

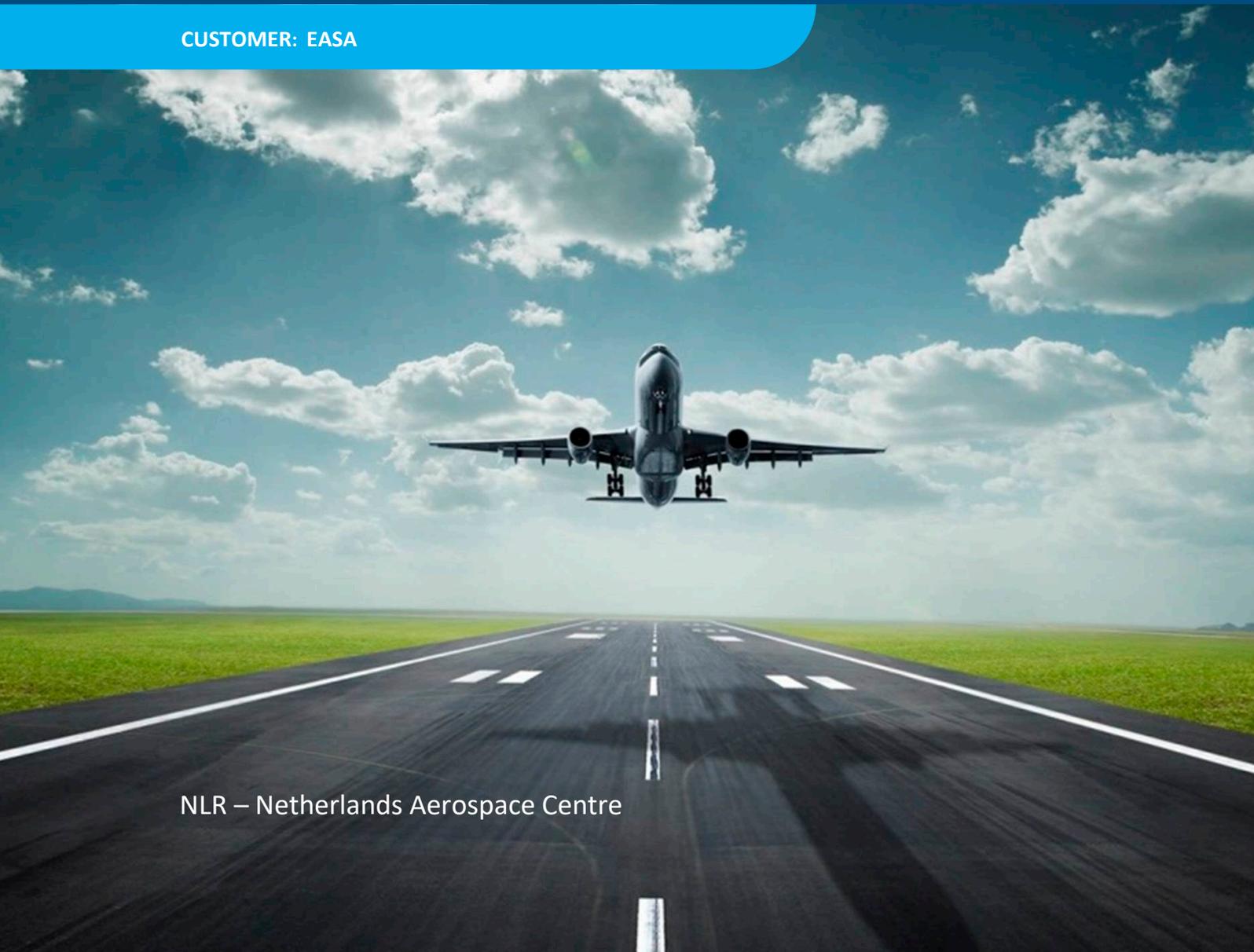


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NLR-TP-2019-229 | October 2019

# Online Survey on Fatigue Hotspots among Flight and Cabin Crew Members across Europe

CUSTOMER: EASA



NLR – Netherlands Aerospace Centre



# Online Survey on Fatigue Hotspots among Flight and Cabin Crew Members across Europe



## Problem area

The European Commission together with EASA commissioned a study to review the effectiveness of the new European flight and duty time limitations. This study, started with a preliminary survey to identify potential work patterns associated with fatigue, and to collect crew insights about perceived fatigue hotspots. This paper contains the results of the online survey.

## Description of work

The respondents (i.e., flight and cabin crew working for European commercial airlines) could select, from a pre-defined list of 'fatigue items', the items that they deemed most relevant for causing fatigue. The list resulted from a scientific literature review and expert input from the study's scientific committee. The respondents could also describe in their own words how they think their work patterns affect fatigue, and when they feel most fatigued during the duty.

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### KNOWLEDGE AREA(S)

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The survey was developed in several iterations and was tested with a small sample of pilots and cabin crew members to ensure high-quality questions using a language and format that is easy to understand for the targeted participants.

## Results and conclusions

The total number of crew respondents was 15,680. Of these respondents 58.2% were pilots and 41.8% cabin crew members.

When asked to indicate which items were most relevant for fatigue, respondents selected the items 'a long working day' most frequently, followed by the items 'starting early', and 'flying during hours when I would normally sleep'.

The most often mentioned spontaneous items that resulted from open questions were divided into items selected for night duties of more than 10 hours (FDP1) or disruptive schedules (FDP2). Survey respondents most frequently indicated 'insufficient time between duties' as a contributing factor to fatigue for both FDPs. However, the second item for FDP 1 was 'starting early' whereas the second item for FDP2 was 'roster changes'. When asked when the fatigue was most pronounced, participants indicated 'during the window of circadian low' and 'at the end of the duty'.

## Applicability

The online survey results were used to scope the review of the European flight and duty time limitations. This review consisted of the analysis of airline rosters using bio-mathematical models and a field study collecting fatigue, alertness and sleep data in pilots and cabin crew members.

### GENERAL NOTE

This report is based on a presentation held at the twenty-fourth international symposium on Shiftwork & Working Time, Coeur d'Alene, Idaho USA. September 9-13, 2019.

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*The contents of this report may be cited on condition that full credit is given to NLR and the author.*

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## Abbreviations

ACRONYM	DESCRIPTION
EASA	European Aviation Safety Agency
EC	European Commission
EU	European Union
FDP	Flight Duty Period
FTL	Flight Time Limitation
NLR	Netherlands Aerospace Centre

# 1 Introduction

Fatigue amongst aircrews (pilots and cabin crew) increases the risk of errors which, in turn, increases the risk incidents and accidents. However, fatigue is more likely to occur due to the nature of the work than in other lines of work. Aircrew, for example, often experience different time zones and can be required to work long hours. Even though they can rest during these long hours, the quality of the available rest facilities may not be optimal due to noise in the aircraft or because aircrew have to rest in a hotel.

The EU has imposed the Flight and Duty Time Limitations (FTL) in Commission Regulations (EU) No. 965/2012<sup>1</sup>. These regulations prescribe how long aircrews are allowed to work, under which circumstances, minimum break times, etcetera. The main goal of the FTL regulations is to prevent high levels of fatigue amongst aircrew. The most recent version came into effect in 2014. Periodic reviews are required to study if high levels of fatigue are indeed prevented or if changes to the regulations are required. Therefore, a review consists of identifying possible circumstances that may cause higher levels of fatigue amongst aircrew, measuring if high levels are present and how regulations can be used to decrease the occurrence of high fatigue. This paper reports the first step of the latest review. In this step aircrew were asked to fill out questionnaires to identify fatigue hotspots.

## 1.1 Main objective

The review commenced in 2017 with the commission of a research study. The research study was broken down into smaller phases; each focused on specific flight duty periods (FDPs). The first research phase studied the following two FDPs:

- FDP1: Duties of more than 10 hours at the less favourable time of day.  
This focuses on operations that encroach (fully or partially) any portion of the period between 02:00h and 04:59h; and
- FDP2: Disruptive schedules.  
This focuses on consecutive early duty starts, late duty finishes, night duties, and combinations thereof.

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<sup>1</sup> Commission Regulation (EU) No. 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No. 216/2008 of the European Parliament and of the Council.

## 2 Online survey

We developed and used an online survey to identify work patterns that were potentially associated with fatigue and to collect aircrew insights about fatigue hotspots.

The respondents (i.e., pilots and cabin crew working for European commercial airlines) could select, from a pre-defined list of 'fatigue items', the items that they deemed most relevant for causing fatigue. The list of fatigue items resulted from a scientific literature review and expert input from the study's scientific committee.

The respondents could also describe in their own words (i.e., answering open questions) how the rosters affected their fatigue, when they felt most fatigued during the duty, and which conditions were worsening their fatigue. These questions were only asked to those respondents who had indicated to have experience with at least one of the two FDPs of interest.

The survey was developed in a number of iterations and was tested with a small sample of pilots and cabin crew members to ensure high-quality questions using a language and format that is easy to understand for the targeted participants. First, the survey outline was designed and a concept survey was developed in a text formatting program for ease of adjustability. This first set-up of the survey was then reviewed by a small committee within the consortium and by two commercial pilots. The results of this review were discussed and when necessary adjustments were made in the next iteration. This next set-up of the survey was reviewed and commented on again by the same committee. After two iterations, the survey was transferred to LimeSurvey, which is a software package for surveys. LimeSurvey allows for sequencing of the questions and defining the format of the data output. A review of the final iterations was performed by a group of 20 participants, including commercial pilots and cabin crew, and the full project consortium.

The survey could be accessed with any type of computer or mobile device with internet access. The data gathered was saved on a dedicated in-house server making it available for the research partners, but not for third parties.

The fact that the survey was anonymized allowed for filling out the survey multiple times. This was countered by gathering IP addresses to inspect if the same address had been used multiple times. If analysis showed that the same IP address was used more than once, the corresponding survey outputs were checked for similarities. This only occurred in instances where one of the two outputs was not finished. In case of high resemblance of the outputs, only a single stream of survey output (the questionnaire with the most answers) was used in the data analysis. The IP addresses were used only for the purpose of this inspection and were removed from the dataset after this inspection.

## 3 Results

### 3.1 Aircrew respondents

All attempts to open the homepage of the survey were registered. In total, 33,259 attempts were made and 29,173 respondents consented to participate.

The reasons for not filling out the complete survey were not registered, but we assume that this may be due to people taking a glance at the survey before deciding to actually fill out all, or at least part of the questions. Also, even though it was possible to save the results, pause the survey and return later, many participants may have restarted the whole process resulting in a double count of several participants.

The aircrew responses were filtered and only responses from aircrew working for a European airline, or aircrew not currently working but living in Europe, were included for analysis. Furthermore, only respondents who filled out the survey completely were included.

The resulting final dataset consisted of 15,680 aircrew respondents (28.4% female); i.e., 10.6% of the entire aircrew population base in Europe<sup>2</sup>. Of these respondents 58.2% were pilots (4.5% female) and 41.8% cabin crew members (61.5% female). The mean age of all crew respondents was 41 years and 8 months old (range 17 - 75). The mean age for pilots was 42 years and 4 months and for cabin crew 40 years and 10 months.

Of the aircrew respondents 27.5% works for a point-to-point operator; 61% works for a network operator; 3.3% for a cargo operator; and 8.1% for another type of airline. The number of pilots and cabin crew working types of operators they work for is presented in Figure 1.

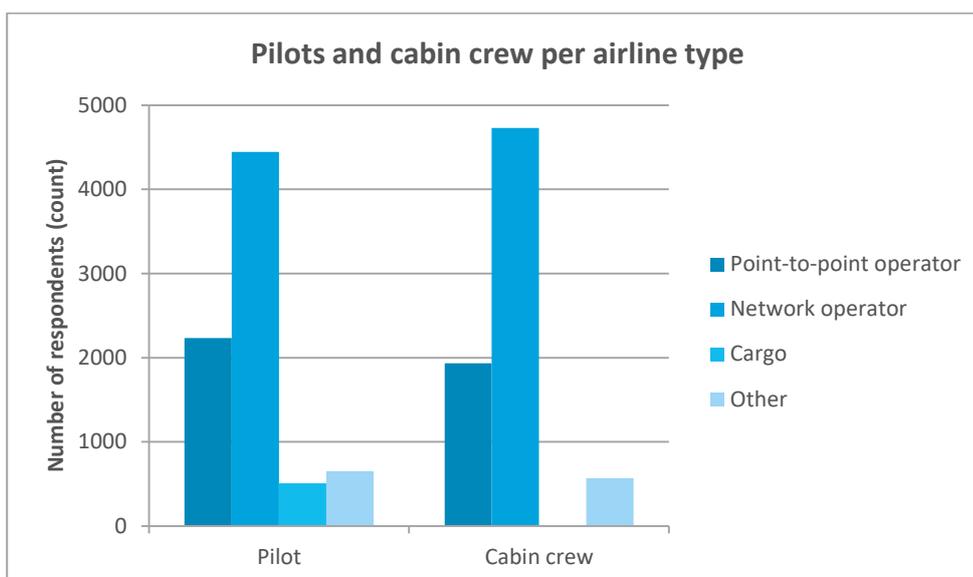


Figure 1: The number of pilots and cabin crew per type of operator

<sup>2</sup> As estimated in D2.2 (Definition of the Data Collection Process).

The distribution of aircrew respondents across Europe was determined to establish if the respondents to the questionnaire are a fair representation of European commercial aircrew members. The results were compared to a population base, which was estimated based on airlines, aircraft numbers, aircraft types and type of operations performed by the airlines. Other demographic information of the population base was not available and could therefore not be used for determining the representativeness of the results. The underlying survey question was: "In which country is your airline based?". Four geographical regions were defined covering Europe: East, West, North, and South (see Table 1). The results are illustrated in Figure 2 (outer circle).

*Table 1: Geographical regions covering Europe*

<i>Region 1 North Europe</i>	<i>Region 2 West Europe</i>	<i>Region 3 South Europe</i>	<i>Region 4 East Europe</i>
Denmark	United Kingdom	Italy	Romania
Sweden	Germany	Spain	Slovakia
Norway	Netherlands	Greece	Czech Republic
Finland	Ireland	Cyprus	Bulgaria
Iceland	Austria	Malta	Poland
	Belgium	Portugal	Hungary
	Liechtenstein	Croatia	Estonia
	Luxembourg	Slovenia	Lithuania
	Switzerland		Latvia
	France		

Figure 2 (in the lower graph) illustrates the estimated population base. It can be stated that the survey sample of aircrew is a fairly good representation of the entire population base when looking at the distribution across Europe. Only the representation of East Europe in the survey sample is smaller than in the entire population base.

The population base concerns all aircrew working for European commercial airlines that have to follow the flight and duty time limitations and rest requirements applicable as of 18 February 2016<sup>3</sup>. The size of this population base was estimated based on numbers received from EASA, completed (and verified) by an internet search and checks at random airlines operators. The estimate was based on:

- The fleet size of all airline operators within the population base (based on number of aircraft); and
- Estimates of required aircrew sizes of all airline operators for each type of aircraft based on the type of operations (short-, medium-, and long-haul, regional, and sole cargo flights).

<sup>3</sup> The provisions concerning flight and duty time limitations and rest requirements contained in Annexes II and III of Commission Regulation (EU) No. 965/2012.

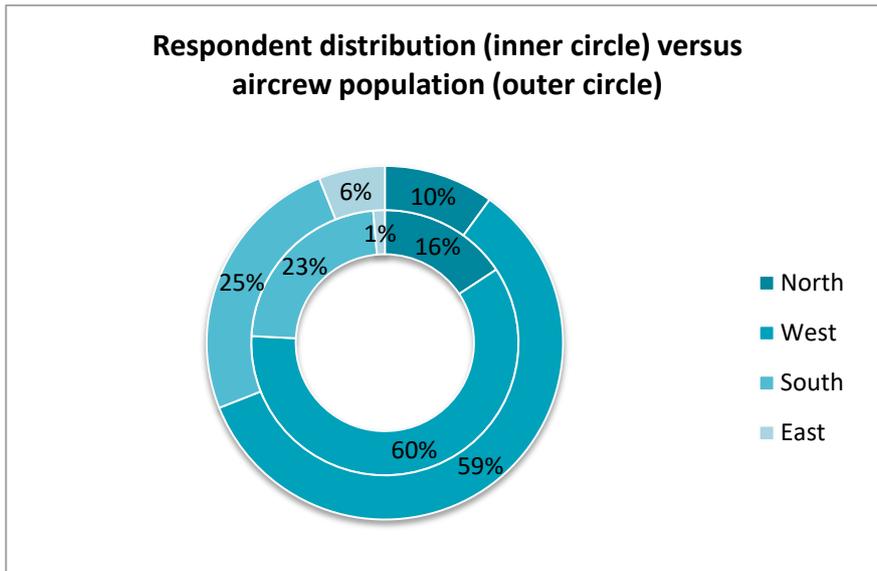


Figure 2: Distribution of aircrew respondents (inner circle) and population base (outer circle) across Europe

Mean travel time from residence to work for the aircrew is 1 hour and 10 minutes (ranging from 5 minutes to 10 hours); i.e., 1 hour and 10 minutes for pilots and 1 hour and 9 minutes for cabin crew.

## 3.2 Fatigue items considered most relevant for causing fatigue

### Results from closed question

The respondents were asked the following question:

- *Think about the last time you were in active duty (not on a positioning<sup>4</sup> flight) and experienced fatigue you believe was caused by the schedule. Then think about your schedule the days before feeling so fatigued. Please indicate from the list below one or more items that you deem relevant for causing the situation.*

The fatigue items from which the respondents could choose and their abbreviations are listed in Table 2.

The frequency of indicated fatigue items was calculated and visualised in the bar and pie charts below. The error bars indicate the 95% confidence interval. Figure 3 shows how frequently pilots and cabin crew indicated the specific fatigue items. It shows that pilots and cabin crew follow a comparable pattern regarding the selected fatigue items. Within the items there are some significant differences between crew types. Long days and early starts, for example, are indicated significantly more often by pilots than by cabin crew members.

<sup>4</sup> Positioning flights are flights intended to bring the aircraft to the next departure airport without having paying passengers on board.

Table 2: Fatigue items

Fatigue item	Abbreviation <sup>5</sup>
Starting early	EarlyStart
Finishing late	LateFinish
Long working days	LongDay
Not sleeping at home for several days in a row	Hotel
Outward westward flight across >6 time zones	OutWest
Outward eastward flight across >6 time zones	OutEast
Return flight after a westward flight across >6 time zone	InWest
Return flight after an eastward flight across >6 time zones	InEast
Flying a great number of sectors	Sector
Unfavourable times for resting (in period when you are not sleepy)	BadRestTime
Short recovery time between duties	ShortReco
Insufficient rest time during flight	InsRestTime
Insufficient quality of on-board rest facilities	BadQual
Flying during hours when I would normally sleep	WorkSleep

The fatigue items that were selected most frequently and by more than 10% of the sample are 'long days', 'early starts', 'flying during hours when I would normally sleep', 'short recovery time between duties', and 'unfavourable times for resting (in period when you are not sleepy)'.

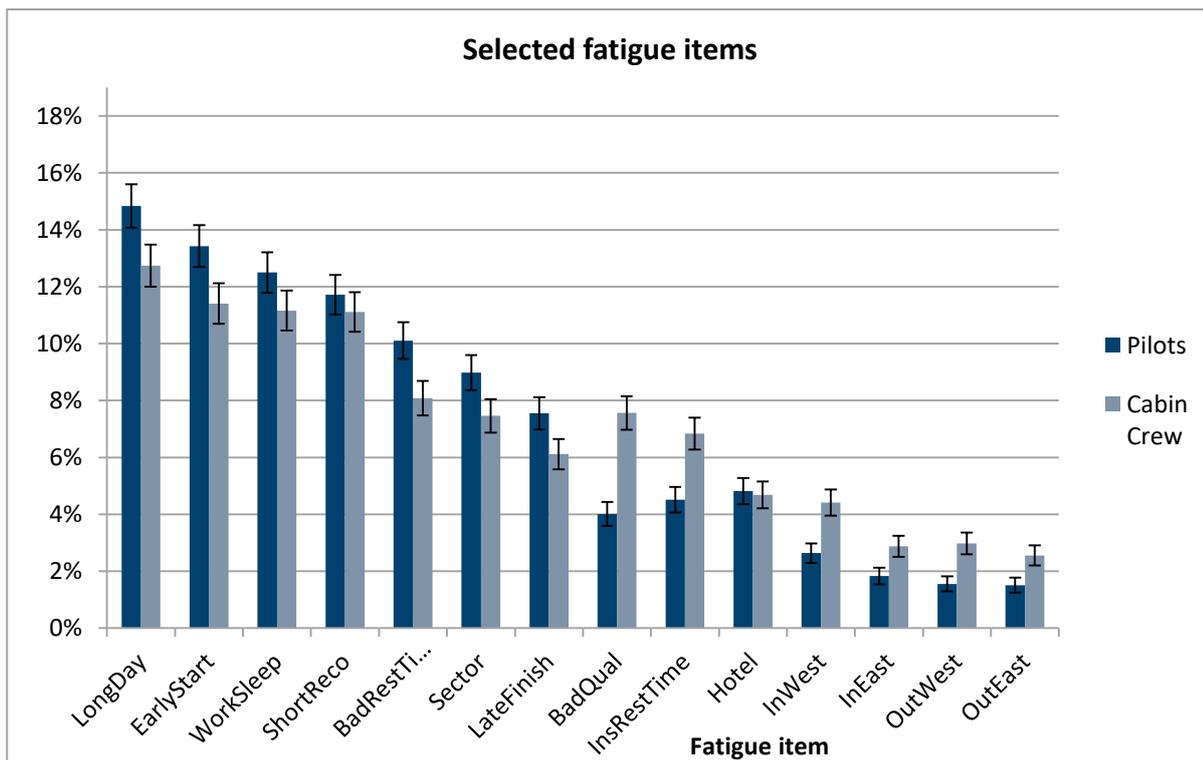


Figure 3: Frequency of indicated fatigue items by pilots and cabin crew

The following figures zoom in on how participants from different regions of Europe (see also Table 1) and how participants who fly different haul types differ in the top 5 fatigue items.

<sup>5</sup> In table 2, next to each fatigue item, the abbreviation for this item was given. These abbreviations were used in figures 3 and 4.

Figure 4 shows small regional differences. The northern European respondents indicated 'long days' significantly more often than respondents from other parts of Europe. Also, northern European and European respondents indicated 'early starts' significantly more often than western and southern European respondents.

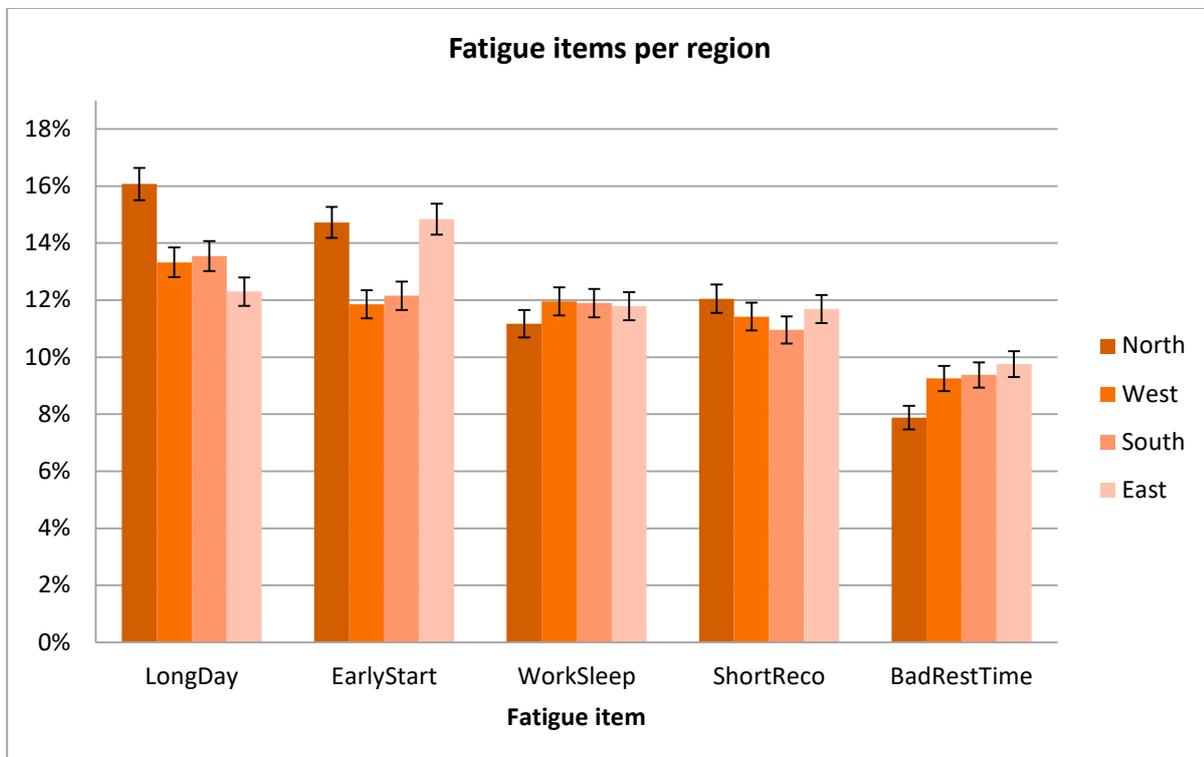


Figure 4: Selected fatigue items per region of Europe

Figure 5 shows that people mainly flying long haul indicated the items 'long day', 'early start' and 'short recovery time between duties' significantly less frequently and the items 'unfavourable times for resting' and 'flying hours when I would normally sleep' more frequently than crew members flying other haul types. Also, 'unfavourable times for resting' and 'flying hours when I would normally sleep' increase significantly with longer haul types.

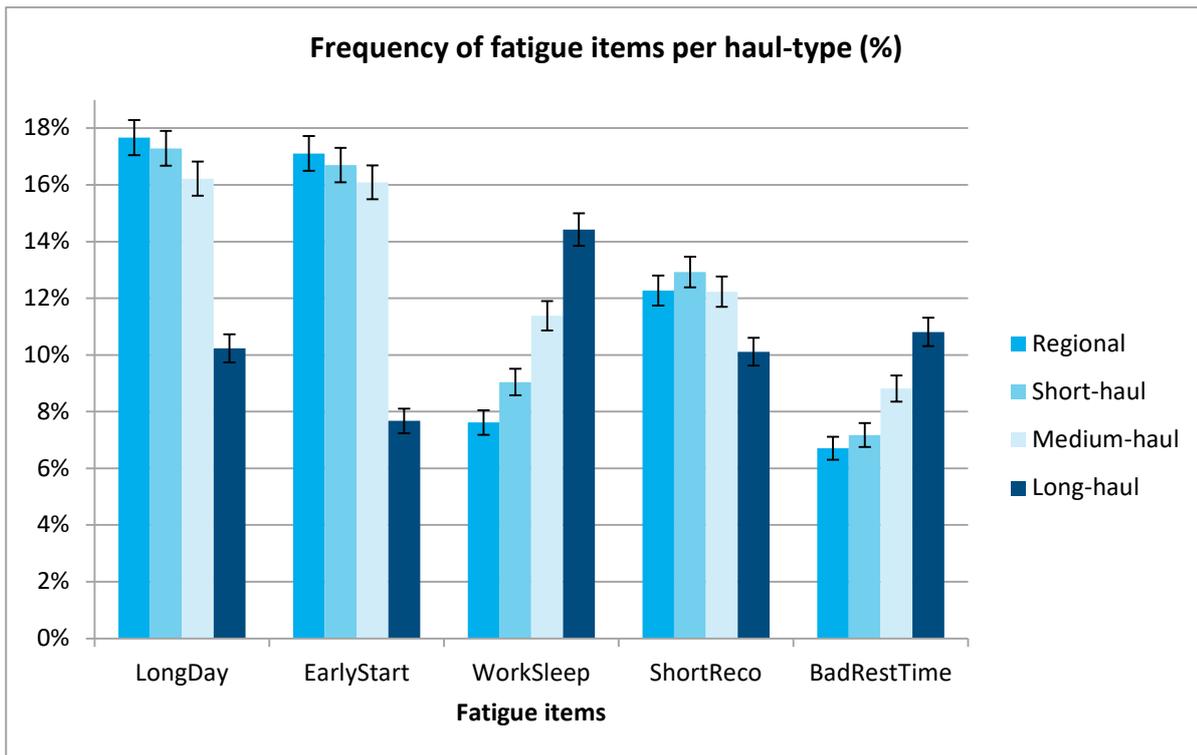


Figure 5: Selected fatigue items per haul type

#### Results from open questions

The survey contained a number of open questions to obtain information on how fatigue was affected. These questions are:

- Please describe how the roster preceding FDP1 or FDP2 affects your fatigue.
- Concerning FDP1 or FDP2, when do you feel most fatigued and what makes this type of duty so fatiguing?
- Which conditions may worsen fatigue in FDP1 or FDP2?

These questions were only presented to respondents who indicated to have experience with either FDP1 or FDP2 to ensure that the answers to these questions were based on own experience instead of experience of other aircrew members or expectations. Therefore, the number of respondents who completed this part of the survey is a subset of the total number of respondents.

Due to the large response to the open questions, we decided to use a randomly selected 10% of the responses in the analysis. Responses to questions on the two FDPs were clustered according to similarity. Respondents could provide several reasons/arguments in one answer. Therefore, the number of responses was not the same as the number of respondents. The category 'no answer provided' was not included, and the category 'others' comprises of answers that did not fit within one of the other categories.

Different respondents used different words to make their statements. For analysis purposes these answers were aggregated into several categories to get a better overview of the types of factors considered most relevant. The aim of this analysis was to identify which (other) factors contribute to being fatigued, in addition to the fatigue items that were already indicated by the respondents in a previous question. The aggregated answers that were given were visualised in pie charts.

**Results for FDP1 (Night duties of more than 10 hours)**

Figure 6 shows features of a roster preceding a duty of more than ten hours at the less favourable time of day (being the night) that contributed to feeling fatigued. The results indicated three main fatigue items for FDP1; i.e. insufficient recovery time in between duties, disruptive schedule (incl. early starts), and flying or being awake during sleeping hours (i.e. in the window of circadian low, WOCL: 02:00h - 05:59h). Thirteen percent of the respondents indicated starting early as a fatigue item, which is remarkable for a night duty.

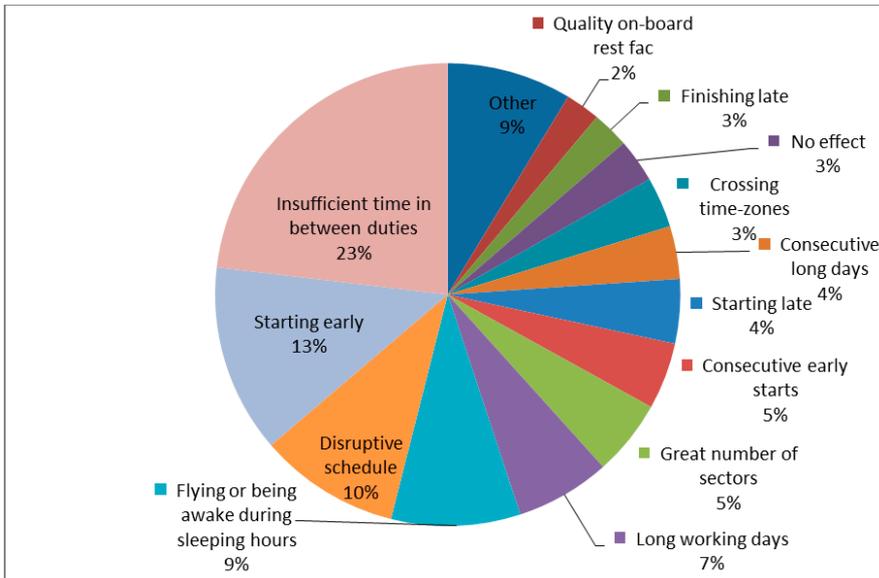


Figure 6: Aggregated responses to: “Please describe how the roster preceding FDP1 affects your fatigue”. This chart is based upon 623 answers

Figure 7 indicates when respondents felt most fatigued and what the main cause was. This figure shows that respondents felt most fatigued during the WOCL. A few hours after duty start and (before) the end of duty were also mentioned frequently. Further, respondents indicated being fatigued after a number of consecutive flights.

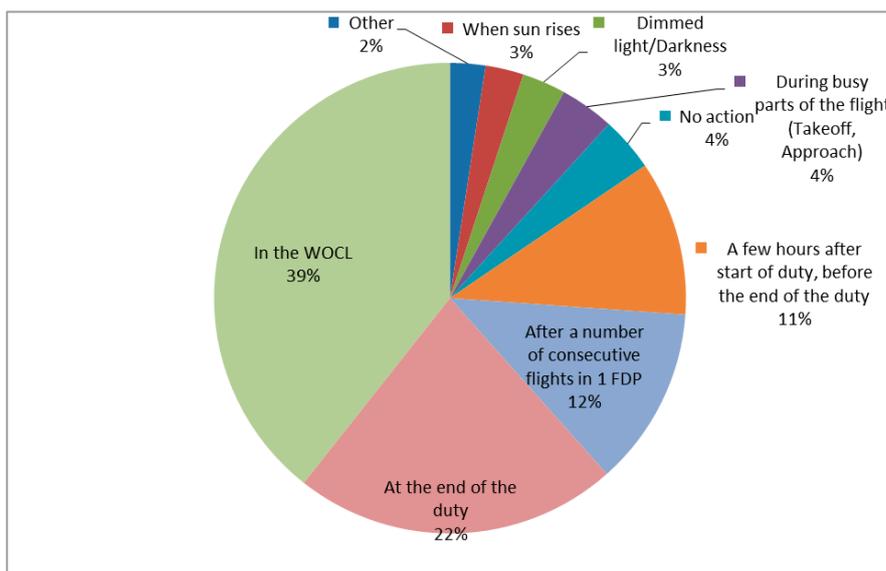


Figure 7: The answers given to: “Concerning FDP1, when do you feel most fatigued and what makes this type of duty so fatiguing?”. This chart is based upon 536 answers

Figure 8 indicates which conditions worsened fatigue. The most often mentioned item here was the item ‘delays’. Respondents reported weather as another important factor that worsens fatigue. The item ‘poor rest on the plane’ referred to the quality of the rest facilities as well as poor quality of sleep. The items ‘crew’ and ‘passengers’ referred to persons asking difficult questions or otherwise hindering/irritating the crew.

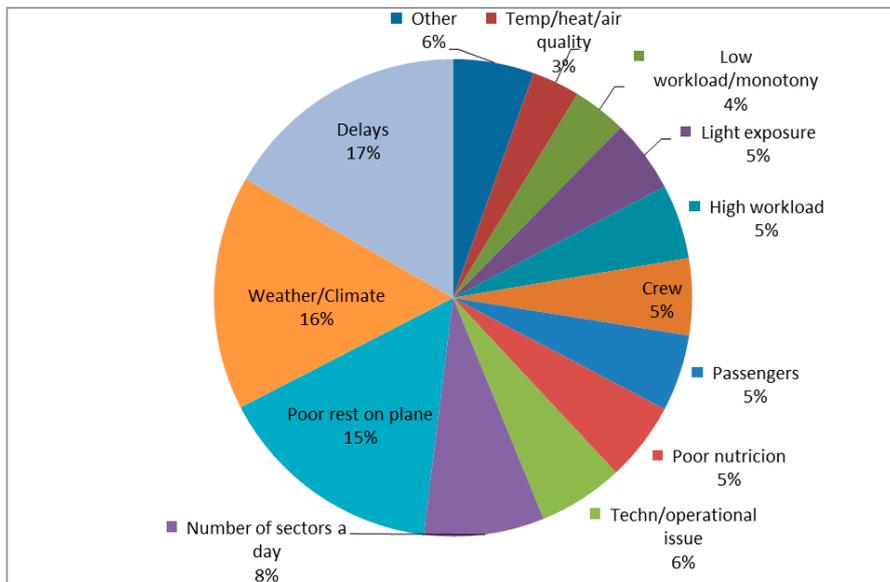


Figure 8: The answers given to: “Which conditions may worsen fatigue in FDP1?”. This chart is based upon 712 answers

**Results for FDP2 (Disruptive schedules)**

Figure 9 indicates what aspects of a roster contributed to fatigue for FDP2 according to the respondents. The results indicated insufficient time in between duties as the main fatigue item. Other frequently mentioned items were roster changes, starting early, unfavourable times for resting, long working days, and flying or being awake during sleeping hours.

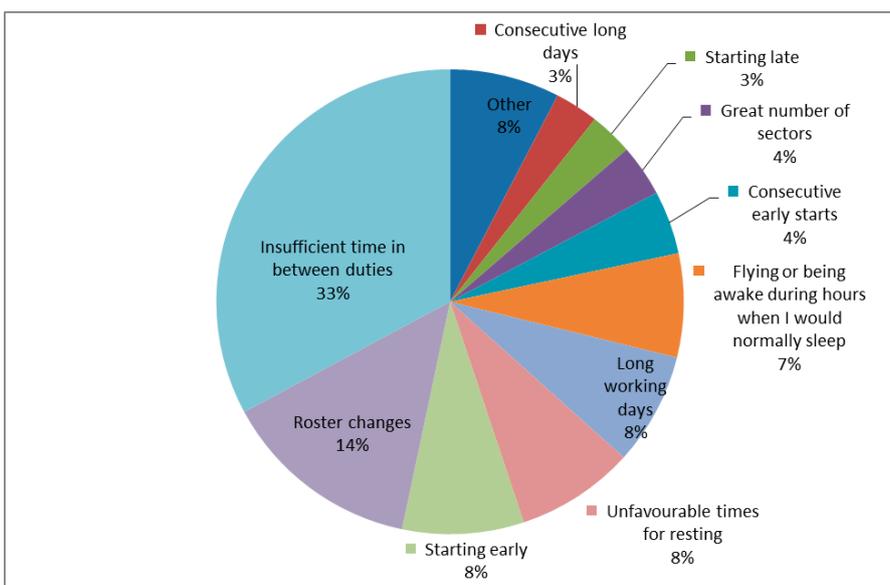


Figure 9: Aggregated responses to: “Please describe how the roster preceding FDP2 affects your fatigue”. This chart is based upon 499 answers

Figure 10 indicates the moments when respondents felt most fatigued and what the main cause of that was. From this figure it was clear that respondents felt most fatigued during the WOCL and at the end of the duty.

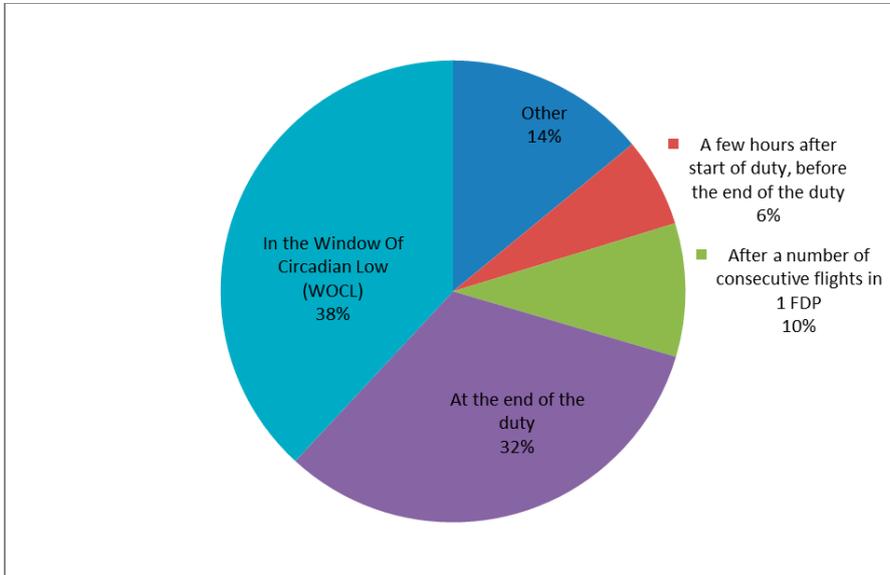


Figure 10 The answers given to: “Concerning FDP2, when do you feel most fatigued and what makes this type of duty so fatiguing?”. This chart is based upon 257 answers

Figure 11 indicates which conditions worsened fatigue. The most often mentioned items that worsened fatigue were ‘delays’ and ‘weather’. The item ‘poor rest on the plane’ referred to the quality of the rest facilities, as well as a poor quality of sleep. The item crew and passengers referred to persons asking difficult questions or otherwise hindering/irritating the respondent.

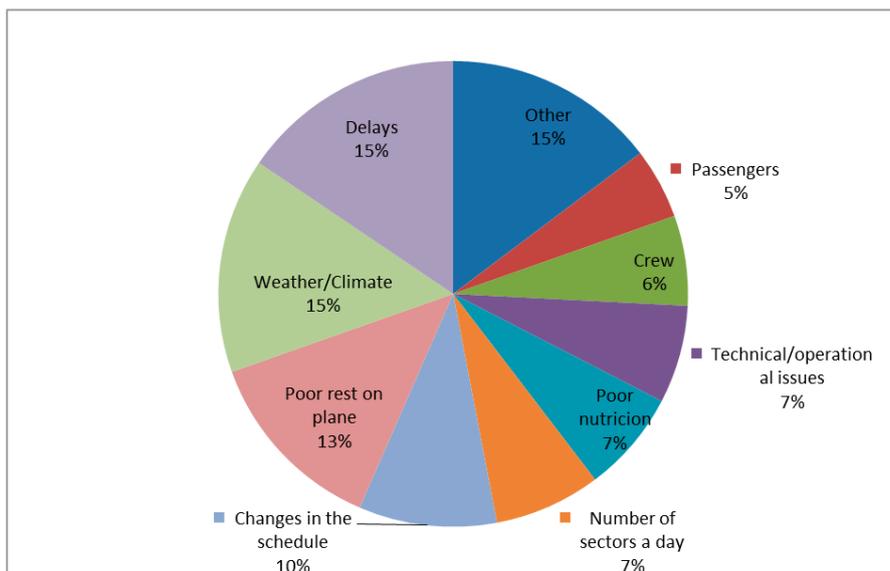


Figure 11 The answers given to: “Which conditions may worsen fatigue in FDP2?”. This chart is based upon 368 answers

## 4 Conclusion

The data from 15,680 participants was analysed to gain a better understanding of what contributes to aircrew fatigue. Of these 15,680 participants, 9,126 were pilots and the other 6,554 were members from the cabin crew.

The most often selected items from a predefined list of fatigue item were 'a long working day', 'starting early', and 'flying during hours when I would normally sleep'. Fatigue items that were mentioned spontaneously to open questions were 'insufficient time between duties', 'starting early' and 'roster changes'. When asked when the fatigue was most pronounced, participants indicated 'during the window of circadian low' and 'at the end of the duty'.

The online survey results were used to scope the review of the European flight and duty time limitations which consisted of the analysis of airline rosters using bio-mathematical models and a field study collecting fatigue, alertness and sleep data in flight and cabin crews.

The results of the review of the European flight and duty time limitations were summarised in the EASA Report SM 2.1 (2019).

## 5 References

EASA Report SM 2.1 (2019). Effectiveness of Flight Time Limitations (FTL): TE.GEN.00400-004.



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