January 2017

A Survey Measuring The Efficacy Of Duty And Rest Guidelines In Business Aviation Operations

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A Survey Measuring the Efficacy of Duty and Rest Guidelines in Business Aviation Operations

by

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Bachelor of Arts, Augustana College, 1989

A Thesis

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

Grand Forks, North Dakota
June
2017

This thesis, submitted by Timothy W. Wollmuth in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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This thesis meets the standards for appearance, conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.

Dean of the Graduate School

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Department	Aviation
Degree	Master of Science

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Timothy W. Wollmuth
June 20, 2017

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ACKNOWLEDGMENTS

My thanks to the business aviation community of professional pilots, mechanics, flight technicians, cabin crew specialists and administrative staff that make business aviation operations so incredibly flexible, effective and efficient. I especially thank the more than 1300 professionals who took the time to respond to a very lengthy and extensive electronic survey. Without their responses, this study would not have been possible. Additionally, many thanks to the fine staff of the National Business Aviation Association, especially Jay Evans and Mark Larsen, and the many other safety committee and sub-committee members. I laud the faculty and staff of the John D. Odegaaard School of Aerospace Studies for providing an exceptional platform for conducting remote graduate studies. In particular, I would like to thank my principal adviser, Warren Jensen, MD for his incredible depth and breadth of knowledge in human factors in aviation. Also, I greatly appreciated the excellent counsel of Mark Dusenbury, PhD regarding the Qualtrics Survey platform. Finally, thanks to Thomas Petros, PhD for his direction in analysis and the rest of the UND staff for supporting me through this process. Finally, I especially heap mountains of praise upon my beloved children, Emily, Angela and Ryan, and especially my loving wife, Stacy for tolerating and helping with this endeavor while concurrently working fulltime in Business Aviation and serving in the Air Force Reserve.

To Stacy, Emily, Angela and Ryan

ABSTRACT

Despite improved understanding of fatigue, reduced cognitive ability continues to contribute to aviation accidents (Drury, Ferguson, & Thomas, 2012; Noy et al., 2011). A comprehensive fatigue study on business aviation (BA) operations in the US has not been published since "Crew Factors in Flight Operations XIII: A Survey of Fatigue Factors in Corporate/Executive Aviation Operations" (Rosekind, Co, Gregory, & Miller, 2000). This study, modeled after the Rosekind survey and conducted in collaboration with the National Business Aviation Association (NBAA), updated the baseline for fatigue in BA, qualitatively examined fatigue perceptions in BA, and examined the efficacy of the "Flight Safety Foundation (FSF) and NBAA Duty/Rest Guidelines for Business Aviation" (BA Guidelines) (2014) by operation type, i.e. governing US Federal Aviation Regulation (FAR) Parts 91, 91(k) and 135. Mann-Whitney *U* statistical tests were conducted to compare nine recommended duty and rest criteria from the BA Guidelines between compliant operators' (COs) and non-compliant operators' (NCOs) total fatigue survey scores. Mann-Whitney *U* values were found to be statistically significant in five of the nine BA Guidelines criteria between COs and NCOs, with small to medium effect in all cases. Additionally, Mann-Whitney *U* statistical tests were conducted to compare six operation types to total fatigue survey scores. Mann-Whitney *U* values were found to be statistically significant in four of the six comparisons, with medium effect size in three pairs and large effect in one pair. These results were unsupportive of the BA Guidelines for all Basic operations recommendations, but support the BA Guidelines in required rest for Window of Circadian Low and Extended operations. Also, the mean fatigue scores for Parts 135 and 91(k) operations were significantly higher than in Part 91operations.

SECTION I

INTRODUCTION

Pilots routinely experience cognitive degradation due to fatigue and have since the early days of aviation. Aviation pioneer Charles Lindbergh (1953) presaged the deleterious effects of fatigue on cognitive ability writing, “[m]y mind is losing resolution and control.” Since Lindbergh’s solo transatlantic flight, extensive research has improved our understanding of workload, sleep and fatigue (Feyer, Williamson, & Friswell, 1997; Sobieralski, 2013; Williamson et al., 2011). Despite this improved understanding, reduced cognitive ability continues to contribute to aviation accidents (Drury, Ferguson, & Thomas, 2012; Noy et al., 2011). Fifty people died in the Colgan Air 3407 accident (United States National Transportation Safety Board (US NTSB), 2010) when the aircraft stalled; an Airbus 300 United Parcel Services Flight 1354 crashed short of the runway killing both pilots (US NTSB, 2014); and Asiana 214, a Boeing 777, hit the sea wall at San Francisco International Airport, killing two and seriously injuring dozens (US NTSB, 2014). In all three cases the NTSB identified fatigue as a contributing factor.

Fatigue affects not only FAR Part 121 commercial air carrier operations as business aviation (BA)--a subset of General Aviation (GA)--accidents also cite fatigue as a contributing factor (Drury, Ferguson & Thomas, 2012; US NTSB, 2011; Sumwalt, 2015). In July 2008, a business aviation air taxi operation flying a Hawker 800 under

FAR Part 135 struck the ground near the Owatonna, MN municipal airport in part due to sleep deprivation (SD) and fatigue (US NTSB, 2011), and a Beech Premier I was destroyed in February of 2013 in Thomson, GA killing five as a result of fatigue induced pilot error (US NTSB, 2014). According to a Lyman and Orlady (1981) review of the Aviation Safety Reporting System data, 21 percent of all incidents cited fatigue. Extensive NTSB studies in the 1990s implicate fatigue in nearly 30 percent of all aviation accidents (1995), and Sobieralski estimates the total cost of GA accidents to be $4.6 billion per annum (2013). Rosekind, Co, Gregory and Miller (2000) produced the only fatigue survey targeting fatigue in BA in the United States and found that 74 percent of pilots described fatigue in BA operations as a "moderate" or "serious" concern and 61 percent characterized fatigue as common.

Outside of the aviation industry, fatigue related incidents are common as well. Trucking has similar fatigue concerns as an NTSB study attributed a 31 percent incidence of fatigue in “fatal-to-the-driver accidents" (1995). The medical industry (Rogers, 2008; Robbins & Gottlieb, 1990), rail (Philip & Åkerstedt, 2006) and other shift workers who operate in the window of circadian low (WOCL) accumulate fatigue over successive work shifts (Åkerstedt, 2007), which might explain the rise in accident rates observed (Åkerstedt, Connor, Gray, & Kecklund, 2008; Folkard & Tucker, 2003). The WOCL, typically defined by the Federal Aviation Administration as 2:00 a.m. to 5:59 a.m., is the internal or biological clock in the brain based on a 24 hour cycle for individuals adapted to a usual day-wake and night-sleep schedule. This estimate of the WOCL is based on extensive scientific data on performance, alertness, subjective fatigue, and body temperature (Van Dogen & Dinges, 2000). Extended time on task, lengthy periods of wakefulness (Åkerstedt, Fredlund, Gillberg, & Jansson, 2002; Philip et al., 2005; Philip & Åkerstedt, 2006) and repeated shift work through the WOCL increase the risk of accident by 17 percent after four days of such work (Boivin, Tremblay, & James, 2007; Folkard & Tucker, 2003). Airport operations, military organizations (Balkin et al., 2004; Caldwell et al., 2009; Gawron, 2015; Heaton, Maule, Maruta, Kryskow, & Ghajar, 2014), mining (Ferguson, Paech, Dorrian, Roach, & Jay, 2011) and other industries (Balkin et al., 2004; Gawron, 2015) have interest in mitigating the deleterious effects of fatigue (Horne & Burley, 2010; Orasanu et al., 2012).

Beyond work, people generally have interest in managing fatigue and mitigating its consequences for various reasons. Reilly and Edwards (2007) found that athletes' perceived exertion level increased with partial sleep deprivation (PSD). Ubiquitously, fatigue contributes to motor vehicle accidents in the everyday lives of people around the world (Di Milia et al., 2011; Eoh, Chung, & Kim, 2005; Jongen, Perrier, Vuurman, Ramaekers, & Vermeeren, 2015; Rogé, Pébayle, Hannachi, & Muzet, 2003; Savage, 2012; Ting, Hwang, Doong, & Jeng, 2008), which comes with an economic cost of $871 billion, equivalent to more than 1 percent of the U.S. Gross Domestic Product (Blincoe, Miller, Zaloshnja, & Lawrence, 2015). Across all human endeavors the likelihood of error increases as humans have reduced cognitive functioning. Whether due to quality of sleep, operations during the WOCL, extended time on task, illness, chemical use or other cognitively debilitating factors, fatigue causes accidents and death which also comes with great economic cost.

Statement of the Problem

A review of the literature showed:

1. Fatigue is a biological response that can only be managed, not eliminated.
2. There is limited data on fatigue in BA operations.
3. BA, as an on-demand operation has unique duty and rest requirements as compared to scheduled operations like air carrier operations.

Therefore, this study had the following goals:

1. Analyze the complexity of fatigue as compared to the only previous BA study in the U.S. (Rosekind et al., 2000).
2. Identify post 9-11 baseline perceptions in the U.S. on fatigue in BA.
3. Compare perceptions of fatigue in BA between compliant operators (COs) and non-compliant operators (NCOs) of the Flight Safety Foundation (FSF) and National Business Aviation Association (NBAA) Duty/Rest Guidelines (2014) (BA Guidelines).

Since 2000, BA operations have changed greatly because of post 9-11 effects, equipment changes and operational requirements. This study broadened the scope of the Rosekind study and set a more current fatigue baseline within BA operations, identifying and comparing BA work types and cultures. Analyzing the survey responses and comparing them to the Rosekind survey results identified similarities, differences and challenges with fatigue in various types of BA operations. An important step outside of the scope of this thesis is to collaborate with the NBAA in identifying specific hazards affecting fatigue in BA operations and to share that information throughout the BA community.

Research Focus

This study specifically and deliberately looked at BA operations in the U.S. While this study was not able to examine all facets of fatigue as it pertained to BA, it scrutinized important questions which yielded vital data to be reported to the BA community at large. Ultimately, the goal of this study was to improve aviation safety, especially in BA operations. Three research focus areas were selected for this study:

1. Comparing qualitative fatigue perceptions, as measured by respondents' responses to fatigue questions, from BA Guideline compliant and non-compliant operators for:
    - basic duty periods, flight times and rest periods,
    - operations in the WOCL duty periods, flight times and rest periods, and
    - extended duty periods, flight times and shortened rest periods.
2. Identifying how BA operations, perceptions of fatigue, sleep habits, work habits and operational cultures in 2000 compare to operations in 2017.
3. Identifying which Type of Operation as aligned with FAR Parts 91, 91(k) and 135 and as reported by the subjects have the highest levels of fatigue.

Fatigue Defined

Cognitive degradation or decline referred to in this research is synonymous with fatigue, SD, alertness or tiredness. For this study fatigue is defined as a biological drive for recuperative rest (Williamson et al., 2011), resulting in a transient state associated with difficulties in maintaining task directed effort and attention during sustained performance (Drury et al., 2012). Individual personal experience makes most causes of fatigue and understanding of cognitive decline empirically self-evident (Horne & Burley, 2010). However, the process of sleep is much more complex than people understand, as it consists of highly complex environmental and biological processes that recharge the body in the early deep stages (I-IV) of non-rapid-eye-movement (NREM) sleep and the mind during rapid-eye-movement (REM) sleep (Akerstedt, 2007; Graw, Kräuchi, Knoblauch, Wirz-Justice, & Cajochen, 2004; Rosekind, Graeber, Dinges, Connell, Rountree, Spinweber, & Gillen, 1994; Rosekind, et al., 2000). Sleep induced fatigue is comprised of three components of the alert and sleep cycle.

The first refers to the tiredness an individual experiences the greater the length of time an individual is awake from the last sleep period. This environmental impact on sleep is known as homeostasis (Graw et al., 2004; Maldonado, Bentley, & Mitchell, 2004) (Figure 1). Length and quality of sleep or sleep efficiency also affects this homeostatic component (Co, Gregory, Johnson, & Rosekind, 1999). Typically, an adult

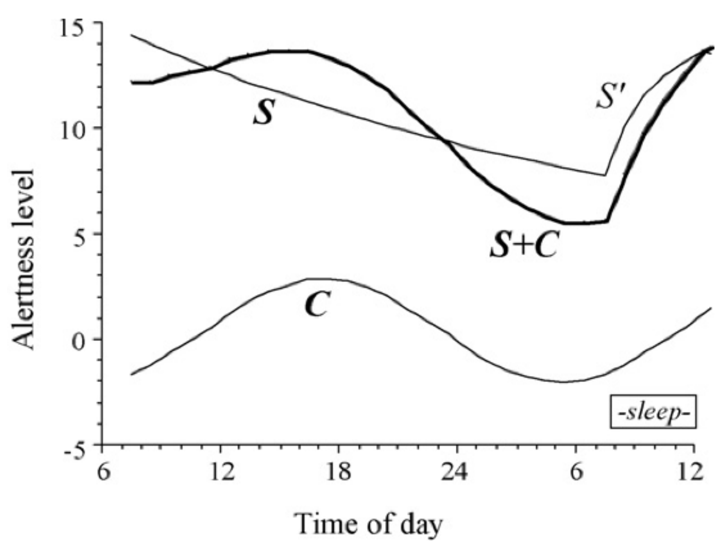

Figure 1. *Sleep Pressure (Åkerstedt, Connor, Gray, & Kecklund, 2008)*

requires approximately eight hours of sleep every 24 hours (Co, Gregory, Johnson, & Rosekind, 1999; Rosekind, Coe, Gregory & Miller, 2000). Specifically, if an individual has a bio-static threshold of eight hours of sleep, then an individual starts with a sleep deficit equal to the difference in the homeostatic baseline and the shortened night of sleep. Repeated reduced sleep deficits create sleep debts, which may take several days to several months to eliminate (Co et al., 1999; Graw et al., 2004; Rosekind et al., 2000). According to Rosekind (2000) most people after one night with two hours sleep deficit realize significant degraded subsequent waking performance and alertness. Prolonged acute sleep debt may become chronic if the sleep debt persists. Symptoms of chronic sleep debt or chronic fatigue are similar to those of acute fatigue but are more persistent and can even affect overall health (Bryant, Trinder, & Curtis, 2004; Vessey et al., 2015).

A second component of alertness and sleep cycles is the circadian or diurnal cycle (Figure 1) which is linked to the twenty-four hour rotational period of the earth and also affects an individual's alertness (Co et al., 1999; Graw et al., 2004; Rosekind et al, 2000). This home-time-zone (HTZ) effect creates a biological anchor (Figure 2), which must be slowly dragged to the new HTZ when an individual travels across time zones or performs shift work (Boivin et al., 2007). Biological anchors consist of commonly known

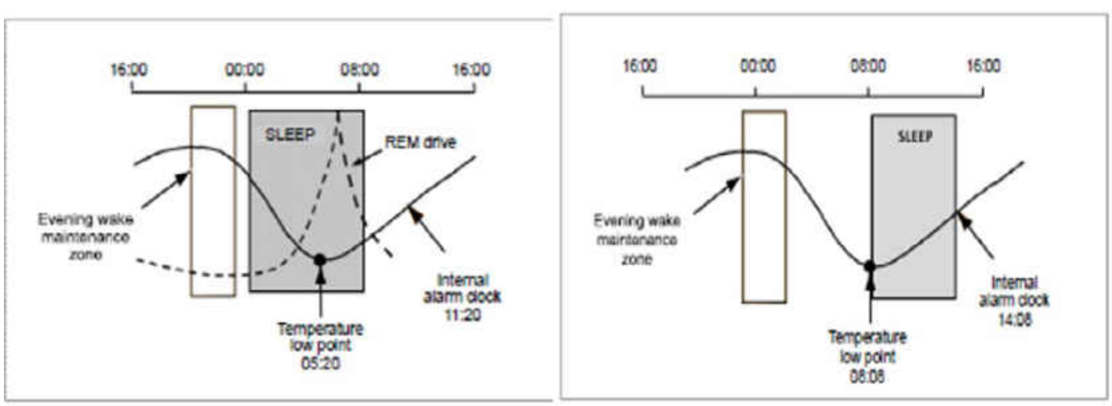

Figure 2. *Example of Shift Work or HTZ Change and the Circadian Sleep Anchor (ICAO, 2012)*

hormones like melatonin and testosterone, which are diurnally synchronized to an individual's HTZ (Boivin et al., 2007). Additionally, body temperature (Panda, Hogenesch, & Kay, 2002; ICAO, 2012) (Figure 2), digestive functions (Bron & Furness, 2009) and blood pressure (Vessey et al., 2015) are connected to this circadian anchor.

Sleep-efficiency metric of homeostasis is the third component playing an important role in zeroing tiredness (Caldwell et al., 2009). Within a sleep period, an individual transits several stages of sleep, which cyclically recharge the body and mind. NREM sleep refreshes the body, while REM sleep refreshes the mind (Buysse et al., 2003; Co et al., 1999; Rosekind et al, 2000). During a typical night of sleep an individual transitions through these various stages of sleep, generally in 90 minute cycles (Figure 3) (Bryant et al., 2004), with seismograph like measures seen in electroencephalogram (EEG) analysis, as the body and mind alternate through modes of rest (Vessey et al., 2015).

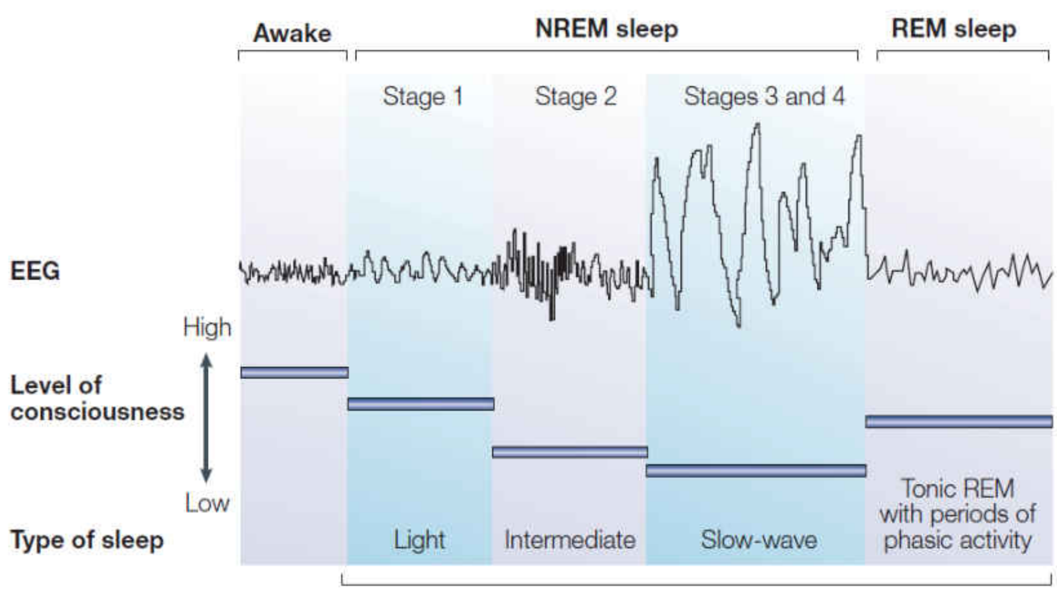

Figure 3. *Typical Sleep Waves of Healthy Adult (Bryant et al., 2004)*

Disruption of this diurnal process, as measured with EEG readings during partial or total sleep deprivation (P/TSD) studies, affects an individual's relative cognition and ultimately impacts individual performance during complex tasks (Akerstedt, 2007; Blatter & Cajochen, 2007). Research using standard deviation of lateral position (SDLP) correlates SD and sleep-deprived-driving during the WOCL to driving with blood alcohol concentrations of .05 and .08 respectively (Rosekind, Boyd, Gregory, Glotzbach, & Blank, 2002; Verster, Taillard, Sagaspe, Olivier, & Philip, 2011). In another study, subjects were tested with the Useful Field of View measure while driving in a simulated environment following 20 hours of SD. The SD test group had a significantly 50 percent less lateral alertness than the well-rested control group (Faber, Maurits, & Lorist, 2012). Thus, alertness and sleep are influenced by this underlying biorhythm of homeostasis, anchored to slow moving diurnal pressure, plus a sleep-efficiency metric and all three play critical roles in mitigating cognitive degradation.

Mitigating the Effects of Fatigue

Pilots of recent decades cannot relate to the discomforts of physical fatigue that Lindbergh experienced; rather they face the arguably more dangerous issue of cognitive errors versus control errors (Ritter, 1993). While Lindbergh purposely planned to go without food, carry only one quart of water and sat on an uncomfortable rubber seat cushion to ward off fatigue, just nine hours into the thirty-three and a half hour flight, he was already fighting the many effects of this biological pressure (Lindbergh, 1953). Modern aircraft are comfortable and quiet and the pilot is relieved of many tedious tasks through automation. Yet, the benefits of automation reducing the frequency of input and degree of direct human manipulation (Reason, 1998) are not realized, as this shift from physical action has increased fatigue as vigilance tasks are exacting, capacity draining assignments that are cognitively resource demanding (Warm, Parasuraman, & Matthews, 2008).

To reduce the consequences of vigilance fatigue and to enhance pilot performance, industry and government efforts have developed systems to reduce pilot cognitive and physical workload, increase pilot situational awareness and mitigate vigilance error. For example, Traffic Collision Avoidance Systems protect against mid-air collision. Enhanced Ground Proximity Warning Systems/Terrain Awareness Warning Systems increase pilot awareness and inform pilots of increased potential of collision with the ground. Real-time and near real-time data sources, like NEXRAD, on-board color radar systems, Automated Flight Information System (AFIS) and Aircraft Communications Addressing and Reporting System (ACARS) improve pilots' decision-making resources. Automated flight systems simplify navigation and aeronautical control. Yet, in spite of systems improvements since the AIA flight 808 accident in a minimally automated DC-8 aircraft (US NTSB, 1994), accidents like the 2013 mishap in San Francisco, California of Asiana flight 214 in a highly automated B-777 (Sumwalt, 2015; US NTSB, 2014) continue to occur. The common thread in these accidents is human error and studies substantiate that fatigue negatively impacts human performance (Williamson et al., 2011). While these many technological improvements have improved aviation safety, the zero accident goals of the USAF, NTSB and industry remain elusive (Petrie, Powell, & Broadbent, 2004). Likewise, despite efforts across many other industries, accident statistics indicate that human factors in complex operational tasks negatively affect routine operations (Banks & Dinges, 2007; Rosekind et al., 2002).

A second and more recent approach to mitigating the effects of fatigue is through the introduction of public policy intended to target duty and rest regulations. Following the Colgan Air 3407 accident in 2009, the United States Congress passed Public Law 111-216. This law directed the Federal Aviation Administration (FAA) to implement the first substantial regulatory change to duty and rest rules of FAR Part 121, which were originally implemented in 1958 through the Federal Aviation Act, which also replaced the Civil Aviation Authority (CAA) rules implemented in 1937. These new rules in FAR Part 117 limit the duty and flying limits based on crew component, quality of rest facilities, WOCL operations, time on duty, flight time and segments flown (Table 1). As these FAR Part 117 rules have only been in effect since January 2014, it will likely be some years before analysis can statistically determine the efficacy of these rules in attaining the intended goal of reducing fatigue-induced accidents in U.S. air carrier operations. Regardless of the impact in air carrier operations, FAR Part 117 rules do not pertain to FAR Part 91 BA operations leaving operators to design and implement their own duty and rest guidelines (Table 2) (FSF, 2014; Rosekind et al, 2000).

Finally, it is important to note that prior to 2012, BA pilots routinely applied the National Aeronautics and Space Administration (NASA) nap as a fatigue mitigation technique for the unpredictable, on-demand nature of BA operations. The nap came from a NASA study of long-haul airline pilots, in which a 40-minute in-seat rest period showed a 34 percent improvement in cognitive performance and a 54 percent increase in physiologic alertness compared to the control group (Rosekind et al., 1994). The Rosekind study (2000) reported 71 percent of BA pilots slept in the seat. Many countries and ICAO rules allow for controlled rest in flight (ICAO, 2014). However, the FAA

Table 1. *FSF and NBAA Duty/Rest Guidelines comparisons (FSF, 2014; FAR, 2017)*

	Duty Hours	Flight Time	Rest Period
FSF Recommendation			
2 Person Crew			
Standard	14	10	10
WOCL	12	10	12
Extended	14*	12	12
3 Person Crew			
Reclining Seat	18	16	12
Supine Bunk	20	18	12
Part 117			
2 Person Crew			
Standard	12-14	9	10
WOCL	9-12	8	10
3 Person Crew			
Reclining Seat	14-16.5	12	12
Supine Bunk	15-17	12	12
Part 91 (k)			
2 Person Crew			
Standard	14	10	10
WOCL			
3 Person Crew			
Reclining Seat	16	12	12^
Supine Bed			
Part 91 Example Operator			
2 Person Crew			
Standard	14	10	10
WOCL	14^^	10	10
Extended	14	12	10
Extended***	18^^	10	10
3 Person Crew			
Supine Bunk	20	18	10
Extended	22**	18	36

* extended WOCL not recommended
** maximum of two landings
*** with six hours of midday rest
^^maximum of two consecutive days
^ 18 hours for flights crossing five or time zones

eliminated this option when it ruled sleep is not a physiological need (FAA, 2010; MacPherson, 2012) as defined in FAR Part 91.105 (a) (1). As a result, BA pilots have to choose between complying with regulation or mitigating risk in recognizing and controlling the physiological need for rest, a physiological stressor the same as hunger, thirst and other biological pressures.

Measures of Fatigue

Most people, including pilots, believe they are a good judge of their actual level of intoxication, alertness and fatigue (Caldwell et al., 2009), but humans are known to be poor at estimating their own level of cognitive ability. While some self-assessment tests like the Karolinska Sleepiness Scale and the Samn-Perelli Fatigue Scale are relevant

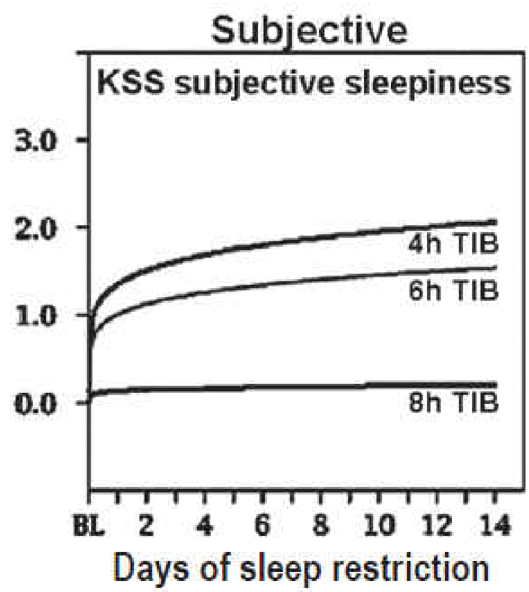

Figure 4. *KSS loss of efficacy with increased SD. (Banks & Dinges, 2007)*

self-measures in some settings, these tests lose their efficacy as SD becomes more chronic (Figure 4) (Banks & Dinges, 2007). Additionally, interpersonal and intrapersonal differences make many self-assessment tools unreliable (Alhola & Polo-Kantola, 2007) as we continue to lack a reliable, passive in situ fatigue measuring solution.

The most accurate measure of fatigue is an electroencephalogram (EEG) which measures the small electrical patterns in the brain as the brain is accomplishing different functions (Faber et al., 2012). These waves indicate levels of cognitive capability and different brain functions from the different lobes of the brain. Acceptable objective measures correlate results with EEG data as a means of validation. The most common field applied test is the Psychomotor Vigilance Test (PVT), which measures reaction

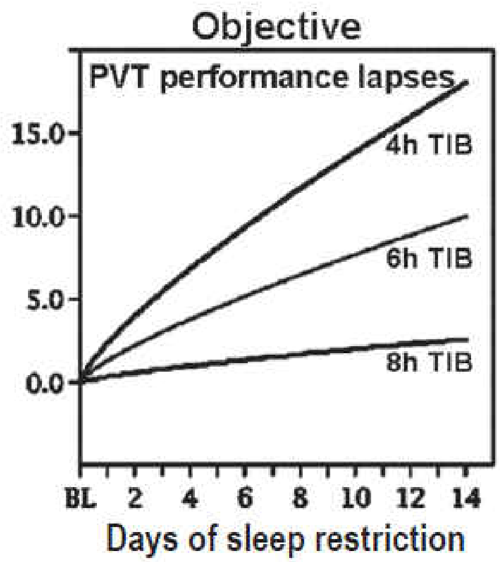

Figure 5. *PVT reliability with increased SD. (Banks & Dinges, 2007)*

times to external stimuli (Figure 5). These reaction times correlate directly to EEG data (Faber et al., 2012). Several other objective measures have been developed and many are correlated to reaction times in the PVT. Yet, many of the cognitive tests have decreasing reliability with increasing SD as indicated by the direction of the arrows in the "Effect" column in Figure 6. These measures align with either objective, quantitative measures or

Cognitive test	Effect	Authors
Attention		
Simple reaction time	↓	Choo et al 2005, Karakorpi et al 2006
Choice reaction time tasks	↓	Wilkinson et al 1990, Smulders et al 1997, Wright and Badia 1999, Frey et al 2004, Karakorpi et al 2006, Kendall et al 2006
Serial reaction time test	↔	Nilsson et al 2005
Vienna Test System (computerized): Vigilance, simple reaction time; Cognitrone (visual analytical ability, attention and working memory	↔	Lee et al 2003
Vigilance)	↓	Wu et al 1991, Corsi-Cabrera et al 2003, Karakorpi et al 2006, Sagaspe et al 2006, Tallard et al 2006
Flanker task (computerized: attention, vigilance?)	↓	Tsai et al 2005
Dichotic listening (vigilance)	↓	Johnsen et al 2002
Psychomotor vigilance task (PVT)	↓	Dinges et al 1994, Wright and Badia 1999, Doran et al 2001, Van Dongen et al 2003, Frey et al 2004, Graw et al 2004, Van Dongen et al 2004, Adam et al 2006, Blatter et al 2006
Serial addition and/or subtraction task	↓	Drummond et al 1999, Thomas et al 2000, Van Dongen et al 2003 and 2004, Kendall et al 2006
Two column addition	↓	Wright and Badia 1999, Frey et al 2004
Visuo-spatial attention (saccadic eye movements)	↓	Bocca and Denise 2006
Finding Embedded Figures Test	↓	Blagrove et al 1995
Auditory attention task	↓	Blagrove et al 1995, Linde et al 1999
Dual task	↓	Wright and Badia 1999, Frey et al 2004
Dual task	↔	Drummond et al 2001, Alhola et al 2005
Paced Auditory Serial Addition Test (PASAT)	↔	Binks et al 1999
Working memory		
N-back	↓	Smith et al 2002, Choo et al 2005
LTR, PLUS	↓	Chee and Choo 2004, Chee et al 2006
PLUS-L (verbal working memory)	↓	Chee et al 2006
Delayed-match-to-sample task	↓	Habeck et al 2004
Choise-reaction time task (with working memory component)	↓	Jennings et al 2003
Brown-Peterson	↓	Forest and Godbout 2000
Sternberg verbal working memory task	↓	Mu et al 2005
Working memory task	↓	Wimmer et al 1992
Digit recall	↓	Frey et al 2004
Digit span	↔	Linde and Bergström 1992 (2 studies), Quigley et al 2000
Word recall (working memory)	↔	Quigley et al 2000
Verbal working memory, visuo-spatial working memory test	↔	Nilsson et al 2005
Spatial working memory task	↔	Heuer et al 2005
Attentional power (effortful information processing)	↔	Linde and Bergström 1992 (2 studies)
Long-term memory		
Word memory test	↓	Drummond et al 2000
Temporal memory for faces (recency)	↓	Harrison and Horne 2000
Probed forced memory recall and digit recall	↓	Wright and Badia 1999
Memory search	↓	McCarthy and Waters 1997
Paired word learning (implicit memory)	↓	Forest and Godbout 2000
Episodic memory (Claeson-Dahl test)	↔	Nilsson et al 2005
Implicit memory test, prose recall, Mill Hill vocabulary test (chrystallized semantic memory), procedural memory, face memory	↔	Quigley et al 2000
Benton visual retention test	↔	Alhola et al 2005
Visuomotor performance		
Critical tracking	↓	Van Dongen et al 2004
Letter cancellation task (visual search)	↓	Casagrande et al 1997, De Gennaro et al 2001
Trail-making task	↓	Wimmer et al 1992
Maze tracing task	↓	Blatter et al 2005
Digit symbol	↓	Van Dongen et al 2003, 2004
Digit symbol, Bourdon-Wiersma, other psychomotor tests	↔	Quigley et al 2000, Alhola et al 2005
Procedural motor task	↓↔	Forest and Godbout 2000
Decision making		
Critical reasoning, Masterplanner	↓	Harrison and Horne 1999
Decision-making task	↓	Linde et al 1999, Kilgore et al 2006
Verbal functions		
Logical reasoning	↓	McCarthy and Waters 1997
Logical reasoning test (Baddeley)	↓	Blagrove et al 1995, Monk and Carrier 1997
Logical reasoning test (Baddeley)	↔	Linde and Bergström 1992 (2 studies), Quigley et al 2000, Drummond et al 2004
Word detection task, repeated acquisition of responce sequence task	↓	Van Dongen et al 2004
Vowel/consonant discrimination task, letter recognition task	↓	Wimmer et al 1992
Sentence processing, categories test, spot the word, word recognition	↔	Quigley et al 2000
Word fluency, Booklet form of the Category test	↔	Binks et al 1999
Response inhibition		
Response inhibition (the Haylings sentence completion task), verb generation to nouns	↓	Harrison and Horne 1998
Go-NoGo (response inhibition)	↓	Drummond et al 2006
Stroop (color-word, emotional, specific)	↓	Sagaspe et al 2006
Spatial Stroop (suppression of prepotent responses)	↓	Heuer et al 2005
Stroop	↔	Binks et al 1999
Other measures		
Dichotic temporal order judgment	↓	Babkoff et al 2005
Negative priming (effect vanished during SD)	↓	Harrison and Espelid 2004
Task-shifting	↓	Heuer et al 2004 (2 studies)
Simon task	↓	Heuer et al 2005
Raven's progressive matrices	↓	Linde and Bergström 1992
Figural form of the Torrance Tests of Creative Thinking	↓	Wimmer et al 1992
Modified Six Elements test (story-telling, simple arithmetic calculations and object naming)	↓	Nilsson et al 2005
Switching Task	↓	Frey et al 2004
Implicit sequence learning in the serial reaction task	↓	Heuer et al 1998, Heuer and Klein 2003
Explicit sequence learning task (serial reaction tasks)	↔	Heuer et al 1998
Luria-Nebraska Neuropsychological Battery, Calculation and digit span from WAIS	↓↔	Kim et al 2001
Number-series inductions	↔	Linde and Bergström 1992
Novel oddball task (auditory)	↓↔	Gosselin et al 2005
Random generation tasks	↓↔	Heuer et al 2005 (3 studies)
Complex navigation task	↔	Strangman et al 2005
Wisconsin Card Sorting Test (computerized), WAIS-R short form	↔	Binks et al 1999

Abbreviations: SD, sleep deprivation; WAIS, Wechsler Adult Intelligence Scale; WAIS-R, Wechsler Adult Intelligence Scale-Revised.

Figure 6. *Cognitive tests effectiveness as measures with increasing sleep deprivation* (*Alhola & Polo-Kantola, 2007)*

subjective, qualitative measures in concept, yet none of these are simple or passive as in situ measures. Ultimately, objective measures are desired and there are several scientifically accepted measures, but these are either cumbersome or require user activity in their application (Alhola & Polo-Kantola, 2007). The standard of fatigue measures is a passive, in situ device which learns each individual and meters their performance respective to their individual baseline. This device would need to be robust enough to continuously adjust to the physiology of the person using it in order to compensate for the minute and perpetual variations that occur as age affects change cognitive performance (Blatter et al., 2006)

Industry Changes

Most aircraft during the Rosekind study (2000) had a maximum range of approximately 4500 nautical miles (NM) (General Aviation Manufacturers Association, 2015). In 2000, there were less than on hundred 6500NM Gulfstream V and 6200NM Bombardier Global Express aircraft. Furthermore, the Global Express had only recently begun operations in the first quarter of 1999 and the Gulfstream V in December of 1997. As such, BA operators had limited experience in managing these long-range aircraft when accomplishing the Rosekind survey (2000). Today there are more than 1000 long-range (LR) and ultra-long-range (ULR) aircraft in use. The newest ULR aircraft are the Gulfstream 650ER having a maximum range of 7500NM and the Bombardier 8000, currently in development, which is to have a range of 7900NM. These ranges equate to 15 to 16 hours of flight time non-stop at .83 to .85 indicated Mach number, while two decades ago aircraft cruise endurance was ten hours or less based on slower cruising speeds of .78 to .80 indicated Mach number.

An important new regulatory change governing FAR Part 91(k) operations, not defined in 2000 (FAR, 14 CFR 2107), further differentiated a new construct for BA operations much more similar to Part 121. According to the FAA the number of fractional programs had substantially increased since the early 1980s, and the agency felt the new regulations were needed to establish a regulatory environment commensurate for this type of operational control. FAR Part 91(k) regulated fractional ownership programs, where owners buy a "quarter share" of an aircraft which are maintained by a management company, who schedule and furnish trained flight crews. These quarter shares can be no smaller than 1/16th of an aircraft, or the operations would be governed by FAR Part 135. The quarter share owners are guaranteed an aircraft within a defined period of time, thus creating an on-demand type of air carrier which is owner operated and includes all the comforts and convenience of traditional BA operations, without the full cost of ownership depending on the amount of annual utilization. Unlike Part 91 operations, the crews of these quarter share operations are restricted by regulations in their duty, flight and rest times (Table 1). Various financial, company, cultural and transportation needs and desires determine whether traditional Part 91, Part 91(k) or Part 135 charter operations is a better fit for owners.

Finally, the post 9-11 BA environment has changed with additional requirements for international operations. Airspace has been unavailable due to open conflict as in Syria, Iraq, Afghanistan, and southeastern Ukraine, or due to political conflict as in the South China Sea, North Korea and Qatar. Air traffic has increased 15 to 20 percent based upon the FAA Air Traffic Activity Data (2017), at the same time airport security training and requirements have increased with new airspace restrictions for VIPTFRs and DCA

TFRs either preventing travel to specific areas at specific times or requiring DASSP and FBOSSP program compliance and management. The Europeans require carbon emissions logging and reporting and ICAO is currently working on an international environmental standard (2017) in addition to environmental noise compliance. Operators have enhanced their ability to comply with required procedures as in the case of SAFA checks and many have developed and manage SOPs and Safety Management Systems which in many cases rival Part 121 operations. All of this is being managed by the personnel within the departments, who in most cases are pilots or maintainers in their primary roles. There are many implications of the many changes in BA operations and while not comprehensive, this survey intended on establishing a post 9-11 framework for future research in fatigue in BA operations.

SECTION II

METHOD

Rosekind in coordination with the NBAA and the FSF conducted a survey targeting six main topics: demographics, sleep habits, flight experience, duty and rest patterns, fatigue, and the work environment (2000). This thesis research conducted a similar study targeting BA, the first since Rosekind's study 17 years ago. A Qualtrics based, electronic survey containing as many as 472 data points per subject was made available through NBAA electronic mailings, the NBAA website and via informal communication (networking, chief pilot and safety roundtables and business luncheons) to NBAA members and their contacts. NBAA membership was not required nor expected to participate in the study. The survey (Appendix 1) contained six sections regarding:

1. Personnel demographics (23 questions) covering gender, age, time zones of work and residence, commuting modes and times, crew position and ratings as examples.
2. Targeted duty information (10 - 45 questions) based upon primary responsibilities determined in the demographics section, allowing cabin crew to answer relevant questions differently from pilots or mechanics.
3. Sleep information (30 questions) assessing typical sleep patterns, schedules and interruptions and their effects.
4. Fatigue (24 questions) examining retrospective respondent assessment under varying circumstances, fatigue countermeasures, fatigue impacts and recommendations to mitigate fatigue in BA operations.
5. Management questions (8) assessing the flying, office and rest challenges of

flying managers.

6. Work environment (14 questions) which provided company demographics, culture, and operational characteristics of the respondents' companies.

Survey questions were similar or identical to the Rosekind survey questions to improve understanding in differences and similarities between the two surveys. One important improvement in this survey was to broaden the scope to include maintenance personnel, administrative personnel, flight mechanics and flight attendants, who were not included in the previous survey in 2000. The survey was electronically available for respondents for a period of six weeks. NBAA correspondence encouraged participation and ensured anonymity of the subjects through generic mailers and advertisements. Anonymity of the subjects was maintained by de-identifying all survey responses with personnel or company information before any analysis was conducted.

All survey questions were reviewed and tested through the NBAA safety committee and a sub-committee from all functional areas of line operations. Required modifications, to include appropriate suggested changes made by the NBAA Safety Committee, were completed prior to final approval by the University of North Dakota's Institutional Review Board and electronic distribution through a Qualtrics survey link.

SECTION III

RESULTS

Demographics

A total of 1329 business aviation professionals responded to the survey which included office administrative personnel (scheduling, dispatch, and administrative assistants), cabin crewmembers (flight attendant, cabin safety crewmembers), flight technicians, maintenance personnel, and pilots (captain or copilot/first officer). Most respondents (*N*=916) identified as being either captain (*N*=754) or first officers (FO) (*N*=162) (Table 2). Of those, only surveys in which respondents completed fatigue perception questions and duty and rest requirements were considered for quantitative analysis (*N*=462).

Subjects represented flight operations ranging in size from single pilot operations to more than 4500 pilots (average 959.0, *N*=385) who worked for companies with as many as 400,000 total employees (average 18441.5, *N*=332). According to the subjects, their flight operations operated an average of 107.3 aircraft (*N*=479), ranging from one to 800 aircraft. However, the median number of aircraft was five and the mode was one aircraft. The majority of respondents (78 percent) reported flying jet aircraft, while 13 percent reported flying turboprop aircraft, four percent reciprocating-engine aircraft and five percent rotorcraft. Operators reported the mean number of jet aircraft was 136.5; the average number of turboprop aircraft was 3.8; helicopters average 3.0 per subject and reciprocating aircraft average 1.5 per subject. One in five (19 percent) reported flying domestic only trips, 41 percent (*N*=451) fly US and Canada only trips and 39 percent fly internationally, yet 92 percent of respondents (*N*=514) reported their companies fly internationally. Results from many of the other demographic based questions from Rosekind (2000) and this author are found in Table 2.

Table 2. *Survey Demographics results.*

	Rosekind	Wollmuth
Gender		
Female	1%	3%
Male	99%	95%
Unidentified	--	2%
Mean Age	45.2 years	49.6 years
Home base time zone		
Eastern	48%	50%
Central	40%	28%
Mountain	5%	7%
Pacific	6%	12%
Other	1%	1%
Various	0%	2%
Domicile Time Zone		
Eastern	49%	43%
Central	39%	32%
Mountain	5%	8%
Pacific	6%	14%
Other	1%	2%
Commute Time	32.9 minutes	63.9 minutes
Mode of Transportation		
Auto	99%	91%
Plane	1%	7.5%
Other	<1%	1.5%
Moonlighting		
Yes	15%	15%
No	85%	85%
Moonlighting Time	57.6 hours/month	35.4 hours/month
Crew Position		
Capt	91%	83%
FO	9%	17%

Table 2. *Survey Demographics result continued.*

	Rosekind	Wollmuth
Under Which FAR Part(s) Do You Fly?		
91 only	90%	38%
135 only	1%	2%
91 and 135	9%	9%
91(k)	--	49%
Other	0%	2%

Duty

Respondents (*N*=512) reported having an average of 6350 hours of flying experience when hired for their current position. They have logged an average of 10,670 flight hours in their career in all categories. Mean career hourly distributions can be found in Table 3.

Table 3. *Career flight hours of respondents*

Flying type (FAR Part)	*n*	*Flight hours*
Part 91 Business Aviation	423	4232
Part 91(k)	234	2495
Part 121	174	4505
Part 135	366	2904
Military	96	3670
Part 91 General Aviation	320	1836

The majority (97 percent, *N*=517) of the pilots held an Airline Transport Pilot (ATP) rating in addition to multiple other ratings. Six percent of respondents held Rotorcraft ratings. In a typical month, respondents reported flying 37.9 hours of business aviation (*N*=517), 29.0 hours under FAR Part 135(*N*=197), and 15.1 hours on average in

Table 4. *Survey Duty results.*

	Rosekind	Wollmuth
Duty Days Flown Per Month		
Typical	13.8	14.1
Fewest	6.9	9.6
Most	20.1	18.7
Flight Hours Per Month		
Typical	35.2	38.5
Fewest	15.0	20.0
Most	55.5	56.6
Flight Segments Per Day		
Typical	3.2	3.0
Fewest	1.2	1.4
Most	7.6	7.1
Ground Time Between Flights in Hours		
Typical	7.0	5.0
Fewest	2.0	3.3
Most	26.0	12.5
Number of Reports During the Following Time Periods		
0000-0359	0.3	2.0
0400-0759	7.1	6.7
0800-1159	5.5	5.2
1200-1559	2.1	2.6
1600-1959	1.7	2.3
2000-2359	0.4	2.1
Duty Time Range Days Per Month		
<8 hours	11.1	10.3
8-12 hours	3.3	5.5
>12 hours	1.7	4.2
Duty Day Durations in Hours		
Typical	9.9	10.5
Shortest	4.1	6.2
Longest	16.0	15.1
Longest Duty Day in Career	20.2	17.6

Table 4. *Survey Duty results.(cont)*

	Rosekind	Wollmuth
Layover Accommodations Times Per Month		
Hotel	13.2	10.8
Crew Lounge	0.6	3.1
Day Room	--	0.9
Other	0.2	0.8
Dispatch/Scheduling?		
Yes	67%	83%
Both	--	59%
Scheduling	--	24%
Dispatch	--	1%
No	33%	16%
Preposition Crews?		
Yes	35%	58%
No	65%	42%
Augment Crews?		
Yes	40%	60%
No	60%	40%
Position Augmented?		
Capt	56%	54%
FO	44%	35%
Either	--	11%
Flights Per Month		
Domestic	18.5	14.9
International	1.0	3.9
Flight Hours Per Month		
Domestic	35.0	31.1
International	6.2	11.5
Flights Crossing Time Zones Per Month		
0-3 time zones	14.5	16.9
4-6 time zones	0.7	3.8
>6 time zones	0.3	2.2

all other categories. Eighty-three percent of survey participants identified themselves as Captains and 17 percent as FOs. Respondents (N=462) reported typically flying 6.5 hours of instrument time per month with mean ranges of 2.6 to 12.7 hours per month.

Concerning high density operations, pilots (*N*=462) reported eight sorties per month typically, with a range of 4.2 to 22.2 flights per month. Flying in un-controlled and non-radar environments, pilots (*N*=423) reported 6.9 events per month on average with a range of 4.6 to 22.2 times per month. Pilots (*N*=483) reported that 97 percent of delays were attributed to four reasons:

1. Passengers or company requirements (47 percent)
2. Weather (27 percent)
3. Air Traffic Control and congestion (17 percent)
4. Maintenance. (52 percent of subjects listed this as the least likely cause for delays).

Pilots were asked four questions regarding on-call or standby duty (Table 5). Standby duty was divided into three categories-less than two hour call out, between two

Table 5: Short, medium and long call schedules and response rates

	n	Weekly	Monthly	3-4 times/yr	1-2 times/yr	Rarely/ Never
Short Call (< 2 hrs)						
Scheduled	441	42%	10%	6%	10%	31%
Called	441	31%	12%	8%	15%	34%
Medium Call (>2-5 hrs)						
Scheduled	416	28%	13%	11%	15%	32%
Called	416	18%	15%	12%	18%	37%
Long Call (>5 hrs)						
Scheduled	411	29%	16%	11%	14%	30%
Called	411	21%	16%	13%	15%	34%

hour and five hour call out, and more than five hour call out. The subjects (*N*=502) reported a typical month to be 14.1 duty days with the fewest being 9.6 duty days and the most being 18.7 duty days on average. Pilots (*N*=500) reported flying 38.5 hours in a typical month with as few as 20.1 hours and as many as 56.6 hours on average. A typical duty day consisted of 3.0 sorties (*N*=492) falling in a mean range of 1.4 to 7.1 sorties per day. Subjects reported flying a mean of 10.3 days per month with less than 8 hours of flight time (*N*=429), 5.5 days per month with 8 to 12 hours of flight time (*N*=363) and 4.2 days per month with more than 12 hours of flight time (*N*=201). Average daily layover durations were 5.0 hours (*N*=491) ranging from 3.3 to 12.5 hours of layover time between flights. A typical duty day averaged 10.5 hours (*N*=493) with mean durations of 6.2 hours to 15.1 hours. The mean number of times pilots reported during six, four hour windows as compared to Rosekind (2000) can be found in Figure 7. The respondents reported their

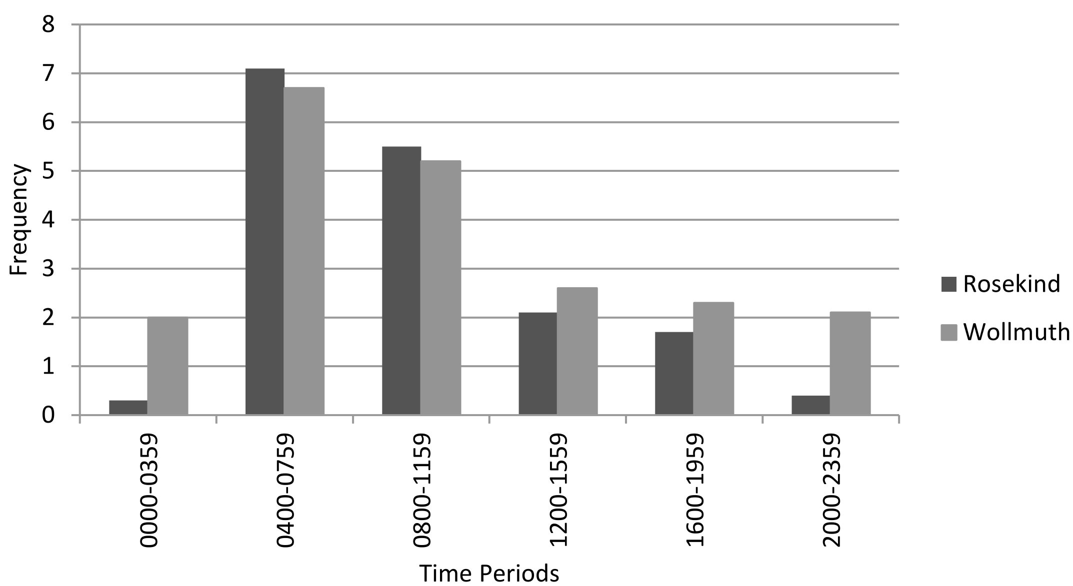

Figure 7: *Average number of report times per month during each of the four hour windows.*

longest duty day ever in business aviation was an average of 17.6 hours (*N*=469), with the least being 8.7 hours and the most being 36 hours. Pilots reported typically flying 14.9 days domestically per month and 3.9 days internationally per month. The subjects (*N*=447) averaged flying 30.9 hours domestically and 11.4 hours internationally. These hours were spread across 22.1 segments per month domestically and 4.0 segments per month internationally. The number of duty days with flights crossing time zones divided into three categories and compared to Rosekind (2000) can be found in Figure 8. Most pilots (89 percent) reported staying in hotels 10.8 nights per month. The respondents

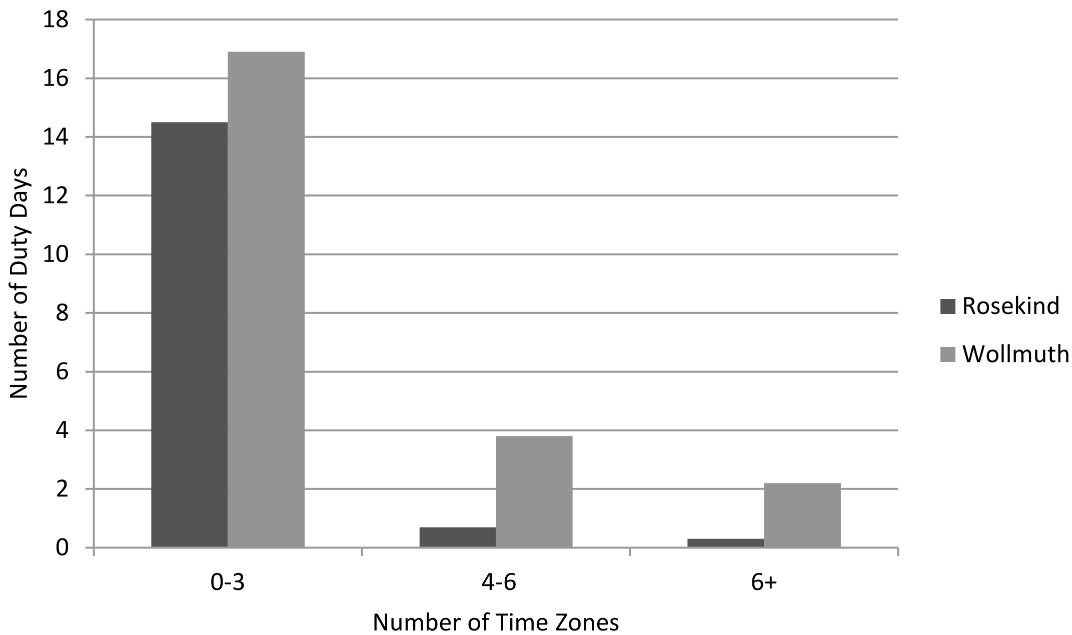

Figure 8: *Average number of duty days crossing time zones by category per month.*

reported using other accommodations such as family friends, private accommodations or the aircraft 2.3 times per month. Additionally, 24 percent of subjects reported utilizing hotel day rooms 1.8 stays per month and 29 percent reported using a sleep room or pilot lounge at a fixed base operator 5.3 times per month.

Most of the respondents (83 percent) stated their company had a scheduling and/or dispatch department. Almost all respondents (93 percent) reported having duty day limits, flight time limits and minimum rest requirements. Those basic duty day limits are 93 percent compliant with the BA Guidelines of 14 hours maximum (N=462). Subjects reported flight time limits were 89 percent compliant with BA Guidelines of 10 hours maximum. Reported rest minimums were 97 percent compliant with BA Guidelines of 10 hours rest minimum per 24 hour period. A much smaller group (*N*=170) provided WOCL operation limits which were reported as 49 percent compliant with FSF recommendations for duty day limits, 83 percent compliant for flight time limits and 47 percent compliant with rest recommendations. Another small group (*N*=118) reported on augmented crew operations as 82 percent compliant with FSF recommendations for duty day limits, 87 percent compliant for flight time limits and 77 percent compliant with rest recommendations.

Almost two thirds (65 percent) reported a maximum number of consecutive days which averaged 8.6 days per month. Fifty-nine percent of the group reported that their companies augment some portion of the crew on international flights, with 89 percent of companies augmenting the captain and/or the first officer. Similarly, 58 percent of the subjects reported their companies pre-position crews for long duty days with 100 percent of companies pre-positioning the captain and/or the first officer. In both cases this did not preclude additional crewmembers from being augmented or pre-positioned. The group was asked to describe their augmentation and pre-positioning policies. More than half (61 percent, *N*=89) stated that augmenting and pre-positioning crews was accomplished based upon fatigue duty or flight time limitations exceedances or early departures in the WOCL, or software fatigue algorithmic analysis. Most cited pilot positions as being augmented and only two entries included flight attendant or flight technicians in the augmentation or pre-positioning plans.

A small group of subjects (*N*=32) reported that they participate in single pilot operations (SPO). Of that group, almost half (47 percent) reported that 75 percent or more of all their operations are SPO. Additionally, 31 percent of the respondents reported having a passenger in the empty pilot seat, but only 25 percent of the time or less. This group also reported that 28 percent have nodded off at some time during single pilot operations, 44 percent have questioned the ability to safely to continue a flight and 56 percent have not flown because they were too tired during SPO. The top three techniques cited to combat fatigue for SPO were cool air, naps, and caffeine.

Sleep

Respondents reported the following information based upon an average night of rest at least two days following completion of duty. The subjects (*N*=462) reported an average of 5.4 days at home between trips. They reported going to bed on average at 2233 and waking at 0706 for an average of 7.6 hours of sleep per night. Respondents reported falling to sleep in an average of 20.7 minutes after going to bed. The group reported waking up an average of 1.25 times per night with 84 percent of respondents reporting waking up one or more times per night. The top reasons for waking up included to use the bathroom (58 percent), due to children or spouse (10 percent), insomnia (5 percent), due to noise (10 percent), due to the comfort of sleeping location (6 percent), temperature being too hot or cold (6 percent) and other (7 percent). After waking, the subjects reported an average of 14 minutes to go back to sleep. Fifty-one percent of the group reported “rarely” having sleep problems, 14 percent reported “never” having sleep problems, 26 percent reported “sometimes” having sleep problems, 8 percent reported “often” having sleep problems and 2 percent reported “very often” having sleep problems.

Over half of the group of respondents reported that they "rarely" nap (36 percent) or "never" nap (19 percent), while 25 percent "sometimes" nap, 17 percent "often" nap and 3 percent nap "very often." Mean nap durations were 48.6 minutes (*N*=432). Medication usage rates and perceived effectiveness are shown in Figure 9. The most

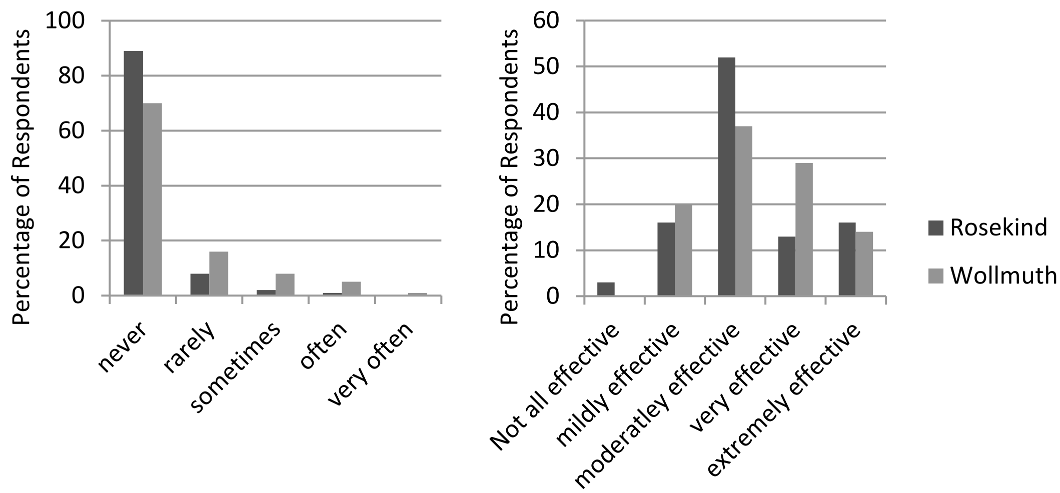

Figure 9: *Responses to the questions:*
How often do you take over-the-counter or prescription medication, or a supplement to help you sleep?
Rate the effectiveness of the medications.

commonly listed types of medications included nutritional supplements like melatonin (46 percent) and over-the-counter sleep aids (32 percent). Similarly, alcohol usage rates and comparisons can be seen in Figure 10. Rosekind (2000) did not report perceived efficacy of alcohol. Average alcohol use as a sleep aide was 1.7 drinks (*N*=80) with 58 percent using a dosage of 2 or more drinks and 23 percent using 3 or more drinks to aid in sleeping.

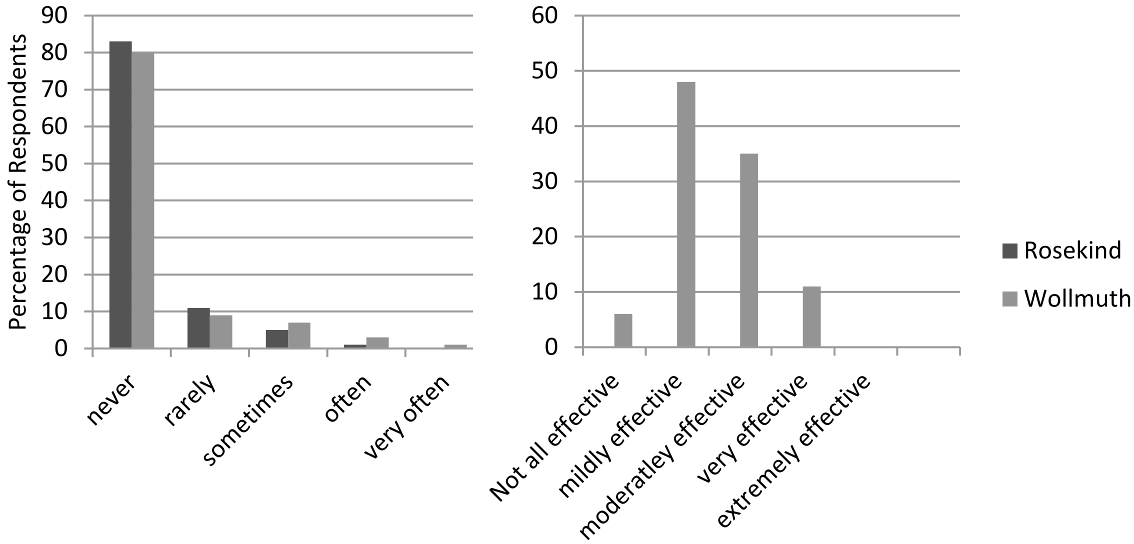

Figure 10: *Responses to the questions:*
How often do you use alcohol to help you sleep?
Rate the effectiveness of alcohol in helping you sleep.

Sixty-one percent of all respondents reported snoring and 83 percent reported not having a sleep problem, while 17 percent reported they have or may have a sleep problem. Of those reporting a sleep problem (*N*=78), 17 percent have been diagnosed by a physician and 17 percent of respondents reported their sleep problem had prevented them from flying. Overall, respondents (*N*=462) describe themselves as "very good" sleepers (19 percent) or "good" sleepers (49 percent), while 26 percent were "fair" sleepers, 5 percent were "poor" sleepers and 1 percent considered themselves to be "very poor" sleepers.

The group (*N*=434) was asked to select from a list of 21 items those top five items which most promote sleep and those top five which most inhibit sleep while at home. The most often identified item promoting sleep was "dark" selected in the top five choices by 85 percent of respondents, "readiness for sleep" was the second most selected (70 percent), "sleep surface" was third most selected (67 percent), "sheets/blankets/ pillows" was fourth most selected (62 percent) and "cold" (56 percent) was fifth most selected factor to promote sleep. The top five factors which most interfered with sleep were, “thoughts running through head” (85 percent), “heat” (64 percent), “light” and “random noises” each at 62 percent and “bathroom” at 47 percent for the group. The same question was asked of the subjects concerning the top five factors which promote and interfere with sleep while on trips. The results for promoting sleep were: “dark” (89 percent), “readiness for sleep” (70 percent), “sleep surface” (65 percent), “cold” (59 percent) and “sheets/blankets/pillows” (56 percent). The results for interfering with sleep were: “random noises” (79 percent), “thoughts running through head” (71 percent), “light” (58 percent), “heat” (55 percent) and bathroom (36 percent).

Fatigue

Almost all pilots (91 percent, N=460) opined that fatigue is a “moderate” or “serious” concern in business aviation operations (Figure 11) and 96 percent of the group

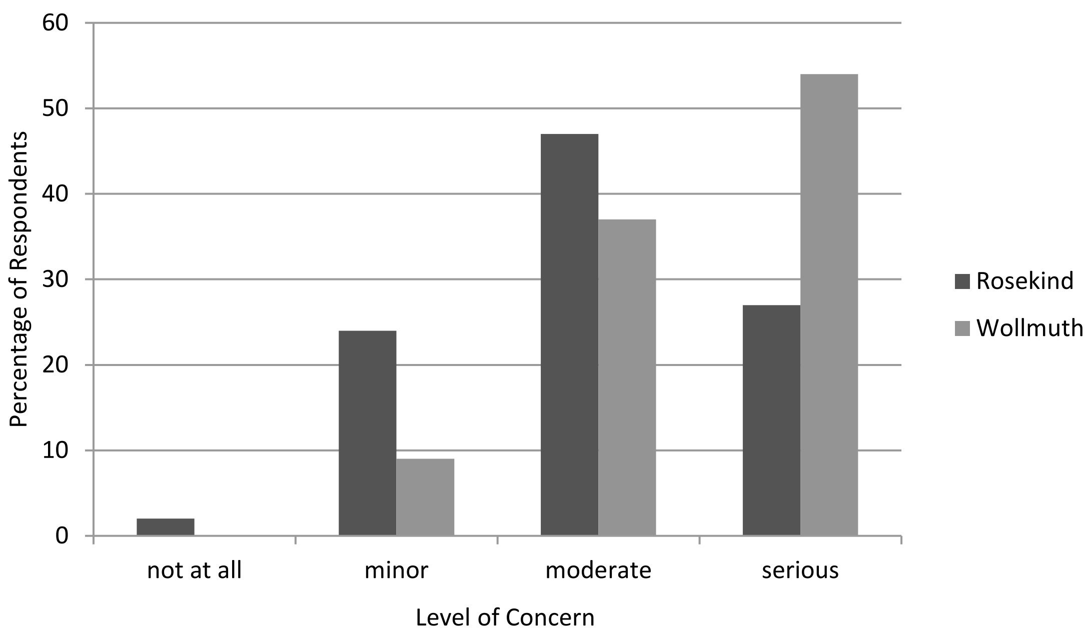

Figure 11: *Responses to the question: In your opinion, to what extent is fatigue a concern in business aviation?*

stated fatigue was a "moderate" or "serious" issue when it occurred in BA (Figure 12). Of the group (*N*=461), 66 percent admitted to having unintentionally "nodded off" during

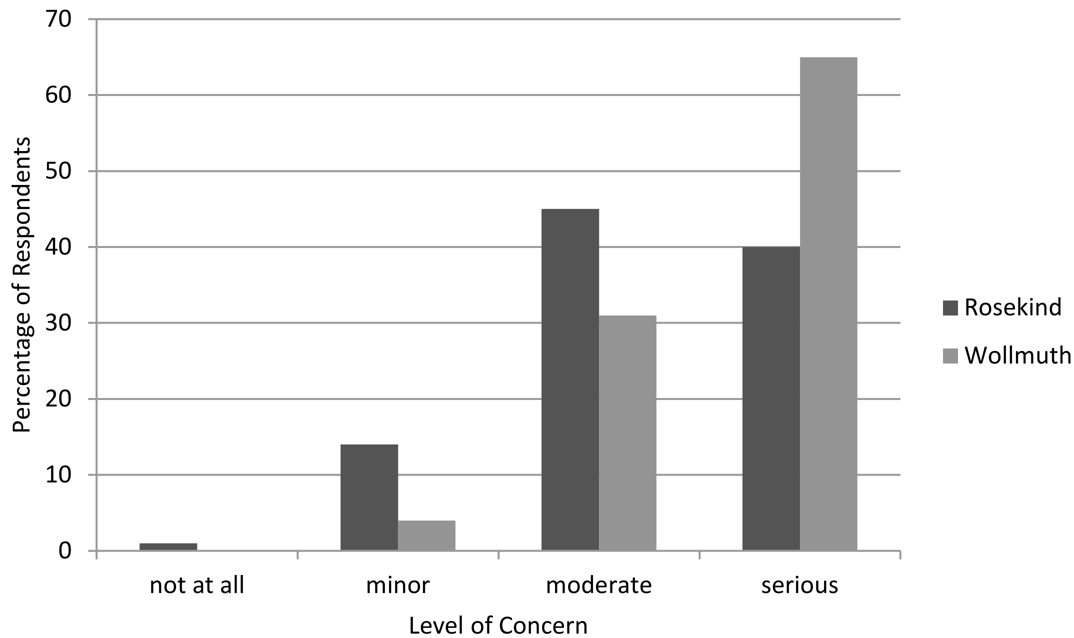

Figure 12: *Responses to the question: When crew fatigue occurs, how significant an issue is it?*

flights with this occurring on 3.3 percent of the flights in a month. When asked to identify how fatigue affects performance, pilots (*N*=460) selected "alertness" (62 percent) or "tiredness" (29 percent), "errors" (43 percent) and "concentration" (41 percent) as the top impacts.

Another series of three questions had the subjects pick from a list of 18 items the top three fatigue mitigation techniques, pre-trip, during the trip and post-trip. The most frequently reported strategies pre-trip were caffeine (45 percent), napping (43 percent), exercise (34 percent), diet (31 percent) and shower (29 percent). The most frequently reported strategies during trips were caffeine (56 percent), movement/stretching (56 percent), and conversation (32 percent). The most frequently reported strategies post-trip were napping (54 percent), exercise (42 percent), diet (35 percent), shower (31 percent) and fresh air (21 percent). Of the subjects, 29 percent (*N*=463) have used Controlled Rest in Flight (CRIF) on an average of 9 percent of the flights in a typical month with the low being 1 percent and the highest being 95 percent of the flights in a typical month. Four hundred forty-six pilots picked the top five from a list of nineteen suggested methods of reducing fatigue in BA operations. They selected flight time/duty limits (85 percent), improve scheduling (83 percent), improve rest time (80 percent), shorter duty days (71 percent) and educate management and passengers about fatigue (69 percent). Respondents reported that fatigue had prevented 59 percent of the group from flying a trip on at least one occasion. Slightly more than half (52 percent) of respondents had received formal fatigue mitigation training (*N*=463) by one or more methods. The most often described training methods included on-line training (82 percent) and instructor led courses (43 percent), while 33 percent of the subjects had been self-taught.

Management

Pilots who held both management and flying responsibilities were asked to complete this section. On average, the subjects reported an even split of management and flying duties (50 percent, *N*=146). A large majority, 86 percent performed management duties on flying days. On a typical day of flying, 26 percent of the day was designated as management time. The duration of an average management duty day for management only duties was typically 7.6 hours, the least being 3.6 and the most 14.0 hours. On a duty day that included both management and flying, the duration was typically 10.6 hours, the shortest being 5.9 hours and the longest 16.0 hours. When asked about specific duties, the group (*N*=146) most frequently identified chief pilot (62 percent), department manager/director (54 percent), supervisor (50 percent), and operations manager (46 percent). These individuals were asked to rank order scheduling priorities in making scheduling decisions. The highest ranked response was duty time at 88 percent (*N*=103), availability of equipment was second at 67 percent, takeoff times/early mornings/late nights was third at 64 percent, followed by layover rest time (62 percent), number of legs flown (57 percent), maximizing efficiency (50 percent), WOCL ops (43 percent) and time zones crossed (36 percent).

Work Environment

This section asked four department and flight operations specific questions with those results reported in the demographics section, and two questions on safety emphasis within BA flight operations. Of the group (*N*=448), 91 percent selected standard operating procedures as their number one emphasis area. Crew resource management was selected second most often at 86 percent. Safety reporting was selected by 70 percent of respondents, communication by 64 percent of respondents, and passenger safety by 60 percent of respondents. Thereafter, the subjects listed duty and rest (58 percent), maintenance (55 percent), regulations (54 percent), weather (53 percent), flight planning (52 percent) and controlled flight into terrain (CFIT) (51 percent). The group frequently identified the following methods of emphasizing safety through these priorities within their operations:

1. Training (79 percent)
2. Written policies (72 percent)
3. Standardization and line checks (58 percent)
4. Duty and rest policies (56 percent)

5. A positive culture (48 percent)
6. An SMS (47 percent)
7. Aviation Safety Action Program (ASAP) (44 percent).
8. Flight Operations Quality Assurance (FOQA) (26 percent)
9. International Standards for Business Aircraft Operations (ISBAO) (27 percent)
10. Safety audits (28 percent)

Finally, participants were asked if they recalled completing the Rosekind survey published in 2000. Only a total of 22 respondents reported having completed the survey. Although, a small group, only two of these respondents thought fatigue awareness had increased below average or far below average, while 14 of the remaining 20 subjects (64 percent) thought fatigue awareness had increased moderately to far above average.

Comparative Analysis

Fatigue responses to five fatigue based questions were evaluated en masse and independently. Questions were all ordinal in intent although three of the questions allowed for binary only (yes, no) responses to target specific indicators of fatigue. Two of the questions utilized a four point Likert scale to further assess fatigue based upon respondents' perceptions:

1. In your opinion, to what extent is fatigue a concern in business aviation operations? 0 - Not at all, 1-Minor, 2-Moderate, 3-Serious
2. When fatigue occurs, how significant a safety issue is it? 0 - Not at all, 1-Minor, 2-Moderate, 3-Serious
3. Has your sleep problem ever prevented you from flying a trip? 0 - No, 1 - Yes

4. Have you ever nodded off while flying? 0 - No, 1 - Yes
5. Has fatigue ever prevented you from flying a trip? 0 - No, 1 - Yes

A total fatigue score was generated for each respondent. IBM's SPSS Version 24 was used for all statistical computations. Outliers were determined using Tukey's method. Both the Kolmogorov-Smirnov and the Shapiro-Wilk tests for normality indicated the total fatigue score and the responses for questions 1 and 2 above were not from a normally distributed population group ($p < .001$). Additionally, histogram skew and kurtosis indicated the CO were very different from the NCO groups and not normally distributed (Table 6). Furthermore, the Likert response range of only four choices did not provide for robust mean analysis through *t*-tests, thus the Mann-Whitney *U* rank tests, which test for median differences, were the preferred statistical measures (Field, 2013, Gravetter & Wallnau, 2008) in this thesis.

Independent samples Mann-Whitney *U* tests were conducted to compare each sub-category of Duty Period, Flight Time Limit and Required Rest within three categories of Basic operations, operations in the WOCL and Extended operations for a total of nine analyses. Significant statistical results were found in five of the nine possible nonparametric independent samples Mann-Whitney *U* tests. Three results in the Basic category indicated that COs have greater mean rank of the total fatigue score than NCOs. These results, based on subjects' responses to fatigue perception based questions, indicated those pilots who operated in compliance with the Basic BA Guidelines perceived fatigue to be greater than those who were non-compliant in their operations. Two additional results in the Required Rest subcategory for the categories of WOCL and

Extended operations were statistically significant with the mean rank of total fatigue scores being significantly higher in the NCO population group than in the CO group

Table 6. *CO and NCO descriptive statistics*

	N	*Range*	*M(SD)*	*Median*	*Skew*	*Kurtosis*
Basic						
Duty Period						
CO	406	2-9	6.29(1.495)	7	-0.589	-.332
NCO	56	2-8	5.53(1.399)	6	-.437	-.454
Flight Time Limit						
CO	372	2-9	6.34(1.463)	7	-.542	-.477
NCO	79	2-8	5.54(1.560)	6	-.452	-420
Required Rest						
CO	403	2-9	6.28(1.480)	7	-.550	-.400
NCO	48	2-8	5.43(1.514)	6	-.420	-.497
WOCL						
Duty Period						
CO	99	2-9	6.00(1.565)	6	-.375	-.598
NCO	202	2-9	6.21(1.545)	6	-.574	-.415
Flight Time Limit						
CO	142	2-9	6.12(1.427)	6	-.377	-.554
NCO	155	2-9	6.21(1.644)	6	-.632	-.416
Required Rest						
CO	73	2-8	5.51(1.529)	5	-.025	-.752
NCO	212	2-9	6.34(1.526)	7	-.680	-.147
Extended						
Duty Period						
CO	95	2-8	5.71(1.465)	6	-.343	-.235
NCO	114	2-9	5.96(1.637)	6	-.384	-.754
Flight Time Limit						
CO	95	2-8	5.68(1.416)	6	-.132	-.446
NCO	112	2-9	5.99(1.652)	6	-.535	-.518
Required Rest						
CO	86	2-8	5.59(1.466)	6	-.176	-.525
NCO	125	2-9	6.06(1.581)	6	-.547	-.359

(Table 7) in both cases with small to medium effect in all analyses, r < .23. Thus NCOs indicated significantly higher fatigue scores in the WOCL and Extended operations as compared to COs of the BA Guidelines.

Table 7. *Mann-Whitney U rank tests*

	Mean Rank		*U*	*Z*	*p*	*r*
	CO	NCO				
Basic						
Duty Period	240.047	169.57	7900.000	-3.781	< .001	.16
Flight Time Limitations	237.53	171.72	10406.00	-4.161	< .001	.19
Required Rest Time	233.68	161.51	65676.50	-3.703	< .001	.18
WOCL						
Duty Period	144.41	155.68	9347.00	-1.070	0.285	ns
Flight Time Limitations	145.17	154.42	10464.00	-0.942	0.346	ns
Required Rest Time	110.87	154.06	5392.00	-3.935	< .001	.23
Extended						
Duty Period	100.22	109.87	4960.50	-1.166	0.244	ns
Flight Time Limitations	97.23	110.61	4677.00	-1.625	0.104	ns
Required Rest Time	94.81	113.70	4413.00	-2.247	0.025	.15

While not the preferred method of statistical analysis for this study, two-tailed independent samples *t*-tests assuming unequal variances (Table 8) were conducted to further substantiate the nonparametric independent samples tests. Again, the results were statistically significant in the same cases and in the same directions except for in the subcategory Required Rest of Extended operations. However, even these results approached significance with the mean total fatigue score (*M*=6.02, *SD*= 1.666) of the NCOs exceeding the mean total fatigue score (*M*=5.59, *SD*= 1.466) of the COs (p=.053).

Finally, Types of Operations (Table 9), based upon FAR overarching constructs as reported by respondents, were compared using independent sample Mann-Whitney *U*

Table 8. *Two-tail, independent sample t-test means of fatigue between COs and NCOs*

	M	*SD*	*n*	*95 percent CI for mean difference*	*t*	*df*	*p*
Basic							
Duty Period							
CO	6.26	1.555	406	.384, 1.276	3.711	70.707	< .001
NCO	5.43	1.571	56				
Flight Time Limitations							
CO	6.31	1.531	372	.436, 1.245	4.121	107.582	< .001
NCO	5.47	1.671	79				
Required Rest Time							
CO	6.25	1.541	403	.421, 1.445	3.648	56.700	.001
NCO	5.31	1.690	48				
WOCL							
Required Rest Time							
CO	5.51	1.529	73	-1.214, -.386	-3.820	129.026	< .001
NCO	6.31	1.583	212				
Extended							
Required Rest Time							
CO	5.59	1.466	86	-.851, .005	-1.947	196.657	.053
NCO	6.02	1.666	125				

Table 9. *Operational Types descriptive statistics.*

	N	*Range*	*M(SD)*	*Median*	*Skew*	*Kurtosis*
Type of Operations						
Part 91	174	2-8	5.24(1.298)	5	-.255	-.358
Parts 91,135	37	2-8	5.41(1.554)	5	-.025	-.568
Part 135	11	5-8	6.55(1.293)	7	-.291	-1.780
Part 91(k)	230	3-9	7.07(1.019)	7	-.999	1.411

tests and were substantiated by two-tailed unpaired samples *t*-tests. Respondents multiple selections to the question: "Under which of the following Federal Aviation Regulations do you operate with your current company and flight operation? (check all that apply, do not include contract flying)" led to six major permutations of FAR Parts 91, 91(k) and 135. If Part 91(k) was selected by respondents, they were categorized as Part 91(k) even if they selected other Types of Operations such as Part 135 or Part 91. Four of the six permutations:

1. Part 91 - Part 135
2. Part 91 - Part 91(k)
3. Part 91, 135 - Part 135
4. Part 91, 135 - Part 91(k)

produced statistically significant results with medium to large effect ($.22 \leq r \leq .62$) based upon the Mann-Whitney *U* tests of mean rank of the total fatigue scores (Table 10) and substantiated by the means of the total fatigue score analyzed with independent sample, two-tailed *t*-tests (Table 11).

Table 10. *Mann-Whitney U tests of mean total fatigue scores by Types of Operation.*

Type of Operations A	Type of Operations B	*Mean Rank* A	*Mean Rank* B	*U*	*Z*	*P*	*R*
Part 91	Parts 91,135	105.71	110.22	3100.00	-.414	ns	ns
Part 91	Part 135	90.57	140.05	450.50	-3.020	.003	.22
Part 91	Part 91(k)	121.46	266.26	5855.00	-12.557	< .001	.62
Parts 91,135	Part 135	22.08	32.64	114.00	-2.241	.025	.32
Parts 91,135	Part 91(k)	65.97	146.01	1738.00	-6.053	< .001	.37
Part 135	Part 91(k)	97.95	123.14	1011.50	-1.223	ns	ns

Table 11. *Two-tail, independent sample t-test means between Types of Operation*

	M	*SD*	*n*	*95% CI for mean difference*	*t*	*Df*	*p*
Type of Operations							
Part 91	5.24	1.298	174	-.720, .381	-.620	47.255	ns
Parts 91, 135	5.41	1.554	37				
Part 91	5.24	1.298	174	-2.192, -.428	-3.257	11.311	.007
Part 135	6.55	1.293	11				
Part 91	5.24	1.298	174	-2.073, -1.604	-15.431	319.498	< .001
Parts 91(k)	7.07	1.019	230				
Parts 91, 135	5.41	1.554	37	-2.114, -.166	-2.446	19.430	.024
Part 135	6.55	1.293	11				
Parts 91, 135	5.41	1.554	37	-2.202, -1.135	-6.317	41.122	< .001
Part 91(k)	7.07	1.019	230				
Part 135	6.55	1.293	11	-1.403, .346	-1.335	10.602	ns
Parts 91(k)	7.07	1.019	230				

SECTION IV

DISCUSSION

The overall useable response rate was low at 1329 partial or complete survey responses from an estimated available pool of approximately 11000 NBAA member companies with several employees per company. The response rate was low for a few reasons. Primarily, the survey was targeted at specific NBAA members who had defined "relationships" based upon previous interaction with NBAA beyond basic membership correspondence. This NBAA policy was to avoid wholesale broadcasting of surveys to all members, and their respective companies, who would not have the desire for a fatigue survey developed for line operations. Secondly, this survey was very extensive. Considering that the majority of people have limited endurance of just a few minutes for surveys (Porter, Whitcomb, & Weitzer, 2004), this survey had a median time to completion of 42 minutes and required concerted effort on the participants' parts to provide relevant data. People are becoming annoyed by frequent requests to fill out surveys in every facet of their lives (Oliver, 1997), especially a difficult 42 minute survey. Finally, analysis showed that administering multiple surveys in one academic year can significantly suppress response rates in later surveys (Porter et al., 2004) and NBAA has surveys in progress on an on-going basis.

All survey based studies have limitations due to the subjective nature of the data and the accuracy of subject input. Responses depend on "subjects' perception, memory, and understanding of the questions" (Rosekind et al, 2002). The survey format, although electronic, was limited in scope as the primary means of communication was through NBAA channels. This data may not be reflective of non-NBAA member companies who were allowed to take the survey, but likely had limited exposure to the survey link. A likely example of this is seen in the low response rate from cabin crewmembers who typically are not NBAA members as they are often independent contractors. Finally, drawing conclusion from survey data on human recollections and perceptions can be risky, especially without the underlying data from both surveys for statistical comparison, and all results from a study of this nature must be carefully considered.

Comparing the Rosekind (2000) survey from a broadly qualitative level with this second survey, however, does strengthen the overall results as many of the responses to the factual based questions are similar. Responses to aircraft ratings, going to bed time, time to fall asleep, waking time, length of sleep, time to fall back to sleep when awoken, division of time by management in flying and management duties, as examples, were very similar between the two surveys. Subjects in 2017 reported average sleep times of 7.6 hours of sleep per night and sleep latency of 21 minutes, both numbers very similar to the Rosekind's numbers of 7.2 hours and 22 minutes (2000). As Rosekind (2000) states, subjects presented “normal home sleep profiles” and thus their fatigue perceptions are more likely a reflection of the work environment and less so of latent sleep concerns. Acknowledging the risk of making Type I errors, no significance can be declared between the survey responses, however some ratio differences between the two surveys are noteworthy.

The 2017 survey subjects (mean age = 49.6) were an older group by more than four years than the 2000 survey subjects (mean age = 45.2). Considering a 35 year average work lifespan, these four years equate to approximately a ten percent older group, which is of interest when considering aging effects on sleep (Blatter et al, 2006). Decreased sleep efficiency can lead to increased SD (Co, Gregory, Johnson & Rosekind, 1999) ultimately affecting cognitive performance (Åkerstedt, 2007, Blatter et al, 2006). The data also indicate the subjects' self-assessment of their sleep quality fell from 89 percent in 2000 being "very good" or "good" sleepers to 68 percent in 2017. Medication and alcohol habits appear to have increased both in frequency and rated effectiveness as sleep aides (Figures 7 and 8). The decrease in response rates of 89 percent "never" using medication to aid in sleeping down to 70 percent in 2017 would certainly be worth future inquiry. Likewise, although on a lesser scale, alcohol use has increased by approximately four percent across the spectrum of respondents. This result may well have been within statistical error rates, but any reliance on medication or alcohol can have deleterious effects (Verster et al., 2011), of which self-medication was relevant to the findings in the Owatonna, MN accident in 2008 (US NTSB, 2011).

Also of importance in this data was the increase in airline travel as a method of commuting from one percent to 7.5 percent of subjects in 2017. Traditional shorter commutes verses long commutes have been shown to have a positive effect on quality of life which may play a role in reducing fatigue as well (Kleinfehn, 2016). Moreover, commuting increases the risk of SD and long commutes increase the opportunity for fatigue, as in Colgan Air 3407 (US NTSB, 2010). Following the Colgan Air 3407 accident, the NTSB (2010) recommended the FAA "require all 14 Code of Federal Regulations Part 121, 135, and 91K operators to address fatigue risks associated with commuting, including identifying pilots who commute, establishing policy and guidance to mitigate fatigue risks for commuting pilots, using scheduling practices to minimize opportunities for fatigue in commuting pilots, and developing or identifying rest facilities for commuting pilots." A larger variance was noted in the mean commute times having increased from 33 minutes (Rosekind et al, 2000) to 64 minutes in 2017. The U.S. Census Bureau (Brown and Whitehurst, 2011) defined an extreme commute as 90 minutes, which nearly fifteen percent of respondents (14.6 percent) reported in the 2017 survey. Additionally, slightly more than half (50.2 percent) of respondents in 2017 reported commute times exceeding the 2000 mean commute time of 33 minutes indicating commuting induced fatigue may be a concern in BA.

A primary concern of the study was to compare and evaluate the 2014 FSF and NBAA Duty and Rest Guidelines as a benchmark tool for mitigating fatigue. Significant results between BA Guidelines compliant operators and non-compliant operators were found in the Basic Duty category for all three subcategories. Interestingly the mean fatigue scores of the COs of the Basic Duty guidelines seem to refute the hypothesis that the BA Guidelines would mitigate fatigue. The apparent inverse response rate to expected results in the statistical significance of the mean fatigue score may be in part due to the great variance in response rates for COs and NCOs in the Part 91(k) operation type (Figure 13). The Part 91(k) responses made up 49 percent (N=230) of the overall subjects (N=462) and this group was more leptokurtic and negatively skewed which may have affected the overall fatigue scores between COs and NCOs. Also, Part 91(k) reported nearly complete compliance with the BA Guidelines (Table 1) for duty (99 percent CO), flight (94 percent CO) and rest (97 percent CO), yet Part 91(k) reported significantly higher fatigue scores (M=7.07, SD=1.019) as a group than Part 91 mean fatigue scores (M=5.24, SD=1.298), $t(319.498) = -15.431$, $p<.001$. Additionally, all but one of the Part 91(k) operations was heterogeneous in that they also operate under Part 91, 135 and

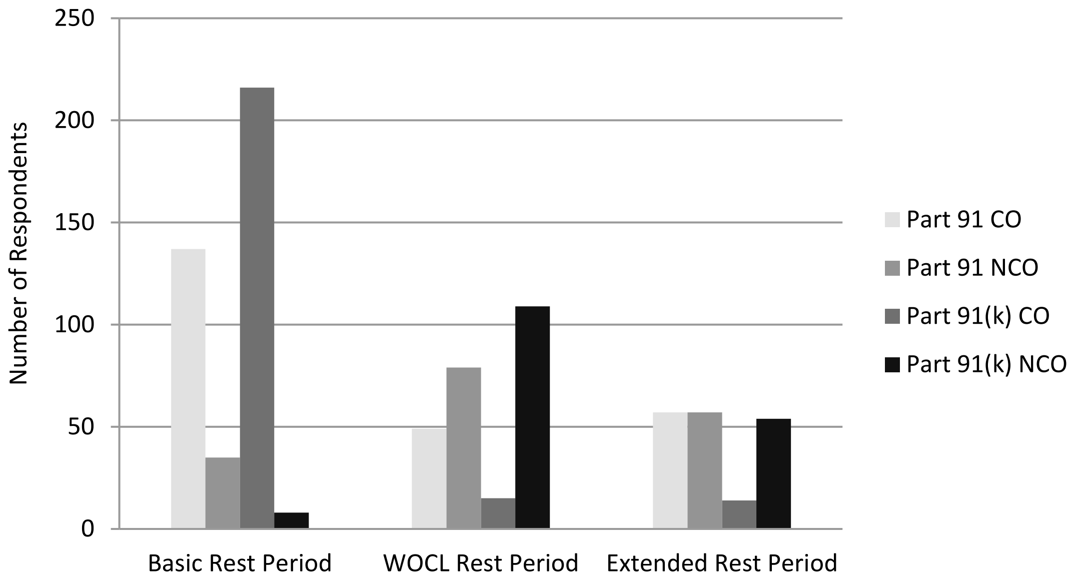

Figure 13: *Number of respondents by operator type and BA Guideline compliance.*

sometimes Part 121. An additional confounding variable may be the absence of statistical significance between Part 91 and 91(k) COs' and NCOs' mean fatigue scores. In contrast the results for WOCL and extended duty day operations, typically as many as 18 hours long, validate the BA Guidelines with COs reporting lower mean fatigue rank scores than NCOs. These results met expected results. It is worth noting that supine bunk accommodations are typically not available for extended operations as few aircraft offer a truly private supine bunk that meets Part 117 standards.

This survey appeared to reflect cultural changes in operations in the BA aviation community since 2000. When comparing the average times per month that a subject reported for work between the hours of 2000 and 2359 and again from 0000 to 0359 (Figure 6), the number of occurrences in these windows were up by five times and more than six times respectively. At the same time the early morning and mid-morning reports had decreased slightly, overall flattening pilot's duty and rest rhythms on a more frequent basis, thus disrupting the homeostasis cycle with shortened rest (Åkerstedt, 2007; Rosekind et al 1994; Graw et al., 2004; Moldanodo, Bentley & Mitchell, 2004) and diurnal cycle (biological anchor) similar to the impacts of shift work (Co et al, 1999; Boivin et al, 2007; ICAO, 2012). Furthermore, international operations had increased from 1.0 international segment per month to 4.0 segments per month. Similarly, crew augmentation was up from 40 percent to 59 percent and pre-positioning of crewmembers had risen from 35 percent to 58 percent.

An additional fundamental question was to examine strategies in mitigating fatigue in BA operations. With 66 percent of respondents admitting to having "nodded off" and 28 percent of SPO pilots (*N*=32) admitted to "nodding off", fatigue mitigation and education in BA operations continues to remain highly relevant. From 2000 to 2017, there was a large increase in those subjects who stated fatigue had prevented them from flying a trip (Figure 14).

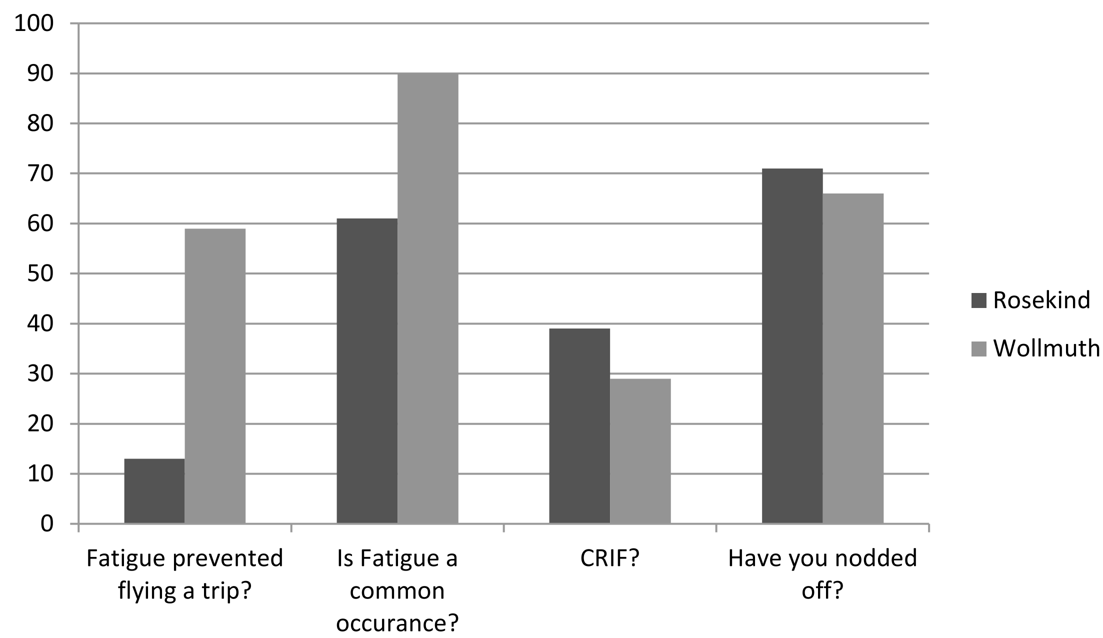

Figure 14: *Fatigue questions with response rates.*

A series of questions examined fatigue mitigation techniques for pre-trip, during the trip, and post-trip time periods. Respondents chose three from a list of 18 common fatigue mitigation techniques or could add their own to the list in each phase of the trip (Figure 15). While the raw percentages varied from Rosekind (2000) to this survey, overall the same basic techniques and recommendations applied:

1. Operate wisely within experiential and legal requirements.
2. Get plenty of rest.
3. Maintain a healthy lifestyle and diet.
4. Use caffeine wisely at timely points during the fatigue mitigation period.

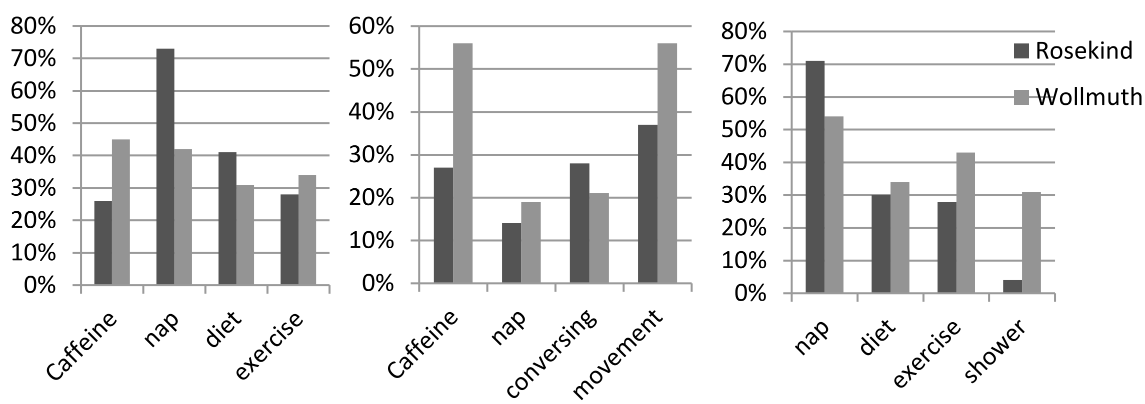

Figure 15: *Fatigue mitigation for pre-trip, during the trip and post trip (left to right).*

Another goal of this thesis was to establish a new baseline for fatigue management in Business Aviation. Respondents continued to rate fatigue as a “moderate” (54 percent) or “serious” (37 percent) concern (Figure 9), up from 2000 when 74 percent of respondents rated fatigue a “moderate” or “serious” concern. Pilots’ concerns over fatigue have increased since 2000. There are several possible causes for this trend.

First, aircraft have become more reliable and capable, which can easily exceed the limits of human physiology without adequate rest facilities. Unlike commercial air carriers, which augment or double crews on trips and have the real estate in their aircraft to accommodate separate supine bunked sleeping quarters for several crew members, BA aircraft, while much larger today than twenty years ago, in most cases are not afforded supine bunks and rarely multiple supine bunks.

Secondly, Part 91(k) operations have become a large portion of the total Part 91 population. FAR 91.1057, 1059 and 1061 do not provide any additional relief or operator guidance for operations in the WOCL. For operations in the WOCL, based on survey responses, fractional operators are mostly non-compliant on a percentage basis of those 91(k) operators who reported duty and rest rules for the WOCL. Results of this study raise questions about the efficacy of Part 91(k) duty and rest policies as reported by respondents.

Additionally, there appears to be a globalization effect of increased international operations, with operators more routinely crossing more time zones and more frequently having report times between 8:00 pm and 4:00 am. This shift work through the window of circadian low more negatively impacts the cognitive capability of the pilots.

Finally, and perhaps most importantly, numerous studies from multiple researchers have validated the effectiveness of napping in improving cognitive ability and alertness in various settings to include controlled rest in flight (Bonnet, 1990, 1991; Dinges, Whitehouse, Orne, & Orne, 1988; Matsumoto & Harada, 1994; Rogers, Spencer, Stone & Nicholson, 1989; Rosekind et al, 1994; Rosekind et al, 2000; Vgontzas, Pejovic, Zoumakis, Lin, Bixler, Basta, et al, 2007). Yet, the number of pilots utilizing CRIF as a counter fatigue measure has decreased by roughly 25 percent from 2000. While the FAA acknowledges that other aviation governing bodies throughout the world allow for un-augmented crews to rest in the seat under controlled parameters (2010), and the FAA concurs with the science supporting CRIF, the FAA still opposes sleep as being a physiological need under FAR 91.105 (MacPherson, 2012). This compliance pressure likely has reduced the use of CRIF (Figure 7) and may have likewise increased the overall increase in perceived fatigue rates.

Regardless of the affectivity of the BA Guidelines, one positive note is that the data in this study indicates that compliance with the basic duty, flight, and rest recommendations of the FSF and NBAA is becoming a cultural norm as 88 percent, 83 percent and 90 percent of all operators respectively comply with these recommendations. Over time perhaps the other NBAA Guidelines will be more widely accepted then they currently are as only 22 percent, 32 percent and 34 percent of respondents reported compliance with the BA Guidelines in the WOCL duty day, flight time and rest time recommendations. Marginally better, augmented operations are 40 percent, 47 percent and 44 percent compliant for duty, flight and rest, respectively.

Future Research

This study was only able to target specific demographics of BA operators associated either directly or indirectly with the NBAA. Cabin crewmembers typically are not NBAA members and thus would have had less opportunity to complete the survey. Comparative analysis of the 2000 and 2017 data sets would provide statistically significant insight into industry and cultural changes in BA operations. Pair-wise comparisons of identical survey questions in both surveys, focusing on commuting, sleep habits, report times, operation types, and duty and rest rules would provide more specific results on work and rest cycles and their correlation to fatigue. These comparisons may also provide more clarity on the impact of FAR Part 91(k) on fatigue in BA.

Parts 91(k) and 135 could be specifically targeted with fatigue targeted research questions. Part 91(k) especially could be further questioned to better define the Part 91(k) work environment, duty and rest procedures, commuting impacts and the effect of the heterogeneity of their operations. Survey analysis should include multiple fatigue questions only, limiting survey response time to three to five minutes, to specifically address Part 91(k) and Part 135 fatigue levels. One limitation of both surveys was the four point Likert scales used for fatigue questions. Future questions should provide broader response options with a minimum of a ten point scale, ideally with a minimum of five questions to create a more robust and meaningful total fatigue score, which could be analyzed better using parametric measures.

Another question from this research concerned the increase of augmenting crew members and pre-positioning crew members. Geopolitical strife, business shifts and aircraft capabilities make augmenting and pre-positioning more feasible and required. The need for this is evident in the marked increase in international, long haul operations as indicated by a seven fold increase in the average number of flights per month crossing more than six time zones. Likewise, respondents reported crossing four to six time zones more than four times as often as they did in 2000. Future study of operators who routinely augment and pre-position crew members could provide greater insight into the hypothesis that both have increased because of increased long haul and ultra-long haul operations around the world. Augmentation and pre-positioning may also be a result of broader acceptance of the BA Guidelines for extended and WOCL operations, or duty and rest rules self-imposed by operators or through regulation in Parts 91(k) and 135.

Finally, this thesis has only touched on a few areas of statistical analysis from the extensive data collected. As BA operations continue to stretch physiological limits of all personnel involved in operations, fatigue induced errors can come from any area within an organization. From the broader survey results, the NBAA safety committee and its sub-committees could continue to look at specific comparisons between types of operations and all personnel in operations, including maintenance, flight technicians, cabin crew, management and administrative support personnel.

The scientific body of knowledge on SD, cognitive performance and error prevention continues to improve. Currently, technology is being developed for in situ devices with unobtrusive real-time monitoring of fatigue which measure multiple biorhythmic indicators and "learn" the specific nuances of the users' personnel biological variances (The CURA System™, 2016). Until those devices are widely available in the transportation industries, healthy lifestyles, solid rest habits, utilization of proven fatigue mitigation techniques like CRIF and pre and post trip napping, effective operator duty and rest guidelines, and modernization of Part 91 language or interpretation thereof will continue to best mitigate the negative effects of fatigue in Business Aviation.

APPENDIX

CONSENT FORM

Hold handheld devices horizontally for the best experience

Business Aviation (BA) operations have extensively changed since 2000. In 2000, there were less than 100 Ultra Long Range (ULR) aircraft in use as compared to well over 1500 today, the Very Light Jet (VLJ) market, also known as personal jets, matured into a market segment with more than 1000 aircraft in operation today, and the events of 9-11 have increased requirements for operators in the entire aviation industry.

Purpose of the Study:
The purpose of this research is to update current duty, rest and fatigue data in business aviation operations. Fatigue survey data has not been collected on business aviation operations for more than 17 years. In 2000, Dr. Mark Rosekind (the current administrator of the National Highway and Transportation Safety Administration (NHTSA)) in collaboration with the NBAA, the Flight Safety Foundation and the National Aeronautics and Space Administration (NASA) conducted a similar survey study on fatigue in business aviation entitled "Crew Factors in Flight Operations XIII: A Survey of Fatigue Factors in Corporate/Executive Aviation Operations."

NBAA, in collaboration with the John D. Odegaard School of Aerospace at the University of North Dakota, respectfully request your assistance in providing current survey data on fatigue in BA operations.
This survey data will be analyzed for significant findings concerning fatigue within the data collected in this survey and between this survey and the previous survey. Additionally, the survey is more comprehensive in that it includes cabin crew and flying maintenance technicians for the first time in a national fatigue survey.

Informed Consent:
This survey is completely anonymous. In order to ensure your anonymity, do not write your name or company name anywhere during this survey. The data collected in this survey is for research purposes only

Procedures to be followed:
You will be asked a series of questions pertaining to DEMOGRAPHICS, FLYING/DUTY INFORMATION, SLEEP DATA, FATIGUE DATA, and MANAGEMENT (Management personnel only) specific issues.

Risks:
There are no risks in participating in this research beyond those experienced in everyday life. However, the NBAA and UND recognize people can feel survey fatigue. Unfortunately, there is no other current method of collecting this type of data pertaining to fatigue in BA operations. Thus, the research investigator and NBAA respectfully request you answer these questions as accurately and completely as possible.

Benefits:
Your participation is **completely voluntary, anonymous and highly encouraged**. Your

participation will greatly aid the BA industry in understanding alertness and fatigue of all aircrew--pilots, flight technicians and all varieties of cabin crew--during BA operations. There are no direct guaranteed benefits for participants.

Additionally, in appreciation for your participation, after completing the survey you will have the ability to opt-in for a random drawing sponsored by the NBAA and the principal investigator as described in the Compensation section below.

Duration:
The survey will take 15-30 minutes to complete depending on your role, responsibilities and experience in business aviation.

Statement of Confidentiality:
The survey does not ask for any information that would identify to whom the responses belong. Therefore, your responses are recorded anonymously. If this research is published, no information that would identify you will be included since your name is in no way linked to your responses. Any data deemed to be identifiable to a company or individual will be redacted in part or full to protect the identities. All data obtained will be kept confidential and will only be reported in aggregate. The principal researcher and NBAA will not report individual participant's survey results.

The data collected will be stored in a secure database which only UND and the NBAA will retain for a three year period starting upon completion of the survey analysis and reporting. Thereafter, only the NBAA will retain a copy of the survey data.

Analysis from this survey will be published by the NBAA safety committee as soon as possible. All survey responses will be treated confidentially and stored on a secure server. However, given that the surveys can be completed from any computer (e.g., personal, work, school), we are unable to guarantee the security of the computer on which you choose to enter your responses. As a participant in our study, we want you to be aware that certain "key logging" software programs exist that can be used to track or capture data that you enter and/or websites that you visit.

Right to Ask Questions:
The researchers conducting this study are Tim Wollmuth, Certified Aviation Manager (CAM) from the University of North Dakota and Mark Larsen, CAM from the NBAA Safety Committee. If you have immediate questions regarding this research, Tim can be emailed by clicking on his name or by phone at (612) 770- 4112. For specific NBAA related concerns, Mark can be reached via email or by phone at (202) 737-4473. If you later have questions, concerns, or feedback about the research please contact Dr. Warren Jensen at (701) 777-3284.

If you have questions regarding your rights as a research subject, you may contact the University of North Dakota Institutional Review Board via email or at (701) 777-4279. You may also call this number with problems, complaints, or concerns about the research. Please call this number if you cannot reach research staff, or you wish to talk with someone who is an informed individual who is independent of the research team.

The UND IRB is fully accredited by the Association for the Accreditation of Human Research Protection Programs, Inc. (AAHRPP). General information about being a research subject can be found on the Institutional Review Board website “Information for Research Participants” http://und.edu/research/resources/human-subjects/research-participants.cfm

Compensation:
You will not receive direct compensation for your participation. However, upon completion of this survey, you can opt-in to be considered for a NBAA randomly selected prize drawing. 1 winner will receive a $250 Amazon, Best Buy, Target or other gift card of their choice, 2 winners will receive a
complimentary registration to the 2017 National Business Aviation Association Convention and Exhibition (NBAA-BACE) in Las Vegas, 1 winner will receive a complimentary registration to the 2017 National business Aviation Association Flight Attendant/Flight Technician Conference (June 13-15) in Long Beach, CA and 4 winners will receive a hardcover edition of The Wright Brothers, by David McCullough. Winners will be notified by 1 May 2017.

Voluntary Participation:
You do not have to participate in this research. You may refuse to participate or choose to discontinue participation at any time. If you desire to withdraw, please close your Internet browser before clicking on the submit button at the end of the survey.

You do not have to answer any questions you do not want to answer.

You must be 18 years of age older to consent to participate in this research study.

Completion and return of the survey implies that you have read the information in this form and consent to participate in the research.

Please keep this form for your records or future reference.

I have read and understood the above consent form and desire of my own free will to participate in this study.

- ❍ Yes
- ❍ No

Condition: Yes Is Selected. Skip To: 2.1.

1.2 Your have declined to participate in the survey. You will not be given the opportunity to opt-in for the NBAA randomly selected prize drawing upon completion of the survey. Remember, as a token of our appreciation, by completing the survey you would have the opportunity to win a $250 Amazon, Best Buy, Target or other gift card of their choice, a complimentary registration to the 2017 National Business Aviation Association Convention and Exhibition (NBAA-BACE) in Las Vegas, a complimentary registration to the 2017 National Business Aviation Association Flight Attendant/Flight Technician Conference (June 13-15) in Long Beach, CA or a hardcover edition of The Wright Brothers, by David McCullough. Winners will be notified by 1 May 2017. If you chose, you can re-start the survey by selecting "BACK" below, else select "CONTINUE" to exit the survey. Thank you for considering this important NBAA study.

2.1 Hold handheld devices horizontally for the best experience

2.2 SECTION 1: DEMOGRAPHIC INFORMATION
Gender:

- ❍ Male
- ❍ Female
- ❍ I'd rather not identify my gender

2.3 Age:

2.4 Enter the time zone of your work place/hangar:
- ❍ Eastern
- ❍ Central
- ❍ Mountain
- ❍ other
- ❍ Pacific
- ❍ Hawaiian
- ❍ Alaskan

Display Question 2.5:
If Enter the time zone of your work place/hangar: other Is Selected

2.5 Please enter the time zone of your work place/hangar:

2.6 Enter the time zone where you live:
- ❍ Eastern
- ❍ Central
- ❍ Mountain
- ❍ other
- ❍ Pacific
- ❍ Hawaiian
- ❍ Alaskan

Display Question 2.7:
If Enter the time zone where you live: other Is Selected

2.7 Please enter the time zone where you live:

2.8 Please enter your average commute time from your home to your work place/hangar
Hours
Minutes

2.9 Enter your typical mode of transportation from your home to your work place/hangar:
- ❍ Car/Motorcycle
- ❍ Airplane or Helicopter
- ❍ Other

Display Question 2.10:
If Enter your typical mode of transportation from your home to your work place/hangar: Other Is Selected

2.10 Enter your other type of transportation:

2.11 In addition to you primary employer, do you have another job (Guard or Reserve, contract work, personal business, etc.)?

❍ Yes
❍ No

Condition: No Is Selected. Skip To: 2.17

2.12 Please select your additional work in addition to your primary employment.

❑ Personal business
❑ Guard or Reserve
❑ other
❑ Contract Flying
❑ Contract Cabin Crew (Flight Attendant, CSR, etc.)
❑ Contract Maintenance

Display This Question:
If Please select your additional work in addition to your primary employment. other Is Selected

2.13 Enter your other type of additional employment.

2.14 How many hours do you typically spend at your additional employment each month:

2.15 Please select the reason(s) for your additional employment?

❑ Enjoy the work
❑ Want/desire to earn extra income
❑ other
❑ Improve my skills
❑ Job security

Display This Question:
If Please select the reason(s) for your additional employment? other Is Selected

2.16 Please enter your other reason(s) for additional employment.

2.17 Which of these responsibilities most closely matches your primary role/duty position?

- ❍ Captain
- ❍ Copilot/First Officer
- ❍ Maintenance
- ❍ Flight Technician/Flight Mechanic
- ❍ Cabin Crewmember (Flight Attendant, Cabin Service Representative, etc.)
- ❍ Office Administration (scheduling, dispatch, non-flying management, etc.)

Display This Question:

If Which of these responsibilities most closely matches your primary role/duty position? Maintenance Is Selected

2.18 In addition to working in the role of Maintenance, do you also perform Flight Technician/Flight Mechanic duties?

- ❍ Yes
- ❍ No

Display This Question:

If Which of these responsibilities most closely matches your primary role/duty position? Office Administration (scheduling, dispatch, non-flying management, etc.) Is Selected

2.19 In addition to your administrative role, do you also perform Cabin Crewmember duties?

- ❍ Yes
- ❍ No

2.20 Select all ratings/certificates you currently hold?
Airframe and Powerplant

- ❑ Flight Attendant Certificate of Demonstrated Proficiency
- ❑ Ground Instructor
- ❑ Remote Pilot Certificate (UAS)
- ❑ Sport Pilot
- ❑ Private Pilot
- ❑ Instrument Airplane
- ❑ Commercial Single Engine
- ❑ Commercial Multi-Engine
- ❑ ATP Single Engine
- ❑ ATP Multi-Engine
- ❑ CFI/MEI Aircraft
- ❑ Commercial Rotorcraft
- ❑ Instrument Rotorcraft
- ❑ CFI/MEI Rotorcraft
- ❑ ATP Rotorcraft
- ❑ Dispatcher Certificate
- ❑ Air Traffic Control Certificate

Display This Question:

If Which of these responsibilities most closely matches your primary role/duty position? Captain Is Selected

Or In addition to working in the role of Maintenance, do you also perform Flight Technician/Flight M... Yes Is Selected

Or Which of these responsibilities most closely matches your primary role/duty position? Copilot/First Officer Is Selected

Or Which of these responsibilities most closely matches your primary role/duty position? Cabin Crewmember (Flight Attendant, Cabin Service Representative, etc.) Is Selected

Or Which of these responsibilities most closely matches your primary role/duty position? Flight Technician/Flight Mechanic Is Selected

Or In addition to your administrative role, do you also perform Cabin Crewmember duties? Yes Is Selected

2.21 SECTION 2: DUTY INFORMATION

3.1 Do you perform Cabin Crewmember duties en route when working in the capacity of a Flight Technician/Flight Mechanic?

- ❍ Yes
- ❍ No

3.2 On trips, is it a company policy/guideline to be given a rest period prior to performing maintenance duties immediately following en route duties?

- ❍ Yes
- ❍ No

Display This Question:

If On trips, is it a company policy/guideline to be given rest period prior to performing maintenance duties immediately following en route duties? Yes Is Selected

3.3 Do those maintenance duties count toward your duty day limit?

- ❍ Yes
- ❍ No

Display This Question:

If On trips, is it a company policy/guideline to be given rest period prior to performing maintenance duties immediately following en route duties? Yes Is Selected

3.4 Briefly describe your company policy:

Display This Question:

If On trips, is it a company policy/guideline to given rest period prior to performing maintenance duties immediately following en route duties? Yes Is Selected

3.5 Does your company deviate from this policy/guideline?

- ❍ Always
- ❍ Most of the time
- ❍ About half the time
- ❍ Sometimes
- ❍ Never

3.6 Is it company policy/guideline to be given additional non-charged time off following an international trip prior to returning to routine maintenance duties?

- ❍ Yes
- ❍ No

Display This Question:

If Is it company policy/guideline to be given additional non-charged time off following an international trip prior to returning to routine maintenance duties? Yes Is Selected

3.7 Briefly describe your company policy/guideline:

Display This Question:

If Is it company policy/guideline to be given additional non-charged time off following an international trip prior to returning to routine maintenance duties? Yes Is Selected

3.8 Does your company deviate from this policy/guideline?
- ❍ Always
- ❍ Most of the time
- ❍ About half the time
- ❍ Sometimes
- ❍ Never

3.9 Have you ever felt pressured to perform maintenance duties when you felt fatigued?
- ❍ Yes
- ❍ No

Display This Question:

If Have you ever felt pressured to perform maintenance duties when fatigued? Yes Is Selected

3.10 During which general time period did you feel pressured to perform maintenance while feeling fatigued? (Select all that apply)
- ❑ During daytime duty hours
- ❑ During evening duty hours
- ❑ During night/graveyard duty hours
- ❑ During early morning duty hours (before 0600)
- ❑ Following a trip as a flight technician
- ❑ While performing flight technician duties

4.1 Do you perform additional contract work as a Cabin Crewmember outside of your primary employment? (i.e. if contract work is your sole source of employment answer "No".)
- ❍ Yes
- ❍ No

Display This Question:

If Do you perform additional contract work as a Cabin Crewmember outside of your primary employment? (i.e. if contract work is your sole source of employment answer "No".) Yes Is Selected

4.2 How many days a month do you typically perform contract work?

4.3 In which aircraft do you currently work as a Cabin Crewmember? (check all that apply)

- ❑ Jet
- ❑ Long Range Jet (> 7 hour/leg)
- ❑ Ultra Long Range Jet (>10 hour/leg)
- ❑ Propeller
- ❑ Helicopter
- ❑ other

Display This Question:
If In which aircraft do you currently work as a Cabin Crewmember? (check all that apply) other Is Selected

4.4 Enter any other type of aircraft you work on as a Cabin Crewmember.

4.5 How much time do you typically work preparing for a trip prior to the day of the trip?

4.6 How much time prior to official report do you typically spend preparing for a trip on the day of the trip?

4.7 Does your employer require you to carry a cell phone (or be available by other means) to be subject to call?

- ❍ Yes
- ❍ No

Condition: No Is Selected. Skip To: 4.12

4.8 Please select the approximate frequency of the types of call/standby duty as defined below.

	SCHEDULED				
	weekly	monthly	3-4 times in year	1-2 times in year	rarely/ never
short call.... (2 hours or less notice)					
medium call... (>2 hours					
long call..... (>5 hours)					

4.9 Please select the approximate frequency of actually being called to duty from on call/standby.

	FREQUENCY CALLED				
	weekly	monthly	3-4 times in year	1-2 times in year	rarely/ never
short call.... (2 hours or less notice)					
medium call... (>2 hours					
long call..... (>5 hours)					

4.10 Compared to the time usually allowed for preflight duties, how much time was allowed when you were called to duty from on call/standby?

- ❍ Much more
- ❍ Somewhat more
- ❍ About the same
- ❍ Somewhat less
- ❍ Much less

4.11 Please use this space to explain any unique features of your on-call/standby procedures:

4.12 Accomplish the following to the best of your ability (using estimates if necessary).

	typically	least	most
How many duty days do you fly in a month?			
How many flight segments do you fly in a duty day?			
How much time do you have on the ground between segments (layover time)?			
How many actual flight hours do you fly in a month?			

4.13 Do you have to be present at your place of work/hangar during normal business hours even when you are not scheduled to fly?

❍ Yes
❍ No

Display This Question:
If Do you have to be present at your place of work/hangar during normal business hours even when you are not scheduled to fly? Yes Is Selected

4.14 What are your responsibilities in addition to your flying duties? (check all that apply)

❑ baggage handling
❑ dispatch
❑ safety
❑ aircraft servicing
❑ scheduling
❑ aircraft cleaning
❑ management
❑ other

Display This Question:
If What are your responsibilities in addition to your flying duties? (check all that apply) other Is Selected

4.15 Please describe other duties:

4.16 Does your company fly international trips?

❍ Yes
❍ No

Condition: No Is Selected. Skip To: 4.21

4.17 Which crew positions does your operation pre-position for long duty days?

❑ Captain
❑ First Officer/Co-Pilot
❑ None
❑ Cabin Crewmember
❑ Flight Technician/Flight Mechanic

Display This Question:
If Which crew positions does your operation pre-position for long duty days? None Is Not Selected

4.18 Please describe your company/flight operation crewmember pre-position policies:

4.19 Which crew positions does your flight operation/company augment on international trips?

- ❑ Captain
- ❑ First Officer/Co-Pilot
- ❑ None
- ❑ Cabin Crewmember
- ❑ Flight Technician/Flight Mechanic

Display This Question:

If Which crew positions does your flight operation/company augment on international trips? None Is Not Selected

4.20 Please describe your company/flight operation crewmember augmentation policies:

4.21 What are your company/flight operation policies on scheduling? If no limit enter 99. If not applicable leave blank for each answer. (WOCL is window of circadian low 0200-0559).

	limit in hours/days
Basic Duty Period:	
Basic flight time limit	
Basic Off Duty Period	
WOCL Duty Period	
WOCL Flight Time	
WOCL Off Duty Period	
Augmented crew duty time limit:	
Augmented crew flight time limit:	
International duty time limit:	
International flight time limit:	
Minimum rest per 24 hour period:	
Minimum rest in a 7 day period or week:	
Minimum time off between trips:	
Maximum consecutive duty days	
Augmented crew Off Duty Period	

4.22 In a typical month, on how many duty days did your actual flying time fall in each range?

	Number of Events
< 8 hours	
8 - 12 hours	
> 12 hours	

4.23 In a typical month, how many times did you report for duty during each of the following time periods?

	Number of Events
0000-0359	
0400-0759	
0800-1159	
1200-1559	
1600-1959	
2000-2359	

4.24

	Domestic	International
In a typical month, how many flights do you fly in each category? In a typical month, how many hours do you fly in each category?		

4.25

	flights crossing 0-3 timezones	flights crossing 4-6 timezones	flights crossing more than 6 timezones
In a typical month, how many flights involve timezone changes of the following magnitude?			

4.26 What is the longest duty day you have had in your business aviation flying experience?

Hours

Minutes

4.27 In a typical month, how many times did you stay in the following accommodations during your layover periods (include rooms utilized to extend duty days)?

Overnight Hotel

Hotel Dayroom

FBO sleep room/pilot lounge

Other Accomodations

Display This Question:

If In a typical month, how many times did you stay in the following accommodations during your layover periods (include rooms utilized to extend duty days)? Other Accomodations Is Greater Than 0

4.28 Describe all other types of accommodations.

4.29 Please describe/clarify any scheduling/duty policies you feel were not adequately captured from the previous questions in this section:

5.1 List all company/flight operation aircraft you currently fly and the total hours flown in each aircraft?

	Current Flight Experience	
	Aircraft Type	Total Hours
Aircraft 1		
Aircraft 2		
Aircraft 3		
Aircraft 4		
Aircraft 5		
Aircraft 6		
Aircraft 7		
Aircraft 8		

5.2 How many flight hours did you have when you were hired by your current company/flight operation? (estimate numbers if necessary)

5.3 How many total career flight hours have you logged? (estimate numbers if necessary)

5.4 Under which of the following Federal Aviation Regulations do you operate with your current company/flight operation? (check all that apply, do not include contract flying)

- ❑ Part 91
- ❑ Part 91(k)
- ❑ Part 135
- ❑ Part 121
- ❑ Part 125
- ❑ other

Display This Question:

If Under which of the following Federal Aviation Regulations do you operate with your current company/flight operation? (check all that apply, do not include contract flying) other Is Selected

5.5 Please explain other:

Display This Question:

If Under which of the following Federal Aviation Regulations do you operate with your current company/flight operation? (check all that apply, do not include contract flying) Part 135 Is Selected

Or Under which of the following Federal Aviation Regulations do you operate with your current company/flight operation? (check all that apply, do not include contract flying) Part 125 Is Selected

5.6 How many hours do you fly in each category in a typical month? All categories are separate and exclusive (estimate numbers if necessary)?

Business Aviation
General Aviation
Part 135
Part 125
Military
all others

Display This Question:

If Under which of the following Federal Aviation Regulations do you operate with your current company/flight operation? (check all that apply, do not include contract flying) Part 135 Is Not Selected

And Under which of the following Federal Aviation Regulations do you operate with your current company/flight operation? (check all that apply, do not include contract flying) Part 125 Is Not Selected

5.7 How many hours do you fly in each category in a typical month? All categories are separate and exclusive (estimate numbers if necessary)?

Business Aviation
General Aviation
Military
all others

5.8 How many days do you fly in each category in a typical month? All categories are separate and exclusive.

Business Aviation
General Aviation
Military
all others

5.9 How many hours have you flown in your career in the following categories? All categories are separate and exclusive (estimate numbers if necessary)?

Business Aviation - 91
Business Aviation - 91(k)
General Aviation
Part 121
Part 135
Part 125
Military
all others

5.10 Using your logbook or pay-sheet (electronic reporting in most scheduling software will generate reports) and company/flight operation manual, please answer the following questions for only your business aviation job within the past 12 months.

5.11 Using your logbook or paysheet, complete the following to the best of your ability thinking only of your business aviation operations in the past year.

	typically	least	most
How many duty days do you fly in a month?			
How many actual flight hours do you fly in a month?			
How many flight segments do you fly in a duty day?			
In hours and tenths, what is the length of a duty day?			
How much time do you have on the ground between segments on the same duty day (layover time)?			

5.12 What are your company/flight operation policies on scheduling? If no limit enter 99. If not applicable leave blank for each answer. (WOCL is window of circadian low (0200-0559).

	limit
Basic Duty Period: (hours/day)	
Basic flight time limit: (hours/day	
Basic Off Duty Period: (hours/day)	
WOCL Duty Period: (hours/day)	
WOCL Flight Time: (Hours/day)	
WOCL Off Duty Period: (hours/day)	
Augmented crew duty time limit: (hrs/day)	
Augmented crew flight time limit: (hrs/day)	
Augmented crew Off Duty Period: (hrs/day)	
International duty time limit: (hrs/day)	
International flight time limit: (hrs/day)	
Minimum rest per 24 hour period: (hours)	
Minimum rest in a 7 day period or week:	
Minimum time off between trips:	
Maximum consecutive duty days:	

5.13 Answer the following thinking only of business aviation flying accomplished within the past 12 months.

	typical	shortest	longest
How many actual instrument flight hours do you fly in a month?			
How many times per week did you fly into high density operating areas?			
How many times per month did you fly into a non-radar operating area?			
In minutes describe the duration of flight delays for any reason during the past year.			

5.14 When only considering your professional flying time within the past year, how would you rank order the reasons for delays? (Drag and drop to rank order)
______ Traffic/ATC
______ Weather
______ Company/Passenger
______ Mechanical/Maintenance
______ Other---->

5.15 Does your employer require you to carry a cell phone (or be available by other means) to be subject to call?
❍ Yes
❍ No
Condition: No Is Selected. Skip To: 5.20

5.16 Please select the approximate frequency of the types of call/standby duty as defined below.

	SCHEDULED				
	weekly	monthly	3-4 times in year	1-2 times in year	rarely/ never
short call.... (2 hours or less notice)	❍	❍	❍	❍	❍
medium call... (>2 hours	❍	❍	❍	❍	❍
long call..... (>5 hours)	❍	❍	❍	❍	❍

5.17 Please select the approximate frequency of actually being called to duty from on call/standby.

	FREQUENCY CALLED				
	weekly	monthly	3-4 times in year	1-2 times in year	rarely/ never
short call.... (2 hours or less notice)	❍	❍	❍	❍	❍
medium call... (>2 hours	❍	❍	❍	❍	❍
long call..... (>5 hours)	❍	❍	❍	❍	❍

5.18 Compared to the time usually allowed for preflight duties, how much time was allowed when you were called to duty from on call/standby?
❍ Much More
❍ Somewhat more
❍ About the same
❍ Somewhat less
❍ Much less

5.19 Please use this space to explain any unique features of your on-call/standby procedures:

5.20 Do you have to be present at your place of work/hangar during normal business hours even when you are not scheduled to fly?
❍ Yes
❍ No

Display This Question:
If Do you have to be present at your place of work/hangar during normal business hours even when you are not scheduled to fly? Yes Is Selected

5.21 Excluding your primary duties, what are your responsible for in addition to your flying duties? (check all that apply)
❑ flight planning
❑ baggage handling
❑ dispatch
❑ safety officer
❑ aircraft servicing
❑ maintenance
❑ scheduling
❑ aircraft cleaning
❑ management
❑ other

Display This Question:
If Excluding your primary duties, what are your responsible for in addition to your flying duties? other Is Selected

5.22 Please describe other duties:

5.23 Does your flight operation/company fly international trips?
❍ Yes
❍ No

Condition: No Is Selected. Skip To: 5.28

5.24 Which crew positions does your flight operation/company augment on international trips?

- ❑ Captain
- ❑ First Officer/Co-Pilot
- ❑ None
- ❑ Cabin Crewmember
- ❑ Flight Technician/Flight Mechanic

Display This Question:

If Which crew positions does your flight operation/company augment on international trips? None Is Not Selected

5.25 Please describe your company/flight operation augmentation policies:

5.26 Which crew positions does your flight operation/company pre-position for long duty days?

- ❑ Captain
- ❑ First Officer/Co-Pilot
- ❑ None
- ❑ Flight Technician/Flight mechanic
- ❑ Cabin Crewmember

Display This Question:

If Which crew positions does your flight operation/company pre-position for long duty days? None Is Not Selected

5.27 Please describe your company/flight operation pre-position policies:

5.28 In a typical month, on how many duty days did your actual flying time fall in each range?

	Number of Events
< 8 hours	
8 - 12 hours	
> 12 hours	

5.29 In a typical month, how many times did you report for duty during each of the following time periods?

	Number of Events
0000-0359	
0400-0759	
0800-1159	
1200-1559	
1600-1959	
2000-2359	

5.30

	Domestic	International
In a typical month, how many flights do you fly in each category?		
In a typical month, how many hours do you fly in each category?		

5.31

	flights crossing 0-3 timezones	flights crossing 4-6 timezones	flights crossing more than 6 timezones
In a typical month, how many flights involve timezone changes of the following magnitude?			

5.32 What is the longest duty day you have had in your business aviation flying experience?

Hours

Minutes

5.33 In a typical month, how many times did you stay in the following accommodations during your layover periods (include rooms utilized to extend duty days)?

Overnight Hotel

Hotel Dayroom

FBO sleep room/pilot lounge

Other Accomodations

Display This Question:

If In a typical month, how many times did you stay in the following accommodations during your layover periods (include rooms utilized to extend duty days)? Other Accomodations Is Greater Than or Equal to 1

5.34 Describe all other types of accommodations.

5.35 Does your operation have a dispatch/scheduling department?

- Scheduling
- Dispatch
- Both
- None

5.36 Do you fly Single Pilot Operations?

- Yes
- No

6.1 What percentage of your flights are Single Pilot Operations?

- < 25%
- 26 - 50%
- 51 - 75%
- > 75%

6.2 Do you typically have a passenger in the empty pilot seat?

- Yes
- No

Condition: No Is Selected. Skip To: 6.6

6.3 What percentage of the flights do you use the passenger to assist in managing the flight deck? (getting things for you, adjusting lights, managing paperwork, etc.)

- < 25%
- 26 - 50%
- 51 - 75%
- > 75%

6.4 How do you typically use a passenger in the empty pilot seat to assist in flight?

6.5 What percentage of the flights is the passenger in the seat helpful in combating fatigue?

- < 25%
- 26 - 50%
- 51 - 75%
- > 75%

6.6 Have you ever "nodded off" during Single Pilot Operations?
- ❍ Yes
- ❍ No

6.7 Have you ever been so tired that you questioned your ability to safely continue the flight?
- ❍ Yes
- ❍ No

6.8 Have you ever not flown because you were too tired?
- ❍ Yes
- ❍ No

6.9 Please describe any specific fatigue mitigation techniques you use for single pilot operations:

7.1 SECTION 3: SLEEP INFORMATION
For the following questions base your answers on an average night of sleep at home (at least 2 days after you return home from a trip), please give your best answer to each of the following questions.

7.2 How many nights of sleep do you typically get at home between trips?

7.3 On your days off duty, what time do you usually go to bed? Please use your local 24 hour clock. (0615, 2330, etc.)

7.4 On your days off duty, how long after going to bed do you usually fall asleep (in minutes)?

7.5 On your days off, what time do you usually wake for the day (24 hour clock)?

7.6 When sleeping at home, what is the total amount of sleep you get on average per night?

Hours
Minutes

7.7 When sleeping at home, how often do you have problems getting to sleep?
- ❍ never
- ❍ rarely/ 1-10 times per year
- ❍ sometimes/ 1-3 times per month
- ❍ often/ 1-4 times per week
- ❍ very often/ 5-7 times per week

Condition: never Is Selected. Skip To: 7.14

7.8 How often do you take over-the-counter or prescription medication, or a supplement to help you sleep?
- ❍ never
- ❍ rarely/ 1-10 times per year
- ❍ sometimes/ 1-3 times per month
- ❍ often/ 1-4 times per week
- ❍ very often/ 5-7 times per week

If never Is Selected, Then Skip To 7.11

7.9 Please describe the medication or supplement you take to help you sleep:
Medication/Supplement

7.10 Rate the effectiveness of the medication/supplment:
- ❍ Extremely effective
- ❍ Very effective
- ❍ Moderately effective
- ❍ Slightly effective
- ❍ Not at all effective

7.11 How often do you use alcohol to help you sleep?
- ❍ never
- ❍ rarely/ 1-10 times per year
- ❍ sometimes/ 1-3 times per month
- ❍ often/ 1-4 times per week
- ❍ very often/ 5-7 times per week

Condition: never Is Selected. Skip To: 7.14

7.12 How many 1 ounce drinks do you use to help you sleep?
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ more than 3

7.13 Rate the effectiveness of alcohol in helping you sleep:
- ❍ Extremely effective
- ❍ Very effective
- ❍ Moderately effective
- ❍ Slightly effective
- ❍ Not at all effective

7.14 When sleeping at home, how many times on average do you wake up each night?
❍ None
❍ Once
❍ Twice
❍ 3 or more times

Condition: None Is Selected. Skip To: 7.18

7.15 What most often wakes you (rank order by dragging and dropping in order)?
_______ bathroom
_______ noise
_______ insomnia
_______ hot/cold
_______ bed/pillow comfort
_______ children/spouse
_______ snoring, etc.
_______ hunger
_______ other

Display This Question:
If What most often wakes you (rank order by dragging and dropping in order)? other Is Less Than or Equal to 5

7.16 Please describe other thing(s) that wake you:

7.17 On average, how long does it take you to go back to sleep?
Minutes

7.18 How often do you nap at home?
❍ never
❍ rarely/ 1-10 times per year
❍ sometimes/ 1-3 times per month
❍ often/ 1-4 times per week
❍ very often/ 5-7 times per week

Condition: never Is Selected. Skip To: 7.20

7.19 On average, how long are your naps at home?
Hours
Minutes

7.20 Overall, what kind of sleeper are you?

- ❍ very poor
- ❍ poor
- ❍ fair
- ❍ good
- ❍ very good

7.21 Do you snore or has anyone told you that you snore?

- ❍ Yes
- ❍ No

7.22 Do you have a sleep problem?

- ❍ Yes
- ❍ Maybe
- ❍ No

#SkipLogicDescription

7.23 What is your sleep problem?

7.24 Has your sleep problem been diagnosed by a physician?

- ❍ Yes
- ❍ No

7.25 Has your sleep problem ever prevented you from flying?

- ❍ Yes
- ❍ No

Display This Question:

If Has your sleep problem ever prevented you from flying? Yes Is Selected

7.26 How many times has your sleep problem prevented you from flying in your career?

- ❍ Rarely (1-2)
- ❍ Occasionally (3-4)
- ❍ Several (5-7)
- ❍ Often (8+)

7.27 From the list, drag and drop the top five factors which most promote and the top five factors which most interfere with sleep at home. (Please rank order. 1 being the item which most promotes or most interferes with sleep.)

Promote Sleep	Interfere with Sleep
_______ sleep surface	_______ sleep surface
_______ heat	_______ heat
_______ cold	_______ cold
_______ light	_______ light
_______ dark	_______ dark
_______ thoughts running through your head	_______ thoughts running through your head
_______ random noises	_______ random noises
_______ constant background noise	_______ constant background noise
_______ readiness for sleep	_______ readiness for sleep
_______ comfort of clothing	_______ comfort of clothing
_______ low humidity	_______ low humidity
_______ high humidity	_______ high humidity
_______ bathroom	_______ bathroom
_______ bed partner	_______ bed partner
_______ privacy	_______ privacy
_______ ventilation	_______ ventilation
_______ sheets/ blankets/ pillows	_______ sheets/ blankets/ pillows
_______ sexual activity	_______ sexual activity
_______ respiratory factors /illness	_______ respiratory factors /illness
_______ hunger	_______ hunger
_______ thirst	_______ thirst
_______ other	_______ other
_______ other	_______ other

Display This Question:

If From the list, drag and drop the top five factors which most promote and the top five factors wh... other - Promote Sleep Is Selected

Or From the list, drag and drop the top five factors which most promote and the top five factors wh... other - Interfere with Sleep Is Selected

7.28 What is(are) the other item(s) that most promote or interfere with sleep at home:

7.29 From the list, drag and drop the top five factors which most promote and the top five factors which most interfere with sleep on trips. (Please rank order. 1 being the item which most promotes or most interferes with sleep.)

Promote Sleep	Interfere with Sleep
_______ sleep surface	_______ sleep surface
_______ heat	_______ heat
_______ cold	_______ cold
_______ light	_______ light
_______ dark	_______ dark
_______ thoughts running through your head	_______ thoughts running through your head
_______ random noises	_______ random noises
_______ constant background noise	_______ constant background noise
_______ readiness for sleep	_______ readiness for sleep
_______ comfort of clothing	_______ comfort of clothing
_______ low humidity	_______ low humidity
_______ high humidity	_______ high humidity
_______ bathroom	_______ bathroom
_______ bed partner	_______ bed partner
_______ privacy	_______ privacy
_______ ventilation	_______ ventilation
_______ sheets/ blankets/ pillows	_______ sheets/ blankets/ pillows
_______ sexual activity	_______ sexual activity
_______ respiratory factors /illness	_______ respiratory factors /illness
_______ hunger	_______ hunger
_______ thirst	_______ thirst
_______ other	_______ other
_______ other	_______ other

Display This Question:

If From the list, drag and drop the top five factors which most promote and the top five factors wh... other - Promote Sleep Is Selected

Or From the list, drag and drop the top five factors which most promote and the top five factors wh... other - Interfere with Sleep Is Selected

7.30 What is(are) the other item(s) that most promote or interfere with sleep on trips:

8.1 SECTION 4: FATIGUE

Has fatigue ever prevented you from flying a trip?

- ❍ Yes
- ❍ No

8.2 Select from the following contributing factors which cause fatigue in business aviation operations. (Select all that apply)

- ❑ Long Duty Day
- ❑ Early AM departure
- ❑ Multiple legs
- ❑ Night flight
- ❑ Weather/Turbulence
- ❑ Long layovers between flights
- ❑ Crossing multiple timezones
- ❑ Flying Work Load
- ❑ Consecutive days
- ❑ Delays
- ❑ No or few breaks
- ❑ Maintenance problem
- ❑ No meals
- ❑ Shortened rest period
- ❑ Collateral/Additional Duties

8.3 In your opinion, to what extent is fatigue a concern in business aviation operations?

- ❍ Not at all
- ❍ Minor
- ❍ Moderate
- ❍ Serious

8.4 In your opinion, is fatigue a common occurrence in business aviation?

- ❍ Yes
- ❍ No

8.5 When fatigue occurs, how significant a safety issue is it?

- ❍ Not at all
- ❍ Minor
- ❍ Moderate
- ❍ Serious

8.6 In which of the following ways does fatigue affect your performance? (Select top 3 that apply)

- ❑ attention/alertness
- ❑ omissions
- ❑ apathy
- ❑ judgment
- ❑ slow reaction
- ❑ errors
- ❑ concentration
- ❑ motor skills
- ❑ mood change
- ❑ tired/sleepy
- ❑ memory
- ❑ crew resource management

8.7 When affected by fatigue, which phase of flight is most affected?

- ❍ taxi
- ❍ takeoff
- ❍ enroute
- ❍ descent
- ❍ approach
- ❍ landing

8.8 Please select your top three strategies that you use to manage fatigue prior to a trip.

- ❑ wash face
- ❑ brush teeth
- ❑ shower
- ❑ conversation
- ❑ caffeine
- ❑ napping
- ❑ exercise
- ❑ music
- ❑ video
- ❑ reading
- ❑ writing
- ❑ diet/nutrition
- ❑ snacking
- ❑ recreation
- ❑ CRM/SOPs
- ❑ trip planning
- ❑ hydration
- ❑ fresh air/cool air

8.9 Please select your top three strategies that you use to manage fatigue during a trip.

- ❑ wash face
- ❑ brush teeth
- ❑ shower
- ❑ conversation
- ❑ caffeine
- ❑ napping
- ❑ movement/stretching
- ❑ music
- ❑ video
- ❑ reading
- ❑ writing
- ❑ diet/nutrition
- ❑ snacking
- ❑ recreation
- ❑ CRM/SOPs
- ❑ trip planning
- ❑ hydration
- ❑ fresh air/cool air

8.10 Please select your top three strategies that you use to manage fatigue following a trip.

- ❑ wash face
- ❑ brush teeth
- ❑ shower
- ❑ conversation
- ❑ caffeine
- ❑ napping
- ❑ exercise
- ❑ music
- ❑ video
- ❑ reading
- ❑ writing
- ❑ diet/nutrition
- ❑ snacking
- ❑ recreation
- ❑ CRM/SOPs
- ❑ trip planning
- ❑ hydration
- ❑ fresh air/cool air

8.11 What top five changes would you make to reduce fatigue in business aviation operations?

_______ flight/duty time limits
_______ improve scheduling
_______ improve rest time
_______ improve days off
_______ improve recovery time
_______ educate management and passengers about fatigue
_______ educate crew-members about fatigue
_______ shorter duty days
_______ hiring crew-members
_______ rest facility at layover
_______ education
_______ avoid early departures
_______ avoid late night flights
_______ reduce consecutive days
_______ augment crews
_______ increase company support
_______ improve health
_______ switch crew
_______ minimize additional duties

8.12 Have you ever unintentionally slept during flight ("nodded off")?

❍ Yes
❍ No

Display This Question:
If Have you ever unintentionally slept during flight ("nodded off")? Yes Is Selected

8.13 On what percentage of flights in a typical year does this happen?

8.14 Does your employer offer any fatigue training?

❍ Yes
❍ No

Display This Question:
If Does your flight department offer any fatigue training? Yes Is Selected

8.15 Select the type(s) of fatigue training you have received.

❑ On-line training
❑ Instructor led course
❑ Individual fatigue study
❑ Self-taught/learned
❑ other

Display This Question:
If Select the type(s) of fatigue training you have received. other Is Selected

8.16 Please describe other fatigue training you have received.

8.17 Have you ever been on a flight where arrangements were made for the pilot or co-pilot to nap in the seat (controlled rest in flight)?

- ❍ Yes
- ❍ No

Display This Question:
If Have you ever been on a flight where arrangements were made for the pilot or co-pilot to nap in t... Yes Is Selected

8.18 On what percentage of flights in a typical month does this happen?

8.19 Are arrangements made for Cabin Crewmembers (flight attendant, cabin service representatives, etc.) to rest in flight in your operation?

- ❍ Yes
- ❍ No
- ❍ Don't use Cabin Crew

Display This Question:
If Are arrangements made for Cabin Crewmembers (flight attendant, cabin service representatives, etc... Yes Is Selected

8.20 On what percentage of flights does this happen for Cabin Crewmembers?

8.21 Are arrangements made for Flight Technicians/Flight Mechanics to rest in flight in your operation?

- ❍ Yes
- ❍ No
- ❍ Don't use Flt Techs/Mechs

Display This Question:
If Are arrangements made for Flight Technicians/Flight Mechanics to rest in flight in your operation? Yes Is Selected

8.22 On what percentage of flights does this happen for Flight Technicians/Flight Mechanics?

Display This Question:

If Are arrangements made for Flight Technicians/Flight Mechanics to rest in flight in your operation? Yes Is Selected

Or Are arrangements made for Cabin Crewmembers (flight attendant, cabin service representatives, etc... Yes Is Selected

8.23 Please describe arrangements that your company makes for Cabin Crewmembers and Flight Technicians/Flight Mechanics to rest in flight:

8.24 Have you ever felt like you shouldn't fly a trip due to fatigue, but did?

❍ Yes
❍ No

9.1 SECTION 5: MANAGEMENT INFORMATION

Do you hold a management position as your primary title/position/responsibility and also have flying responsibilities?

❍ Yes
❍ No

Condition: No Is Selected. Skip To: 10.1

9.2 Approximate the percentage of your overall work which is flying related per month.

9.3 On flying days do you also perform management duties??

❍ Yes
❍ No

Display This Question:

If On flying days do you also perform management duties?? Yes Is Selected

9.4 Approximate the percentage of your work which is management related on flying days.

9.5 Accomplish the following to the best of your ability (using estimates if necessary).

	typically	shortest	longest
What is the duration of a duty day that includes ONLY management duties?			
What is the duration of a duty day that includes BOTH management and flying duties?			

9.6 Select all management duties that apply.
- ❑ Supervisor
- ❑ Chief Pilot
- ❑ Department Manager
- ❑ Scheduling
- ❑ other ____________________
- ❑ Training
- ❑ Operations
- ❑ Finance
- ❑ Personnel
- ❑ other ____________________

9.7 Are you responsible for scheduling on any level?
- ❍ Yes
- ❍ No

Display This Question:
If Are you responsible for scheduling on any level? Yes Is Selected

9.8 Please drag and drop the scheduling priorities in the order of priority in your company's scheduling decisions. (1 being highest priority, etc.)

______ number of legs flown
______ currency
______ duty time for each work day
______ takeoff times during the night/early morning
______ operations during the circadian low
______ time zones crossed
______ layover rest time
______ availability of equipment
______ maximizing cost efficiency
______ other
______ other

10.1 SECTION 6: WORK ENVIRONMENT

How many of each type of aircraft does your company/operation operate?
turbojet/fan
helicopter/rotorcraft
turboprops
recips

10.2 How many people work in each category of positions to support your flight operations?

Pilots

- ❑ Maintenance Personal

Cabin Crewmembers

Administrative personnel

10.3 How many employees does your company employ? (estimate if necessary, leave blank if non-company affiliated flight operation)

Employees

10.4 Please select from the following the one which most closely matches your flight operations.

- ❍ Domestic Routes Only
- ❍ Domestic and Canada Routes
- ❍ International

10.5 What safety initiatives does your company/flight operation emphasize?

- ❑ crew resource management
- ❑ communication
- ❑ duty/rest policies
- ❑ Standard Operating Procedures
- ❑ other ____________________
- ❑ maintenance
- ❑ Flight Planning
- ❑ Regulations
- ❑ Fitness/Health
- ❑ Loss of Control In-flight
- ❑ passenger safety
- ❑ Safety Reporting
- ❑ Weather
- ❑ Controlled Flight Into Terrain
- ❑ other ____________________

10.6 Through what mechanisms does your company/flight operation emphasize or implement these safety issues?

- ❑ meetings
- ❑ written policies
- ❑ standardization/line checks
- ❑ impromptu communication
- ❑ contract workers
- ❑ other ____________________
- ❑ email/blogs/web-site
- ❑ scheduling department
- ❑ dispatch department
- ❑ duty/rest policies
- ❑ positive company support/culture
- ❑ other ____________________
- ❑ safety audit
- ❑ training
- ❑ ISBAO
- ❑ SMS
- ❑ ASAP
- ❑ C-FOQA

11.1 SECTION 7: CONCLUSION
Did you participate in the NBAA/FSF study sponsored my Dr. Mark Rosekind in the 1999-2000 timeframe?

- ❍ Yes
- ❍ No

Display This Question:
If SECTION 7:CONCLUSION Did you participate in the NBAA/FSF study sponsored my Dr. Mark Rosekind in the 1999-2000 timeframe? Yes Is Selected

11.2 From your perspective has fatigue awareness increased since 2000?

- ❍ Far above average
- ❍ Moderately above average
- ❍ Slightly above average
- ❍ Average
- ❍ Slightly below average
- ❍ Moderately below average
- ❍ Far below average

Display This Question:

If SECTION 7: CONCLUSION Did you participate in the NBAA/FSF study sponsored my Dr. Mark Rosekind in the 1999-2000 timeframe? Yes Is Selected

11.3 How has fatigue been managed more or less effectively since 2000?

11.4 If you have any additional comments or information regarding this survey, please use this space to provide feedback concerning fatigue in business aviation or any aspect of this survey.

11.5 On behalf of NBAA and the John D. Odegaard School of Aerospace Sciences at the University of North Dakota, thank you very much for your participation in this survey. The time you devoted to this research will improve our understanding of fatigue in the business aviation community. Please encourage others to complete the survey by sharing the email link you were sent. NBAA membership is not required to participate in this survey or to enter the prize drawing. Survey analysis will be available to NBAA members later this summer on the NBAA website. Would you like to be considered for a chance to win one of the following? A$250 Amazon, Best Buy, Target or other gift card of their choice; A complimentary registration to the 2017 National Business Aviation Association Convention and Exhibition (NBAA-BACE) in Las Vegas, NV; A complimentary registration to the 2017 National Business Aviation Association Flight Attendant/Flight Technician Conference (June 13-15) in Long Beach, CA; or A hardcover edition of The Wright Brothers, by David McCullough. If you select "yes", on the next page you will be asked to enter your email address. Your email address will not be tied to your survey responses. Your email address will only be used to contact you if you are one of the randomly selected winners for participating in this study. Only one entry per survey participant is allowed. Winners will be notified by May 1, 2017.

- ❍ Yes
- ❍ No

Condition: No Is Selected. Skip To: 11.7

11.6 Your email address will not be tied to your survey responses. Your email address will only be used to contact you if you are one of the randomly selected winners for participating in this study.

Please enter your email address

Please re-enter your email address

11.7 Thank you for your participation! You have been entered into the random drawing and will be notified by May 1, 2017 if you are a winner.

Display This Question:

If On behalf of NBAA and the John D. Odegaard School of Aerospace Sciences at the University of North Dakota, thank you very much for your participation in this survey. The time you devoted to t... No Is Selected

11.8 Thank you for your participation! You have elected not to be entered into the random drawing.

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