JANT 한국항행학회논문지
Journal of Advanced Navigation Technology

항행 및 항법

J. Adv. Navig. Technol. 25(4): 280-285, Aug. 2021

한국형 운항승무원 피로관리 프로그램의 출두시간에 관한 연구

The Show up Time in the Development of the Korean Pilots Fatigue Management Program

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[요 약]

항공산업의 발전에 따라 국제적으로 운항승무원의 피로 위험 관리에 대한 중요성은 증가하고 있으며, 이와 관련한 피로도 연구와 법 제정은 전 세계적으로 활발하게 진행되고 있다. 이미 미국, 유럽 등의 비행 선진국은 비행시간과 비행근무시간 규정을 운항승무원의 출두 시간, 이착륙 횟수, 휴식시간, 시차적응상태 등의 비행 환경을 반영한 최대 비행근무시간을 유연하게 적용 운항승무원의 피로도를 관리하고 있다. 국내의 경우는 운항승무원의 비행 환경 및 비행 조건을 반영하지 않은 연속되는 일간, 월간, 연간 기준으로 최대 비행근무시간을 정하는 획일적인 방식을 적용하고 있는 실정으로, 피로 위험관리시스템의 개선이 필요한 시점이다. 하지만 선진 해외항공사 위주로 개발된 피로도 관련 법과 규정을 국내의 비행 환경을 고려하지 않고 적용할 시 부작용이 있을 수 있다. 본연구의 국내 운항승무원 피로도 관련 설문 조사 결과에 의하면, 이미 해외에서 적용하고 있는 최대 비행시간 규정을 수정 없이 그대로 국내에 도입 및 적용하는 경우, 오히려 국내 운항승무원의 피로도는 증가할 수 있다는 시사점을 도출하였다. 이에 국내의 비행 환경과 문화에 적합한 한국형 비행근무시간 제한에 관한 연구의 필요성을 제안하고자 한다.

[Abstract]

The significance of pilots' fatigue and the attributed risk management had continuously increased over time as the airline industry expanded. Research and legislation efforts associated with pilot fatigue are being taking place actively all over the world. In the developed world such as the United States and European Union etc., the airline pilot fatigue is already being managed by considering the show up time, the number of take offs and landings made, resting period, jet lag etc., when computing flight duty time. In Korea, the flight duty time is only limited by the total number of hours per given period regardless of the flight conditions and environment. Such lack of regulation demand development of a fatigue management program. According to the survey taken from the airline pilots in Korea, it has been found that acquiring foreign policies directly may in turn, increase the risk of fatigue. This research suggest future studies regarding fatigue management program adapted exclusively to Korean domestic flight environment and culture.

Key word : Culture, Fatigue Risk Management System, Flight duty time, Flight environment, Pilot fatigue.

https://doi.org/10.12673/jant.2021.25.4.280

Received 3 August 2021; **Revised** 6 August 2021
Accepted (Publication) 24 August 2021 (30 August 2021)

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Ⅰ. Introduction

The developments in aviation technology has lead to enhanced safety and reliability in flight however, the risk of accidents still remains. The accidents caused by human error are increasing in terms of proportion[1], consisting 70-75% of all accidents[2]. Out of the many factors that affects pilot performance, fatigue had been defined as one of the major threats, and the National Transportation Safety Board (NTSB) has since 1990 has concentrated efforts to reduce pilot fatigue[3].

A crew member's fatigue can be defined as a physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member"s alertness and ability to safely operate an aircraft or perform safety related duties[4].

A normal adult needs 7 to 9 hours of sleep per night[5]. However, in modern aviation, pilots are often required to stay up overnight, and while passing different time zones. Such sleep deprivation results in accumulated fatigue thereby lowering the pilots performance, leading to risk of pilot error.

On February 12, 2009, Colgan Air Flight 3407 stalled and crashed in Clarence Center, NY, USA taking a total of fifty lives including an individual on the ground. The NTSB Accident report conclusion states that the pilots' performance was likely impaired because of fatigue[6]. Following the accident, the Federal Aviation Administration (FAA) was asked to create a science-based flight, duty, and rest regulations[7].

The Fatigue Risk Management System (FRMS) is a data-driven means of continuously monitoring and managing fatigue-related safety risks, based upon scientific principles, knowledge and operational experience that aims to ensure relevant personnel are performing at adequate levels of alertness[8]. Unlike the existing fatigue related regulations that limits the maximum duty time and minimum resting period in a monolithic manner, the FRMS takes into consideration the flight conditions and environment, and is tailored to work most efficiently for both the operator and the pilots. The advanced nations such as the United States and the European Union have already developed and implemented the FRMS in the airline operations that breaks down the flight duty time limit by the show up time, flight departure time, day and night operations, as well as the number of legs, jet lag, etc.

The Korean regulations however, limits the flight duty time only by the total number of hours per given period regardless of the flight conditions and environments. Such lack of regulation demand development of a fatigue management program[9]. This research suggest future studies regarding fatigue management program adapted exclusively to Korean domestic flight environment and culture.

Ⅱ. Study Methods

In this research, two surveys taken in 2015 from over 1,400 Korean airline pilots were analysed. The survey details are as in Table 1. The surveys were done via survey monkey sent as URL by email or text messages to the members of the Airline Pilots Association of Korea (ALPA-K) and non members. The preferred sleep patterns by the pilots were compared with the FAA regulations.

표 1. 국내 민간항공 운항승무원 피로도 조사
Table 1. Flight crew fatigue survey.

	First Survey	Second Survey
Objective	Root cause of pilot fatigue	Type and magnitude of pilot fatigue
Period	May-June 2015	Sep-Oct 2015
Number of Surveys	929	521
Subject	Airline pilots in Korea	
Method	Survey monkey	

Ⅲ. Flight Duty Time Regulations

3-1 ICAO Regulations

In order to manage the civil aviation pilot fatigue, ICAO enacted the Annex 6 to limit the Flight Time[1)] and the Flight Duty Period[2)]. The Annex 6 defined and provided the standards for the FRMS and its requirements.

The Annex 6 attachment A does not provide detailed limitations in regards to the existing systems and cultural aspects however, it recommends that the maximum flight time and flight duty time should be limited per certain periods of times[10].

1) The total time from the moment an aeroplane first moves for the purpose of taking off until the moment it finally comes to rest at the end of the flight[5].

2) A period which commences when a flight or cabin crew member is required to report for duty that includes a flight or a series of flights and which finishes when the aeroplane finally comes to rest and the engines are shut down at the end of the last flight on which he is a crew member[5].

표 2. FAA 최대 비행시간 (2 Pilot, 기장 & 부기장)
Table 2 .FAA maximum flight time (Unaugmented).

Show up Time	Maximum Flight Time
0000-0459	8 hours
0500-1959	9 hours
2000-2359	8 hours

The maximum flight time and flight duty time is also recommended to be limited in consideration of the local time at which duty begins, the pattern of resting and sleeping relative to the crew member's circadian rhythm, the organization of the working time and the augmentation of the flight crew[5].

3-2 FAA Regulations

The Federal Aviation Regulations (FAR) Parts 117, 119 and 121 on the working hours and rest requirements of crew members, were updated and made public in 2009[11]. The FAR specifies the flight duty period and flight time limitation by the show up time, the departure time, number of legs, augmentation of the flight crew, the magnitude of jet lag, rest facilities etc.

The FAA regulated the maximum flight time for an unaugmented operation as in Table 2. An unaugmented operation allows up to 8-9 hours of flight based on the time of report.

Table 3 shows the maximum allowed flight duty period for unaugmented operations. In an unaugmented operation, the maximum FDP's are allowed between 8 and 14 hours respective to the scheduled time of start. If the flight crew is not acclimated, the maximum time is reduced by 30 minutes[11].

표 3. FAA 최대 비행근무시간 (2 Pilot, 기장 & 부기장)
Table 3 .FAA maximum flight duty period (Unaugmented).

Scheduled Time of Start	Maximum Flight Duty Period based on number of legs (hours)						
	1	2	3	4	5	6	7+
0000-0359	9	9	9	9	9	9	9
0400-0459	10	10	10	10	9	9	9
0500-0559	12	12	12	12	11.5	11	10.5
0600-0659	13	13	12	12	11.5	11	10.5
0700-1159	14	14	13	13	12.5	12	11.5
1200-1259	13	13	13	13	12.5	12	11.5
1300-1659	12	12	12	12	11.5	11	10.5
1700-2159	12	12	11	11	10	9	9
2200-2259	11	11	10	10	9	9	9
2300-2359	10	10	10	9	9	9	9

3-3 EASA Regulations

The European Union Aviation Safety Agency in 2016 established the flight time and flight duty period limitation as table 4. The reference time was divided into 13 sectors and the maximum FDP's were limited between 9 and 13 hours. The maximum FDP's in an unknown state of acclimatization were divided into two tables with the regards to the implementation of an fatigue risk management(FRM) by the operator[12]. When an FRM is implemented, the maximum FDP ranges between 9 and 12 hours depending on the number of legs.

표 4. EASA 최대 비행근무시간 (2 Pilot, 기장 & 부기장)
Table 4. EASA maximum flight duty time (Unaugmented).

Start of FDP at reference time	Sectors								
	1-2	3	4	5	6	7	8	9	10
06:00 – 13:29	13:00	12:30	12:00	11:30	11:00	10:30	10:00	9:30	9:00
13:30 – 13:59	12:45	12:15	11:45	11:15	10:45	10:15	9:45	9:15	9:00
14:00 – 14:29	12:30	12:00	11:30	11:00	10:30	10:00	9:30	9:00	9:00
14:30 – 14:59	12:15	11:45	11:15	10:45	10:15	9:45	9:15	9:00	9:00
15:00 – 15:29	12:00	11:30	11:00	10:30	10:00	9:30	9:00	9:00	9:00
15:30 – 15:59	11:45	11:15	10:45	10:15	9:45	9:15	9:00	9:00	9:00
16:00 – 16:29	11:30	11:00	10:30	10:00	9:30	9:00	9:00	9:00	9:00
16:30 – 16:59	11:15	10:45	10:15	9:45	9:15	9:00	9:00	9:00	9:00
17:00 – 04:59	11:00	10:30	10:00	9:30	9:00	9:00	9:00	9:00	9:00
05:00 – 05:14	12:00	11:30	11:00	10:30	10:00	9:30	9:00	9:00	9:00
05:15 – 05:29	12:15	11:45	11:15	10:45	10:15	9:45	9:15	9:00	9:00
05:30 – 05:44	12:30	12:00	11:30	11:00	10:30	10:00	9:30	9:00	9:00
05:45 – 05:59	12:45	12:15	11:45	11:15	10:45	10:15	9:45	9:15	9:00

표 5. 국내 운항 승무원 비행시간 및 비행근무시간 제한
Table 5. Korean flight time & flight duty period limitations.

	Augmentation	Flight Time	Flight Duty Period
Maximum Flight Time and FDP per 24 hours	1 Captain 1 First Officer	8	13
	1 Captain 2 First Officers	12	16
	2 Captains 1 First Officer	13	17
	2 Captains 2 First Officer	16	20

	Augmentation	30 days	90 days	1 year
Maximum Flight Time	1 Captain 1 First Officer	100	280	1,000
	1 Captain 2 First Officers	120	300	1,000
	2 Captains 1 First Officer	120	300	1,000
	2 Captains 2 First Officer	120	350	1,000

3-4 Korean Regulations

The Korean Aviation Safety Law Article 56, Enforcement Regulation number 127, the ministry of land, Infrastructure, and transport limits the maximum flight time and FDP, where the airline operator must specify operating limitations in accordance with the law. The maximum flight time, FDP per continuous 24 hours, 30 days, 90 days and 1 year are as shown in table 5[13].

Ⅳ. Results

4-1 Sleep Pattern and Best Performance Analysis of Korean Pilots

According to the survey taken from the Korean airline pilots, the average time the individual went to bed was shown as Figure 1. Over half of the pilots went to bed between 23:00 and 00:59. It was also revealed that half of the pilots woke up between 07:00 and 08:59, as shown in Figure 2. The average wake up time was calculated to be 07:44.

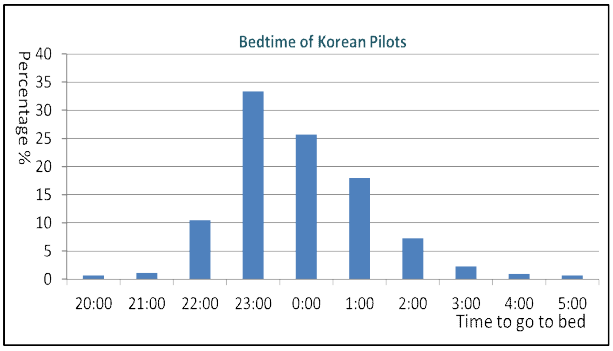

그림 1. 국내 운항승무원 취침 시간 설문 결과
Fig. 1. Bed times of Korean pilots.

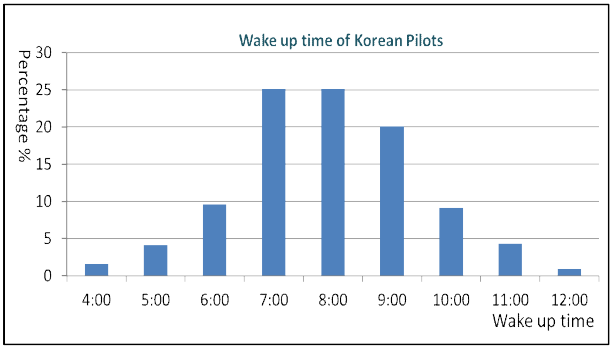

그림 2. 국내 운항승무원 기상 시간 설문 결과
Fig. 2. Wake up times of Korean pilots.

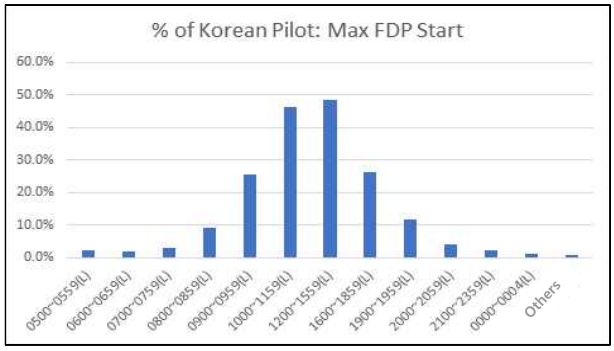

그림 3. 운항승무원 비행근무 출두시간 선호도 조사
Fig. 3. Expected best performance of Korean pilots.

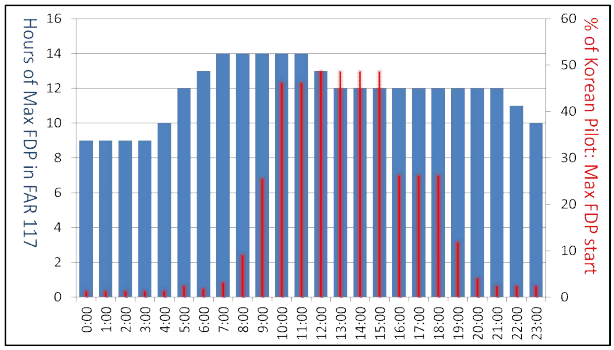

그림 4. 미국과 국내 비행근무 출두시간 및 국내 조종사 출두시간 선호 비교
Fig. 4. Show up time of the US domestic flights and the expected best performance of Korean pilots.

The show up times that provide the maximum flight duty period (FDP) were found to be as figure 4. Almost half of the pilots voted that the show ups between 10:00 and 15:59 provided the greatest concentration levels and the least amount of fatigue.

Night time show ups, especially between 20:00 and 07:59 were not preferred, which suggest implications of night flight duty time limitations.

4-2 Show Up Time Comparison between Korea and the US

Figure # shows a comparison between the hours of maximum FDP as defined in the FAA FAR Part 117, and the results of the maximum FDP survey taken from Korean pilots. The left vertical axis, FAA maximum FDP, takes into consideration the show up time, the flight departure time, the number of legs flown, the flight crew composition, jet lag, rest facility etc. The maximum FDP means the maximum flight duty period allowed per show up time in the horizontal axis. FAR117 implies that the time of day a flight duty starts affect the level of fatigue. The vertical axis on the right shows the preferred show up time voted percentage of the Korean pilots.

It can be seen that there is a discrepancy between the two data. The FAR Part 117 stipulates the show up times between 07:00 and 11:59 to have the longest allowed FDP and the show up times between 00:00 and 04:59 to have the shortest allowed FDP. The Show up time preference by the Korean pilots is greatest between 10:00 and 15:59 and lowest in 20:00 and 07:59. There is a 3 hour difference between the FAR Part 117 and the survey result of the early morning show ups. This indicates that if FAR Part 117 was directly implemented to Korean airline industry, the flights between 07:00 and 10:00 may result in a greater risk of fatigue.

Ⅴ. Conclusion

The survey result compared to the FAR Part 117 for show up indicated that the FAA rules allowed 3 hours earlier show up than the times most voted by the Korean pilots. Studies have shown that the pilots in flights headed east tend to have a harder time recovering from the jet lag. Flying eastward, unlike the opposite, increases the fatigue caused by jet lag as the bio-rythm is forcefully advanced[14]. Thus, the survey result may be interpreted that, if FAR Part 117 were to be directly implemented in Korea, having to show up earlier than normal to work a longer day is likely to cause greater fatigue.

However, the Korean aviation regulations have a history of being influenced by those of Japan and the United States. The first aviation law in Korea was based on that of the Imperial Japan in 1927. The same law subsisted throughout the independence and the Korean War[15]. The first independent Korean aviation law, with the counsel of the FAA, was legislated and made public in 1961[16].

If Korea does not begin its own research or participate in the global cooperation to develop a FRMS, there is a high chance that the existing overseas regulations will be implemented with minimal revision.

Studies show that a system that works in one setting may not result in the same successful manner in a different organization or group with different ethnic or cultural backgrounds[17]. This means that the success of the FAR Part 117 with the American pilots is not guaranteed in the Korean airline environment. The cultural and social backgrounds are another significant factors in the development of an FRMS program that must be looked into in detail.

The limitations faced in the research was the lack of survey for the comparison with the American pilots. There are chances that the American pilots have a similar sleeping cycle as those of Korean pilots. Another aspect is that the Korean pilots' sleep cycle may have been induced by the flight schedule in the first place. The correlations between the existing flight schedule and the pilots' sleeping pattern was not part of the research.

For future studies, in order to create an FRMS tailored for Korean airline environment, factors that affect pilot fatigue must be identified. Korea is positioned in a peninsula in far east Asia and shows significant difference in the working patterns of the full service carriers, the low cost carriers, and the cargo carriers from those of the foreign counterparts. The power difference or the language barrier between the captain and first officer may pose another factor in the level of fatigue.

The Korean regulations provide a monolithic fatigue management standards. A detailed and scientific development of an FRMS program that takes into consideration the specific operating environment and the many different factors that contribute to pilot fatigue is needed in the future.

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