

# APPENDIX 4

# ADVANCED

# STATISTICS FOR

# BALLOONS



# Appendix 4

## Advanced statistics for balloons

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This appendix covers the advanced statistics for hot air balloon operations where the state of registry is an EASA Member State.

The first section outlines the safety risks, that have been derived from occurrence data from the European Central Repository (ECR). They provide per domain, and per type of operation as necessary, the relative safety risk level and frequency of each key risk area (KRA). The KRA is the most likely type of accident that would have resulted if an occurrence had escalated into an accident. It is one element of the European Risk Classification Scheme (ERCS). In terms of safety performance, they are the Tier 2 safety performance indicators for the domain. The KRAs are prioritised based on their aggregated risk contribution using the ERCS, as applied by the competent authorities from 2023 onwards in accordance with the Commission Implementing Regulation (EU) 2021/2082 published in November 2021. The timespan of the 2024 edition is, therefore, limited to one year (i.e., 2023, the first year of ERCS implementation), and will be expanded on a yearly basis until a five-year timespan is achieved. The frequency of occurrences and the related aggregated ERCS numerical equivalent scores are determined per KRA, considering accidents, serious incidents and incidents, where the KRA and the ERCS safety risk score have been completed by the competent authority. An ERCS completion rate per domain, and operation type as necessary, complements therefore the presented data for the contextualisation.

The two other sections provide an overview of the human factors (HF) and human performance (HP) issues, as well as an overview of the airworthiness issues.

The term HF describes human characteristics, abilities, and limitations. The knowledge of HF is used throughout the aviation industry to design systems, equipment and work in ways that support humans in performing at their best. HP refers to how people perform their tasks. Following safety occurrences, HF and HP knowledge can also be used diagnostically to better understand what went wrong, what went right and, more importantly, to understand how to prevent such occurrences from happening again. The same European Co-ordination Centre for Accident and Incident Reporting Systems (ECCAIRS) taxonomy that helps us to identify our safety issues and (KRAs) also provides us with HF and HP codes. This taxonomy groups event types at different levels, so that all the issues relating to personnel are grouped at the highest level into 'personnel'. The personnel issues are then further subdivided into four categories: experience and knowledge events, physiological events, situational awareness and sensory events and personnel task performance events. A further two levels of subdivision exist, providing increasing granularity on the type of HF or HP issues identified. The presented data consider all occurrences of a domain, i.e., accidents, serious incidents, and incidents.

The term 'airworthiness' includes aircraft design, aircraft production, and aircraft maintenance. The attribute 'event type' in the ECCAIRS taxonomy allows regulators and industry to code the causes and contributing factors to occurrences. The first level of airworthiness analysis shows the contribution of the aircraft system loss and malfunction to accidents and serious incidents, including the distribution of the main Air Transport Association (ATA) chapters and aircraft general/generic events. The second level of analysis goes a step further, showing the contribution of design, production, and maintenance to aircraft system loss and malfunction, i.e., highlighting the systemic root cause of a

system or equipment failure. The presented data consider all occurrences of a domain, i.e., accidents, serious incidents, and incidents.

## 1 Safety risks

The safety risks for balloons are derived from occurrences data recorded in the ECR, covering the one-year period 2023. From the 120 occurrences in 2023, only 46 occurrences were completed with the KRA and ERCS safety risk score, representing a completion rate of 38% for the domain. The hereafter information is solely based on this restricted dataset.

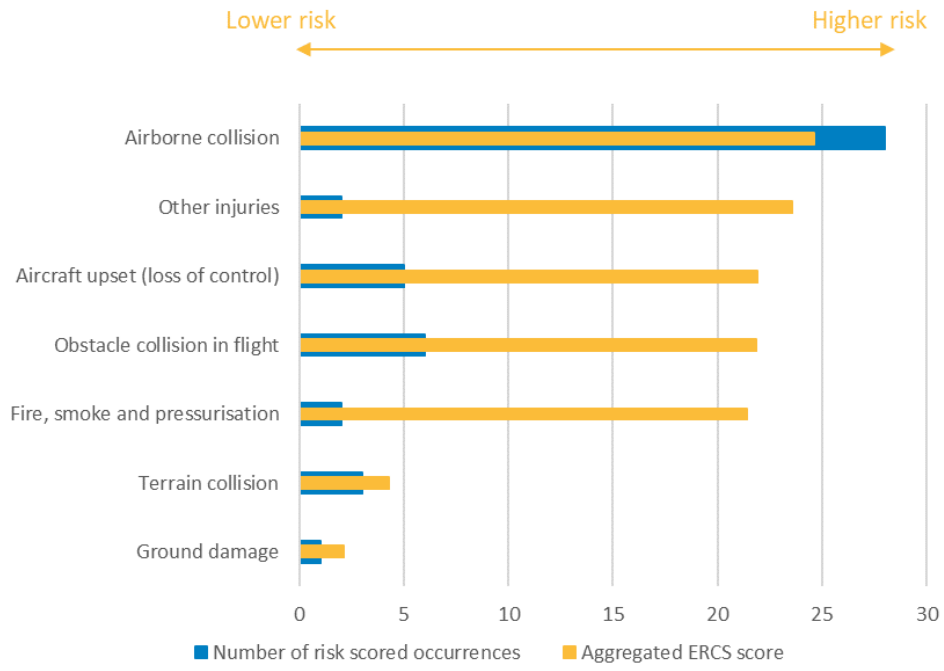
The KRAs for balloons are shown in **Appendix 4 Figure 1**. KRAs and occurrence categories (refer to core document Figure 4.3) have different purposes. While occurrence categories describe actual factors and outcomes of an occurrence, KRAs describe the potential outcome of an occurrence. The KRA is defined by the most likely type of accident that an occurrence could have escalated to. Unlike occurrence categories, where multiple categories may be assigned to a single occurrence, there can only be one KRA per occurrence. The KRA is one element of the ERCS. This scheme is applied when determining the safety risk score of an occurrence and is further detailed in the ASR introduction.

The most critical KRA outlined in the ECR dataset is airborne collision, with 28 occurrences recorded in 2023. Additionally, obstacle collision in flight is the second KRA in absolute number of occurrences for balloon operations, with six occurrences noted in the same year, including powerline collisions or collisions with trees and buildings. For a more accurate assessment of safety risks for balloons, it is paramount to be mindful of the ERCS definition for airborne collision, i.e., a collision between aircraft while both aircraft are airborne, or between aircraft and other airborne objects (excluding birds and wildlife); as opposed to obstacle collision in flight addressing collision between an airborne aircraft and obstacles rising from the surface of the earth (obstacles include tall buildings, trees, power cables, telegraph wires and antennae as well as tethered objects). Proper recording of both KRAs airborne collision and obstacle collision in flight is crucial for further assessment.

The aircraft upset KRA had five recorded occurrences in 2023 and the terrain collision KRA had three occurrences. The two KRAs include hard landings which have resulted in serious injuries to passengers, but without damage to the basket or other balloon components. Injuries are often due to the firmness of the landings, which could potentially be mitigated through better preparation of passengers for touchdown. There have been cases where pilots have fallen from the basket during hard landings because restraints were either not available or not used. Occurrences like these should be captured under the KRA excursion: “an occurrence when an aircraft leaves the runway or movement area of an aerodrome or landing surface of any other predesignated landing area, without getting airborne. It includes high-impact vertical landings for rotorcraft or vertical take-off and landing aircraft and balloons or airships.” ((EU) 2020/2034).

Additionally, there have been instances where a pilot was unable to board the balloon during take-off, leading to an uncontrolled balloon situation. These circumstances justify considering these occurrences as cases where the balloon, as an aircraft, is upset.

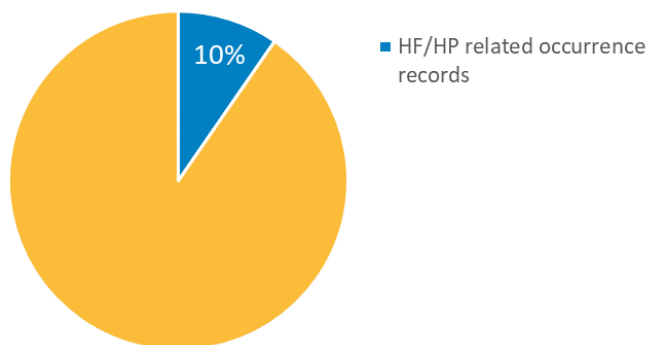
The other injuries KRA shows up as a critical KRA in 2023. Occurrences where injuries have been inflicted from the inflation of the balloon until the passengers have exited the balloon basket, and which cannot be attributed to any other KRA, are included there.



**Appendix 4 Figure 1** KRAs by aggregated ERCS score and number of risk-scored occurrences involving balloons

## 2 Human factors and human performance (HF/HP)

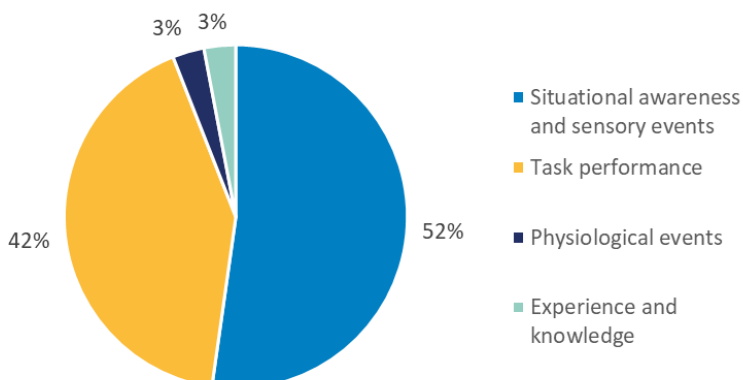
There were 644 occurrence records involving balloons over the period 2019-2023. From this dataset extracted from the ECR on April 15, 2023, 62 occurrence records identified HF/HP as a contributing factor, including seven accidents and three serious incidents. These occurrences are labelled as personnel occurrences in the ECCAIRS taxonomy. It is important to highlight that HF/HP issues are often not recorded within the initial occurrence report and may become evident at a later date. In addition, there is often less data available to analysts/investigators owing to the lack of recording devices on board aircraft in this category. **Appendix 4 Figure 2** presents the percentage of HF/HP related occurrence records relative to the total number of occurrence records that concern balloon operations, from 2019 to 2023.



Appendix 4 Figure 2 HF/HP occurrences involving balloons

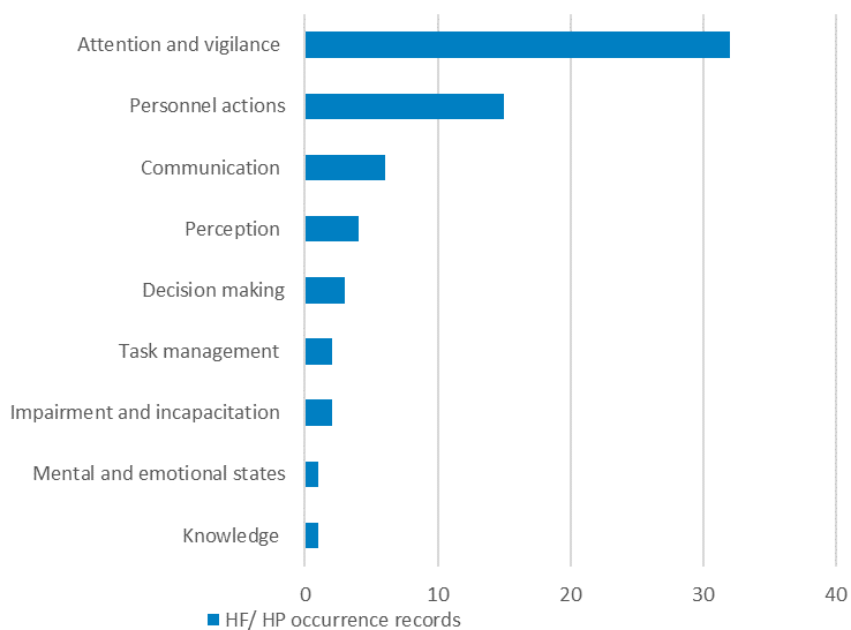
The application of the first level of HF/HP event codes can be seen in **Appendix 4 Figure 3**. Out of the 62 HF/HP related occurrence records, 35 were coded under situational awareness events, 28 under task performance events, 2 under experience and knowledge events and 2 under psychological events. Note that one occurrence may indicate more than one HF/HP event. Issues relating to situational awareness and sensory events (events where the way that humans sense their environment misleads them) are more commonly experienced, reported, or discernible following an occurrence than the factors that cause them. A significant number of reports citing issues related to task performance were reported and referred to the effectiveness and efficiency with which the operator completes a designated task. This involves quality of the output and the achievement of the desired outcome.

Both situational awareness issues and issues related to task performance may be caused by a number of contributing factors, to mention only a few: complexity of the environment, technological malfunctions, inadequate information or training, high workload, stress or fatigue.



Appendix 4 Figure 3 High-level HF/HP event codes applied to occurrences involving balloons

**Appendix 4 Figure 4** compares the number of occurrences involving balloons, using more detailed HF/HP event codes. Issues related to attention and vigilance that have been reported in 32 records, are the most prevalent among the HF/HP related ones, indicating it as an area with the most HF/HP related safety concerns for the balloons community.

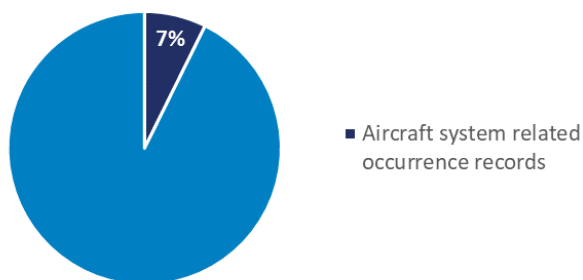


**Appendix 4 Figure 4** Detailed HF/HP event codes by number of occurrences involving balloons

### 3 Airworthiness

There were 644 occurrence records involving balloons over the period 2019-2023. The data were extracted from the from the ECR on April 23, 2024.

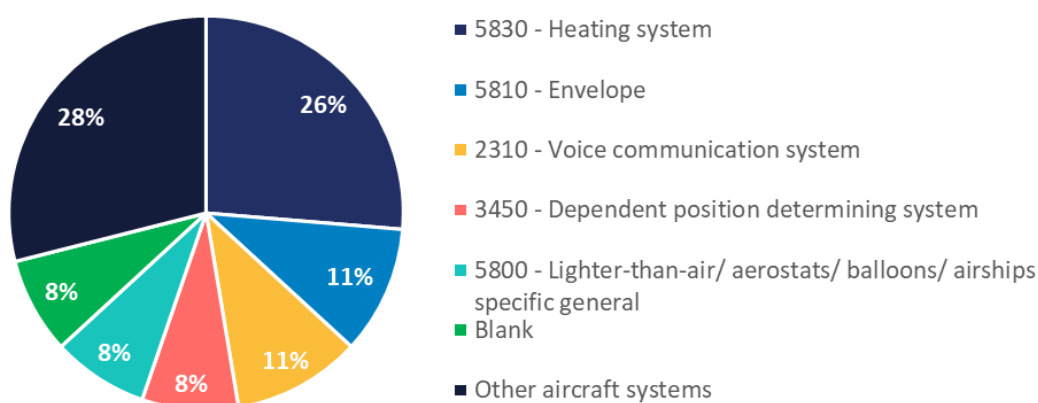
**Appendix 4 Figure 5** provides the percentage of occurrence records that were aircraft systems related. Around one record out of 14 identified that the loss or malfunction of an aircraft system contributed to the occurrence, corresponding to 43 occurrence records, including 12 accidents (no serious incident). These numbers mainly include records where the loss or malfunction of an aircraft system is the cause of the occurrence (e.g., burner failure). They may also include records where an aircraft system is adversely affected by another event.



**Appendix 4 Figure 5** Aircraft system-related occurrence records involving balloons

**Appendix 4 Figure 6** provides the list of the values for the event type 'equipment', excluding 'aircraft general explosions/fire/fumes/smoke events' and 'aircraft generic', and shows their relative distribution in terms of number of occurrence records. Affected aircraft systems with less than two occurrence records were grouped together in the value 'other aircraft systems'.

The main affected aircraft systems were heating systems (10 records), envelope (four records), voice communication system (four records) and dependent positioning determining system (three records).



**Appendix 4 Figure 6** Aircraft system-related occurrence records per ATA chapter involving balloons

Considering the event types 'aircraft general explosions/fire/fumes/smoke events' and 'aircraft generic', the only coded value was 'fire', in 10 occurrence records.

From these 43 occurrence records where the loss or malfunction of an aircraft system was identified in the occurrence, only three occurrence records were attributed to an airworthiness issue, distributed in two records to aircraft design and one record to aircraft maintenance.