26 is not provided in this scenario, resulting in a high share of non-compliant aeroplanes in the CS-25 fleet.

CS-25 large aeroplane fleet evolution (EASA Member States): implementation of a TOPMS via CS-25 new certification specifications AND via a Part-26 rule (production cut-in)

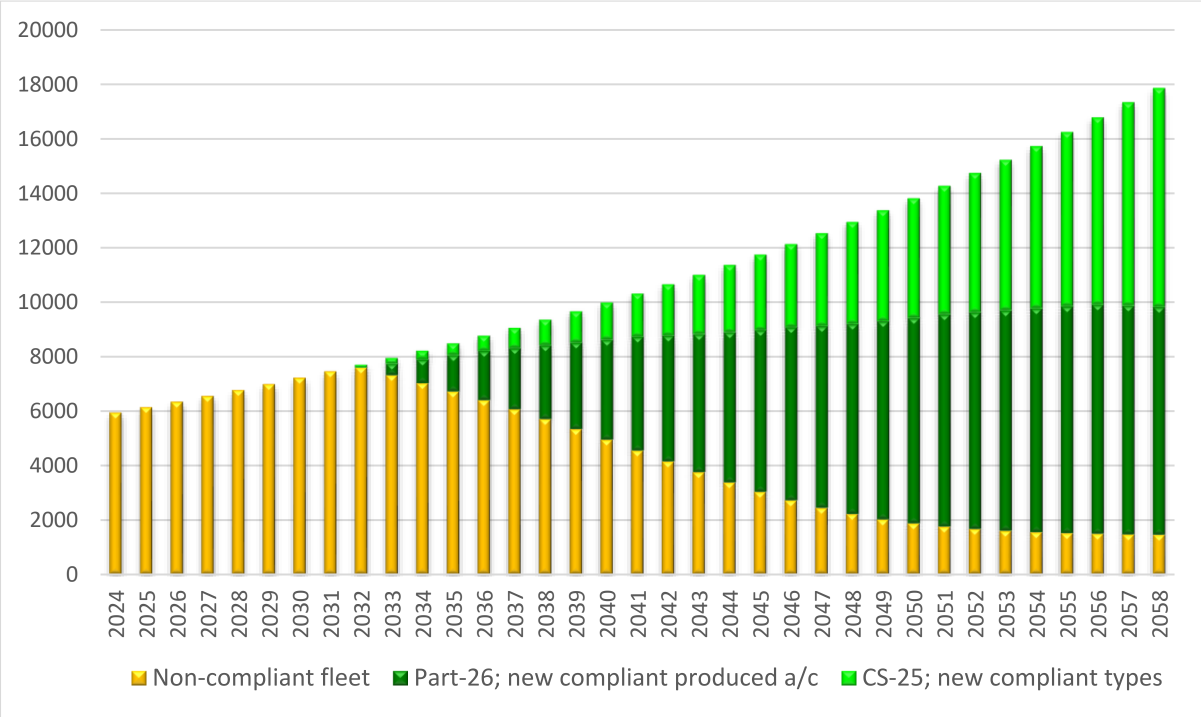

Figure 12. CS-25 large aeroplane fleet evolution (EASA Member States) — CS-25 and Part-26

The orange bars in Figure 12 show the current fleet size that is not yet equipped with a TOPMS. As per the assumptions made to model the fleet evolution (i.e. annual growth rate, annual retirement rate) the light green bars show the aeroplanes entering the market (new TC) that are equipped with a TOPMS. The dark green bars show new deliveries of aeroplanes equipped with a TOPMS per the Part-26 mandate.

3. Methodology and data

3.1. Methodology applied

A multi-criteria analysis (MCA) was used to evaluate the different impacts of the options identified above. The MCA encompasses various methods designed to integrate both positive and negative effects into a unified framework, making it easier to compare different scenarios.

3.2. Data collection

Various data sources were used, as listed below.

— Safety data. As previously presented (see Section 2.1.3.3), a review was conducted of the reported occurrences present in the EASA occurrences database between 1998 and 2023 and received official accidents and incidents investigation reports. The review analysed incidents and accidents involving large aeroplanes used in CAT as a result of the use of erroneous take-off performance parameters or errors made during the positioning of the aeroplane for initiation of take-off.

— Workshops with stakeholders. Three workshops were held with the industry (CS-25 large aeroplane manufacturers, avionics manufacturers) and partner foreign aviation authorities (ANAC, FAA, TCCA), in November 2023, March 2024 and May 2024. This gave EASA the opportunity to collect information from stakeholders on existing systems and systems being developed and technical comments on the EASA draft CS-25 specifications and AMC and GM (concept paper) and also to collect some cost data from some large aeroplane manufacturers in support of the economic impact assessment.

— CS-25 aeroplane fleet data. Data was collected from the Cirium database, which contains over 450 000 unique aircraft records across 770+ aircraft types.

4. What are the impacts

4.1. Safety impact

CS-25 options (see Table 1)

Option 0a would not address the safety issue identified for future aeroplane designs. Although one manufacturer (Airbus) developed and implemented design solutions (certified by EASA), without introducing new certification specifications in CS-25, there is no guarantee that other manufacturers will develop and implement equivalent design solutions that adequately mitigate the reported occurrences.

Option 1a, requiring functions F1, F2 and F3 for all new CS-25 aeroplane designs (i.e. new TCs and some modified aeroplanes (Major changes) that have the new CS in the certification basis) would provide the best safety improvement. The three functions could prevent 89 % of the potential future occurrences involving new aeroplane designs. A new large aeroplane type certification is launched on average every five years.

Option 2a is similar to Option 1a but with function F3 required only for the large transport aeroplane category. Looking at the list of reported occurrences, there is no occurrence involving aeroplanes outside this category that could have been mitigated by function F3 only and not by function F1 or function F2. Therefore, Option 1a would not significantly improve the safety benefit over Option 2a.

Part-26 option (see Table 2)

Option 0b would not address the safety issue identified for already certified aeroplane designs that are still being produced. Although one manufacturer (Airbus) has developed and implemented design solutions on some aeroplanes in production, and has also taken action to retrofit other aeroplanes, without introducing a new rule in Part-26, there is no guarantee that other manufacturers will develop and implement equivalent design solutions that adequately mitigate the reported occurrences. Also, considering the small number of new large aeroplane type designs coming to the market (a new large aeroplane type certification is launched on average every five years), Option 0b would potentially result in very slow implementation of design solutions in the overall fleet of large aeroplanes in operation if we were to rely on Options 1a or 2a for a CS-25 amendment.

Option 1b, requiring functions F1, F2 and F3 for all aeroplanes used in CAT after a production cut-in date would provide the best safety improvement for the fleet of newly produced aeroplanes. The three functions could prevent 89 % of the potential future occurrences involving these aeroplanes.

Option 2b is similar to Option 1b but with function F3 required only for the large transport aeroplane category. Looking at the list of reported occurrences, there is no occurrence involving aeroplanes outside this category that could have been mitigated by function F3 only and not by function F1 or function F2. Hence, this gives an indication that Option 1b would not significantly improve the safety benefit over Option 2b.

Option 3b, requiring functions F1, F2 and F3 only for large transport aeroplanes used in CAT after a production cut-in date, would provide a lower safety improvement compared with Options 1b and 2b. Although turboprop and business jet aeroplanes appear to be less exposed to the risk of weight- and CG-related errors, and have more performance margins than large transport aeroplanes, they are also exposed to the risk of other errors, and in particular position errors. As position errors (e.g. take-off from a taxiway or incorrect runway) represent a high risk of fatal accident (e.g. collision with other aeroplanes/vehicles/buildings on the ground or collision with construction work obstacles), this risk should be mitigated on all CS-25 aeroplanes and Option 3b is not recommended.

4.2. Environmental impact

None identified.

The design solutions to be implemented per the different options do not require the installation of new hardware that would significantly add weight to the aeroplane. In some cases, the implementation can be done by a software upload. Hence, no effect is expected in term of energy consumption and emissions.

4.3. Social impact

None identified.

4.4. Economic impact

Costs of the development, certification and implementation of the design solutions (TOPMS)

EASA asked large aeroplane original equipment manufacturers (OEMs) to provide an estimation of the costs that could be involved in the development, certification and implementation of the functions (F1, F2 and F3) envisaged to be mandated (TOPMS) for aeroplanes in the scope of the regulatory options described in Section 2.3 (new CS-25 TC, certain Major changes and aeroplanes subject to Part-26).

Based on the responses received, the following cost values can be considered.

Non-recurrent costs (development and certification of the functions) are estimated for the CS-25 and Part-26 options to range between:

— EUR 5 million for business aviation aeroplane types, and

— EUR 8 million for other transport aeroplane (hereafter designated by ‘airliner’) types.

Considering a given aeroplane manufacturer, these costs are estimated to be valid for the first TOPMS development and certification project (to be compliant with either the CS-25 or Part-26 proposed regulations), and then to decrease by 50 % for the projects introducing the TOPMS on other aeroplane types owned by the same manufacturer.

It is assumed that the development and certification of function F3 (real-time take-off performance monitoring and alerting) will represent the highest contribution to the above estimated costs. The assumption made is that 50 % of the cost is related to F3.

Recurrent costs are considered negligible, as the functions should be implemented via software upload on the production line.

The estimated total costs are provided in Table 3 for a period of 10 years.

Table 3. Cost calculations

Indicators and type of OEM		CS-25 options		Part-26 options		
		Option 1a	Option 2a	Option 1b	Option 2b	Option 3b
		Mandate F1, F2 and F3 for all aeroplanes	Mandate F1 and F2 for all aeroplanes, and F3 for 'large transport aeroplanes'	Mandate F1, F2 and F3 for all CS-25 aeroplanes used in CAT after a 'production cut-in' date'	Mandate F1 and F2 for all CS-25 aeroplanes, and F3 for 'large transport aeroplanes' used in CAT after a 'production cut-in' date'	Mandate F1, F2 and F3 for 'large transport aeroplanes' used in CAT after a 'production cut-in' date'
Number of aeroplane (a/c) types where a TOPMS is implemented over a period of 10 years						
Airliner a/c OEMs	First type	1	1	6	6	6
	Next types	1	1	3	3	3
Business aviation a/c OEMs	First type	1	1	5	5	5
	Next types	1	1	12	12	12
Unit cost (million EUR)						
Airliner a/c OEMs	First type	8	8	8	8	8
	Next types	4	4	4	4	4
Business aviation a/c OEMs	First type	5	2.5	5	2.5	n/a
	Next a/c types	2.5	1.25	2.5	1.25	n/a
Total costs (million EUR)						
Airliner a/c OEMs	First type	8	8	48	48	48
	Next types	4	4	12	12	12
	Total	**12**	**12**	**60**	**60**	**60**
Business aviation a/c OEMs	First type	5	2.5	25	12.5	n/a
	Next types	2.5	1.25	30	15	n/a
	Total	**7.5**	**3.75**	**55**	**27.5**	**n/a**
Overall costs		**19.5**	**15.75**	**115**	**87.5**	**60**
Annual estimated market turnover (million EUR)						
Airliner a/c OEMs		313 333				
Business aviation a/c OEMs		26 667				
Relative share of cost impacts and qualitative statement						
Airliner a/c OEMs	Total cost airliner a/c / turnover airliner OEMs	0.004 %	0.004 %	0.02 %	0.02 %	0.02 %
		Very low – score 0	Very low – score 0	Low – score 1	Low – score 1	Low – score 1
Business aviation a/c OEMs	Total cost BA a/c OEMs / turnover BA a/c OEMs	0.03 %	0.01 %	0.21 %	0.10 %	n/a
		Very low to low – score 1	Very low – score 0	Medium – score 4	Low – score 3	n/a

The assessment based on the estimated market turnover is a methodology developed by EASA with its Advisory Bodies. It uses the scale presented in Table 4.

Table 4. Economic scale based on the annual worldwide financial estimate of the civil OEMs market (in million EUR, year 2025)

Impact	Score		Airliner OEMs	Business aviation OEMs
Total turnover (million EUR)			313°333	26°667
Turnover relative share			*1.5 %*	*1.5 %*
Threshold		1.50%		
Scale				
Not acceptable	10	>1.50%		
Very high	9	1.50%	*4°700.0*	*400.0*
	8	1.00%	*3°133.3*	*266.7*
High	7	0.80%	*2°506.7*	*213.3*
	6	0.60%	*1°880.0*	*160.0*
Medium	5	0.40%	*1253.3*	*106.7*
	4	0.20%	*626.7*	*53.3*
Low	3	0.10%	*313.3*	*26.7*
	2	0.05%	*156.7*	*13.3*
Very low	1	0.02%	*62.7*	*5.3*
Neutral	0	0.01%	*31.3*	*2.7*

It is important to note the following.

— The cost assessment is made assuming that the whole costs are supported in a single year, although, in reality, these costs are spread over several years. This means that the real annual cost impact will be de facto lower than what is taken into account in this analysis.

— For a given manufacturer, the cost of development and certification of a TOPMS decreases over time, as any additional project following the first one will benefit from the engineering effort already made. This is described as the 'economies of scale'. Hence, the above-estimated costs will decrease over time in the medium to long term. In the assessment, it is assumed only that the cost of implementation of a TOPMS is 50 % of the first implementation on the first aeroplane type, when, in reality, this cost could be much less than 50 % after the third or fourth implementation by the same manufacturer.

— The total estimated cost impacts are therefore overestimated, and, despite this, the outcome shows that the range of cost impact is mainly between very low and low, depending on the options.

Other costs

The introduction of a TOPMS has other direct and indirect costs that have not been quantified and that are considered sufficiently low to be acceptable to operators:

— the adaptation of SOPs/checklists,

— the adaptation of crew training, and

— additional functional checks.

Economic benefit

The estimated cost for an accident involving a CS-25 large aeroplane could easily reach tens of millions of euro. With a safety analysis demonstrating that between 78 % and 94 % of the previous occurrences could have been prevented, the potential monetary benefit by far exceeds the estimated cost impacts.

4.5. General aviation and proportionality issues

None identified.

5. Comparison of the options and conclusion

Tables 5 and 6 show the result of the MCA of the different options, which is derived from the previous sections.

A scoring of the impacts on several criteria (safety, economic, environmental and social impacts) is used, with a scale ranging from – 10 to + 10, to indicate the negative and positive impacts of each option (i.e. from ‘very low’ to ‘very high’ negative/positive impacts):

Negative impact	Score	Positive impact	Score
– 10	Very high negative impact	+ 10	Very high positive impact
– 8	High negative impact	+ 8	High positive impact
– 6	Medium negative impact	+ 6	Medium positive impact
– 4	Low negative impact	+ 4	Low positive impact
– 2	Very low negative impact	+ 2	Very low positive impact
0	Neutral/insignificant	0	Neutral/insignificant

Option 0 is the baseline scenario and hence receives a score of 0. Other options are scored in comparison with Option 0.

Table 5. Comparison of the CS-25 options

Impact criterion	***Option 0a CS-25 – Do nothing***	***Option 1a CS-25 – Mandate F1, F2 and F3 for all aeroplanes***	***Option 2a CS-25 – Mandate F1 and F2 for all aeroplanes, and F3 for 'large transport aeroplanes'***
Safety impact	0 Voluntary implementation by some manufacturers	+ 9 High safety benefit for all new CS-25 designs	+ 9 High safety benefit, very close to Option 1a, as F3 benefits mainly large transport aeroplanes
Economic impact	0 Voluntary implementation by some manufacturers	– 3 Very low to low costs on CS-25 manufacturers	– 2 Very low costs on CS-25 manufacturers Function F3, requiring the highest development costs, not required for CS-25 business jets and turboprop aeroplane manufacturers
Environmental impact	0	0	0
Social impact	0	0	0
Total	0	+ 6	+ 7

Option 0a would rely on voluntary implementation by the CS-25 aeroplane manufacturers. As of 2024, EASA was informed that Airbus had already implemented three functions that should be applied in new designs, while Boeing and Embraer had started the development of their own functions. Hence, the deployment of these safety functions by these three major large aeroplane manufacturers in the coming years is highly probable even without an EU regulatory mandate, and a safety improvement on new designs is expected.

Option 1a would provide the best safety improvement by requiring the three functions for all new CS-25 designs. All manufacturers would face the same (acceptable) costs. However, function F3, being the most complex and most expensive function to implement, and given its very limited benefit for turboprop and business jets (no occurrence in the EASA list would have benefited from it), does not justify a mandate.

Option 2a would also provide a high safety improvement (similar to Option 1a), while avoiding generating some development and certification costs for function F3 on regional turboprops and business jets that are not sufficiently supported by the analysis of occurrences to date.

Hence, CS-25 Option 2a is the preferred option.

Table 6. Comparison of the Part-26 options

Impact criterion	***Option 0b Part-26 – Do nothing***	***Option 1b Part-26 – Mandate F1, F2 and F3 for all CS-25 aeroplanes used in CAT after a 'production cut-in' date'***	***Option 2b Part-26 – Mandate F1 and F2 for all CS-25 aeroplanes, and F3 for 'large transport aeroplanes' used in CAT after a 'production cut-in' date'***	***Option 3b Part-26 – Mandate F1, F2 and F3 for 'large transport aeroplanes' used in CAT after a 'production cut-in' date'***
Safety impact	0 Voluntary implementation by some manufacturers	+ 9 Optimal implementation and safety benefit for all newly produced CS-25 aeroplanes operated in CAT	+ 9 Safety impact very close to Option 1b, as F3 benefits mainly large transport aeroplanes	+ 6 Safety improvement for large transport aeroplanes only Risk for business jets and turboprop remains unchanged
Economic impact	0 Voluntary implementation by some manufacturers	– 5 Low to medium costs on CS-25 manufacturers	– 4 Low costs on CS-25 manufacturers Function F3, requiring the highest development cost, not required for CS-25 business jets and turboprop aeroplane manufacturers	– 2 Low costs on large transport aeroplane manufacturers only
Environmental impact	0	0	0	0
Social impact	0	0	0	0
Total	0	+ 4	+ 5	+ 4

Option 0b would rely on voluntary implementation by the CS-25 aeroplane manufacturers. As of 2024, EASA was informed that Airbus had already implemented three functions that are applied on newly produced aeroplanes as far as technically and economically feasible, while Boeing and Embraer have started the development of their own functions with the intention of implementing them in production. Hence, the deployment of these safety functions by these three major large aeroplane manufacturers, and their implementation in production in the coming years, is highly probable even without an EASA mandate, and an improvement in the safety of newly produced aeroplanes is expected.

Option 1b would provide the best safety improvement by requiring the three functions for all newly produced CS-25 aeroplanes (for CAT operations). All manufacturers concerned would face the same (acceptable) costs. However, function F3, being the most complex and most expensive function to implement, and given its very limited benefit for regional turboprops and business jets (no occurrence in the EASA list would have benefited from it), does not justify a mandate.

Option 2b would also provide a considerable improvement in safety (similar to Option 1b), while avoiding generating some development and certification costs for function F3 on regional turboprops and business jets that are not sufficiently supported by the analysis of occurrences to date.

Option 3b would improve safety on newly produced large transport aeroplanes only. This would generate costs only for this category of manufacturers. However, the fleet of regional turboprops and business jets would not enjoy a safety improvement until new designs are certified and enter into service (e.g. if CS-25 Option 1a or Option 2a of Table 4 is selected). In addition, EASA is particularly concerned by the risk of position errors, which relevant to any CS-25 aeroplane, with potentially catastrophic consequences. Therefore, Option 3b is not recommended.

Hence, Part-26 Option 2b is the preferred option.

The combination of CS-25 Option 2a and Part-26 Option 2b is considered the optimal choice to guarantee an improvement in safety in the years to come, while limiting manufacturers' effort in the development and implementation of mitigation functions to the most beneficial cases.

Question to stakeholders

Consultees are invited to provide any other quantitative information they consider necessary to bring to the attention of EASA.

EASA will consider that information when finalising the impact assessment.

Confidential information may be sent to: impact.assessment@easa.europa.eu. EASA guarantees the protection of confidentiality; the information provided will be de-identified.

Appendix 2 — List of occurrences

Below is the list of occurrences analysed and taken into account in the regulatory impact assessment.

The types of errors are identified by a code in the column entitled 'Error type' using the following definitions:

Position	Error Type	Incorrect Position
23	POS_1	Wrong A/C position (T/O initiated from planned position (RUNWAY, INTERSECTION), **programmed position INCORRECT** (wrong value entered into FMS)
26	POS_2	Wrong A/C position (**T/O initiated from INCORRECT position (RUNWAY, INTERSECTION, TAXIWAY)**, programmed position CORRECT (correct value entered into FMS)
6	POS_3	Wrong A/C position (**NOTAM** not respected; e.g., displaced threshold)
0	POS_4	Wrong A/C position (**Threshold** not respected; e.g., poorly executed takeoff procedure, rolling takeoff)
0	POS_5	Inadequate available runway distance (distance of selected/used runway ≤ T/O distance needed based upon data entered in FMS (TOW, Thrust, OAT/FLEX, Vr/V2, displaced threshold)
0	POS_6	Inadequate RTO distance (distance remaining insufficient to stop)
Weight and Balance (load sheet, EFB,		**Incorrect Payload**
2	WB_1	**Computation error - manual calculation**
1	WB_2	Input error - Number of Passengers
0	WB_3	Input error - Average Weight of Passengers
5	WB_4	Input error - Distribution of Passengers/Fuel
0	WB_5	Dispatch error - Number of Passengers
1	WB_6	Dispatch error - Average Weight of Passengers
3	WB_7	Dispatch error - Distribution of Passengers/Fuel
		Incorrect Fuel On Board (less than actual)
1	WB_8	Input error - Total Fuel onboard
0	WB_9	Dispatch error - Total Fuel onboard
		Incorrect TOW (less than actual)
14	WB_10	Input error - ZFW used for TOW (TOW=ZFW)
17	WB_11	Input error - manual input error
		Incorrect ZFW
1	WB_12	Out of range **(ZFWMIN ≤ ZFW ≤ ZFWMAX)**
A/C Configuration		**Correct setting in entered in FMS, lever/control put in INCORRECT Position**
1	TRIM_01	Incorrect configuration (trim, slat, flap) for takeoff (based on takeoff phase of flight)
1	THRUST_01	Incorrect thrust selected
		INCORRECT setting in FMS, lever in CORRECT Position
0	TRIM_02	Incorrect configuration (trim, slat, flap) for takeoff (based on FMS values of weight/runway distance etc)
4	THRUST_02	Incorrect thrust selected
		Incorrect FMS T/O Speeds
1	SPEED_01	Input error - T/O Speeds out of range **(V1 ≤ VR ≤ V2)**
0	SPEED_02	Input error - T/O Speeds **(V1 ≤ VR ≤ V2) ≤ minimums**
1	SPEED_03	Input error - T/O Speeds not calculated/available in FMS
0	SPEED_04	Input error - T/O Speeds not available (e.g., not entered, after runway change in FMS)
		Incorrect FLEX Setting
7	TEMP_01	Incorrect OAT entered into FMS
0	TEMP_02	Incorrect Static Air Temp (SAT) entered in FMS
3	TEMP_03	Incorrect FLEX temp (SAT ≥ FLEX Temp)
0	OTHER_01	Residual braking
0	OTHER_02	Aerodynamic degradation
0	OTHER_03	Deflated Tyre
0	OTHER_04	Asymmetric Thrust
0	OTHER_05	Wind
Total		
118		

In the 'Position' column of the table above, the total number of occurrences actually involving each type of error is indicated.

On the right-hand side (grey columns) of the table below, the potential detection of errors by a design function is indicated. Note that hyperlinks to the occurrence reports are provided in another separate table at the end of this appendix.

Date	Registration Marks	Aeroplane model	Description	Report	Type of occurrence	Consequence	People on board	Fatal injuries	Serious injuries	Minor injuries	Damage to the Airplane	Location	State of Registry	Error Type	Error detection by syst checking T/O perf parameters input	Error detection by syst checking T/O position	Error detection by syst monitoring the A/C perfo during T/O roll acceleration	Error detection by system checking OBWBS data vs FMS (or equivalent) data	NB of occurrences	Manufacturer
11/11/1998	N801DE	MD11	FMS take-off data input error (approx 100 000lbs) Although the exact FMS entry error was not determined, the most likely would be the crew missing the hundred thousand entry by one when inputting the takeoff gross weight, entering the empty weight into the zero fuel weight prompt, or entering the zero fuel weight in the aircraft takeoff gross weight prompt.	Y	Accident	**Tailstrike at landing**	124	0	0	0	Substantial	Portland (USA)	USA	**WB_10**	YES	NO	YES	YES	1	McDonnell Douglas
24/08/1999	OY-KDN	B767-300	Before engine start, a take-off data input was sent via the Aircraft Communication and Reporting System (ACARS) to the operator mainframe computer. The loadmaster delivered the loadsheet to the commander. The commander entered the correct zero fuel weight (ZFW) via the MCDU into the FMS. The co-pilot noted the ZFW (123500 kg), the Actual Take-off Weight (ACT TOW 186800 kg), the planned landing weight, fuel figures and passenger figures. The co-pilot entered ZFW into the ACARS in the space where the ACT TOW should have been entered. The input data was then transmitted to the mainframe computer. The mainframe computer made the take-off performance calculation and transmitted the result back to the aircraft ACARS	Y	Incident	**Rejected take-off**	181	0	0	0	None	Copenhagen (Denmark)	Denmark	**WB_10**	YES	NO	YES	NO	1	Boeing
31/10/2000	9V-SPK	B747-400	Take-off from Runway 05R despite construction work meant the runway was closed. Take off was to be performed on Runway 05L. Bad weather involved (strong wind, low visibility), night time.. Collision with ground equipment and obstacles, post crash fire, leading to aircraft destruction, fatalaties and injuries.	Y	Accident	**Collision with construction equipment and runway construction pits, post crash fire**	176	83	39	32	Destroyed	Taoyuan (Taiwan)	Singapore	**POS_2**	NO	YES	NO	NO	1	Boeing
28/12/2001	N3203Y	B747-100F	The Boeing 747 sustained substantial damage as a result of a tail strike during takeoff from Anchorage. After the accident aeroplane arrived in Anchorage, it was refueled with about 100,000 lbs. of fuel in preparation for the final leg of the flight to Travis AFB. The crew however failed to account for the weight of the additional fuel, and inadvertently used the same performance cards that were used for the previous landing. The crew was unaware that the tail had struck the runway until after arrival at Travis AFB.	Y	Accident	**Tailstrike at take-off**	3	0	0	0	Substantial	Anchorage (USA)	USA	**WB_11**	YES	NO	YES	YES	1	Boeing
25/01/2002	B-18805	A340-300	Take off in Anchorage from taxiway Kilo instead of runway 32. The airplane took off, proceeded to its destination and landed without further incident. After departure, main landing gear tire impressions were found in a snow berm at the west end of taxiway Kilo.	Y	Incident	**Take-off from a taxiway** (distance less than the calculated T/O distance)	252	0	0	0	None	Anchorage (USA)	USA	**POS_2**	NO	YES	NO	NO	1	Airbus
14/06/2002	C-GHLM	A330-300	The pilots introduced a wrong V1 value in the MCDU (126 knots instead of 156 knots).	Y	Accident	**Tailstrike at take-off & pitch up on final approach**	266	0	0	0	Substantial	Frankfurt/Main (Germany)	Canada	**SPEED_01**	YES	NO	NO	NO	1	Airbus
29/11/2002	TC-APJ	B737-800	The aircraft was operated with an improper CG position. Erroneous load & trim sheet.	Y	Serious incident	**Tailstrike at take-off & rejected take-off**	118	0	0	0	None	Dortmund (Germany)	Turkey	**WB_4**	NO	NO	NO	YES	1	Boeing
11/03/2003	ZS-SAJ	B747-300	The crew introduced the ZFW instead of the TOW for the performance calculations (EFB).	Y	Incident	**Tailstrike at take-off**	157	0	0	0	Minor	Johannesburg (South Africa)	South Africa	**WB_10**	YES	NO	YES	NO	1	Boeing
12/03/2003	9V-SMT	B747-400	A tail strike occurred because the rotation speed was 33 knots less than the 163 knots required for the aeroplane weight. The rotation speed had been mistakenly calculated for an aeroplane weighing 100 tonnes less than the actual weight	Y	Accident	**Tailstrike at take-off**	389	0	0	0	Substantial	Auckland (USA)	Singapore	**WB_11**	YES	NO	YES	NO	1	Boeing
17/06/2003	TC-ONP	MD88	During take-off at a speed of approximately 130 knots the captain, who was pilot flying, rejected the take-off above the decision speed because he experienced a heavy elevator control force at rotation. The stabilizer warning sounded during the entire take-off roll. The aircraft overran the runway end and came to a stop in the soft soil. During subsequent evacuation one cabin crew member and a few passengers sustained minor injuries. The aircraft sustained substantial damage. There was no fire. The crew calculated the CG with a distribution of pax in the cabin that was not the actual one (in addition mean pax weight values were slightly lower the standard).	Y	Accident	**Rejected take-off & runway overrun**	149	0	0	A few	Substantial	Groningue Eelde (Netherlands)	Turkey	**WB_4**	NO	NO	NO	YES	1	McDonnell Douglas

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04/09/2003	OY-KBK	A321	The calculations by the handling agent were made with a lower weight than the actual TOW (60 tons instead of 76.4 tons). The mistake came from a miscommunication between two operator's offices.	Y	Incident	**Early rotation at take-off**	171	0	0	0	None	Oslo (Norway)	Denmark	**WB_11**	YES	NO	YES	NO	1	Airbus
22/10/2003	JA8191	B747	The liftoff was delayed due to rotation being initiated at lower than the appropriate speed.The flight engineer used the value of the ZFW instead of the TOW in the performance charts for reading the T/O speeds..	Y	Accident	**Tailstrike at take-off**	4	0	0	0	Moderate	Narita (Japan)	Japan	**WB_10**	YES	NO	YES	NO	1	Boeing
25/12/2003	3X-GDO	B727	During takeoff the airplane, overloaded in an anarchic manner, was not able to climb at the usual rate and struck an airport building located a hundred and eighteen meters past the runway end on the extended runway centerline, crashed onto the beach and ended up in the ocean. The flight crew had not received information on the TOW and CG location.	Y	Accident	**Collision with obstacle after take-off**	164	141	23	0	Destroyed	Cotonou Cadjèhoun (Benin)	Guinea	**WB_7**	NO	NO	YES	YES	1	Boeing
04/03/2004	UR-ZVA	IL76	The take-off was initiated with clean wing because apparently the crew forgot to extend flaps and slats. After flying for 490 meters the aircraft struck the ground and crashed.	Y	Accident	**Collision with ground after take-off with tailstrike**	7	3	0	0	Destroyed	Baku (Azerbaijan)	Ukraine	**TRIM_01**	NO	NO	NO	NO	1	Ilyushin
14/07/2004	F-GLZR	A340-300	The crew entered a weight close to ZFW instead of TOW in ACARS for calculations. The error was around 100t, resulting in wrong take-off parameters being inserted in the FMS.	Y	Incident	**Tailstrike at take-off**	?	0	0	0	None	Paris (France)	France	**WB_10**	YES	NO	YES	NO	1	Airbus
08/10/2004	N275WA	MD-11	The flight crew had received an FAA-approved permit to ferry the empty, three engine airplane to Atlanta with the center (number two) engine inoperative. In order to enhance the climb performance and reduce drag, the crew elected to takeoff on runway 32 with the center landing gear (CLG) retracted, but calculated the airplane's center of gravity (CG) with the CLG extended. As calculated, using data for the CLG extended, the airplane's CG was in close proximity to the allowable aft CG limitations. However, when the CLG, (centered between the two main landing gear trucks) is retracted, the aft CG limit shifts forward. Using the correct, gear retracted CG data, the vice president of flight operations noted the actual takeoff CG was approximately 3.2 percent of mean aerodynamic chord (MAC) aft of the allowable limit. Upon application of full takeoff power and brake release, the airplane immediately rotated to an excessive nose-up attitude, and the lower empennage struck the runway. The crew aborted the takeoff, and taxied to parking.	Y	Accident	**Tailstrike at take-off, aborted take-off**	2	0	0	0	Minor	Anchorage (USA)	USA	**WB_1**	NO	NO	NO	YES	1	McDonnell Douglas
14/10/2004	9G-MKJ	B747-200	The Bradley take-off weight was likely used to generate the Halifax take-off performance data, which resulted in incorrect V speeds and thrust setting being transcribed to the take-off data card. The pilots did not carry out the gross error check in accordance with the company's standard operating procedures (SOPs), and the incorrect take-off performance data were not detected.	Y	Accident	**Collision with obstacle after take-off**	7	7	0	0	Destroyed	Halifax (Canada)	Ghana	**WB_11**	YES	NO	YES	NO	1	Boeing
23/04/2005	TC-SKC	B737-800	The aeroplane was scheduled to fly Hurghada-Dusseldorf-Stuttgart, the flight plan however was changed last minute to have the aeroplane fly Hurghada-Stuttgart-Dusseldorf. The aeroplane arrived with 189 passengers, 100 of which disembarked in Stuttgart. The remaining passengers, all seated in the rear of the aircraft, were not reseated. This resulted in an extreme aft position of the CG caused by the remaining passengers and their luggage all located in the rear of the aircraft. Contributing factor was the insufficient safety attitude of all involved except for the loadmaster.	Y	Serious incident	**Tailstrike at take-off & rejected take-off**	96	0	0	1	Substantial	Stuttgart (Germany)	Turkey	**WB_7**	NO	NO	NO	YES	1	Boeing
24/08/2005	LN-RKF	A340-300	The second officer misread the preliminary load info and entered ZFW instead of TOW into the take-off data calculation. He did not update figures when receiving final load sheet.	N	Accident	**Tailstrike at take-off**	256	0	0	0	Substantial	Shanghai Pudong (China)	Norway	**WB_10**	YES	NO	YES	NO	1	Airbus
12/07/2006	C-FHIU	ERJ-190	An incorrect aircraft weight was used to calculate take-off performance data. This error was not detected, and resulted in the crew conducting the take-off with lower-than-required thrust and speed references. The crew used a wrong value for the Fuel on Board at take-off in the EFB.	Y	Incident	**Abnormal pitch response during rotation**	86	0	0	0	None	Edmonton (Canada)	Canada	**WB_8**	YES	NO	YES	NO	1	Embraer
27/08/2006	N431CA	CL-600-2B19 (CRJ100)	The aeroplane crashed during takeoff from Blue Grass Airport (LEX), Lexington, Kentucky. The flight crew was instructed to take off from runway 22 but instead lined up the aeroplane on runway 26 and began the takeoff roll. The aeroplane ran off the end of the runway and impacted the airport perimeter fence, trees, and terrain. The captain, flight attendant, and 47 passengers were killed, and the first officer received serious injuries. The aeroplane was destroyed by impact forces and postcrash fire.	Y	Accident	**Runway excursion and collision with airport fence, trees, and terrain**	50	49	1	0	Destroyed	Lexington, Kentucky (USA)	USA	**POS_2**	NO	YES	NO	NO	1	Bombardier
10/12/2006	F-HLOV	B747-400	The crew used the ZFW instead of the TOW for the take-off performance parameters calculation.	Y	Incident	**Tailstrike at take-off**	578	0	0	0	Minor	Paris (France)	France	**WB_10**	YES	NO	YES	NO	1	Boeing

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25/11/2007	HB-IKR	Gulfstream IV	Take-off run on taxiway Alpha, adjacent to the active runway 01. Aborted take-off under ATC instruction.	Y	Serious incident	**Rejected take-off** (ADC instructed the pilot to cancel the T/O clearance)	8	0	0	0	None	Brisbane (Australia)	Switzerland	**POS_2**	NO	YES	NO	NO	1	Gulfstream Aerospace
16/08/2008	SU-BPZ	B737-800	At night in VMC conditions, the crew of flight AMV6104 to Luxor lined up from intersection Y11 on runway 27L at Paris Charles de Gaulle Airport. The runway distance available for take-off was temporarily reduced because of construction work. During the takeoff run, the airplane struck some provisional lights at the end of the runway then, during the rotation, destroyed some markers on the safety-barrier positioned in front of the construction zone. It took off before a provisional blast fence and continued its flight to its destination. The crew did not take into account the reduction of the available runway length (by about one third) due to **work on going at the end of the runway**	Y	Serious incident	**Reduced take-off distance available** **Collision with end runway lights** (end lights and plastic markers hit and flew over the blast fence at low height). In this particular case, it is uncertain whether in the case of an engine failure after V1, SU-BPZ would have avoided the work site machines if they had still been in the works zone during takeoff or whether it would not have struck the blast screen in case of an aborted takeoff.	192	0	0	0	Minor	Paris (France)	Egypt	**POS_3**	NO	NO	NO	NO	1	Boeing
27/10/2008	OO-CBA	B747-200F	The accident was caused by an inadequate take-off performance calculation, due to wrong gross weight data input error in the software used for the computation of the takeoff performance parameters and the failure to comply with the operator's SOP for checking the validity of the data. ZFW instead of TOW (ZFW 101 tons lower)	Y	Accident	**Long take-off** **Tailstrike at take-off** (leaving approximately 600 m take-off run available (TORA))	6	0	0	0	Substantial	Brussels (Belgium)	Belgium	**WB_10**	YES	NO	YES	NO	1	Boeing
28/10/2008	G-OJMC	A330-200	The dispatcher probably used a wrong lower TOW value (89.4 tons lower than the actual value) for the Take-off performance parameters calculation. The flight crew did not identify the error. The value on the loadsheet was correct.	Y	Serious incident	**Long take-off** **Abnormal pitch response during rotation** (Airport: Takeoff Run Available (TORA) for Runway 07 is 2,663 m with an Accelerate/Stop Distance Available (ASDA) of 2,724 m) Performance: the aircraft manufacturer calculated that in the event of a rejected takeoff at V1 with all engines operative, the required Accelerate-Stop Distance (ASD) would have been 1,828 m. In wet conditions this would have increased to 2,082 m.	331	0	0	0	None	Montego Bay (Jamaica)	United Kingdom	**WB_11**	YES	NO	YES	NO	1	Airbus
13/12/2008	G-OOAN	B767-39H	The pilots wrongly introduced the ZFW instead of the TOW in the CTOP (Computer Take-Off Program). This generated significantly slower takeoff speeds than required for the actual weight of the aircraft.	Y	Serious incident	**Long take-off** **Tailstrike at take-off**	265	0	0	0	Minor	Manchester (United Kingdom)	United Kingdom	**WB_10**	YES	NO	YES	NO	1	Boeing
20/03/2009	A6-ERG	A340-500	The crew introduced an abnormally low TOW value in the EFB tool, probably due to a typing error (100 tons less).	Y	Accident	**Long take-off** **Tailstrike at take-off** **Collision with ligth and antenna**	275	0	0	0	Substantial	Melbourne (Australia)	United Arab Emirates	**WB_11**	YES	NO	YES	NO	1	Airbus
01/09/2009	LZ-BHC	A320	The airplane passengers were not located in accordance with the load sheet assumptions but in accordance with their destination	Y	Incident	**Early rotation** **Tailstrike at take-off**	94	0	0	4	Substantial	Verona Villafranca (Italy)	Bulgaria	**WB_4**	NO	NO	NO	YES	1	Airbus
31/08/2009	PH-?	B777	The aircraft suffered minor damage during a tailstrike incident. The engine thrust selected for the take-off was lower than was required for the weight of the aircraft, because the takeoff data was based on an incorrect weight input (error~ Δ 100 ton).	Y	Serious incident	**Tail strike at take-off**	?	0	0	0	Minor	?	Netherlands	**WB_11**	YES	NO	YES	NO	1	Boeing
26/09/2009	G-VIIR	B777-200	The crew misidentified the runway intersection and took-off from the wrong runway intersection.	Y	Serious incident	**Reduced take-off distance available** (V1 was achieved as the aircraft reached the touchdown zone aiming point markers for Runway 25 and rotation was commenced with the aircraft lifting off shortly afterwards) (The aircraft's manufacturer calculated a hypothetical V1 of 101 kt (ignoring VMCG) for the Intersection Bravo departure TORA of 1,220 m. If the crew had rejected the takeoff at their calculated V1 of 120 kt, the aircraft would have overrun the end of the paved runway by approximately 100 m.)	101	0	0	0	None	Saint Kitts (West Indies)	United Kingdom	**POS_2**	NO	YES	NO	NO	1	Boeing
12/12/2009	G-VYOU	A340-600	The crew used the ELW instead of the TOW (86.5 tons lower) for the take-off parameters calculation request (sent via ACARS to a central computer)	Y	Serious incident	**Long take-off** (the aircraft was slow to rotate and initial climb performance was degraded)	298	0	0	0	None	London (United Kingdom)	United Kingdom	**WB_11**	YES	NO	YES	NO	1	Airbus
10/02/2010	PH-BDP	B737-300	While taxiing the crew lost their positional awareness as a result of which they took off frow taxiway B instead of the adjacent runway 36C	Y	Serious incident	**Take-off from a taxiway**	?	0	0	0	None	Amsterdam (Netherlands)	Netherlands	**POS_2**	NO	YES	NO	NO	1	Boeing
25/02/2010	VP-BWM	A320-214	Takeoff from Oslo taxiway M instead of runway 01L.	Y	Serious incident	**Take-off from a taxiway**	67	0	0	0	None	Oslo (Norway)	Russia	**POS_2**	NO	YES	NO	NO	1	Airbus

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03/03/2010	B-18723	B747-400F	When entering the required data into Runway Analysis System, the pilot took the Max Landing Weight as Max Take-Off Weight obtained from Computerized Flight Plan; which led the calculation to provide erroneous take-off thrust, take-off reference speed and take-off model.	Y	Accident	**Long take-off** **Tailstrike at take-off**	3	0	0	0	Substantial	Anchorage (USA)	China	**WB_11**	YES	NO	YES	NO	1	Boeing
13/10/2010	VH-NXD	B717-200	The pilot wrongly read out the OW instead of the ZFW and that value was introduced in the FMS. Additionally there was an error when introducing the bagagge weights into the EFB. The result was a landing weight 9415 kg lower than the actual one).	Y	Serious incident	**Landing with lower landing speed** (stick shaker activation during approach (two go around maneuvres needed)	102	0	0	0	None	Kalgoorlie (Australia)	Australia	**WB_11**	NO	NO	YES	YES	1	Boeing
21/11/2010	5N-MJI	B737-700	The crew had programmed the aircraft's Flight Management Computer (FMC) for a maximum thrust takeoff from Runway 24 at Southend Airport. As the aircraft taxied out, ATC changed the runway in use to Runway 06. The FMC was re-programmed but an incorrect 'assumed' temperature was entered, resulting in too great a thrust reduction for the runway length available.	Y	Incident	**Long take-off** (the aircraft became airborne before the end of the runway, had the takeoff been rejected just before V1 there would have been insufficient runway remaining within which to stop)	2	0	0	0	None	Rochford (United Kingdom)	Nigeria	**TEMP_03**	YES	NO	YES	NO	1	Boeing
29/04/2011	G-NIKO	A321-231	The commander read out (from the loadsheet) what he thought was the Actual Take Off Mass (ATOM) but mistakenly read out the Zero Fuel Mass (ZFM). The commander then wrote down that figure in a space provided on the navigation log for the ATOM. The SOP then required him to compare the Estimated (E)TOM, on the line above, with the ATOM. However, he actually compared the figure he had written down as the ATOM with the EZFM on the line beneath. The commander next entered some data into the FMS, which included entering the ZFM from the loadsheet in the INIT B page. The loadsheet was passed to the co-pilot who checked it and confirmed that it matched the commander's entry in the FMS. Performance calculations were then performed by the 2 pilots using the incorrect ATOM. The SOP required the crew to crosscheck the green dot speed generated by the laptop computer against that generated by the FMS. However, although they crosschecked the performance figures between the two laptops, the crosscheck with the FMS green dot speed was missed.	Y	Serious incident	**Long take-off** (the aircraft accelerated and climbed, but at a slower than normal rate)	231	0	0	0	None	Manchester (United Kingdom)	United Kingdom	**WB_10**	YES	NO	YES	NO	1	Airbus
12/06/2011	VH-VWX	A321-231	In accordance with the operator's SOPs, the copilot checked the performance data done by the PIC and found an error in the takeoff weight calculations. The copilot corrected the error and consulted the performance charts to extract the revised V speeds relating to the correct takeoff weight. However, when doing this, the copilot inadvertently referenced the performance chart for the full length of runway 11 rather than the chart for the planned taxiway Bravo departure.	Y	Incident	**Reduced take-off distance available** (there was sufficient takeoff run and takeoff distance available. However, if the crew had rejected the takeoff at the nominated V1 of 160 kts, an additional 1,000 m of runway was required to meet accelerate-stop requirements. Alternatively, if an engine had failed at the nominated V1, an additional 150 m of runway was required to meet accelerate-go requirements and obstacle clearance would have been compromised)	195	0	0	0	None	Darwin (Australia)	Australia	**POS_1**	NO	YES	NO	NO	1	Airbus
22/11/2011	VH-TJL	B737-400	After the need to recalculate performance due to change of runway, the pilots inadvertently used the full length of the new runway instead of the proper intersection of the new runway for performance calculations (full length being the default option in the EFB).	Y	Incident	**Reduced take-off distance available**	150	0	0	0	None	Melbourne (Australia)	Australia	**POS_1**	NO	YES	NO	NO	1	Boeing
26/11/2010	OH-LQD	A340-300	Take off attempted from taxiway at Hong Kong. Aircraft was cleared for take off from runway 07L. Instead of lining up on the runway, the aircraft made a wrong premature turn onto taxiway A, which was located next to and parallel to the runway in use, and started to roll. The air traffic controller alerted the pilot immediately and instructed the pilot to stop. The aircraft rolled for approximately 10 seconds before slowing down.	Y	Serious incident	**Rejected take-off** The aircraft came to a halt abeam TWY A5, approximately 1400 metres (m) from the western end of TWY A	?	0	0	0	None	Hong Kong (China)	Finland	**POS_2**	NO	YES	NO	NO	1	Airbus
08/12/2011	CS-TOD	A340-300	The runway length was shortened due to works, the pilots were aware and properly calculated the take-off performance but used the wrong intersection and entered the runway 600 meters ahead of the new threshold	Y	Serious incident	**Reduced take-off distance available** **Collision with obstacle during take-off**	266	0	0	0	Minor	Rio de Janeiro (Brazil)	Portugal	**POS_2**	NO	YES	NO	NO	1	Airbus
05/02/2012	4R-ADG	A340-300	The aircraft started its takeoff from a runway intersection for which no regulated takeoff weight chart was available in the aircraft. The pilots calculated performance using a chart for a different runway which did not consider obstacles relevant to the runway in use. The takeoff and subsequent flight were completed without further incident.	Y	Incident	**Reduced take-off distance available** (The investigation calculated that the takeoff run required for the aircraft, based on the conditions at the time of the incident and the weight and configuration, was 2,268 m and the required maximum TFlex was 38°C. The declared takeoff run available was 2,854 m. An analysis of the Heathrow ground movement radar did, however, indicate the approximate position at which the aircraft became airborne. The distance from intersection SB7 to this position was 2,650±50 m)	260	0	0	0	None	London (United Kingdom)	Sri Lanka	**POS_3**	NO	YES	NO	NO	1	Airbus
14/04/2012	G-ZAPZ	B737-300	The pilot did not enter the TOW in the EFB tool and the application took the TOW from the previous flight per default. There was not subsequent cross check by the crew (6.6 tons lower). The commander entered a correct ZFW in the FMC.	Y	Accident	**Long take-off** **Tail strike at take-off**	136	0	0	0	Substantial	Chambery (France)	United Kingdom	**WB_11**	YES	NO	YES	NO	1	Boeing
04/07/2012	G-EZDN	A319-100	The pilots calculated performance for the full runway length but the runway was shortened due to works (from 3715 m to 2500 m). There was a NOTAM the pilots were aware of but forgot in the end. The on-going work was located **at the end of the runway**.	Y	Serious incident	**Reduced take-off distance available**	155	0	0	0	None	Prague (Czech Republic)	United Kingdom	**POS_3**	NO	NO	NO	NO	1	Airbus
16/10/2012	F-GRHU	A319	Take off initiation from taxiway at Sofia - RTO. The crew started the takeoff roll on a taxiway paralel to the runway. ATC asked them to abort. EGPWS RAAS (Runway Awareness and Advisory System) (Honeywell) was installed but did not trigger the ""on taxiway"" message as its threshold is 40kt and the maximum speed reached was 37kt"	Y	Serious incident	**Rejected take-off**	?	0	0	0	None	Sofia (Bulgaria)	France	**POS_2**	NO	YES	NO	NO	1	Airbus

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16/04/2013	XA-TOJ	B767-200	The performance were calculated by the handling agent using ZFW instead of TOW. A correct ZFW was used in the FMC.	Y	Accident	**Long take-off** **Tailstrike at take-off**	163	0	0	2	Substantial	Madrid (Spain)	Mexico	**WB_10**	YES	NO	YES	NO	1	Boeing
21/06/2013	VH-ZPC	ERJ-190	The pilots used the wrong intersection for performance calculations. Take-off was initiated from a position different than the one inserted in the FMS and used for performance calculation. Contributor: misunderstanding between the pilots.	Y	Incident	**Reduced take-off distance available** (calculations by the operator found that the aircraft was below the maximum take-off weight (...) and that the take-off distance required was sufficient)	70	0	0	0	None	Perth (Australia)	Australia	**POS_1**	NO	YES	NO	NO	1	Embraer
01/07/2013	PH-?	B737-800	Take-off performed from RWY19R intersection A6, although performance calculation made with intersection A7. During the takeoff, roll the crew realized that the takeoff performance was compromised. Thrust was increased and the V1 call was made 10 kts below V1.The aircraft was rotated within the confines of the runway.	Y	Incident	**Reduced take-off distance available**	?	0	0	0	None	Oslo (Norway)	Netherlands	**POS_1**	NO	YES	NO	NO	1	Boeing
07/07/2013	PH-BVG	B777-300	The pilot mentioned an incorrect TOW and used that wrong value for performance calculations. The other pilot had made a correct calculation but was distracted and discarded his values	N	Serious incident	**Long take-off**	?	0	0	0	None	Amsterdam (Netherlands)	Netherlands	**WB_11**	YES	NO	YES	NO	1	Boeing
01/10/2013	HB-IOR	A320	The pilot calculated take-off performance for the full runway length, then recalculated for a shorter intersection runway but this new calculation was not introduced in the FMS prior to the take-off (3480 m vs. 1900 m). Contributor: distraction in the cockpit which interrupted the PF calculation (PF had to leave the cockpit in the middle of the calculation).	Y	Serious incident	**Reduced take-off distance available** (the plane took off 350 m before the end of the runway. The aircraft passed the end of the runway at a height of 104 ft) (the engine power was sufficient for a normal takeoff, but in the event of engine failure did not meet the operational requirements for allowing the takeoff to be continued or rejected within the remaining runway length)	159	0	0	0	None	Porto (Portugal)	Switzerland	**POS_1**	NO	YES	NO	NO	1	Airbus
14/10/2013	VH-VUC	B737-300	The pilots calculated the performance for both full runway length and runway intersection in data cards and introduced the data for full lenght runway in the FMS (3354 m vs. 2238 m). Subsequently they decided to take-off from intersection and reprogrammed the FMS. However, the data introduced in the FMS seems to come from a full runway length input.	Y	Incident	**Reduced take-off distance available**	153	0	0	0	None	Darwin (Australia)	Australia	**POS_1**	NO	YES	NO	NO	1	Boeing
01/08/2014	VH-VZR	B737-800	The ATSB found the tail strike was the result of two independent and inadvertent data entry errors in calculating the take-off performance data. As a result, the take-off weight used was 10 tons lower than the actual weight. This resulted in the take-off speeds and engine thrust setting calculated and used for the take-off being too low. As a result, when the aircraft was rotated, it overpitched and contacted the runway.	Y	Incident	**Long take-off**	152	0	0	0	Minor	Sydney (Australia)	Australia	**WB_11**	YES	NO	YES	NO	1	Boeing
18/09/2014	PH-HZD	B737-800	The pilot made a manual wrong calculation of the TOW, which resulted in 16% less than the actual one (10 tons lower), and used that wrong value for performance calculations. Correct weight value from the load and trim sheet was however entered in the FMS that calculated correct speeds but with an insufficient reduced thrust based on the temperature input from the pilots.	Y	Serious incident	**Long take-off** An engine failure at V1 would have resulted in a runway excursion. Even without an engine failure, the available runway length was 68 m too short for the required take-off run distance)	179	0	0	0	None	Groningen (Netherlands)	Netherlands	**WB_11**	YES	NO	YES	NO	1	Boeing
06/10/2014	HB-IOP	A320	After an initial intention to take off on runway 33, prevailing traffic led the crew to decide on a take-off from runway 15 and calculate the required engine power for take-off using the total available run-way length of 3900 m. While taxiing to the threshold of runway 15, the crew decided to save time by taking off from the taxiway Golf intersection, which gave an available runway length of 2370 m. Without stopping after lining up, they took off with an engine power which had been calculated for the entire length of the runway. This engine power did not meet the requirements for allowing the take-off to be continued or rejected within the remaining runway length in the event of engine failure at decision speed. During the final stages of the take-off roll, the commander noticed the low engine power, in-creased it to the maximum possible and initiated aircraft lift-off by rotation. The subsequent climb was uneventful and the flight was able to continue to Djerba.	Y	Serious incident	**Reduced take-off distance available** (the rotation occurred at approximately 790 m from the end of the runway; after a further 250 metres, the aircraft reached a height of 35 ft) (the engine power did not meet the requirements for allowing the take-off to be continued or rejected within the remaining runway length in the event of engine failure at decision speed)	144	0	0	0	None	Mulhouse (France)	Switzerland	**POS_1**	NO	YES	NO	NO	1	Airbus
22/05/2015	F-GUOC	B777-F	The Boeing 777-F took off at low speed and the TailStrike Protection (TSP) of the aeroplane was activated. The aeroplane did not gain altitude. The crew then applied full thrust. The aeroplane flew over the opposite threshold at a height of approximately 170 ft and continued to climb. During the climb, the crew discussed the causes of the incident and realized they had made a mistake of 100 tonnes in the weight used for the calculation of the take-off performance parameters. The crew continued the flight to destination without any further incident. Note: a correct ZFW had been entered in the FMS	Y	Serious incident	**Long take-off** (the aircraft flew over the opposite threshold 08L at a radio altitude of 172 ft)	4	0	0	0	None	Paris (France)	France	**WB_12**	YES	NO	YES	NO	1	Boeing
25/06/2015	G-EZAA	A319-100	The flight crew planned to perform a takeoff from Runway 25 using Intersection Bravo at Belfast Aldergrove Airport. The initial performance figures, calculated using the EFB, were computed for a wet runway; this produced a full power thrust setting. Just before pushback, as the runway was dry, the crew elected to change the runway state on the EFB from wet to dry to see if this would produce a reduced engine thrust setting, which it did. The aircraft subsequently became airborne with about 200 m of runway remaining. After departure, analysis by the crew revealed that an incorrect runway was used to calculate the dry runway performance figures, resulting in erroneous figures being generated. The reason for this could not be confirmed but subsequent investigations revealed that in one scenario, an involuntary runway change could occur on the EFB. This anomaly was not known by the operator or manufacturer at the time of the event and is likely to have been the reason for the incorrect runway selection. These figures were not identified as erroneous and were subsequently used for takeoff.	Y	Serious incident	**Reduced take-off distance available** (the airplane became airborne with about 200 m of runway remaining) (with 2 engines operative, runway length would be sufficient and obstacle clearance too; with one engine inoperative, runway length would be sufficient but obstacle clearance would be 30 ft instead of 35 ft; if rejected take-off, runway length would not be sufficient, with an expected runway overrun at 75 kt)	162	0	0	0	None	Belfast (United Kingdom)	United Kingdom	**POS_1**	YES	YES	NO	NO	1	Airbus
16/07/2015	G-EZUH	A319-100	Before pushback, takeoff performance was calculated for a departure using the full length of Runway 08. When the aircraft was at the holding point, prior to takeoff, it became apparent that an intersection departure may be required, due to an aircraft holding on the runway threshold. The performance was recalculated for this, with a change in flap setting. The aircraft then took off from Intersection Bravo with performance calculated assuming the full length of the runway was available.	Y	Serious incident	**Reduced take-off distance available** (The aircraft became airborne with approximately 180 m of runway remaining) (the aircraft passed over the runway end at a height of 117 ft)	184	0	0	0	None	London (United Kingdom)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus

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16/09/2015	A7-BAC	B777-300	The pilots seem to have wrongly interpreted the (probably confusing) designation of the runway in the EFB and took off from the wrong runway intersection.	Y	Serious incident	**Reduced take-off distance available** **Collision with end of the runway lights** (the recorded data indicates the ground roll was approximately 2,866m long and that the aircraft was still on the ground as it left the runway. Airport security cameras recorded the aircraft then coming into contact with some of the approach lights for Runway 27)	279	0	0	0	Substantial	Miami (USA)	Qatar	**POS_3**	NO	YES	NO	NO	1	Boeing
16/10/2015	G-EZIV	A319-100	During pre-flight preparation performance figures were calculated for a departure from Intersection November Two of Runway 03, at Lisbon Airport when Runway 21 from Intersection Uniform Five was used for takeoff. The error was not noticed during the crew's standard crosschecking procedures due to distraction in the cockpit and some complacency.	Y	Serious incident	**Reduced take-off distance available** (as the aircraft became airborne approximately 213 m of runway remained)	153	0	0	0	None	Lisbon (Portugal)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus
03/12/2015	PH-HSG	B737-800	The crew selected a wrong runway and take-off position in the EFB. Contributing factors included: the ergonomics of the EFB performance module; the ambiguous runway take-off position naming system at the airport.	Y	Serious incident	**Reduced take-off distance** (remaining runway length at lift-off was 430 m)	181	0	0	0	None	Lisbon (Portugal)	Netherlands	**POS_1**	NO	YES	NO	NO	1	Boeing
01/01/2016	PH-?	A330-200	During taxi-out, the flight crew decided to takeoff from intersection B of runway 35 instead of using intersection A, representing the full runway length. The reason for this decision was to gain time due to late arrival of the aircraft. A new LINTOP request was made while taxiing. However, intersection A was inadvertently re-entered. The revised takeoff data were subsequently entered into the FMC. Full takeoff thrust was used. Rotation was started at the calculated VR. The aircraft lifted off between 340 m and 263 m before the runway end and crossed the runway end at a height between 19 and 40 ft RA. By using intersection B instead of A, the takeoff distance was shortened with 750 metres.	Y	Incident	**Reduced take-off distance**	?	0	0	0	None	Entebbe (Uganda)	Netherlands	**POS_1**	NO	YES	NO	NO	1	Airbus
14/04/2016	G-EZFJ	A319-100	Due to an EFB SW deficiency the take-off performance of a different runway than the selected one were wrongly shown to the crew.	Y	Serious incident	**Reduced take-off distance available** (TODA 3419 m instead of 3450 m; ASDA 3030 m instead of 3200 m)	163	0	0	0	None	Malaga (Spain)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus
20/04/2016	VH-YQV	B717-200	Wrong Flex T introduced in the FMS (34 instead of 39 degrees)	Y	Incident	**Long take-off** (take-off with less thrust than required but apparently within the margins)	96	0	0	0	None	Canberra (Australia)	Australia	**TEMP_03**	NO	NO	NO	NO	1	Boeing
09/05/2016	G-EZFP	A319-100	The crew selected the wrong runway in the EFB apparently driven by the existence of a NOTAM and after having (wrongly) compared the lengths of the "temporary" selected runway and the actual intersection that should have been used. Contributors: fatigue.	Y	Serious incident	**Reduced take-off distance available** (TORA 2265 m vs. 2825 m; ASDA 1688 m vs. 2162 m)	160	0	0	0	None	Lille (France)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus
13/07/2016	N279AV	A330-200	The crew did not take into account for the performance calculation a NOTAM reducing the runway length (3950 m vs. 2700 m). Contributors: wrong task sharing (introduction and verification of calculations by PM only) and lack of recurrence of PF (more than 60 days out).	Y	Serious incident	**Reduced take-off distance available** **Collision with end of the runway lights**	264	0	0	0	None	Bogota (Colombia)	Peru	**POS_3**	NO	NO	NO	NO	1	Airbus
30/08/2016	VT-JEK	B777-300	The aircraft took off from intersection S4E on Runway 27L using performance information (power setting, flap setting and takeoff speeds) appropriate for a takeoff from intersection N1 (full length). The manufacturer found that, for the aircraft to meet all regulatory performance requirements, the takeoff distance required was 3,349 m whereas the takeoff distance available from intersection S4E was 2,589 m.	Y	Serious incident	**Reduced take-off distance available** (the aircraft lifted off within the takeoff distance available but: a. Did not meet regulatory requirements for the all-engine, continued takeoff case. b. Would not have been able to reject the takeoff and stop in the runway remaining following an engine failure just below V1. c. Would not have been able to continue the takeoff while meeting regulatory requirements following an engine failure just above V1)	246	0	0	0	None	London (United Kingdom)	India	**POS_1**	NO	YES	NO	NO	1	Boeing
21/01/2017	VH-VNC	A320	The pilot taxied to and took off from a wrong intersection. Contributors: the fact that the pilot was following another airplane may have contributed to the mistake.	Y	Incident	**Reduced take-off distance available** (403 m shorter) (in the event of a rejected take-off, either with all engines operating or one engine inoperative, would have resulted in a runway overrun)	?	0	0	0	None	Cairns (Australia)	Australia	**POS_2**	NO	YES	NO	NO	1	Airbus
21/04/2017	VT-JEW	B777-300	During take-off a tailstrike was caused by an overrotation of the aeroplane, which was the result of a lower than required airspeed at which the rotation was started. The reason for this was that the actual takeoff weight was higher than the takeoff weight that had been used for the takeoff performance calculation. Due to a human error predominantly caused by time pressure, incorrect load sheet data was supplied to the pilots. (TOW 229 tons vs. 299 tons). Note: a correct gross TOW was present in the FMS	Y	Serious incident	**Long take-off** **Tailstrike at take-off** (for an all-engine operative rejected takeoff at a V1, without reverse thrust there would have been a runway overrun, with reverse thrust there would have not been an overrun; If the takeoff would have been continued with an engine failure at or just after V1, the minimum climb gradient of 3.3% for the standard instrument departure at Schiphol would not have been met)	358	0	0	0	None	Amsterdam (Netherlands)	India	**WB_11**	YES	YES	YES	NO	1	Boeing
15/07/2017	N852GT	B747-800F	It is probable that the aircraft commenced a take off roll using a take off thrust lower than the thrust required for the Aircraft to take off, because the Captain did not correctly change the FMC settings for the take off thrust at the time of take off from the runway different from what the Captain and the FO had assumed, the Captain did not correctly change the FMC settings for the take off thrust , in addition, the Captain and the FO did not ensure to verify the take off thrust by the time when they commenced the take off	Y	Serious incident	**Long take-off** (take-off with less thrust than required) (lift off at 340 feet from the end of the runway)	2	0	0	0	None	Narita (Japan)	USA	**THRUST_02**	NO	YES	YES	NO	1	Boeing

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21/07/2017	C-FWGH	B737-87J	Following an operational delay and an updated performance calculation, the correct value for the new assumed temperature (48°C) was entered into the FMC, but another incorrect figure (-52°C) was entered into the OAT field of the N1 limit page.	Y	Serious incident	**Long take-off** **Collision with end of runway light** (take-off with less thrust than required)	185	0	0	0	None	Belfast (United Kingdom)	Canada	**TEMP_01**	YES	YES	YES	NO	1	Boeing
17/08/2017	EI-DTB	A320	Take-off with wrong CG because the pax distribution was assumed as even by the handling agent while that was not actually the case. This was a multiple legs flight and pax were located iaw their destination.	Y	Serious incident	**Tailstrike and aborted take-off**	109	0	0	0	Minor	Milan (Italy)	Italy	**WB_4**	NO	NO	NO	YES	1	Airbus
28/09/2017	G-FDZJ	B737-800	The available evidence indicates that the aircraft was out of trim due to an incorrect MACTOW on the load sheet. This occurred because passenger's actual seating positions were not passed to the handling agent. When producing the load sheet the handling agent assumed an even distribution of passengers within the cabin, when the actual distribution created a forward bias.	Y	Serious incident	**Long take-off** (the aircraft was airborne with approximately 300 m of runway remaining)	142	0	0	0	None	La Valeta (Malta)	United Kingdom	**WB_4**	NO	NO	NO	YES	1	Boeing
16/11/2017	VP-CAM	B737-800	The pilots intended to take-off with full thrust but actually an assumed temperature (AT) of 67°C for reduced thrust was preselected in the system. According to the FDR recording, the AT input was registered by the FMC before the flight crew powered up the engines. The flight crew appeared not to have noticed that the N1 of 90.4% and an AT of 67°C were displayed to them.	Y	Serious incident	**Long take-off** **Collision with end of the runway lights** (take-off with less thrust than required, aircraft rotated at about 500 m before the end of the runway and lifted off at about 120 m before the end of the runway)	4	0	0	0	Minor	Singapore (Singapore)	Singapore	**TEMP_01**	NO	YES	YES	NO	6	Boeing
28/03/2018	G-CKWC	B787-9	The aircraft began its takeoff roll from the displaced landing threshold of Runway 26R at Gatwick Airport, rather than at the beginning of the runway. This decreased the distance available for the takeoff by 417 m. Contributors: specific runway design (taxi to the runway at the same heading is unusual but compliant with regulations, same as lack of lighting in the pre-threshold part of the runway).	Y	Serious incident	**Redued take-off distance available** (had the aircraft suffered an engine failure just before V1 and had the crew decided to stop, a runway overrun could have occurred) (in case of engine failure at V1 followed by a continued take-off, The aircraft would have failed to meet the regulated takeoff performance criteria)	270	0	0	0	None	London (United Kingdom)	United Kingdom	**POS_2**	NO	YES	NO	NO	5	Boeing
29/03/2018	4X-EDB	B787-9	The captain introduced a wrong low ZFW in the FMS (40 tons lower tna the correct one). He realized about the mistake, and said to correct it but actually did not correct it. Both captain and co-pilot then used the FMC displayed ZFW and TOW values to make the performance calculations with the OPT. Captain entered the takeoff speeds and thrust setting into the FMC & MCP, according to the computation results.	Y	Serious incident	**Long take-off** (in case of rejected take-off at V1, the aircraft would have been able to stop on the runway, either with two engines operating or single engine) (in case of continued take-off with engine failure at V1, the aircraft would have been able to stop on the runway, either with two engines operating or single engine)	300	0	0	0	None	Tel-Aviv (Israel)	Israel	**WB_11**	NO	NO	YES	YES	1	Boeing
10/06/2018	PH-BXG	B737-800	After ATC instructed the aircraft to taxi to intersection N4, new takeoff data had to be calculated with the actual wind conditions for this intersection (initial calculation done for intersection N5). This was done just before the plane lined up on the runway. The investigation made clear that only the new wind data were entered into the FMC, whereas the intersection remained N5 instead of N4. The newly entered takeoff data were not checked by the other crew members. Therefore the computation of the takeoff parameters was based on an available runway length that was 3,494 metres instead of the actual 2,460 metres. After the takeoff roll, the aircraft became airborne 176 metres before the end of the runway and passed the runway threshold at a height of 28 feet.	Y	Serious incident	**Reduced take-off distance available** (the aircraft would have been unable to stop on the runway in case the takeoff had to be aborted at V1) (In the event of an engine failure after V1, there would have been insufficient runway length remaining to accelerate the aircraft to the minimum V2 speeds. The risk of the aircraft reaching the end of the runway without being able to become airborne, would have been significant.)	185	0	0	0	None	Amsterdam (Netherlands)	Netherlands	**POS_1**	NO	YES	NO	NO	1	Boeing
15/07/2018	HB-JCC	A220-300	Once the aircraft was aligned to the runway axis, the PF advanced the thrust levers, assuming that the AT would now be engaged and would set the takeoff power to the required level. As the PF had advanced the thrust levers to a thrust lever angle (TLA) of only 20.6°, the AT remained armed without becoming engaged. This went unnoticed by the flight crew. For activation, a TLA of 23° would have been required. After exceeding an indicated airspeed of 60 kt, the spoilers extended as they are designed to do; this was not indicated to the flight crew. As per the standard operating procedures, one of the things that the flight crew must check is that the required takeoff power is set when exceeding a speed of 80 kt. Neither of the pilots could remember whether they had executed this check. The engine power being too low went unnoticed. Due to slow acceleration and the remaining length of the runway, the PF realised that the power had been set too low. By then, the aircraft had reached a speed of between 90 and 100 kt. He pushed the throttles forward and, when the TLA passed 23°, the spoilers retracted as they are designed to do. In addition, the warning CONFIG SPOILER was displayed in red letters. The aircraft took off approximately 1000 metres before the end of the runway, at a distance that was 1.5 times the length of the calculated takeoff distance, continued to climb and landed in Geneva without any further incidents.	Y	Serious incident	**Long take-off**	46	0	0	0	None	Porto (Portugal)	Switzerland	**THRUST_01**	NO	NO	YES	NO	1	Airbus
28/07/2018	YR-BMF	B737-800	Prior to departure the aircraft's takeoff data was calculated on an electronic flight bag (EFB) using its zero fuel weight (ZFW) instead of its takeoff weight (TOW). The FMC was fed with the EFB data without check of the loadsheet. The pilots did not crosscheck or independently calculate the data. During the takeoff the aircraft suffered a tailstrike.	Y	Serious incident	**Long take-off** **Tailstrike at take-off**	196	0	0	0	Minor	Birmingham (United Kingdom)	Romania	**WB_10**	NO	NO	YES	YES	1	Boeing
03/08/2018	VT-JFS	B737-8AL	JAI-523 was cleared to taxi through taxiway (TWY-G) and for take-off from runway (RWY-33R). JAI-523 lined up on the TWY-K that is parallel to RWY-33R and commenced its take-off roll. Approaching the end of TWY-K, the crew realized the situation and aborted the take-off. The aircraft uneventfully came to a complete stop on an unpaved ground along the path of TWY-K past TWY-G4 at approximately 2485 meters (m) from the beginning of take-off roll on TWY-K.	Y	Serious incident	**Rejected take-off and runway excursion** Aircraft stopped on an unpaved ground along the path of taxiway-K	?	0	0	0	?	Riyadh (Saudi Arabia)	India	**POS_2**	NO	YES	NO	NO	1	Boeing
08/08/2018	PH-HXM	B737-800	During take-off, the crew noticed that the aircraft was sluggish in its rotation and in its response to rudder deflections. A review of the take-off performance calculations showed that the take-off mass (TOM) of the aircraft used in the calculations was too low. The reason was that the zero fuel mass (ZFM) had been used by mistake rather than the TOM. The selected engine thrust, which is partially dependent on the TOM, was therefore insufficient for take-off. Preliminary information shows that the aircraft lifted off the ground on the last section of the runway.	N	Incident	**Long take-off**	185	0	0	0	None	Zakynthos (Greece)	Netherlands	**WB_10**	NO	NO	YES	NO	1	Boeing
18/09/2018	A6-ANV	A320-200	The crew was cleared for an intersection takeoff on runway 30 but turned onto the 12 direction and commenced takeoff with less than 1000 metres of runway ahead. On eventually recognising the error the Training Captain took control, set maximum thrust and the aircraft became airborne beyond the end of the runway and completed its international flight. The Investigation attributed the event to the pilots' total absence of situational awareness noting that after issuing takeoff clearance, the controller did not monitor the aircraft.	Y	Serious incident	**Reduced take-off distance available, wrong QFU**	48	0	0	0	None	Dubai (United Arab Emirates)	United Arab Emirates	**POS_2**	NO	YES	NO	NO	1	Airbus

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29/09/2018	VH-VFX	A320-200	In completing the manual calculations for take-off performance, the flight crew inadvertently calculated speeds that were higher than required for the actual aircraft weight and environmental conditions. They used a table based on the maximum regulated take-off weight (RTOW. The incorrect take-off speeds were not identified by independent verification and cross-checking. Take-off was performed with full thrust. During the first segment of the take-off climb period, at maximum engine power settings, the aircraft pitch rate was below the recommended 3° per second, resulting in a higher acceleration rate than anticipated. Due to the incorrect calculated speeds, the aircraft rotated with a margin of only 16 kt to the flap extended limit speed. Five seconds after rotation, the flap extended overspeed event occurred.	Y	Incident	**Flap overspeed, landing gear overspeed**	180	0	0	0	None	Sydney (Australia)	Australia	**WB_1**	YES	NO	NO	NO	1	Airbus
30/09/2018	OE-LQE	A319-100	This serious incident resulted from the error of inputting incorrect data into three fields on the loadsheet application. Incorrect gender/age profile meant that the total passenger weight was underestimated by 1,962 kg. Once the mistake had been made, human performance limitations reduced the likelihood that the slip would be detected. The crew noticed a ZFW anomaly, but despite looking for an error they could not find one. The lack of commonality between LFC and EFB formats was considered by the operator to be an exacerbating factor, as was the lack of gender/age profile information in the loadsheet application's Reduced mode. The undetected error led to the departure being flown with incorrect takeoff performance parameters. The crew's decision to use TOGA thrust if they had any performance concerns during takeoff might not have been a reliable risk control because the C-FWGH incident showed that pilots are unlikely to perceive when extra thrust is required.	Y	Serious incident	**Long take-off**	150	0	0	0	None	London (United Kingdom)	Austria	**WB_2**	NO	NO	YES	YES	1	Airbus
11/12/2018	G-LCYZ	ERJ190	Incorrect Thrust derate selection in the FMC (T/O-3 instead of T/O-1) resulting in insufficient thrust for the actual TOW. To better understand the safety impact of the incorrect takeoff setting, once above FL100 the crew recalculated their takeoff performance based on T/O-3 thrust. The calculations indicated that, while they would have been able to stop safely up to V1, climb performance might have been compromised had an engine failed shortly thereafter.	Y	Serious incident	**Long take-off** (take-off with less thrust than required)	90	0	0	0	None	London (United Kingdom)	United Kingdom	**THRUST_02**	NO	NO	YES	NO	1	Embraer
01/04/2019	PH-?	B737-800	During taxi-out, the flight crew decided to takeoff from intersection N4 of runway 32R instead of intersection N2. Believing they had calculated the takeoff data for intersection N4, they started the takeoff from this intersection. Reduced takeoff thrust was used. During the last part of the takeoff roll, the end of the runway became visible and the crew realized that they were much closer to the runway end than expected. Thrust was not increased though. Rotation was started at the calculated VR and the aircraft lifted off 248 m before the runway end. The runway end was crossed at 32 ft RA. After takeoff, the flight crew reviewed the performance data, which revealed the entry error.	Y	Incident	**Reduced take-off distance available**	?	0	0	0	None	Toulouse-Blagnac (France)	Netherlands	**POS_2**	NO	YES	NO	NO	1	Boeing
24/04/2019	G-EZTD	A320-200	During pre-flight preparations, both pilots completed a takeoff performance calculation for a takeoff from the runway intersection with Taxiway U5. During subsequent re-planning, the crew thought they had recalculated performance information from Taxiway S1 but had, in fact, used S4 (runway full length). The aircraft took off from Taxiway U5 with performance calculated for the full runway length. The takeoff distance available from U5 was 1,395 m less than that used for the performance calculation, and the aircraft passed the upwind end of the runway at 100 ft aal. The operator had another identical event 14 days later.	Y	Serious incident	**Reduced take-off distance available** (the aircraft becoming airborne 400 m before the upwind runway threshold, which it overflew at 100 ft)	181	0	0	0	None	Lisbon (Portugal)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus
07/05/2019	OE-IJL	A320-200	Event identical to the incident to G-EZTD of 24/04/2019. In this event, the aircraft lifted off 350 m before the upwind runway threshold which it crossed at about 75 ft aal.	Y	Serious incident	**Reduced take-off distance available** (the aircraft lifted off 350 m before the upwind runway threshold which it crossed at about 75 ft)	?	0	0	0	None	Lisbon (Portugal)	Austria	**POS_1**	NO	YES	NO	NO	1	Airbus
27/05/2019	G-DRTB	B737-800	Substantial probability that the takeoff was at incorrect thrust setting.	N	Incident	**Long take-off** (take-off with less thrust than required)	?	0	0	0	None	Murcia (Spain)	United Kingdom	**THRUST_02**	NO	NO	YES	NO	1	Boeing
05/08/2019	VQ-BKV	B737-800	Take-off data computation error, possibly using ZFW instead of TOW. Moscow's interregional transport department of the federal Investigative Committee said that five runway end lights were damaged. The aircraft sustained damage to three MLG tyres.	N	Serious incident	**Long take-off** (take-off with less thrust than required)	?	0	0	0	Minor	Moscow (Russia)	Russia	**WB_10**	YES	NO	YES	NO	1	Boeing
29/08/2019	G-EZBI	A319-100	During their initial pre-flight preparation, the flight crew chose to calculate takeoff performance based on the most limiting intersection available, Bravo 3, on Runway 04R at Nice Côte d'Azur Airport. The aircraft departed from intersection Alpha 3 where the runway length available was 316 m greater than from Bravo 3. At lift-off the commander noted that the departure end of the runway was closer than he would have expected but did not perceive any other performance issues. Subsequent analysis of recorded flight data and the flight crew's takeoff calculations indicated that both pilots had inadvertently used performance figures for a departure from intersection Quebec 3. With both pilots making the same mis-selection, the takeoff performance cross-check was invalidated and the error went undetected. The available runway length from Quebec 3 was 701 m greater than from Bravo 3.	Y	Serious incident	**Reduced take-off distance available**	163	0	0	0	None	Nice (France)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus
06/09/2019	PH-HSJ	B737-800	Take-off initiated on Taxiway D at Amsterdam airport, instead of Runway 18C. ATC noticed the error and instructed the crew to stop the aircraft.	Y	Serious incident	**Rejected take-off**	?	0	0	0	None	Amsterdam (Netherlands)	Netherlands	**POS_2**	NO	YES	NO	NO	1	Boeing
16/09/2019	G-EZWE	A320-200	During pre-flight preparations, both pilots completed a takeoff performance calculation for a takeoff from Runway 21 at Lisbon Airport. In calculating the performance, the crew believed they had selected the shortest runway length available (from the intersection with Taxiway S1) but had, in fact, used the runway full length (from Taxiway S4). The aircraft was cleared for takeoff from another intersection (Taxiway U5) and used performance calculated for the full runway length. The takeoff distance available from U5, although longer than from S1, was 1,395 m less than that used for the performance calculation, and the aircraft became airborne with only 110 m of the runway remaining.	Y	Serious incident	**Reduced take-off distance available** (the aircraft became airborne with only 110 m of the runway remaining; the aircraft achieved the regulatory screen height of 35 ft, for a dry runway, and crossed the airport boundary at 225 ft radio altitude; the aircraft could have overrun the available tarmac if it had had to reject the take-off at V1)	173	0	0	0	None	Lisbon (Portugal)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus
25/09/2019	VH-VPJ	ATR 72	The flight crew received a clearance to line-up on runway 35 intersection 'Golf' at Canberra Airport. - While taxiing to the runway, the flight crew inadvertently lined-up on runway 30. - Almost immediately after commencing the take-off roll, and at about the same time air traffic control instructed them to 'stop', the flight crew rejected the take-off. The aircraft was re-positioned for a departure from runway 35.	Y	Incident	**Rejected take-off** (ATC asked the pilots to stop the T/O from the wrong runway)	55	0	0	0	None	Canberra (Australia)	Australia	**POS_2**	NO	YES	NO	NO	1	ATR

Date	Registration Marks	Aeroplane model	Description	Report	Type of occurrence	Consequence	People on board	Fatal injuries	Serious injuries	Minor injuries	Damage to the Airplane	Location	State of Registry	Error Type	Error detection by syst checking T/O perf parameters input	Error detection by syst checking T/O position	Error detection by syst monitoring the A/C perfo during T/O roll acceleration	Error detection by system checking OBWBS data vs FMS (or equivalent) data	NB of occurrences	Manufacturer
02/10/2019	G-EUOG	A319-100	G-EUOG taxied out to Runway 27L at London Heathrow Airport for a flight to Leeds Bradford Airport. The planned departure intersection was N2W (TORA 3,380 m). As the aircraft taxied out, the Pilot Monitoring (PM) asked for intersection N4E (TORA 2,702 m) which was granted by ATC. After starting the second engine and completing the checklist, the aircraft departed from N4E using takeoff performance data calculated for N2W.	Y	Serious incident	**Reduced take-off distance available** (fortunately, the aircraft was light, with a limited payload and fuel for only a short flight, so the takeoff was unremarkable and the takeoff performance was not compromised)	102	0	0	0	None	London (United Kingdom)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Airbus
24/11/2019	G-EUXJ	A321-231	Wrong Flex T of 79deg instead of 49 deg introduced in the FMC. The investigation found the incorrect entry was probably a result of distraction during the data entry. The subsequent standard procedures and checks did not detect the error.	Y	Serious incident	**Long take-off** (take-off with less thrust than required)	216	0	0	0	None	Glasgow (United Kingdom)	United Kingdom	**TEMP_03**	YES	NO	YES	NO	1	Airbus
28/02/2020	CN-RGJ	B737-8B6	During the takeoff roll the "V1 " automatic call did not occur and the takeoff speeds were not displayed on the Primary Flight Display (PFD). The aircraft rotated 37 kt above the correct speed for this departure and 120 m from the end of the runway. It is likely that the flight crew did not enter speeds into the Flight Management Computer (FMC) or inadvertently deleted them after they had been entered.	Y	Serious incident	**Long take-off** (the aircraft was airborne approximately 120 m prior to the end of the runway)	145	0	0	0	None	London (United Kingdom)	Morocco	**SPEED_03**	YES	NO	NO	NO	1	Boeing
21/07/2020	G-TAWG	B737-8K5	Error in the airline reservation system used to generate the loadsheet. With 38 females checked in incorrectly and misidentified as children (system error), the takeoff mass from the load sheet was 1,244 kg below the actual mass of the aircraft.	Y	Serious incident	**Long take-off** **(**whilst an incorrect takeoff weight was used for aircraft performance planning, the thrust required for the actual TOW and environmental conditions (88.2% N1) was marginally less than the thrust used for the takeoff (88.3% N1). This meant the safe operation of the aircraft was not compromised**)**	193	0	0	0	None	Birmingham (United Kingdom)	United Kingdom	**WB_6**	NO	NO	YES	YES	1	Boeing
03/01/2021	G-UZMI	A321-251NX	During the boarding process, the crew recognised that the passenger distribution was incorrect for their aircraft type. The commander subsequently filed a safety report that initiated an investigation by the operator. It was found that the previous sector might have been flown with the aircraft CG out of operating limits, and issues were identified with data transfer between the aircraft management and departure control systems. Although it was subsequently found that the aircraft had not flown outside certified limits, the operator implemented safety actions to strengthen its procedures and prevent recurrence.	Y	Serious incident	**None** (finally the airplane did not take off outside the CG certified limits, but outside the operational CG limits)	65	0	0	0	None	Bristol (United Kingdom)	United Kingdom	**WB_7**	NO	NO	NO	YES	1	Airbus
03/03/2021	PH-BCD	B737-800	The crew wrongly requested (LINTOP) data for intersection "S" when they intended to request data for intersection "S1". Since "S1" was not available in the system, "S4" was assigned. Eventually, the crew initiated their take-off on runway 21 from intersection U5, as instructed by air traffic control. As a result, at the end of the runway, the aircraft was flying too low, at an altitude of between 45 and 70 feet radio height. The flight was continued without further mishap.	Y	Serious incident	**Reduced take-off distance available** (main landing gear lift-off occurred with approximately 284 m of runway remaining, and the aircraft crossed the threshold at a radio altitude between 45ft and 70ft) (despite the lack of obstacles on runway 21 clearway, the nature of the involving terrain, with the urban density in the climb-out path, is a serious concern that, in the event of an engine failure that occurs at a critical moment during the take-off, may lead to serious consequences)	137	0	0	0	None	Lisbon (Portugal)	United Kingdom	**POS_1**	NO	YES	NO	NO	1	Boeing
12/09/2021	PH-NXD	E195-E2	The aircraft took off with a selected amount of takeoff thrust, based on erroneous takeoff data. The investigation found that the aircraft took off from intersection L5 - as the crew intended - while the performance calculation was based on intersection K5. The actual available runway length was 1320 metres less than the runway length used in the calculation of the performance parameters. The selected thrust setting was such that the acceleration of the aircraft was too slow to safely take off from intersection L5. As a result, the aircraft became airborne 443 metres before the end of the runway. Safety margins were reduced during the takeoff. The aircraft would likely not have been able to safely abort the takeoff at speeds close to V1.	Y	Serious incident	**Reduced take-off distance available**	97	0	0	0	None	Berlin (Germany)	Netherlands	**POS_1**	NO	YES	NO	NO	1	Embraer
01/12/2021	G-JZHL	B737-8MG	The aircraft took off with insufficient thrust set because the TOGA button was not pressed. It was not pressed because the co-pilot was startled by the aircraft moving as he commenced the run-up against the brakes. The aircraft started to move because insufficient brake pressure was applied. Human checks designed to detect the insufficient thrust were ineffective because both pilots were attending to other tasks. The commander was responding to a radio call from the FISO during the start of the takeoff roll. Neither pilot detected the low thrust until after the aircraft was airborne.	Y	Serious incident	**Long take-off** (take-off with less thrust than required)	?	0	0	0	None	Kuusamo (Finland)	United Kingdom	**THRUST_02**	NO	NO	YES	NO	1	Boeing
06/01/2022	XA-VIM	A320-200N	A VivaAeroBus Airbus A320-200N, registration XA-VIM performing flight VB-187 from Chicago O'Hare,IL (USA) to Mexico City (Mexico), had taxied to runway 22L via taxiway V, when tower cleared the aircraft to line up runway 22L and wait shortly followed by takeoff clearance from runway 22L. The aircraft however turned immediately right onto taxiway N and commenced takeoff. Tower spotted the aircraft on the taxiway and immediately cancelled the takeoff clearance followed by a number of "STOP" instructions until the crew acknowledged on radio. The aircraft rejected takeoff at low sped (about 15 knots over ground), then turned right twice onto taxiway V again, and departed from runway 22L about 9 minutes after the rejected takeoff.	N	Incident	**Rejected take-off** (low speed)	?	0	0	0	None	Chicago O'Hare (USA)	Mexico	**POS_2**	NO	YES	NO	NO	1	Airbus
18/02/2022	A6-FML	B737-800MAX	A Flydubai Boeing 737-8 MAX, registration A6-FML performing flight FZ-1746 from Belgrade (Serbia) to Dubai (United Arab Emirates), lined up Belgrade's runway 30 at taxiway D, departed at about 13:49L (12:49Z) but crossed the runway end just at a few feet AGL and climbed out slowly. The aircraft subsequently accelerated both IAS and climb and continued to Dubai for a landing without further incident. A ground observer reported the aircraft began rotation about 300 meters short of the runway end but rotated very slowly, became airborne and crossed the runway end just a few feet above the surface, a one engine inoperative (OEI) departure would have been impossible. About 2 minutes after becoming airborne the crew queried with tower, whether they had departed taxiway E (TORA 3000 meters/9800 feet) or taxiway D (TORA 2085 meters/6800 feet), tower reported they had departed from taxiway D. The ground observer could not tell, whether the crew had requested to depart from intersection with taxiway D or E prior to or during taxi for departure. ADS-B data suggest the aircraft crossed the runway end at less than 30 feet AGL at 156 knots over ground, reached 80 feet AGL about 400 meters/1350 feet past the runway end at 168 knots over ground (just past the localizer antenna), then joined a rather normal climb profile. On Feb 23rd 2022 Serbia's Directorate of Civil Aviation announced they have opened an extraordinary inspection into Flydubai with respect to the 737-8 MAX occurrece of Feb 18th 2022 and stated: "As part of the investigation, the Directorate of Civil Aviation of the Republic of Serbia will send a request to investigate the events to the aviation authorities of the United Arab Emirates, in order to inform us about the results of the investigation, since they are in charge of the operator."	N	Incident	**Reduced take-off distance available** (aircraft crossed the runway end at less than 30 feet AGL at 156 knots over ground, reached 80 feet AGL about 400 meters/1350 feet past the runway end at 168 knots over ground (just past the localizer antenna)	?	0	0	0	None	Belgrade (Serbia)	United Arab Emirates	**POS_2**	NO	YES	NO	NO	1	Boeing
21/02/2022	CS-DFG	FALCON 2000EX	The flight crew was cleared for line up and take-off from Runway 09. Instead of that, pilots began take-off roll from Taxiway 'H', which is parallel to Runway 09. Then ATCO of Sofia TWR cancelled take-off clearance. At 40kts, the Runway Awareness Advisory System (RAAS) triggered the aural advisory message 'On Taxiway, On Taxiway'. The aircraft reduced rolling speed and stopped before the intersection of TWY "C". After coordination with the flight crew, Sofia Tower ATCO issues instructions for a reverse turn and taxiing on TWY "H", line-up and take-off from RWY09.	Y	Serious incident	**Rejected take-off** (ATC asked the pilots to stop the T/O from the taxiway)	3	0	0	0	None	Sofia (Bulgaria)	Portugal	**POS_2**	NO	YES	NO	NO	1	Dassault Aviation
12/04/2022	CS-TUL	A330-900	The crew made performance calculations for a take-off on runway 23 at Luanda International Airport. However, due to work-in-progress, the first part of runway 23 (length 3700m) was closed and the take-off was made from intersection E (length 2140m). Aircraft came airborne just at the runway end after the captain selected full thrust, noticing the insufficient runway remaining. Crew was aware of the work-in-progress, but did not select this during the performance calculation.	Y	Serious incident	**Reduced take-off distance available** (At 7 seconds from take-off (lift-off) and with 147 knots of indicated airspeed, the TOGA power (~94% N1) was selected, which allowed the aircraft to get airborne at the edge of runway 23 with 163 knots.)	158	0	0	0	None	Luanda (Angola)	Portugal	**POS_3**	NO	YES	NO	NO	1	Airbus

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11/03/2023	PH-BGF	B737-700	A KLM Boeing 737-700, registration PH-BGF performing flight KL-1884 from Nuremberg (Germany) to Amsterdam (Netherlands), lined up runway 28 via taxiway B (TODA 2022 meters), departed and continued to Amsterdam without further incident. On Jun 1st 2023 the Dutch Onderzoeksraad (DSB) reported the crew had prepared for a full runway length departure (lining up via taxiway A, TODA 2760 meters), however, subsequently entered the runway via an intersection and started their takeoff run from that point.	Y	Serious incident	**Reduced take-off distance available** (2022 m instead of 2760 m)	?	0	0	0	None	Nürnberg (Germany)	Netherlands	**POS_2**	NO	YES	NO	NO	1	Boeing
30/07/2023	G-EJCI	A320	EasyJet Airbus A320-214, registered as G-EJCI, during takeoff from Toulouse-Blagnac Airport (France) on July 30, 2023. After departure from runway 32R in Toulouse-Blagnac airport, both crew members felt the remaining runway length at rotation appeared shorter than usual. A subsequent review of the performed take-off highlighted that the take-off was inadvertently initiated from intersection N4 (+/- 1800m TODA) with performance calculations based on intersection N2 (2300m TODA).	Y	Serious incident	**Reduced take-off distance available**	?	0	0	0	None	Toulouse-Blagnac (France)	United Kingdom	**POS_2**	NO	YES	NO	NO	1	Airbus
01/12/2023	G-JMCV	B737-4K5	The aircraft was operating a cargo flight from East Midlands Airport to Aberdeen Airport. During the departure preparations, an incorrect load sheet (the one from the previous flight) was used to input figures for the takeoff performance calculation and so the aircraft was approximately 10 tonnes heavier than anticipated. During the takeoff the aircraft tail struck the ground damaging the tail skid and a drainage mast. No personnel were injured. Note: it is understood that the wrong weight value was also inserted in the FMC	Y	Serious incident	**Long take off and tail strike** (take-off with less thrust than required)	2	0	0	0	Damage to tail skid and drainage mast	East Midlands Airport (United Kingdom)	United Kingdom	**WB_11**	NO	NO	YES	YES	1	Boeing

Links to the reports for the above occurrences

Note: The column 'Report' provides the link to the report. A 'Y' means that an official investigation report exists, a 'N' means that another kind of report exists.

Date	Registration marks	Aeroplane model	Description	Report	Type of occurrence
11 November 1998	N801DE	MD11	FMS take-off data input error (approximately 100 000 lb). Although the exact FMS entry error was not determined, the most likely would be the crew missing the hundred thousand entry by one when inputting the take-off gross weight, entering the empty weight into the ZFW prompt or entering the ZFW in the aircraft take-off gross weight prompt.	Y	Accident
24 August 1999	OY-KDN	B767-300	Before engine start-up, a take-off data input was sent via the aircraft communication and reporting system (ACARS) to the operator mainframe computer. The loadmaster delivered the load sheet to the commander. The commander entered the correct ZFW via the MCDU into the FMS. The co-pilot noted the ZFW (123 500 kg), the actual TOW (186 800 kg), the planned landing weight, fuel figures and passenger figures. The co-pilot entered ZFW into the ACARS in the space where the actual TOW should have been entered. The input data was then transmitted to the mainframe computer. The mainframe computer made the take-off performance calculation and transmitted the result back to the aircraft ACARS.	Y	Incident

31 October 2000	9V-SPK	B747-400	Take-off from runway 05R despite construction work resulting in the runway being closed. Take-off was to be performed on runway 05L. Bad weather involved (strong wind, low visibility), night-time. Collision with ground equipment and obstacles, post-crash fire, leading to aircraft destruction, fatalities and injuries.	Y	Accident
28 December 2001	N3203Y	B747-100F	The Boeing 747 sustained substantial damage as a result of a tailstrike during take-off from Anchorage. After the accident aeroplane arrived in Anchorage, it was refuelled with about 100 000 lb of fuel in preparation for the final leg of the flight to Travis Air Force Base. The crew, however, failed to account for the weight of the additional fuel and inadvertently used the same performance cards that were used for the previous landing. The crew was unaware that the tail had struck the runway until after arrival at Travis Air Force Base.	Y	Accident
25 January 2002	B-18805	A340-300	Take-off in Anchorage from taxiway Kilo instead of runway 32. The aeroplane took off, proceeded to its destination and landed without further incident. After departure, main landing gear tyre impressions were found in a snow berm at the west end of taxiway Kilo.	Y	Incident
14 June 2002	C-GHLM	A330-300	The pilots introduced a wrong V_1 value in the MCDU (126 knots instead of 156 knots).	Y	Accident
29 November 2002	TC-APJ	B737-800	The aircraft was operated with an improper CG position. Erroneous load and trim sheet.	Y	Serious incident
11 March 2003	ZS-SAJ	B747-300	The crew introduced the ZFW instead of the TOW for the performance calculations (EFB).	Y	Incident

12 March 2003	9V-SMT	B747-400	A tailstrike occurred because the rotation speed was 33 knots less than the 163 knots required for the aeroplane weight. The rotation speed had been mistakenly calculated for an aeroplane weighing 100 t less than the actual weight.	Y	Accident
17 June 2003	TC-ONP	MD88	During take-off at a speed of approximately 130 knots the captain, who was pilot flying, rejected the take-off above the decision speed because he experienced a heavy elevator control force at rotation. The stabiliser warning sounded during the entire take-off roll. The aircraft overran the runway end and came to a stop in the soft soil. During subsequent evacuation one cabin crew member and a few passengers sustained minor injuries. The aircraft sustained substantial damage. There was no fire. The crew calculated the CG with a distribution of pax in the cabin that was not the actual one (in addition mean pax weight values were slightly lower than standard).	Y	Accident
4 September 2003	OY-KBK	A321	The calculations by the handling agent were made with a lower weight than the actual TOW (60 tons instead of 76.4 tons). The mistake came from a miscommunication between two operator's offices.	Y	Incident
22 October 2003	JA8191	B747	The lift-off was delayed due to rotation being initiated at lower than the appropriate speed. The flight engineer used the value of the ZFW instead of the TOW in the performance charts for reading the T/O speeds.	Y	Accident

25 December 2003	3X-GDO	B727	During take-off the aeroplane, overloaded in an anarchic manner, was not able to climb at the usual rate and struck an airport building located 118 m past the runway end on the extended runway centreline, crashed onto the beach and ended up in the ocean. The flight crew had not received information on the TOW and CG location.	Y	Accident
4 March 2004	UR-ZVA	IL76	The take-off was initiated with clean wing because apparently the crew forgot to extend flaps and slats. After flying for 490 m the aircraft struck the ground and crashed.	Y	Accident
14 July 2004	F-GLZR	A340-300	The crew entered a weight close to ZFW instead of TOW in ACARS for calculations. The error was around 100 t, resulting in wrong take-off parameters being inserted in the FMS.	Y	Incident

8 October 2004	N275WA	MD11	The flight crew had received an FAA-approved permit to ferry the empty three-engine aeroplane to Atlanta with the centre (number two) engine inoperative. In order to enhance the climb performance and reduce drag, the crew elected to take-off on runway 32 with the centre landing gear (CLG) retracted, but calculated the aeroplane's CG with the CLG extended. As calculated, using data for the CLG extended, the aeroplane's CG was in close proximity to the allowable aft CG limitations. However, when the CLG (centred between the two main landing gear trucks) is retracted, the aft CG limit shifts forward. Using the correct gear retracted CG data, the vice president of flight operations noted that the actual take-off CG was approximately 3.2 % of mean aerodynamic chord aft of the allowable limit. Upon application of full take-off power and brake release, the aeroplane immediately rotated to an excessive nose-up attitude, and the lower empennage struck the runway. The crew aborted the take-off and taxied to parking.	Y	Accident
14 October 2004	9G-MKJ	B747-200	The Bradley TOW was likely used to generate the Halifax take-off performance data, which resulted in incorrect V speeds and thrust setting being transcribed to the take-off data card. The pilots did not carry out the gross error check in accordance with the company's SOPs, and the incorrect take-off performance data was not detected.	Y	Accident

23 April 2005	TC-SKC	B737-800	The aeroplane was scheduled to fly Hurghada–Dusseldorf–Stuttgart. The flight plan, however, was changed last minute to have the aeroplane fly Hurghada–Stuttgart–Dusseldorf. The aeroplane arrived with 189 passengers, 100 of whom disembarked in Stuttgart. The remaining passengers, all seated in the rear of the aircraft, were not reseated. This resulted in an extreme aft position of the CG caused by the remaining passengers and their luggage all located in the rear of the aircraft. Contributing factor was the poor safety attitude of all involved except for the loadmaster.	Y	Serious incident
24 August 2005	LN-RKF	A340-300	The second officer misread the preliminary load information and entered ZFW instead of TOW into the take-off data calculation. He did not update the figures when receiving the final load sheet.	N	Accident
12 July 2006	C-FHIU	ERJ-190	An incorrect aircraft weight was used to calculate take-off performance data. This error was not detected and resulted in the crew conducting the take-off with lower-than-required thrust and speed references. The crew used a wrong value for the fuel on board at take-off in the EFB.	Y	Incident

27 August 2006	N431CA	CL-600-2B19 (CRJ100)	The aeroplane crashed during take-off from Blue Grass Airport (LEX), Lexington, Kentucky. The flight crew was instructed to take-off from runway 22, but instead lined up the aeroplane on runway 26 and began the take-off roll. The aeroplane ran off the end of the runway and impacted the airport perimeter fence, trees and terrain. The captain, flight attendant and 47 passengers were killed, and the first officer received serious injuries. The aeroplane was destroyed by impact forces and post-crash fire.	Y	Accident
10 December 2006	F-HLOV	B747-400	The crew used the ZFW instead of the TOW for the take-off performance parameters calculation.	Y	Incident
25 November 2007	HB-IKR	Gulfstream IV	Take-off run on taxiway Alpha, adjacent to the active runway 01. Aborted take-off under ATC instruction.	Y	Serious incident

16 August 2008	SU-BPZ	B737-800	At night, in VMC conditions, the crew of flight AMV6104 to Luxor lined up from intersection Y11 on runway 27L at Paris Charles de Gaulle Airport. The runway distance available for take-off was temporarily reduced because of construction work. During the take-off run, the aeroplane struck some provisional lights at the end of the runway, and then, during the rotation, destroyed some markers on the safety barrier positioned in front of the construction zone. It took off before a provisional blast fence and continued its flight to its destination. The crew did not take into account the reduction of the available runway length (by about one third) due to ongoing work at the end of the runway.	Y	Serious incident
27 October 2008	OO-CBA	B747-200F	The accident was caused by an inadequate take-off performance calculation, due to wrong gross weight data input error in the software used for the computation of the take-off performance parameters and the failure to comply with the operator's SOP for checking the validity of the data. ZFW used instead of TOW (ZFW 101 tons lower).	Y	Accident
28 October 2008	G-OJMC	A330-200	The dispatcher probably used a wrong lower TOW value (89.4 tons lower than the actual value) for the take-off performance parameters calculation. The flight crew did not identify the error. The value on the load sheet was correct.	Y	Serious incident

13 December 2008	G-OOAN	B767-39H	The pilots wrongly introduced the ZFW instead of the TOW in the computer take-off programme. This generated significantly slower take-off speeds than required for the actual weight of the aircraft.	Y	Serious incident
20 March 2009	A6-ERG	A340-500	The crew introduced an abnormally low TOW value in the EFB tool, probably due to a typing error (100 tons less).	Y	Accident
1 September 2009	LZ-BHC	A320	The aeroplane passengers were not located in accordance with the load sheet assumptions but in accordance with their destination.	Y	Incident
31 August 2009	PH-?	B777	The aircraft suffered minor damage during a tailstrike incident. The engine thrust selected for the take-off was lower than what was required for the weight of the aircraft because the take-off data was based on an incorrect weight input (error ~ Δ 100 tons).	Y	Serious incident

26 September 2009	G-VIIR	B777-200	The crew misidentified the runway intersection and took off from the wrong runway intersection.	Y	Serious incident
12 December 2009	G-VYOU	A340-600	The crew used the estimated landing weight instead of the TOW (86.5 tons lower) for the take-off parameters calculation request (sent via ACARS to a central computer).	Y	Serious incident
10 February 2010	PH-BDP	B737-300	While taxiing, the crew lost their positional awareness and as a result they took off from taxiway B instead of the adjacent runway 36C.	Y	Serious incident
25 February 2010	VP-BWM	A320-214	Take-off from Oslo taxiway M instead of runway 01L.	Y	Serious incident
3 March 2010	B-18723	B747-400F	When entering the required data into the runway analysis system, the pilot took the maximum landing weight as maximum TOW obtained from the computerised flight plan, which led the calculation to provide erroneous take-off thrust, take-off reference speed and take-off model.	Y	Accident

13 October 2010	VH-NXD	B717-200	The pilot wrongly read out the operating weight instead of the ZFW and that value was introduced in the FMS. Additionally, there was an error when introducing the baggage weights into the EFB. The result was a landing weight 9 415 kg lower than the actual one).	Y	Serious incident
21 November 2010	5N-MJI	B737-700	The crew had programmed the aircraft's FMC for a maximum thrust take-off from runway 24 at Southend Airport. As the aircraft taxied out, ATC changed the runway in use to runway 06. The FMC was reprogrammed, but an incorrect 'assumed' temperature was entered, resulting in too great a thrust reduction for the runway length available.	Y	Incident

29 April 2011	G-NIKO	A321-231	The commander read out (from the load sheet) what he thought was the actual take-off mass (ATOM), but mistakenly read out the zero fuel mass (ZFM). The commander then wrote down that figure in a space provided on the navigation log for the ATOM. The SOP then required him to compare the estimated take-off mass, on the line above, with the ATOM. However, he actually compared the figure he had written down as the ATOM with the estimated ZFM on the line beneath. The commander next entered some data into the FMS, which included entering the ZFM from the load sheet in the INIT B page. The load sheet was passed to the co-pilot who checked it and confirmed that it matched the commander's entry in the FMS. Performance calculations were then performed by the two pilots using the incorrect ATOM. The SOP required the crew to cross-check the green dot speed generated by the laptop computer against that generated by the FMS. However, although they cross-checked the performance figures between the two laptops, the cross-check with the FMS green dot speed was missed.	Y	Serious incident
12 June 2011	VH-VWX	A321-231	In accordance with the operator's SOPs, the co-pilot checked the performance data computed by the pilot-in-command and found an error in the TOW calculations. The co-pilot corrected the error and consulted the performance charts to extract the revised V speeds relating to the correct TOW. However, when doing this, the co-pilot inadvertently referenced the performance chart for the full length of runway 11 rather than the chart for the planned taxiway Bravo departure.	Y	Incident

22 November 2011	VH-TJL	B737-400	After the need to recalculate performance due to change of runway, the pilots inadvertently used the full length of the new runway instead of the proper intersection of the new runway for performance calculations (full length being the default option in the EFB).	Y	Incident
26 November 2010	OH-LQD	A340-300	Take-off attempted from taxiway at Hong Kong. Aircraft was cleared for take-off from runway 07L. Instead of lining up on the runway, the aircraft made a wrong premature turn onto taxiway A, which was located next to and parallel to the runway in use, and started to roll. The air traffic controller alerted the pilot immediately and instructed the pilot to stop. The aircraft rolled for approximately 10 seconds before slowing down.	Y	Serious incident
8 December 2011	CS-TOD	A340-300	The runway length was shortened due to works. The pilots were aware and properly calculated the take-off performance but used the wrong intersection and entered the runway 600 m ahead of the new threshold.	Y	Serious incident
5 February 2012	4R-ADG	A340-300	The aircraft started its take-off from a runway intersection for which no regulated TOW chart was available in the aircraft. The pilots calculated performance using a chart for a different runway that did not consider obstacles relevant to the runway in use. The take-off and subsequent flight were completed without further incident.	Y	Incident

14 April 2012	G-ZAPZ	B737-300	The pilot did not enter the TOW in the EFB tool and the application took the TOW from the previous flight per default (6.6 tons lower). There was no subsequent cross-check by the crew. The commander entered a correct ZFW in the FMC.	Y	Accident
4 July 2012	G-EZDN	A319-100	The pilots calculated performance for the full runway length but the runway was shortened due to works (from 3 715 to 2 500 m). There was a NOTAM the pilots were aware of but forgot in the end. The ongoing work was located at the end of the runway.	Y	Serious incident
16 October 2012	F-GRHU	A319	Take-off initiation from taxiway at Sofia – rejected take-off. The crew started the take-off roll on a taxiway parallel to the runway. ATC asked them to abort. EGPWS RAAS (Runway Awareness and Advisory System) (Honeywell) was installed but did not trigger the 'on taxiway' message as its threshold is 40 knots and the maximum speed reached was 37 knots.	N	Serious incident
16 April 2013	XA-TOJ	B767-200	The performance was calculated by the handling agent using ZFW instead of TOW. A correct ZFW was used in the FMC.	Y	Accident
21 June 2013	VH-ZPC	ERJ-190	The pilots used the wrong intersection for performance calculations. Take-off was initiated from a position different from the one inserted in the FMS and used for performance calculation. Contributor: misunderstanding between the pilots.	Y	Incident

1 July 2013	PH-?	B737-800	Take-off performed from RWY19R intersection A6, although performance calculation made with intersection A7. During the take-off roll the crew realised that the take-off performance was compromised. Thrust was increased and the V_1 call was made 10 knots below V_1.The aircraft was rotated within the confines of the runway.	Y	Incident
7 July 2013	PH-BVG	B777-300	The pilot mentioned an incorrect TOW and used that wrong value for performance calculations. The other pilot had made a correct calculation but was distracted and discarded his values.	Y	Serious incident
1 October 2013	HB-IOR	A320	The pilot calculated take-off performance for the full runway length and then recalculated for a shorter intersection runway but this new calculation was not introduced in the FMS prior to the take-off (3 480 v 1 900 m). Contributor: distraction in the cockpit, which interrupted the pilot flying calculation (pilot flying had to leave the cockpit in the middle of the calculation).	Y	Serious incident

14 October 2013	VH-VUC	B737-300	The pilots calculated the performance for both full runway length and runway intersection in data cards and introduced the data for full runway length in the FMS (3 354 v 2 238 m). Subsequently, they decided to take-off from the intersection and reprogrammed the FMS. However, the data introduced in the FMS seemed to come from a full runway length input.	Y	Incident
1 August 2014	VH-VZR	B737-800	The Australian Transport Safety Bureau found that the tailstrike was the result of two independent and inadvertent data entry errors when calculating the take-off performance data. As a result, the TOW used was 10 tons lower than the actual weight. This resulted in the take-off speeds and engine thrust setting calculated and used for the take-off being too low. As a result, when the aircraft was rotated, it overpitched and contacted the runway.	Y	Incident
18 September 2014	PH-HZD	B737-800	The pilot made a wrong manual calculation of the TOW, which resulted in 16 % less than the actual one (10 tons lower), and used that wrong value for performance calculations. Correct weight value from the load and trim sheet was, however, entered in the FMS, which calculated correct speeds but with an insufficiently reduced thrust based on the temperature input from the pilots.	Y	Serious incident

6 October 2014	HB-IOP	A320	After an initial intention to take off from runway 33, prevailing traffic led the crew to decide on a take-off from runway 15 and calculate the required engine power for take-off using the total available runway length of 3 900 m. While taxiing to the threshold of runway 15, the crew decided to save time by taking off from the taxiway Golf intersection, which gave an available runway length of 2 370 m. Without stopping after lining up, they took off with an engine power that had been calculated for the entire length of the runway. This engine power did not meet the requirements for allowing the take-off to be continued or rejected within the remaining runway length in the event of engine failure at decision speed. During the final stages of the take-off roll, the commander noticed the low engine power, increased it to the maximum possible and initiated aircraft lift-off by rotation. The subsequent climb was uneventful and the flight was able to continue to Djerba.	Y	Serious incident

22 May 2015	F-GUOC	B777-F	The Boeing 777-F took off at low speed and the tailstrike protection of the aeroplane was activated. The aeroplane did not gain altitude. The crew then applied full thrust. The aeroplane flew over the opposite threshold at a height of approximately 170 ft and continued to climb. During the climb, the crew discussed the causes of the incident and realised they had made a mistake of 100 t in the weight used for the calculation of the take-off performance parameters. The crew continued the flight to destination without any further incident. Note: a correct ZFW had been entered in the FMS.	Y	Serious incident

25 June 2015	G-EZAA	A319-100	The flight crew planned to perform a take-off from runway 25 using intersection Bravo at Belfast Aldergrove Airport. The initial performance figures, calculated using the EFB, were computed for a wet runway; this produced a full power thrust setting. Just before pushback, as the runway was dry, the crew elected to change the runway state on the EFB from wet to dry to see if this would produce a reduced engine thrust setting, which it did. The aircraft subsequently became airborne with about 200 m of runway remaining. After departure, analysis by the crew revealed that an incorrect runway was used to calculate the dry runway performance figures, resulting in erroneous figures being generated. The reason for this could not be confirmed, but subsequent investigations revealed that in one scenario an involuntary runway change could occur on the EFB. This anomaly was not known by the operator or manufacturer at the time of the event and is likely to have been the reason for the incorrect runway selection. These figures were not identified as erroneous and were subsequently used for take-off.	Y	Serious incident

16 July 2015	G-EZUH	A319-100	Before pushback, take-off performance was calculated for a departure using the full length of runway 08. When the aircraft was at the holding point, prior to take-off, it became apparent that an intersection departure might be required due to an aircraft holding on the runway threshold. The performance was recalculated for this, with a change in flap setting. The aircraft then took off from intersection Bravo with performance calculated assuming that the full length of the runway was available.	Y	Serious incident
16 September 2015	A7-BAC	B777-300	The pilots seem to have wrongly interpreted the (probably confusing) designation of the runway in the EFB and took off from the wrong runway intersection.	Y	Serious incident
16 October 2015	G-EZIV	A319-100	During pre-flight preparation, performance figures were calculated for a departure from intersection November Two of runway 03 at Lisbon Airport when runway 21 from intersection Uniform Five was used for take-off. The error was not noticed during the crew's standard cross-checking procedures due to distraction in the cockpit and some complacency.	Y	Serious incident
3 December 015	PH-HSG	B737-800	The crew selected a wrong runway and take-off position in the EFB. Contributing factors: the ergonomics of the EFB performance module; the ambiguous runway take-off position naming system at the airport.	Y	Serious incident

1 January 2016	PH-?	A330-200	During taxi-out, the flight crew decided to take-off from intersection B of runway 35 instead of using intersection A, representing the full runway length. The reason for this decision was to gain time due to late arrival of the aircraft. A new Lintop request was made while taxiing. However, intersection A was inadvertently re-entered. The revised take-off data was subsequently entered into the FMC. Full take-off thrust was used. Rotation was started at the calculated VR. The aircraft lifted off between 340 and 263 m before the runway end and crossed the runway end at a height between 19 and 40 ft RA. By using intersection B instead of A, the take-off distance was shortened by 750 m.	Y	Incident
14 April 2016	G-EZFJ	A319-100	Due to an EFB software deficiency, the take-off performance of a different runway from the selected one was wrongly shown to the crew.	Y	Serious incident
20 April 2016	VH-YQV	B717-200	Wrong flex temperature introduced in the FMS (34 °C instead of 39 °C).	Y	Incident
9 May 2016	G-EZFP	A319-100	The crew selected the wrong runway in the EFB, apparently driven by the existence of a NOTAM and after having (wrongly) compared the lengths of the ‘temporary’ selected runway and the actual intersection that should have been used. Contributors: fatigue.	Y	Serious incident

13 July 2016	N279AV	A330-200	The crew did not take into account for the performance calculation a NOTAM reducing the runway length (3 950 v 2 700 m). Contributors: wrong task sharing (introduction and verification of calculations by pilot monitoring only) and lack of recurrence of pilot flying (more than 60 days out).	Y	Serious incident
30 August 2016	VT-JEK	B777-300	The aircraft took off from intersection S4E on runway 27L using performance information (power setting, flap setting and take-off speeds) appropriate for a take-off from intersection N1 (full length). The manufacturer found that, for the aircraft to meet all regulatory performance requirements, the take-off distance required was 3 349 m, whereas the take-off distance available from intersection S4E was 2 589 m.	Y	Serious incident
21 January 2017	VH-VNC	A320	The pilot taxied to and took off from a wrong intersection. Contributors: the fact that the pilot was following another aeroplane may have contributed to the mistake.	Y	Incident

21 April 2017	VT-JEW	B777-300	During take-off, a tailstrike was caused by an overrotation of the aeroplane, which was the result of a lower-than-required airspeed at which the rotation was started. The reason for this was that the actual TOW was higher than the TOW that had been used for the take-off performance calculation. Due to a human error predominantly caused by time pressure, incorrect load sheet data was supplied to the pilots (TOW: 229 v 299 tons). Note: a correct gross TOW was present in the FMS.	Y	Serious incident
15 July 2017	N852GT	B747-800F	It is probable that the aircraft commenced a take-off roll using a take-off thrust lower than the thrust required for the aircraft to take off because the captain did not correctly change the FMC settings for the take-off thrust at the time of take-off from a runway different from what the captain and the first officer had assumed. The captain did not correctly change the FMC settings for the take-off thrust and in addition the captain and the first officer did not verify the take-off thrust by the time they commenced the take-off.	Y	Serious incident

21 July 2017	C-FWGH	B737-87J	Following an operational delay and an updated performance calculation, the correct value for the new assumed temperature (48 °C) was entered into the FMC, but another incorrect figure (– 52 °C) was entered into the OAT field of the N1 limit page.	Y	Serious incident
17 August 2017	EI-DTB	A320	Take-off with wrong CG because the pax distribution was assumed as even by the handling agent when that was not actually the case. This was a multiple-leg flight and pax were located in accordance with their destination.	Y	Serious incident
28 September 2017	G-FDZJ	B737-800	The available evidence indicates that the aircraft was out of trim due to an incorrect mean aerodynamic chord TOW on the load sheet. This occurred because passengers' actual seating positions were not passed to the handling agent. When producing the load sheet the handling agent assumed an even distribution of passengers within the cabin, when the actual distribution created a forward bias.	Y	Serious incident

16 November 2017	VP-CAM	B737-800	The pilots intended to take off with full thrust but actually an assumed temperature (AT) of 67 °C for reduced thrust was preselected in the system. According to the FDR recording, the AT input was registered by the FMC before the flight crew powered up the engines. The flight crew appeared not to have noticed that the N1 of 90.4 % and an AT of 67 °C were displayed to them.	Y	Serious incident
28 March 2018	G-CKWC	B787-9	The aircraft began its take-off roll from the displaced landing threshold of runway 26R at Gatwick Airport, rather than at the beginning of the runway. This decreased the distance available for the take-off by 417 m. Contributors: specific runway design (taxi to the runway at the same heading is unusual but compliant with regulations, same as lack of lighting in the pre-threshold part of the runway).	Y	Serious incident

29 March 2018	4X-EDB	B787-9	The captain introduced a wrong ZFW in the FMS (40 tons lower than the correct one). He realised the mistake, and intended to correct it but actually did not correct it. Both captain and co-pilot then used the FMC-displayed ZFW and TOW values to make the performance calculations with the onboard performance tool. The captain entered the take-off speeds and thrust setting into the FMC and mode control panel, according to the computation results.	Y	Serious incident
10 June 2018	PH-BXG	B737-800	After ATC instructed the aircraft to taxi to intersection N4, new take-off data had to be calculated with the actual wind conditions for this intersection (initial calculation done for intersection N5). This was done just before the plane lined up on the runway. The investigation made clear that only the new wind data was entered into the FMC, whereas the intersection remained N5 instead of N4. The newly entered take-off data was not checked by the other crew members. Therefore, the computation of the take-off parameters was based on an available runway length that was 3 494 m instead of the actual 2 460 m. After the take-off roll, the aircraft became airborne 176 m before the end of the runway and passed the runway threshold at a height of 28 ft.	Y	Serious incident

15 July 2018	HB-JCC	A220-300	Once the aircraft was aligned to the runway axis, the pilot flying advanced the thrust levers, assuming that the autothrottle (AT) would now be engaged and would set the take-off power to the required level. As the pilot flying had advanced the thrust levers to a thrust lever angle (TLA) of only 20.6 °, the AT remained armed without becoming engaged. This went unnoticed by the flight crew. For activation, a TLA of 23 ° would have been required. After exceeding an indicated airspeed of 60 knots, the spoilers extended as they are designed to do; this was not indicated to the flight crew. As per the SOPs, one of the things that the flight crew must check is that the required take-off power is set when exceeding a speed of 80 knots. Neither of the pilots could remember whether they had executed this check. The engine power being too low went unnoticed. Due to slow acceleration and the remaining length of the runway, the pilot flying realised that the power had been set too low. By then, the aircraft had reached a speed of between 90 and 100 knots. He pushed the throttles forward and, when the TLA passed 23 °, the spoilers retracted, as they are designed to do. In addition, the warning 'Config Spoiler' was displayed in red letters. The aircraft took off approximately 1 000 m before the end of the runway, at a distance that was 1.5 times the length of the calculated take-off distance, continued to climb and landed in Geneva without further incident.	Y	Serious incident
28 July 2018	YR-BMF	B737-800	Prior to departure, the aircraft's take-off data was calculated on an EFB using its ZFW instead of its TOW. The FMC was fed with the EFB data without a check of the load sheet. The pilots did not cross-check or independently calculate the data. During take-off, the aircraft suffered a tailstrike.	Y	Serious incident

3 August 2018	VT-JFS	B737-8AL	JAI-523 was cleared to taxi through taxiway G and for take-off from runway 33R. JAI-523 lined up on the TWY-K that is parallel to RWY-33R and commenced its take-off roll. Approaching the end of TWY-K, the crew realised the situation and aborted the take-off. The aircraft uneventfully came to a complete stop on an unpaved ground along the path of TWY-K past TWY-G4 at approximately 2 485 m from the beginning of take-off roll on TWY-K.	Y	Serious incident
8 August 2018	PH-HXM	B737-800	During take-off, the crew noticed that the aircraft was sluggish in its rotation and in its response to rudder deflections. A review of the take-off performance calculations showed that the take-off mass of the aircraft used in the calculations was too low. The reason was that the zero fuel mass had been used by mistake rather than the take-off mass. The selected engine thrust, which is partially dependent on the take-off mass, was therefore insufficient for take-off. Preliminary information shows that the aircraft lifted off the ground on the last section of the runway.	Y	Incident
18 September 2018	A6-ANV	A320-200	The crew was cleared for an intersection take-off on runway 30 but turned onto runway 12 and commenced take-off with less than 1 000 m of runway ahead. On eventually recognising the error, the training captain took control, set maximum thrust and the aircraft became airborne beyond the end of the runway and completed its international flight. The investigation attributed the event to the pilots' total absence of situational awareness, noting that after issuing take-off clearance, the controller did not monitor the aircraft.	Y	Serious incident

29 September 2018	VH-VFX	A320-200	In completing the manual calculations for take-off performance, the flight crew inadvertently calculated speeds that were higher than those required for the actual aircraft weight and environmental conditions. They used a table based on the maximum regulated TOW. The incorrect take-off speeds were not identified by independent verification and cross-checking. Take-off was performed with full thrust. During the first segment of the take-off climb period, at maximum engine power settings, the aircraft pitch rate was below the recommended 3 ° per second, resulting in a higher acceleration rate than anticipated. Due to the incorrect calculated speeds, the aircraft rotated with a margin of only 16 knots to the flap extended limit speed. Five seconds after rotation, the flap extended overspeed event occurred.	Y	Incident

30 September 2018	OE-LQE	A319-100	This serious incident resulted from the error of inputting incorrect data into three fields on the load sheet application. Incorrect gender/age profile meant that the total passenger weight was underestimated by 1 962 kg. Once the mistake had been made, human performance limitations reduced the likelihood that the slip would be detected. The crew noticed a ZFW anomaly, but despite looking for an error they could not find one. The lack of commonality between loading form certificate and EFB formats was considered by the operator to be an exacerbating factor, as was the lack of gender/age profile information in the load sheet application's reduced mode. The undetected error led to the departure being flown with incorrect take-off performance parameters. The crew's decision to use take-off / go-around thrust if they had any performance concerns during take-off might not have been a reliable risk control because the C-FWGH incident showed that pilots are unlikely to perceive when extra thrust is required.	Y	Serious incident
11 December 2018	G-LCYZ	ERJ190	Incorrect thrust derate selection in the FMC (T/O-3 instead of T/O-1) resulted in insufficient thrust for the actual TOW. To better understand the safety impact of the incorrect take-off setting, once above FL100, the crew recalculated their take-off performance based on T/O-3 thrust. The calculations indicated that, while they would have been able to stop safely up to V_1, climb performance might have been compromised had an engine failed shortly thereafter.	Y	Serious incident

1 April 2019	PH-?	B737-800	During taxi-out, the flight crew decided to take off from intersection N4 of runway 32R instead of intersection N2. Believing they had calculated the take-off data for intersection N4, they started the take-off from this intersection. Reduced take-off thrust was used. During the last part of the take-off roll, the end of the runway became visible and the crew realised that they were much closer to the runway end than expected. Thrust was not increased though. Rotation was started at the calculated VR and the aircraft lifted off 248 m before the runway end. The runway end was crossed at 32 ft RA. After take-off, the flight crew reviewed the performance data, which revealed the entry error.	Y	Incident
24 April 2019	G-EZTD	A320-200	During pre-flight preparations, both pilots completed a take-off performance calculation for a take-off from the runway intersection with taxiway U5. During subsequent re-planning, the crew thought they had recalculated performance information from taxiway S1 but had, in fact, used S4 (runway full length). The aircraft took off from taxiway U5 with performance calculated for the full runway length. The take-off distance available from U5 was 1 395 m less than that used for the performance calculation, and the aircraft passed the upwind end of the runway at 100 ft above airport level. The operator had another identical event 14 days later.	Y	Serious incident

7 May 2019	OE-IJL	A320-200	Event identical to the incident of G-EZTD of 24 April 2019. In this event, the aircraft lifted off 350 m before the upwind runway threshold, which it crossed at about 75 ft above airport level.	Y	Serious incident
27 May 2019	G-DRTB	B737-800	Substantial probability that the take-off was at incorrect thrust setting.	N	Incident
5 August 2019	VQ-BKV	B737-800	Take-off data computation error, possibly using ZFW instead of TOW. Moscow's interregional transport department of the federal investigative committee said that five runway end lights were damaged. The aircraft sustained damage to three MLG tyres.	N	Serious incident

29 August 2019	G-EZBI	A319-100	During their initial pre-flight preparation, the flight crew chose to calculate take-off performance based on the most limiting intersection available, Bravo 3, on runway 04R at Nice Côte d'Azur Airport. The aircraft departed from intersection Alpha 3 where the runway length available was 316 m greater than from Bravo 3. At lift-off, the commander noted that the departure end of the runway was closer than he would have expected but did not perceive any other performance issues. Subsequent analysis of recorded flight data and the flight crew's take-off calculations indicated that both pilots had inadvertently used performance figures for a departure from intersection Quebec 3. With both pilots making the same mis-selection, the take-off performance cross-check was invalidated and the error went undetected. The available runway length from Quebec 3 was 701 m greater than from Bravo 3.	Y	Serious incident
6 September 2019	PH-HSJ	B737-800	Take-off initiated on taxiway D at Amsterdam Airport, instead of runway 18C. ATC noticed the error and instructed the crew to stop the aircraft.	Y	Serious incident

16 September 2019	G-EZWE	A320-200	During pre-flight preparations, both pilots completed a take-off performance calculation for a take-off from runway 21 at Lisbon Airport. In calculating the performance, the crew believed they had selected the shortest runway length available (from the intersection with taxiway S1), but had in fact used the runway full length (from taxiway S4). The aircraft was cleared for take-off from another intersection (taxiway U5) and used performance calculated for the full runway length. The take-off distance available from U5, although longer than from S1, was 1 395 m less than that used for the performance calculation, and the aircraft became airborne with only 110 m of the runway remaining.	Y	Serious incident
25 September 2019	VH-VPJ	ATR72	The flight crew received clearance to line up on runway 35 intersection 'Golf' at Canberra Airport. While taxiing to the runway, the flight crew inadvertently lined-up on runway 30. Almost immediately after commencing the take-off roll, and at about the same time ATC instructed them to stop, the flight crew rejected the take-off. The aircraft was re-positioned for a departure from runway 35.	Y	Incident
2 October 2019	G-EUOG	A319-100	G-EUOG taxied out to runway 27L at London Heathrow Airport for a flight to Leeds Bradford Airport. The planned departure intersection was N2W (take-off run available 3 380 m). As the aircraft taxied out, the pilot monitoring asked for intersection N4E (take-off run available 2 702 m), which was granted by ATC. After starting the second engine and completing the checklist, the aircraft departed from N4E using take-off performance data calculated for N2W.	Y	Serious incident

24 November 2019	G-EUXJ	A321-231	Wrong flex temperature of 79 ° instead of 49 ° introduced in the FMC. The investigation found that the incorrect entry was probably a result of distraction during the data entry. The subsequent standard procedures and checks did not detect the error.	Y	Serious incident
28 February 2020	CN-RGJ	B737-8B6	During the take-off roll, the 'V_1' automatic call did not occur and the take-off speeds were not displayed on the primary flight display. The aircraft rotated 37 knots above the correct speed for this departure and 120 m from the end of the runway. It is likely that the flight crew did not enter speeds into the FMC or inadvertently deleted them after they had been entered.	Y	Serious incident
21 July 2020	G-TAWG	B737-8K5	Error in the airline reservation system used to generate the load sheet. With 38 females checked in incorrectly and misidentified as children (system error), the take-off mass from the load sheet was 1 244 kg below the actual mass of the aircraft.	Y	Serious incident

3 January 2021	G-UZMI	A321-251NX	During the boarding process, the crew recognised that the passenger distribution was incorrect for their aircraft type. The commander subsequently filed a safety report that initiated an investigation by the operator. It was found that the previous sector might have been flown with the aircraft CG out of operating limits, and issues were identified with data transfer between the aircraft management and departure control systems. Although it was subsequently found that the aircraft had not flown outside certified limits, the operator implemented safety actions to strengthen its procedures and prevent recurrence.	Y	Serious incident
3 March 2021	PH-BCD	B737-800	The crew wrongly requested (Lintop) data for intersection 'S' when they intended to request data for intersection 'S1'. As 'S1' was not available in the system, 'S4' was assigned. Eventually, the crew initiated their take-off on runway 21 from intersection U5, as instructed by ATC. As a result, at the end of the runway, the aircraft was flying too low, at an altitude of between 45 and 70 ft radio height. The flight was continued without further mishap.	Y	Serious incident

12 September 2021	PH-NXD	E195-E2	The aircraft took off with a selected amount of take-off thrust, based on erroneous take-off data. The investigation found that the aircraft took off from intersection L5 – as the crew intended – while the performance calculation was based on intersection K5. The actual available runway length was 1 320 m less than the runway length used in the calculation of the performance parameters. The selected thrust setting was such that the acceleration of the aircraft was too slow to safely take off from intersection L5. As a result, the aircraft became airborne 443 m before the end of the runway. Safety margins were reduced during the take-off. The aircraft would likely not have been able to safely abort the take-off at speeds close to V_1.	Y	Serious incident
1 December 2021	G-JZHL	B737-8MG	The aircraft took off with insufficient thrust set because the TOGA (take-off / go-around) button was not pressed. It was not pressed because the co-pilot was startled by the aircraft moving as he commenced the run-up against the brakes. The aircraft started to move because insufficient brake pressure was applied. Human checks designed to detect insufficient thrust were ineffective because both pilots were attending to other tasks. The commander was responding to a radio call from the flight information service officer during the start of the take-off roll. Neither pilot detected the low thrust until after the aircraft was airborne.	Y	Serious incident

6 January 2022	XA-VIM	A320-200N	A VivaAeroBus Airbus A320-200N, registration XA-VIM, performing flight VB-187 from Chicago's O'Hare International Airport, Illinois, United States, to Mexico City, Mexico, had taxied to runway 22L via taxiway V, when ATC cleared the aircraft to line up on runway 22L and wait shortly followed by take-off clearance from runway 22L. The aircraft, however, turned immediately right onto taxiway N and commenced take-off. ATC spotted the aircraft on the taxiway and immediately cancelled the take-off clearance followed by a number of 'stop' instructions until the crew acknowledged on radio. The aircraft rejected take-off at low speed (about 15 knots over ground), then turned right twice onto taxiway V again, and departed from runway 22L about nine minutes after the rejected take-off.	N	Incident

18 February 2022	A6-FML	B737-800MAX	A Flydubai Boeing 737-8 MAX, registration A6-FML, performing flight FZ-1746 from Belgrade, Serbia, to Dubai, United Arab Emirates, lined up on Belgrade's runway 30 at taxiway D, departed at about 13:49L (12:49Z) but crossed the runway end just at a few feet AGL and climbed out slowly. The aircraft subsequently accelerated both indicated airspeed and climb and continued to Dubai for a landing without further incident. A ground observer reported that the aircraft began rotation about 300 m short of the runway end but rotated very slowly, became airborne and crossed the runway end just a few feet above the surface; a one engine inoperative departure would have been impossible. About two minutes after becoming airborne the crew queried with ATC whether they had departed taxiway E (take-off run available 3 000 m / 9 800 ft) or taxiway D (take-off run available 2 085 m / 6 800 ft), ATC reported they had departed from taxiway D. The ground observer could not tell whether the crew had requested to depart from intersection with taxiway D or E prior to or during taxi for departure. ADS-B data suggests that the aircraft crossed the runway end at less than 30 ft AGL at 156 knots over ground, reached 80 ft AGL about 400 m / 1 350 ft past the runway end at 168 knots over ground (just past the localiser antenna), then joined a rather normal climb profile. On 23 February 2022 Serbia's Directorate of Civil Aviation announced that they have opened an extraordinary inspection into Flydubai with respect to the 737-8 MAX occurrence of 18 February 2022 and stated 'As part of the investigation, the Directorate of Civil Aviation of the Republic of Serbia will send a request to investigate the events to the aviation authorities of the United Arab Emirates, in order to inform us about the results of the investigation, since they are in charge of the operator'.	N	Incident

21 February 2022	CS-DFG	Falcon 2000EX	The flight crew was cleared for line-up and take-off from runway 09. Instead, pilots began take-off roll from taxiway 'H', which is parallel to runway 09. Then ATC of Sofia cancelled the take-off clearance. At 40 knots, the Runway Awareness Advisory System (RAAS) triggered the aural advisory message 'On Taxiway, On Taxiway'. The aircraft reduced rolling speed and stopped before the intersection of taxiway 'C'. After coordination with the flight crew, Sofia ATC issued instructions for a reverse turn and taxiing on taxiway 'H', line-up and take-off from runway 09.	Y	Serious incident
12 April 2022	CS-TUL	A330-900	The crew made performance calculations for a take-off on runway 23 at Luanda International Airport. However, due to work in progress, the first part of runway 23 (length 3 700 m) was closed and the take-off was made from intersection E (length 2 140 m). The aircraft came airborne just at the runway end after the captain selected full thrust, noticing the insufficient runway remaining. Crew were aware of the work in progress, but did not select this during the performance calculation.	Y	Serious incident

11 March 2023	PH-BGF	B737-700	A KLM Boeing 737-700, registration PH-BGF, performing flight KL-1884 from Nuremberg, Germany, to Amsterdam, Netherlands, lined up on runway 28 via taxiway B (take-off distance available 2 022 m), departed and continued to Amsterdam without further incident. On 1 June 2023 the Dutch Onderzoeksraad reported that the crew had prepared for a full runway length departure (lining up via taxiway A, take-off distance available 2 760 m), however, subsequently entered the runway via an intersection and started their take-off run from that point.	Y	Serious incident
30 July 2023	G-EJCI	A320	EasyJet Airbus A320-214, registered as G-EJCI, during take-off from Toulouse-Blagnac Airport, France, on 30 July 2023. After departure from runway 32R in Toulouse-Blagnac Airport, both crew members felt that the remaining runway length at rotation appeared shorter than usual. A subsequent review of the performed take-off highlighted that the take-off was inadvertently initiated from intersection N4 (take-off distance available ± 1 800 m) with performance calculations based on intersection N2 (take-off distance available 2 300 m).	Y	Serious incident
1 December 2023	G-JMCV	B737-4K5	The aircraft was operating a cargo flight from East Midlands Airport to Aberdeen Airport. During the departure preparations, an incorrect load sheet (the one from the previous flight) was used to input figures for the take-off performance calculation and so the aircraft was approximately 10 t heavier than anticipated. During the take-off, the aircraft tail struck the ground, damaging the tail skid and a drainage mast. No personnel were injured. Note: it is understood that the wrong weight value was also inserted in the FMC.	Y	Serious incident

Appendix 3 — Quality of the NPA

To continuously improve the quality of its documents, EASA welcomes your feedback on the quality of this document with regard to the following aspects.

Please provide your feedback on the quality of this document as part of the other comments you have on this NPA. We invite you to also provide a brief justification, especially when you disagree or strongly disagree, so that we can consider this for improvement. Your comments will be considered for internal quality assurance and management purposes only and will not be published (e.g. as part of the CRD).

1. The regulatory proposal is of technically good/high quality

Please choose one of the options

Fully agree / Agree /Neutral /Disagree /Strongly disagree

2. The text is clear, readable and understandable

Please choose one of the options

Fully agree /Agree /Neutral /Disagree /Strongly disagree

3. The regulatory proposal is well substantiated

Please choose one of the options

Fully agree /Agree /Neutral /Disagree /Strongly disagree

4. The regulatory proposal is fit for purpose (achieving the objectives set)

Please choose one of the options

Fully agree /Agree /Neutral /Disagree /Strongly disagree

5. The regulatory proposal is proportionate to the size of the issue

Please choose one of the options

Fully agree /Agree /Neutral /Disagree /Strongly disagree

6. The regulatory proposal applies the 'better regulation' principles[1]

Please choose one of the options

Fully agree /Agree /Neutral /Disagree /Strongly disagree

7. Any other comments on the quality of this document (please specify)

[1] For information and guidance, see:
- https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how_en;
- https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how/better-regulation-guidelines-and-toolbox_en.