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Report on the Assessment of proposed FTL tables for Air Taxi and Emergency Medical Services Operations

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Administration Page

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Introduction.

FRMSc has been approached by the European Business Aviation Association on behalf of themselves and the European Cockpit Association (ECA) to give an assessment of their jointly constructed proposed Flight Time Limitations (FTL) tables for air taxi (AT) and emergency medical service (EMS) as shown in Appendix 1. EBAA and ECA wish to use these tables in their rule making group to guide discussions with European Aviation Safety Agency (EASA) on setting operating limits for AT and EMS operations.

FRMSc has recently completed a study on behalf of EBAA and ECA that identified the main drivers of fatigue in these operations as well as measuring the fatigue levels of a sample cadre of pilots as they performed their normal duties. The study and its findings has been accepted for presentation at the Aerospace Medical Association's Conference in April 2016 entitled "Work Patterns and Fatigue in Air Taxi (AT) and Emergency Medical Services (EMS) pilots within Europe; Stone BM, Turner C and Spencer MB"

The output of this study included construction of the model to describe the likely fatigue expected by the average pilot.

FRMSc were asked to make their assessment with particular emphasis on the following questions:

1. How would the findings of your study on fatigue in business aviation support the use of a third sector without FDP reduction when the FDP encroaches the WOCL?
2. How would the findings of your study on fatigue in business aviation support the use of FDP extensions encroaching the WOCL in line with table x and the proposed mitigations ring fencing cumulative flying hours as proposed in CS FTL.3.210 and enhancing the requirements for positioning as proposed in CS FTL.3.215?
3. How would the findings of your study on fatigue in business aviation support a prescriptive limit on flying time in the FDP immediately prior to the reduced rest period?

EBAA has provided the FTL table for assessment that is shown in Appendix 1.

Approach

This assessment of the proposed FTL scheme for EMS and AT operations has drawn principally from the results of the study recently carried out by FRMSc. It was found that the workload in these operations was relatively low in terms of cumulative flying hours, total days free of duty and consecutive days of duty, and also that, when controlling for flying time, there was little significant increase in fatigue with the number of sectors. Specific suggestions were made for a modified approach to controlling fatigue, including:

- relaxing the link between max FDP and number of sectors;
- permitting 1h extensions outside the WOCL as standard;
- relaxing the link between minimum rest and the duration of the previous duty, when the rest period is overnight.

The main results from the study were used to construct a model to represent the build-up in fatigue throughout a duty period. The components of the model were time of day, the length of the duty period, total flying time and the time spent positioning. This model has been used to evaluate the proposed new FTL scheme, and its predictions have been compared with predictions made by the SAFE model for Commercial Air Transport (CAT) operations.

The basic FDP table

There are three main areas where the basic FDP table in the standard EASA FTL regulations has been modified: i) the one- and two-sector limits have been extended to three sectors, ii) the maximum limit has been extended to 14 hours, for start times before midday to as early as 07:00, with a tapering down to the standard 13 hours at 06:00, and iii) the reduction in maximum FDP with number of sectors starts with the fourth sector so that, for example, some five-sector limits are one hour longer than standard. However, the six-sector limits remain unchanged.

These changes are consistent with the study recommendations, but questions have been raised about the use of a third sector without FDP reduction when the FDP encroaches the WOCL. Accordingly, comparisons have been carried out between the fatigue levels predicted by the SAFE model for CAT operations with those from the model derived from the study for EMS and AT operations (here referred to as the EMAT model).

The predictions of the EMAT model for a given duration of duty depend on both the time of day and the amount of flying undertaken during the duty period. Accordingly, the SAFE two-sector predictions have been compared with those for duties with 90% flying, on the basis that these would represent, in the absence of positioning, the most fatiguing duties at any particular time of day. The figure below shows the comparison for an 11-hour duty starting at 20:00, where the blue line corresponds to the SAFE prediction and the continuous red line to the EMAT prediction.

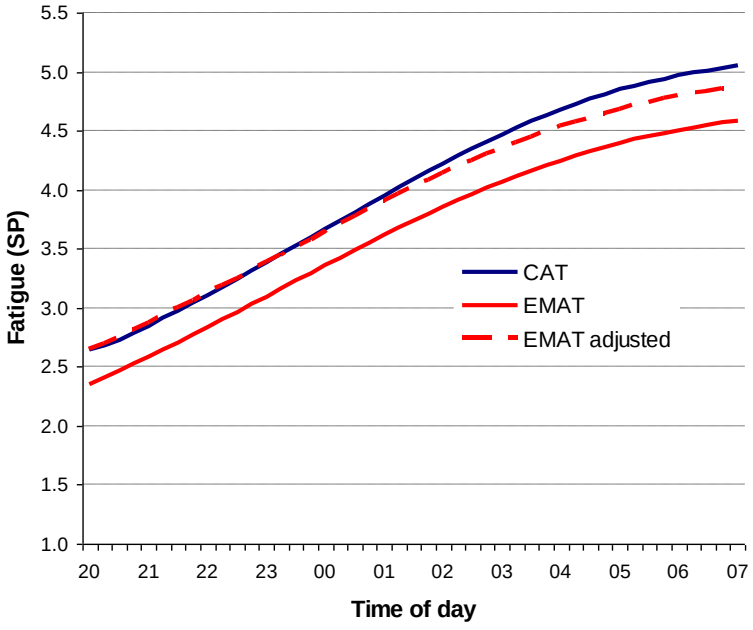

Figure 1: comparison for an 11-hour duty starting at 20:00, where the blue line corresponds to the SAFE prediction and the continuous red line to the EMAT prediction

One issue that arises from the comparison of the two models is that the starting values are slightly different. Some of this may be due to normal statistical variation. However, the SAFE model includes a component related to time since sleep as well as a sleep predictor. The EMAT model, although based directly on the data from the study, does not include sleep specifically. As the explanation for any initial difference in fatigue levels is unclear, the EMAT prediction has been adjusted so that they are identical, and the adjustment is shown by the broken red line. In this case, it will be seen that the predicted level at the end of the duty period, though much closer to the SAFE prediction, remains just below it.

Table 1 lists the Samn Perelli fatigue predictions at the end of the duty period for duty periods throughout the day.

Duty start time	CAT two-sector limit (h)	Proposed AT/EMS limit (1-3 sectors)	SP at duty end (SAFE prediction)	SP at duty end (EMAT prediction)	SP at end (adjusted prediction)	Increase in fatigue	Increase in fatigue - adjusted
00:00	11	11	4.64	4.13	4.58	-0.51	-0.06
01:00	11	11	4.41	3.99	4.37	-0.42	-0.04
02:00	11	11	4.21	3.86	4.19	-0.35	-0.02
03:00	11	11	4.03	3.74	4.01	-0.29	-0.02
04:00	11	11	3.95	3.65	3.94	-0.30	-0.01
05:00	12	12	4.00	3.69	4.04	-0.31	0.04
06:00	13	13	4.14	3.87	4.21	-0.27	0.07
07:00	13	14	4.07	4.18	4.37	0.11	0.30
08:00	13	14	3.96	4.31	4.27	0.35	0.31
09:00	13	14	3.90	4.45	4.18	0.55	0.28
10:00	13	14	4.01	4.59	4.23	0.58	0.22
11:00	13	14	4.22	4.72	4.39	0.50	0.17
12:00	13	13.5	4.44	4.72	4.45	0.28	0.01
13:00	13	13	4.65	4.71	4.53	0.06	-0.12
14:00	12.5	12.5	4.72	4.70	4.59	-0.02	-0.13
15:00	12	12	4.79	4.68	4.65	-0.11	-0.14
16:00	11.5	11.5	4.85	4.65	4.70	-0.20	-0.15
17:00	11	11	4.91	4.62	4.74	-0.29	-0.17
18:00	11	11	5.03	4.64	4.84	-0.39	-0.19
19:00	11	11	5.05	4.63	4.84	-0.42	-0.21
20:00	11	11	5.05	4.58	4.87	-0.47	-0.18
21:00	11	11	5.00	4.50	4.83	-0.50	-0.17
22:00	11	11	4.91	4.39	4.77	-0.52	-0.14
23:00	11	11	4.78	4.27	4.68	-0.51	-0.10

Table 1: CAT and AT/EMS fatigue predictions for the basic FDP table. Scores use the Samn Perelli scale

The fourth and fifth columns list the SAFE and the EMAT predicted fatigue levels, and the sixth column is the adjusted EMAT prediction. The final two columns show the difference between the predictions for CAT and AT/EMS operations, where positive values correspond to those instances where higher levels are predicted for AT/EMS. With one minor exception, the predicted fatigue values for duty periods that extend into the WOCL, although high, remain below the SAFE

predictions, and they are also all below the critical value of 5.0. These results would therefore support the current proposal, even when the duty periods extend into the WOCL.

The increase to a 14h limit outside the WOCL results in higher fatigue levels than for the CAT operations, but predicted fatigue is still relatively low. Indeed, as has been previously suggested, it would be possible to justify an increase to 14h for all commercial air-transport operations. However, there are grounds for exercising some caution regarding duties stating before 0900, for example between 0700 and 0900, when fatigue levels are higher than for CAT operations. Although these are not early starts by the usual definition, the earlier duty start times are associated with a reduction in the preceding sleep time [Spencer & Robertson (2002)].

In normal circumstances, the problem is not the level of fatigue during these earlier starts if pilots start in a fully rested condition, but with the potential effect of a loss of sleep. It would therefore be wise to exercise caution and, slightly modifying the original recommendation, to allow the proposed limits for earlier starts (i.e. those before 09:00) only as extensions to the normal limits, and to apply the tapering to the period between 08:00 and 09:00.

The conclusion from the study that fatigue was not dependent on the number of sectors flown was robust for up to three sectors. However, the number of data points in each category reduced from over 100 (three sectors) to fewer than 50 (four sectors), with only a few instances in the database of five or more sectors. Therefore, it is a reasonable precaution to incorporate the standard reduction of 30 minutes per sector, starting with the fourth sector. Table 2 is the revised FDP table, based on these considerations.

Start of FDP at reference time	1–3 Sectors	4 Sectors	5 Sectors	6 Sectors	7 Sectors	8 Sectors	9 Sectors	10 Sectors
06:00-08:14	13:00	12:30	11:30	11:00	10:30	10:00	09:30	09:00
08:15-08:29	13:15	12:45	11:45	11:00	10:30	10:00	09:30	09:00
08:30-08:44	13:30	13:00	12:00	11:00	10:30	10:00	09:30	09:00
08:45-08:59	13:45	13:15	12:15	11:00	10:30	10:00	09:30	09:00
09:00-11:59	14:00	13:30	12:30	11:00	10:30	10:00	09:30	09:00
12:00-12:29	13:30	13:30	12:30	11:00	10:30	10:00	09:30	09:00
12:30-12:59	13:00	13:00	12:30	11:00	10:30	10:00	09:30	09:00
13:00-13:29	13:00	12:30	12:30	11:00	10:30	10:00	09:30	09:00
13:30-13:59	12:45	12:15	11:15	10:45	10:15	09:45	09:15	09:00
14:00-14:29	12:30	12:00	11:00	10:30	10:00	09:30	09:00	09:00
14:30-14:59	12:15	11:45	10:45	10:15	09:45	09:15	09:00	09:00
15:00-15:29	12:00	11:30	10:30	10:00	09:30	09:00	09:00	09:00
15:30-15:59	11:45	11:15	10:15	09:45	09:15	09:00	09:00	09:00
16:00-16:29	11:30	11:00	10:00	09:30	09:00	09:00	09:00	09:00
16:30-16:59	11:15	10:45	09:45	09:15	09:00	09:00	09:00	09:00
17:00-04:59	11:00	10:30	09:30	09:00	09:00	09:00	09:00	09:00
05:00-05:14	12:00	11:30	10:30	10:00	09:30	09:00	09:00	09:00
05:15-05:29	12:15	11:45	10:45	10:15	09:45	09:15	09:00	09:00
05:30-05:44	12:30	12:00	11:00	10:30	10:00	09:30	09:00	09:00
05:45-05:59	12:45	12:15	11:15	10:45	10:15	09:45	09:15	09:00

Table 2: Revised basic FDP table

The extensions table

The assessment of the extensions table follows the same methodology as for the basic FDP table. The comparisons between the SAFE and the EMAT predictions are shown in Table 3, where the omitted start times are those for which there is no change from Table 1.

Duty start time	CAT two-sector limit (h)	Proposed AT/EMS limit (1-3 sectors)	SP at duty end (SAFE prediction)	SP at duty end (EMAT prediction)	SP at end (adjusted prediction)	Increase in fatigue	Increase in fatigue - adjusted
07:00	14	14	4.29	4.18	4.37	-0.11	0.08
08:00	14	14	4.20	4.31	4.27	0.11	0.07
09:00	14	14	4.17	4.45	4.18	0.28	0.01
10:00	14	14	4.29	4.59	4.23	0.30	-0.06
11:00	14	14	4.49	4.72	4.39	0.23	-0.10
12:00	14	14	4.70	4.84	4.57	0.14	-0.13
13:00	14	14	4.88	4.93	4.74	0.05	-0.14
14:00	13.5	13.5	4.94	4.90	4.79	-0.04	-0.15
15:00	13	13	4.99	4.86	4.83	-0.13	-0.16
16:00	12.5	12.5	5.04	4.82	4.87	-0.22	-0.17
17:00	12	12	5.07	4.76	4.89	-0.31	-0.18
18:00	11.5	11.5	5.09	4.70	4.90	-0.39	-0.19

Table 3: CAT and AT/EMS predictions for the extensions table

There is a period of six hours when the predicted values are over 4.75. However, unlike the SAFE predictions, they never reach the critical value of 5.0, and in most cases both the raw and the adjusted predictions are lower than the SAFE predictions. Moreover, even these relatively high values are only achieved on the most demanding duties when the amount of flying reaches 90% of the total duty time. On a more typical duty with 50% flying, the fatigue predictions at duty end would be reduced by at least 0.3. For example, after a 13.5-hour duty starting at 14:00, the final fatigue value would be 4.54, compared with the value in the table of 4.90.

Based on these considerations alone, there is no clear reason to reduce the limits in the proposed table. However, this conclusion relies on a comparison with the levels of fatigue predicted for CAT operations that extend into the WOCL, which are themselves extremely high. The revised extensions table, incorporating the extensions to the earlier start times, is shown in Table 4, below.

Start of FDP at reference time	1–3 Sectors	4 Sectors
0600-0614	13:00	12:30
0615-0629	13:15	12:45
0630-0644	13:30	13:00
0645-0659	13:45	13:15
0700–1329	14:00	13:30
1330–1359	13:45	13:15
1400–1429	13:30	13:00
1430–1459	13:15	12:45
1500–1529	13:00	12:30
1530–1559	12:45	Not allowed
1600–1629	12:30	Not allowed
1630–1659	12:15	Not allowed
1700–1729	12:00	Not allowed
1730–1759	11:45	Not allowed
1800–1829	11:30	Not allowed
1830–1859	11:15	Not allowed
1900–0359	Not allowed	Not allowed
0400–0414	Not allowed	Not allowed
0415–0429	Not allowed	Not allowed
0430–0444	Not allowed	Not allowed
0445–0459	Not allowed	Not allowed
0500–0514	Not allowed	Not allowed
0515–0529	Not allowed	Not allowed
0530–0544	Not allowed	Not allowed
0545–0559	Not allowed	Not allowed

Table 4: Revised extensions table

Reduced rest

The removal of the requirement that the minimum rest should be at least as long as the preceding duty period can be justified when the following rest period is overnight and in the absence of circadian desynchronization and cumulative fatigue or sleep loss. To protect against cumulative fatigue, the current proposal includes a limit on the workload over the previous seven days (no more than 24 hours' flying) and within the previous duty (eight hours' flying and no more than four sectors).

It is sensible to put some restriction on the workload during the previous duty so that the most fatiguing duties are avoided. Based on the study findings, this would entail placing some limit on the amount of flying. Nevertheless, the proposed eight-hour limit is somewhat arbitrary, and might be considered unduly restrictive. An alternative might be to set a longer limit, of say 10 hours, provided that duty period includes no positioning. The overall objective would be to exclude only the most fatiguing duties, as an additional precaution to supplement the longer-term limits already in place.

Overall workload

There are two other issues to address with regard to these proposals, relating to the need to protect against high levels of workload, both in the long term and in the short term.

The long-term issue is the need to ensure that the overall work rate over periods from a week to several months does not extend far beyond the levels in the study, upon which the recommended modified FTL rules are based. The proposed limits are based on flying time, which has been shown to be a key component in the development of fatigue. However, there are no further limits imposed on duty hours. The flying-hour limits themselves, at least over 28 and 84 days, are rather generous: although they are well below the CAT limits, they are substantially above typical AT rates of working, and correspond to a rate of flying 25% above the average in the study for EMS. They should therefore cover the large majority of both current AT and current EMS operations.

Some further limits on duty time over seven, 14 and 28 days might also be considered. This would provide additional protection against cumulative fatigue in future operations, particularly when duty schedules regularly encroach on normal sleep time.

The short-term issue is the need to account for the extra fatigue associated with positioning/travelling time. Although it was not possible in the study to analyse the different forms of travel and their impact on fatigue, there were indications from the individual comments that combining modes of travel and long periods of self-drive were particular concerns. This issue is addressed in the provisions of CS FTL.3.215, which should be sufficient to give adequate protection, at least for self-driving. It is not clear whether the 30-minute reduction would be adequate in every example of mixed-mode travel, for example where more than two transport modes are used. In this case, it would be advisable to apply an additional 30-minute reduction.

Conclusions and Recommendations

These are as follows:

1 The findings of the study on fatigue in business aviation support the use of a third sector without FDP reduction when the FDP encroaches the WOCL, as average levels of fatigue, although high, are predicted to remain below the very high levels predicted for CAT operations.

2 The findings of the study on fatigue in business aviation support the use of FDP extensions encroaching the WOCL, as average levels of fatigue, although high, are predicted to remain below the very high levels predicted for CAT operations.

3 It is suggested that the standard application of one-hour extensions outside the WOCL is not applied to start times earlier than 09:00.

4 It is recommended that some restriction is applied to the FDP immediately prior to the reduced rest period, but alternatives to the proposed eight-hour limit on flying time could be considered, e.g. a 10-hour limit with no positioning.

5 The reduced work-rate limits are based on flying time, and would permit the large majority of both current AT and current EMS operations. Further limits on duty time might also be considered useful as an additional protection.

Reference

Spencer MB and Robertson KA (2002). Aircrew alertness during short-haul operations, including the impact of early starts, QinetiQ Report No QINETIQ/CHS/PPD/CR010406/1.0.

Appendix 1: CS FTL.3.205 Flight duty period (FDP)

(a) Night duties under the provisions of ORO.FTL.205 (b) and (d) comply with the following:

(1) When establishing the maximum FDP for consecutive night duties, the number of sectors is limited to 4 sectors per duty.

(2) The operator applies appropriate fatigue risk management to actively manage the fatiguing effect of night duties of more than 10 hours in relation to the surrounding duties and rest periods.

(b) Maximum daily FDP without the use of extensions for acclimatised crew members in air taxi operations

The maximum daily FDP without the use of extensions for acclimatised crew members in air taxi operations under the provisions of ORO.FTL.205(b)(4) is limited to the values specified in Table1 below.

BASIC FDP Table

Start of FDP at reference time	1–3 Sectors	4 Sectors	5 Sectors	6 Sectors	7 Sectors	8 Sectors	9 Sectors	10 Sectors
06:00-06:14	13:00	12:30	11:30	11:00	10:30	10:00	09:30	09:00
06:15-06:29	13:15	12:45	11:45	11:00	10:30	10:00	09:30	09:00
06:30-06:44	13:30	13:00	12:00	11:00	10:30	10:00	09:30	09:00
06:45-06:59	13:45	13:15	12:15	11:00	10:30	10:00	09:30	09:00
07:00-11:59	14:00	13:30	12:30	11:00	10:30	10:00	09:30	09:00
12:00-12:29	13:30	13:30	12:30	11:00	10:30	10:00	09:30	09:00
12:30-12:59	13:00	13:00	12:30	11:00	10:30	10:00	09:30	09:00
13:00-13:29	13:00	12:30	12:30	11:00	10:30	10:00	09:30	09:00
13:30-13:59	12:45	12:15	11:15	10:45	10:15	09:45	09:15	09:00
14:00-14:29	12:30	12:00	11:00	10:30	10:00	09:30	09:00	09:00
14:30-14:59	12:15	11:45	10:45	10:15	09:45	09:15	09:00	09:00
15:00-15:29	12:00	11:30	10:30	10:00	09:30	09:00	09:00	09:00
15:30-15:59	11:45	11:15	10:15	09:45	09:15	09:00	09:00	09:00
16:00-16:29	11:30	11:00	10:00	09:30	09:00	09:00	09:00	09:00
16:30-16:59	11:15	10:45	09:45	09:15	09:00	09:00	09:00	09:00
17:00-04:59	11:00	10:30	09:30	09:00	09:00	09:00	09:00	09:00
05:00-05:14	12:00	11:30	10:30	10:00	09:30	09:00	09:00	09:00
05:15-05:29	12:15	11:45	10:45	10:15	09:45	09:15	09:00	09:00
05:30-05:44	12:30	12:00	11:00	10:30	10:00	09:30	09:00	09:00
05:45-05:59	12:45	12:15	11:15	10:45	10:15	09:45	09:15	09:00

Table 1

(c) Extension of FDP without in-flight rest

The extension of FDP without in-flight rest under the provisions of ORO.FTL.205(d)(5) is limited to the values specified in table 2 below.

Extensions Table		
Start of FDP at reference time	1–3 Sectors	4 Sectors
1200–1329	14:00	13:30
1330–1359	13:45	13:15
1400–1429	13:30	13:00
1430–1459	13:15	12:45
1500–1529	13:00	12:30
1530–1559	12:45	Not allowed
1600–1629	12:30	Not allowed
1630–1659	12:15	Not allowed
1700–1729	12:00	Not allowed
1730–1759	11:45	Not allowed
1800–1829	11:30	Not allowed
1830–1859	11:15	Not allowed
1900–0359	Not allowed	Not allowed
0400–0414	Not allowed	Not allowed
0415–0429	Not allowed	Not allowed
0430–0444	Not allowed	Not allowed
0445–0459	Not allowed	Not allowed
0500–0514	Not allowed	Not allowed
0515–0529	Not allowed	Not allowed
0530–0544	Not allowed	Not allowed
0545–0559	Not allowed	Not allowed

Table 2