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Crew Factors in Flight Operations XIII: A Survey of Fatigue Factors in Corporate/Executive Aviation Operations

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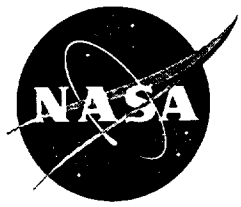

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1.0 Operational Overview

This report is the thirteenth in a series on physiological and psychological effects of flight operations on flight crews, and the operational significance of these effects.

Corporate/executive flight operations face unique challenges in the aviation industry. Most corporate flight crews operate under Part 91 of the Federal Aviation Regulations (FARs), which does not limit flight or duty periods as do other Parts that regulate commercial operations. Corporate aviation is often characterized by unscheduled flights, quickly changing schedules, time zone changes, and extended duty days, sometimes with long periods spent "on-call." Additionally, corporate pilots' workload may include non-flight -related duties such as baggage handling or refueling. Due to rapid industry growth in recent years, there are numerous anecdotal reports of fatigue-related problems experienced by corporate flight crews in both long- and short-haul operations. However, this is the first scientific examination of fatigue issues in this operational environment. This study was designed to identify operationally significant factors that may influence fatigue, alertness, and performance in corporate flight operations.

A survey was developed, consisting of 107 questions in varied format, which targeted six main areas: demographics, home sleep habits, flight experience, duty/rest patterns, fatigue, and the work environment. In collaboration with the National Business Aircraft Association (NBAA) and the Flight Safety Foundation, NASA investigators targeted a representative sample of corporate/executive operators by mailing surveys to all U.S.-based member companies of NBAA that operated business aircraft at the time. Approximately 11,000 surveys were distributed to 2,100 selected companies. A cover letter accompanied each survey explaining the study and emphasizing that all information provided by subjects was anonymous and confidential. An enclosed postage-paid envelope ensured that data were returned directly to the NASA investigators.

A total of 1,488 corporate flight crewmembers responded. The sample was 99% male and averaged 45.2 years of age. Responses from 55 individuals (4%) over age 60, reflect that Part 91 FARs do not regulate retirement age as does Part 121. Subjects reported an average of 14.9 yr. of corporate flying and an average total flight time of 9,750 h.

Describing off-duty sleep at home, the group reported an average sleep duration of 7 h. 17 min., and 89% characterized themselves as "good" or "very good" sleepers. More than half (60%) reported that they snore and about 8% reported having a sleep problem. The most commonly reported sleep problems were insomnia, disturbed sleep, and apnea. Only 16% of these problems were diagnosed by a physician.

Most of the respondents (91%) identified their flight deck position as captain, and the group's average salary was $65,500. The majority (68%) reported flying jet aircraft, 20% turboprops, 7% reciprocating-engine aircraft, and 5% helicopters. Most (82%) indicated that they were required to wear pagers or were subject to call for duty but reported that they were rarely "called out" (mean = 1.8 times/mo.). They reported that, within the last year, they flew an average of 13.8 days/mo. and logged 35.2 h./mo. of flight time. On average, they described typical duty days of 9.9 h. that included 3.2 flight segments.

While Part 91 FARs provide minimal guidance on the issue, many corporate aviation departments set their own flight and duty time limits. About two-thirds of the respondents reported having a daily duty time limit, which averaged 14.8 h./day, yet most have no monthly (96%) or annual (98%) duty limits. Over half (57%) of the group reported having a daily flight time limit, which averaged 9.7 h., and again the majority reported no monthly (89%) or annual (91%) limits. More than 60% reported

having a policy on minimum rest time, which averaged 9.4 h./24 h.

Almost three-quarters of the group (74%) described fatigue as a "moderate" or "serious" concern, and a majority (61%) characterized it as a common occurrence in corporate operations. A large majority (85%) identified fatigue as a "moderate" or "serious" safety issue, and approach/landing was the most commonly cited flight phase affected by fatigue (53%).

Nearly three-quarters (71%) of the pilots reported that they have "nodded off" during a flight. Thirty-nine percent reported having made arrangements for one pilot to nap in the cockpit seat during flight[1]. Thirteen percent of the crewmembers reported that at some time fatigue had prevented them from flying a scheduled trip. Fewer than a quarter (21%) reported that their flight departments offer training on fatigue issues.

Crewmembers identified factors that influence fatigue in responses to several questions. In one question, subjects rated 34 items for their effects on fatigue level. The highest rated factors, on average, were scheduling issues (including multiple flight segments, time of day of operation, late night arrivals, and early morning departures); operational factors (including weather, turbulence, and workload); and sleep loss. Additionally, crewmember responses to other questions identified long duty days, short rest periods, extended waits between flight segments, consecutive duty days, and crossing time zones as factors that contributed to fatigue.

Overall, data from this survey indicate that corporate pilots perceive fatigue as a significant issue in flight operations. These experienced corporate flight crews, who rated themselves as good sleepers at home, identified specific problems with fatigue in their operational environment. The finding that a vast majority of subjects reported "nodding off" in flight is further evidence of the fatigue issues facing corporate operations. Yet according to the pilots, relatively few organizations address these issues through either comprehensive flight and duty limits or education. More widespread education on alertness management strategies combined with the application of scientifically-based scheduling and flight/duty time considerations would provide a strong foundation for an approach through which corporate flight departments may address fatigue issues and enhance corporate aviation safety.

[1]Current FARs do not specifically sanction or prohibit napping in the cockpit seat.

2.0 Introduction

2.1 Fatigue in Corporate/Executive Flight Operations

Modern commercial aviation requires 24-hour operations. While sophisticated technology is utilized in aircraft, air traffic control, maintenance, and other parts of the system, the human operator remains central to all of these activities. Therefore, human physiological capabilities and limitations are critical factors in maintaining safety and productivity in the air transport industry.

Corporate/executive flight operations are defined as the use of aircraft owned or leased and operated by a corporate or business firm for the transportation of personnel or cargo in furtherance of the firm's business, and which are flown by professional pilots who receive direct compensation for piloting (ref. 1). Corporate operations encompass a broad range of activities. An operation may consist of a single pilot who flies one reciprocating-engine aircraft or an extensive flight department that manages over 50 aircraft with hundreds of associated personnel. Duty days can entail several short "hops" or all-night transoceanic crossings. Flights terminate at small, uncontrolled airstrips, offshore oil platforms, or busy international airports. Many corporate operations are characterized by a long wait at the destination, during which business is conducted, followed by a return flight. Other

common features are unscheduled flights, rapidly changing schedules, and extended duty days. Frequently, corporate pilots have additional pre- or post-flight responsibilities, such as baggage handling or refueling.

The primary objective of this study was to identify operationally significant factors that may influence fatigue, alertness, and performance in corporate/executive flight operations. Because corporate operations are so diverse, they may incorporate many of the challenges that face other flight environments, including short-haul, long-haul, overnight cargo, regional, and rotorcraft operations. Studies of these other commercial flight operations have established that crewmembers routinely face long or irregular duty schedules, rapid multiple time-zone changes, sleep disturbances, circadian disruption, and other challenges unique to the specific operational demands (ref. 2–6). These factors can result in fatigue, cumulative sleep loss, decreased alertness, and degraded performance. The potential effects on flight safety and operational effectiveness substantiate fatigue as a safety concern.

Many sources validate this concern. Numerous studies have shown fatigue-effects in commercial flight crews, including accumulated sleep loss, alertness and performance decrements, and unintended episodes of falling asleep during flight (e.g., refs. 2–8). The NTSB identified fatigue as a probable cause in an aircraft accident involving a DC-8 in Guantanamo Bay, Cuba in 1993, and as a contributing factor in the 1997 Korean Air accident in Guam (refs. 9 and 10). Incidents reported to the NASA Aviation Safety Reporting System (ASRS), a confidential reporting system for flight crews and others who operate in the National Airspace System, have identified fatigue as a significant safety issue (ref. 11).

Corporate and business aviation operations have increased steadily since 1992, and projections indicate that they will continue to grow substantially in the coming years (refs. 1 and 12). Further, while more corporate operations are conducted, the National Airspace System continuously becomes more crowded and more complex, and business aircraft performance capabilities improve, making longer flights possible. As corporate aviation grows, the industry's concern with fatigue and alertness issues as they relate to safety in corporate operations may increase as well.

Unlike other commercial flight environments studied, most corporate crews operate under Part 91 FARs[2]. These operators are not regulated by flight time limitations or rest requirements, as are Part 121 and Part 135 operators. Nevertheless, acknowledging that fatigue plays a significant role in flight safety, some proactive corporate operators have developed and adopted their own flight/duty/rest policies. Anecdotal evidence of this initiative prompted investigators to examine the extent to which corporate operators, as a group, have taken preventive measures against fatigue, and what remaining areas may benefit from further action.

2.2 Physiological Background

Fatigue, alertness, and performance are physiologically determined. A basic understanding of two physiological factors—sleep and the internal body clock (called the circadian clock)—are necessary background information. Together, sleep and circadian rhythms play a fundamental role in determining fatigue and alertness at a given time. Therefore, factors that affect sleep or the circadian system have the potential to affect fatigue, alertness, and performance as well.

Sleep is a vital physiological need. Most individuals require about 8 hours of sleep each day. When a person loses sleep, essentially all aspects of functioning can suffer, including alertness, performance, and mood. Sleep loss can degrade cognitive processes, vigilance, physical coordination, judgment and decision making, communication, outlook, and

[2]Some corporate departments operate under other FAR Parts, notably Part 135.

countless other parameters (refs. 13–14). In fact, research has demonstrated that 1 hour of sleep loss can affect waking alertness, and that 2 hours of sleep loss can significantly affect both alertness and performance (ref. 15). Sleep loss, over time, accumulates into a sleep debt, which can exacerbate the effects of acute sleep loss.

Sleep is a complex process, influenced by many factors. The quantity and quality of sleep an individual obtains at a given time depend on prior sleep and wakefulness, time of day, age, and environment. Further complicating the matter, these factors interact with one another.

The basic concept behind the influence of prior sleep/wake patterns is the following: when individuals don't sleep, they become sleepy. That is, a homeostatic drive to sleep builds from the time of awakening until the next sleep, just as the drive to eat (hunger) builds between one meal and the next. The longer the period of time since sleep, the stronger the drive to sleep. Conversely, the homeostatic drive is weaker shortly after sleep. A very long period of continuous wakefulness can create an intense sleep drive and associated sleepiness. When the drive for sleep becomes strong enough, it can send the brain and body into spontaneous sleep, regardless of whether sleep is appropriate or safe under the circumstances.

Almost every aspect of sleep changes with age. In general, the quantity and quality of sleep decrease with age. While older people do not necessarily need less sleep, they tend to obtain less sleep at night, have more nocturnal awakenings, truncate sleep in the morning, and nap more during the day. Therefore, the age of crewmembers may affect their experience of fatigue and alertness.

The sleep environment also plays a large role in the quantity and quality of sleep. Dark, quiet surroundings and a comfortable temperature and sleep surface are key elements for a sleep-conducive environment (ref. 16). Because individual preferences differ widely, the ability to adjust the environment for comfort is an important consideration.

Even with an ideal sleep environment, sleep may be difficult due to stress, thoughts, or worries. Long-haul commercial pilots identified thoughts and worries as one of the top five items that interfered with their sleep in onboard crew rest facilities (ref. 17).

The ability to sleep also varies with the circadian rhythm of sleepiness. The term "circadian rhythm" (from Latin *circa* "about" and *dies* "day") refers to the cycle of a physiological function that repeats approximately every 24 hours. Virtually all functions of the body (e.g., sleep/wake, digestion, immune function) are controlled by circadian rhythms, which are regulated by the circadian clock in the brain. Generally, the body is programmed to sleep at night and to be awake during the day. Additionally, humans have two times of maximal sleepiness and two times of peak alertness each day. At approximately 3–5 a.m. and 3–5 p.m., sleepiness peaks, and sleep may come more easily. These times correspond to lower levels of alertness and performance. Conversely, at about 9–11 a.m. and 9–11 p.m., alertness and performance peak, and it may be difficult to obtain sleep, even if sleep-deprived. Time-of-day fluctuations in performance have been observed in several unrelated operational settings (ref. 18).

The circadian system cannot adjust immediately to changes in the work/rest schedule or time zone. When such changes occur, the circadian system is desynchronized from the environment for a period of time, and individual rhythms are out of sync with one another. Circadian disruption caused by irregular schedules or time zone changes can lead to sleep loss, performance decrements, worsened mood, digestive upset, and other symptoms. It can take from days to weeks for the circadian clock to resynchronize completely.

Clearly, a range of physiological factors can influence fatigue, alertness, and performance. While an attempt was made to distinguish fatigue factors from one another in this study for the purpose of clarity, they are not completely independent. Further, beyond the intricacies of physiology, the complexity of flight operations precludes accounting for each difference in circumstance. However, while there is no simple solution to these issues, by managing fatigue and alertness in corporate flight operations, the industry takes an important step in maintaining or improving the safety margin. Identifying the specific challenges that face corporate pilots will inform any efforts to address fatigue in this particular flight environment.

3.0 Methods

A retrospective survey, comprising 107 questions of varied format, targeted six main topics: demographics (10 questions), home sleep habits (24), flight experience (28), duty/rest patterns (19), fatigue during operations (14), and the work environment (8). The sections on demographics, home sleep, and flight experience were designed to provide context for other sections. Pilots who held management positions completed an additional section of 7 questions. See Appendix A for the complete survey.

The demographics section included questions on basic personal information, such as gender, age, and height. The section on home sleep habits requested information on a typical night's sleep at home, including sleep duration, time to fall asleep, and sleep disturbances. "Flying Information" targeted general flight experience, such as total flight hours and certification, as well as specific occurrences, such as flight delays. The duty/rest questions focused on scheduling practices, including flight times, duty durations, and augmentation. In the fatigue section, subjects were asked about their perceptions of fatigue in corporate operations. A key question in this section presented subjects with a list of 34 factors, and asked them to rate each as to the effect it had on fatigue-level and how frequently they encountered the factor. The section on work environment surveyed the subjects' perceptions of their flight departments. The additional section for management pilots focused on the combination of pilot and management duties.

The survey was field tested by sending 47 surveys to three corporate flight departments. Crewmembers returned 18 completed surveys and provided suggestions for improving clarity and relevance. Appropriate changes were incorporated prior to full distribution of the survey.

In collaboration with the Flight Safety Foundation and the National Business Aircraft Association (NBAA), a representative sample of the corporate pilot population was targeted by mailing surveys to all U.S.-based member companies of the NBAA who operated business aircraft. The number of surveys sent to each company was determined based on the number of aircraft operated, using a common industry estimate (i.e., 3:1 ratio of pilots to aircraft). This calculation resulted in 10,863 surveys being to sent to 2,100 companies. Member companies spanned a broad range of sizes (from single aircraft to extensive departments), aircraft types (from reciprocating fixed-wing to turbine rotorcraft), and operations (regional to worldwide). Industry members agreed that the NBAA membership accurately represented the population with regard to aircraft type, home base time zone, and flight department size.

Each survey was accompanied by a postage-paid envelope addressed to the NASA investigators and a cover letter signed by them. To encourage accurate and forthright responses, the cover letter emphasized that participation was voluntary, anonymous, and confidential. Toward that end, pilots were instructed not to identify themselves and to return surveys directly to the NASA researchers in the enclosed envelope.

Data were entered into a FileMaker Pro database and then exported onto a DEC systems Ultrix platform on which the BMDP statistical software (University of California, Los Angeles) and S Plus (Statistical Sciences Inc, Seattle, WA) packages were utilized for data analysis.

4.0 Results

Corporate crewmembers returned a total of 1,488 completed surveys (a 14% return rate). Subjects represented flight departments that employed anywhere from one to 200 pilots, and worked for companies with one to 675,000 general employees, with an average of 28,200 (N = 1172). According to respondents, the companies operated an average of 4 aircraft, ranging from 1 to 64. A large majority of subjects (80%) reported that their companies operated jet aircraft, while under a third (30%) reported turboprops, 15% reported rotorcraft, and 13% reciprocating-engine aircraft ("recips"). Of those who reported that their companies operated jets, the average number of aircraft per company was 3.1 jets; those who identified turboprops reported an average of 2.0 of those aircraft per company; rotorcraft averaged 3.5 per company, and recips averaged 1.8 per company. Over two thirds (68%) of the pilots reported that their companies flew both domestic and international routes, while almost a third (32%) reported that their companies flew only North American routes (see Appendix B for survey results).

4.1 Demographics

Most (99%) of the crewmembers were male, and the mean age was 45.2 yr. On average, subjects were almost 71 in. tall, and weighed 185 lb. The average Body Mass Index (BMI[3]) was 25.9, with 37% of the group falling into the "ideal" 20–25 range, over half (53%) in the "overweight" range of 25–30, and 9% in the "obese" range of ≥30.

[3]The BMI is calculated as follows: weight / height^2 (kg / m^2).

The Eastern time zone was the most frequently reported home base time zone (48%), and Central the second (40%). Similarly, 49% of the group identified the Eastern time zone as the one in which they lived, and 39% Central. Subjects reported an average commute time of 33 min. (range = 2 min.–15 h.), and most (98.5%) reported commuting by automobile, while only 1% cited airplane commutes. Fifteen percent of the pilots reported holding other jobs in addition to their corporate flying positions, and they spent an average of 57 h./mo. at those jobs.

4.2 Home Sleep

Respondents provided the following information based on an average night of sleep at home, at least 2 days after returning from a trip. The crewmembers reported an average of 4.2 nights at home between trips. They reported an average bedtime of 2240 h. when off-duty, and indicated that it took them 22 min. to fall asleep. Subjects reported awakening an average of 1.5 times during a typical night at home, and identified the need to use the bathroom (63%) as the most frequent cause of awakening, followed by disturbance from children or spouse (13%), inability to sleep (10%), and noise (7%). After awakening, it took them an average of 14 min. to go back to sleep. On average, subjects reported getting 7 h. 17 min. of sleep and awakening at 0708 h (7:08 a.m.).

Over half (51%) of the group reported "never" or "rarely" taking naps, another 30% reported "sometimes" napping, and the remaining 19% reported napping "often" or "very often." Those who took naps (N = 1251) reported an average nap duration of 49 min.

Sixty percent of the group reported "never" or "rarely" having problems getting to sleep, almost a third (32%) reported having problems "sometimes," and 7% reported having trouble "often" or "very often." The vast majority of subjects (89%) reported that they "never" used medications to help them sleep,

and another 8% reported using them "rarely". Of those who did, over half (53%) indicated that the medications were "moderately effective," while another 29% reported that they were better than moderately effective (N = 147). The most commonly identified medications (N = 128) were over-the-counter sleep aids (61% of those who reported using medication), and nighttime cold medications (16%), while only 1% reported using prescription sleep medication. A large majority of subjects (82%) reported "never" using alcohol to help them sleep.

Overall, most subjects (89%) characterized themselves as "good" or "very good" home sleepers, while 11% rated themselves "poor" or "very poor." Over half (60%) reported that they snore. A significantly higher proportion (67%) of those with BMIs indicating "overweight" (BMI > 25, N = 916) reported snoring than those with "normal" BMIs (≤ 25, N = 561), of whom less than half (47%) reported snoring ($p < .001$). Snoring can be clinically associated with sleep apnea, a relatively common sleep disorder more prevalent among individuals with higher BMIs.

A great majority (92%) reported having no sleep problem. Of the small group that indicated a sleep problem, 16% had been diagnosed by a physician. Two individuals (2% of those who cited a sleep problem) reported that the sleep problem had never prevented them from flying a scheduled trip.

Subjects rated 18 factors on how each affected home sleep, using a scale from 1–"interferes" to 5–"promotes" (with a middle rating of 3–"no effect"). The factors most often identified as most promoting to sleep (i.e., rated 5) were pillows (13% of all "promotes" responses), readiness for sleep (13%), sleep surface (12%), ventilation (10%), and comfortable clothing (8%). Factors most often identified as interfering with sleep (i.e., rated 1) were thoughts (19% of all "interferes" responses), heat (17%), high humidity (15%), random noise events (9%), and background lighting (8%). When asked to choose and rank the top three sleep-promoting factors from the list of 18, over half of the group (52%) included "sleep surface" as one of the three, 47% cited "readiness for sleep," and 37% ranked "pillows." Consistent with these results, 28% identified "sleep surface" as the number one factor, and another 26% rated "readiness for sleep" first. The same two factors were most frequently cited as the second-rated factor, with 15% ranking "sleep surface" as second and 13% "readiness for sleep." "Pillows" (22%) was the most frequently cited third factor.

Subjects rated four additional factors for the degree to which they interfered with sleep at home, using a scale of 1–"strongly interferes" to 5–"no effect." "Personal worries" was cited most as interfering with sleep, with 64% of subjects rating it 1 or 2, followed by thirst (43%), hunger (27%), and lastly, respiratory factors (20%). Seventy respondents described other interfering factors, which they rated as 1 or 2. These were categorized, and the most common factors were illness (10 responses), family/pets (10), noise (7), thought/worries about work (6), and stress/anxiety (6).

4.3 Flight Information

The crewmembers reported having an average of 5,580 h. of flight time when they were hired for their current corporate flying positions. At the time of the survey, they averaged almost 15 yr. (mean = 14.9 yr.) of corporate flying experience, and 9,750 lifetime hours logged. Of all certificates and ratings held[4], the majority were for fixed-wing aircraft: Air Transport Pilot (ATP) represented 35%, followed by commercial (20%), instrument rating (19%), and flight instructor certificates (16%). Fewer respondents held rotorcraft certificates and ratings, including commercial (4%), instrument rating (3%), ATP (2%), and flight instructor (1%). On average, pilots categorized their flight hours as 5,900 h. of corporate

[4]Many subjects held multiple certificates and ratings.

flying, 1,490 h. of military, 2,500 general aviation hours, and about 800 h. in other categories. Most of those who specified another category (N = 264) indicated hours with a major, regional, or commuter airline (69%), followed by charter or air taxi operations (13%) and air cargo (7%). Per month, the pilots averaged 39.4 h. of corporate flying, 3.7 h. in general aviation, less than an hour (mean = 0.6 h.) of military flying, and less than an hour in other categories.

Pilots reported non-military salaried flying jobs they have held (N = 1414). Over two-thirds of the subjects reported holding other corporate jobs, (951 responses, 67%). Over one third (485, 34%) reported having been employed as flight instructors. Air taxi or charter flying was cited by 423 pilots (30%), and airline jobs, including major airlines as well as regionals and commuters, were reported by 386 pilots (27%). Seven percent (105 responses) reported flying cargo. Various other flying positions, including crop dusting, aircraft testing, surveying, aircraft demonstration, and law enforcement, were reported in 108 responses (8%). Subjects reported having held salaried flying positions with more than 3 companies on average (mean = 3.4), and having been with their present employers for an average of 9.8 yr. at the time of the survey.

Identifying which type of company aircraft they operated at the time, a majority (1248, 84%) identified jets, 25% (367) cited turboprops, 9% (137) recips, and 6% (92) rotorcraft. On average, each pilot reported flying 1.2 types of aircraft with their present companies. Most (91%) described their flight deck position as captain, and the average reported salary was $65,500. The majority (90%) of crewmembers reported operating under Part 91 FARs only, some (9%) cited both Parts 91 and 135, and a small number (1%) solely under Part 135. Very few (< 0.5%) reported operating under an alternate FAR Part, such as Part 121 or 125.

A series of 8 questions concerned subjects' experiences during corporate flight operations in the year preceding the survey. Each of these questions had 3 components: The value for a typical day and a value for each extreme (e.g., "typical," "fewest," and "most"), so that each individual reported a range. The responses for the "low" extreme were averaged, as were those for the "high" extreme, to produce the ranges shown below. In a typical month, crewmembers flew 4.8 h. of "actual IFR" (i.e., in instrument meteorological conditions, or IMC), with 1.1 h. at the fewest and 10.5 h. at most. A typical flight delay lasted almost 17 min., with the shortest 4 min. and the longest 1 h. 16 min. Pilots reported that air traffic control (ATC) delays typically occurred 2.4 times/mo., 0.5 times/mo. at least, and 5.5 times/mo. at most. On average, weather delays occurred 1.4 times during a typical month, 0.2 times in a good month, and 3.7 times during a month of bad weather. Company-mandated delays were reported as occurring 2.1 times/mo. typically, 0.6 times/mo. at least, and 4.3 times/mo. at most. Mechanical delays occurred, on average, 0.3 times in a typical month, 0.1 times/mo. at least, and 1.4 times/mo. at most. Pilots reported flying into a high density operating area 3.8 times in a typical week, at least 1.4 times/wk., and at most 8.2 times/wk. Typically, they encountered non-radar environments 4.4 times/mo., 1.8 times/mo. at the least, and 8.1 times/mo. at most.

A majority of pilots (82%) reported that they were required to wear a pager or to be available and subject to call for duty. They related that, in a typical month, they were subject to call on almost 16 days (mean = 15.6 "24-h. periods"). However, they reported actually being called out only 1.8 times on average, with 83% of the group called out between zero and two times in a typical month. When called out, pilots were typically given 3.7 h. to report for duty. Asked to compare the time normally allowed for preflight activities to the time allowed when called out (N = 846), over half (57%) described having the "same amount"

of time, 30% reported having "somewhat less" time, and 13% "much less" time.

When pilots were asked about their aspirations for advancement within the company, the most frequent response was promotion to management (including chief pilot) or to a higher management position (526 responses, 38%). The next most frequent response was "none" (394 responses, or 28%); some explained that they had already attained their desired position and some cited that no advancement was possible or that their retirement was imminent, while others did not specify a reason. Fifteen percent (210) expressed the desire to remain in their current positions, while 9% hoped to upgrade to more advanced aircraft. Eight percent (116) reported that they planned to retire soon. Seven percent (99) aspired to make captain.

Likewise, subjects were asked to identify long-term aviation goals with the following results. Over one third (481 responses, 34%) indicated retirement, and over one quarter (365, 26%) wished to maintain their current positions. Sixteen percent (230) aspired to management positions, while 10% aspired to generally advance within their present company. Nine percent (125) responded that they wanted safe, accident-free flying careers or secure jobs within the industry, and 7% (106) expressed the desire to simply continue flying. Another 7% (95)wanted to upgrade to more advanced aircraft. Six percent (80) aspired to flying for an airline.

4.4 Duty

Subjects were instructed to answer questions in this section on the flying done for their corporate aviation job only within the past year by referencing a logbook or paysheet for accuracy.

The first 5 questions concerning duty/rest patterns followed the 3-component format described above (sec. 4.3, fourth paragraph), requesting values for a typical day and for each extreme. On average, corporate pilots reported flying 13.8 duty days in a typical month, 6.9 days in the slowest month, and 20.1 days in the busiest month. They reported being scheduled for 33.4 flight hours typically, 14.4 h. at least, and 52.7 h. at most. Actual flight times averaged 35.2 h./mo. typically, 15.0 h. at least, and 55.5 h. at most. These flight hours included 3.2 legs on a typical day, 1.2 legs at least, and 7.6 legs at most. Between flights, crewmembers typically had 7.0 h. on the ground, but ground time ranged from 2.0 h. to 26.0 h., on average.

A vast majority (96%) of the pilots indicated that they performed duties in addition to flying. Maintenance, cited by 88% of these subjects, was the most frequently identified responsibility, followed by flight planning (87%), baggage handling (81%), and aircraft servicing (37%). Additionally, 41% specified other tasks, the most common of which were managerial and administrative duties.

Subjects reported starting times of the duty days in the month leading up to the survey

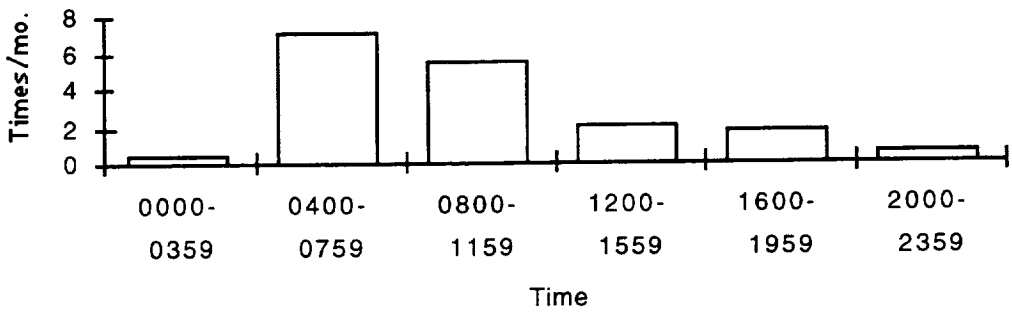


Figure 1. Duty report times in the month leading up to the survey.

(see fig.1). The early morning, from 0400–0759 local time (L), was the most commonly cited, with an average of 7.1 starts during this time period. Next most common was 0800–1159 L, with 5.5 starts on average. An average of 2.1 duty days started between noon and 1559 L, and 1.7 periods between 1600 and 1959 L. Relatively few duty periods started at night, with an average of 0.4 reports times between 2000–2359 L and 0.3 between midnight and 0359 L. On average, pilots reported that 11.1 duty days in a typical month included fewer than 8 h. of actual flight time, 3.3 duty days had between 8 and 12 h. of flight time, and 1.7 duty days required over 12 h. of flight. Pilots reported a typical duty day of 9.9 h., a shortest duty day of 4.1 h., and a longest of 16.0 h. On average, they described the longest duty day of their corporate careers as 20.2 h.

Most subjects (93%) reported staying in hotels during layover rest periods, while 7% reported staying in crew lounges or other accommodations. In a typical month of duty, subjects who stayed in hotels during layovers reported doing so 5.6 times on average, and those who reported staying in other accommodations reported doing so an average of 8.5 times. The most frequently cited alternate accommodations were crew lounges at fixed-based operators (103 responses), followed by company-owned apartments or houses (23) and the houses of friends or relatives (13). Two-thirds (67%) conveyed that their operations had a dispatch or scheduling department.

Over two-thirds of the respondents (68%, N = 1470) reported that their flight departments set a daily duty time limit, which averaged 14.8 h./day, yet most had no monthly (96%) or annual (98%) duty limits. Over half of the group (57%, N = 1462) reported having a daily flight time limit, which averaged 9.7 h., but again the majority reported no monthly (89%) or annual (91%) limits. Sixty-two percent (N = 1448) reported having a policy on minimum rest time, which averaged 9.4 h./24 h. Less than half of the group (46%) reported a minimum rest time between trips, which averaged 11.2 h. between trips. Almost a third (32%, N = 1417) reported a limit on the number of consecutive duty days, which averaged 7.2 days.

Thirty-five percent of the group reported that their companies pre-position crews to manage long-haul requirements. Similarly, 40% reported that their companies augment flight crews. Over half (56%) of those who worked for companies that augment flight crews reported that the augmenting crewmember is capable of flying as a captain.

Subjects who reported that their companies augment crews were asked to describe augmentation policies. Over a third of those who responded (152, or 35%) indicated that there was no official policy, that crews were augmented as necessary. Of those who specified a policy, some described criteria on which augmentation decisions were based, and others detailed how augmentation was implemented during operations. The most commonly cited criterion was a maximum number of duty hours without augmentation (151 responses, or 66% of those who specified a policy), followed by a maximum number of flight hours without augmentation (105, 38%), maximum duty hours with augmentation (40, 14%), whether international flying was required (34, 12%), maximum flight hours with augmentation (27, 10%), off-duty and rest considerations (19, 8%), number of flight legs (15, 5%), and consecutive trips (13, 5%). Those who related details of implementation cited qualifications for the augmenting pilot (75 responses, or 27% of those who specified an augmentation policy), pre-positioning crews (21, 8%), and rotation of crewmembers (19, 7%).

Distinguishing domestic from international flights, subjects reported flying 18.5 domestic flights in a typical month, and 1.0 international flight, on average. These flights represented 35.0 h. of domestic flight and 6.2 h. of

international flight per month. Most flights reportedly crossed 3 or fewer time zones (mean = 14.5 flights in a typical month), while few (0.7 flights/mo.) crossed between 4 and 6 time zones, and even fewer (0.3 flights/mo.) crossed more than 6 zones.

4.5 Fatigue

Subjects were asked to describe the work day during which they had experienced the most fatigue while flying corporate, and to specify contributing factors (N = 1310). These factors were categorized, and Figure 2 shows the most frequently cited factors, which included long duty days (49%), early morning departures (40%), multiple flight legs (33%), night flying (26%), weather or turbulence (26%), long waits (15%), crossing time zones (15%), workload (15%), consecutive duty days (14%), and delays (10%).

Almost three quarters of the pilots (74%) described fatigue in corporate flight operations as a "moderate" or "serious" concern, and a majority (61%) characterized fatigue as a common occurrence in corporate flying. A large majority (85%) expressed the attitude that, when crew fatigue occurs, it is a "moderate" or "serious" safety concern.

An open-ended question on the ways fatigue affects flight performance yielded responses from 1402 subjects, many of whom identified multiple effects (see fig.3 for the ten most frequently cited). Responses were categorized into general effects. The most frequently cited effect was degradation of cognitive abilities, especially judgment and decision-making, with 526 responses (38%).

Almost a quarter of the respondents (340, 24%) reported slowed reaction times. Over a fifth (293, 21%) reported decreased alertness, including loss of situational awareness and slowed perception. Inability to concentrate was cited by 247 pilots (18%). Fifteen percent (215) reported worsened mood, with 157 (11%) specifying apathetic or complacent attitudes and 69 (5%) reporting irritability. Errors of omission, especially missed radio calls and missed checklist items, were cited by 173 subjects (12%). Degradation of basic flying skills were reported by 152 pilots (11%), while sloppiness and the commission of errors were cited by 132 (9%). Almost 6% (82 responses) reported being tired, sleepy, or having trouble staying awake. Five percent (75) reported decreased crew resource management (CRM) and communication skills. Another five percent (70) responded only that their performance was degraded, without elaboration. Sixty-two pilots (4%) reported

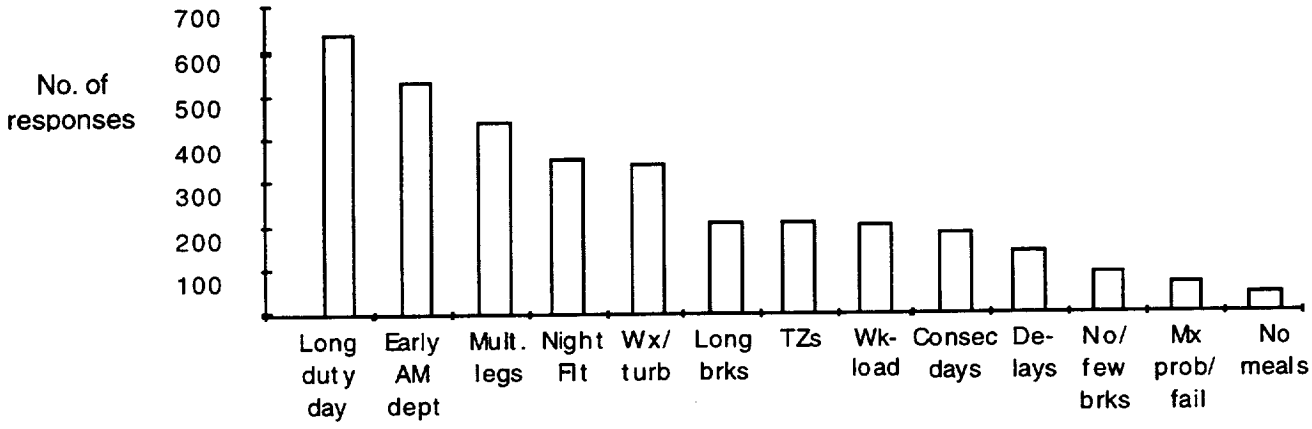


Figure 2. Factors contributing to subjects' most fatiguing work days flying corporate operations.

physical strain, especially vision problems, accompanying fatigue. Less than 2% of the respondents (21 subjects) reported that they experienced only minor or no effects from fatigue.

Over half (53% of N = 1342) of the respondents identified approach/landing as the flight phase most affected by fatigue, while 37% cited the enroute phase.

An open-ended question asked subjects to describe strategies that they use to cope with fatigue before, during, and after trips, and the responses were categorized. The most frequently reported pre-trip strategy was sleeping or napping, identified by 976 respondents (73% of those who responded to the question). Healthy diet, a category that included specific strategies such as eating lightly, was cited in 549 responses (41%). Exercise, which included staying active, was identified as a pre-trip strategy by 375 respondents (28%). Flight planning activities were cited by 352, or 26% of respondents. Sixteen percent (218) reported using caffeine to cope with pre-trip fatigue, while 139 (10%) attempted to relax or engaged in recreational activities. Crew Resource Management (CRM) was emphasized by 87 pilots (6%) as a strategy during pre-flight duties. Other coping mechanisms included staying hydrated (72, 5%), minimizing or avoiding pre-trip alcohol consumption (65, 5%), and showering or washing face and hands (62, 5%).

The most frequently reported strategies for coping with fatigue during flights were moving and stretching, identified in 494 responses (37% of those who responded to the question) (see fig. 4 for the ten most common). Keeping busy with mental or physical activities, such as reading or writing, was cited by 481 pilots (36%). Twenty-eight percent (375) emphasized staying hydrated as a coping mechanism, and approximately the same number (372, 28%) reported that engaging in conversation helped them manage fatigue. Over a quarter cited caffeine use (362, 27%). A fifth of the respondents (272, 20%) identified strategies for maintaining safe operations while fatigued, such as CRM or standard operating procedures (SOPs). Another frequently identified strategy was eating, cited by 231 subjects (17%). Napping was reported as an in-flight strategy by 184 pilots (14%). Fresh air, open vents, and cool temperatures were reported by 179 (14%) to help cope with fatigue. Other strategies identified were concentrating (68, 5%), plan ning for upcoming flight events (51, 4%), and listening to talk or music on aircraft radios (38, 3%).

Almost three-quarters of those who identified post-trip strategies cited sleeping and napping (873 respondents, 71%). Like the pre-trip strategies reported, diet (362, 30%) and exercise (346, 28%) were frequently cited. Relaxing, which included recreation, was cited by 337 (28%), followed by leaving the airport as quickly as possible, which was cited by 150

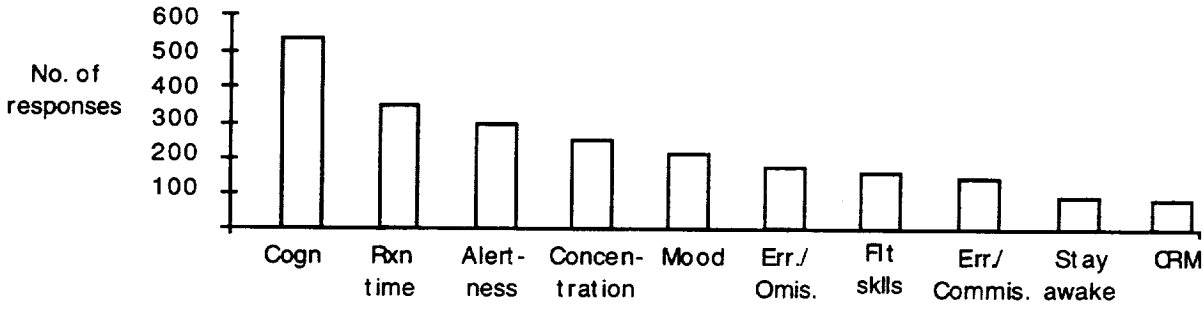


Figure 3. Effects of fatigue on flight performance.

respondents (12%). Seventy-eight pilots (6%) cited completing various duties, while 61 (5%) described resuming their normal routines or adjusting to a new time zone. Fifty-two (4%) subjects reported showering or washing face and hands. Almost 4% (46 respondents) identified drinking alcoholic beverages as a post-trip strategy for coping with fatigue.

Twelve hundred fifty-seven pilots made recommendations on how to reduce fatigue in corporate operations. Most responses (3,042) were categorized, with the following results (see fig. 5). Over a third of those who made recommendations (432 responses, 34%) suggested setting flight/duty/rest time limits—within the company, throughout the industry, or in the FARs. The second most common recommendation (423, 34%) was to improve scheduling, including detailed scheduling suggestions as well as broader scheduling considerations. The third most frequent suggestion (357, 28%) was to establish minimum rest time, recovery, and days off. Other common recommendations were shorter duty days (distinguished from setting duty limits—252 responses, 20%) and hiring additional crewmembers to relieve the flight load (192, 15%). According to 138 subjects (11%), rest facilities at layover locations would help reduce fatigue. Avoiding early morning departures or late night flights when possible was suggested by 134 (11%). The importance of education was emphasized by 122 subjects (10%), with 88 (7%) stressing the education of management and passengers on the effects of fatigue, while 68 (5%) recommended educating crewmembers. One hundred six pilots (8%) suggested that fatigue would be reduced if passengers gave more advanced notice of departure times and stayed on schedule as much as possible. Others (94, 7%) recommended avoiding consecutive early or long duty days, as well as several consecutive days. Subjects also proposed augmenting crews (85 responses, 7%), maintaining a supportive corporate environment concerning fatigue issues (82, 6%), replacing crews during long days or trips (75, 6%), and minimizing peripheral duties on flight days and days off (72, 6%).

Almost three quarters (71%) of the group reported having "nodded off" during a flight. Those who acknowledged that this had happened more than once (N = 1051) reported that, in a typical month, it occurred on an average of 4% of flights. Thirty-nine percent reported that they had ever been on a flight where arrangements were made for one crewmember to nap in the cockpit seat during the leg. Obviously, aircraft operated by a single pilot clearly do not have this option. For two-person crews, current FARs neither sanction nor specifically prohibit planned napping in the cockpit. Those who had made such arrangements (N = 799) reported that they did so on 4% of flights in a typical month. Thirteen percent acknowledged that fatigue prevented them from flying a scheduled trip at some time.

Subjects were asked to rate the extent to which

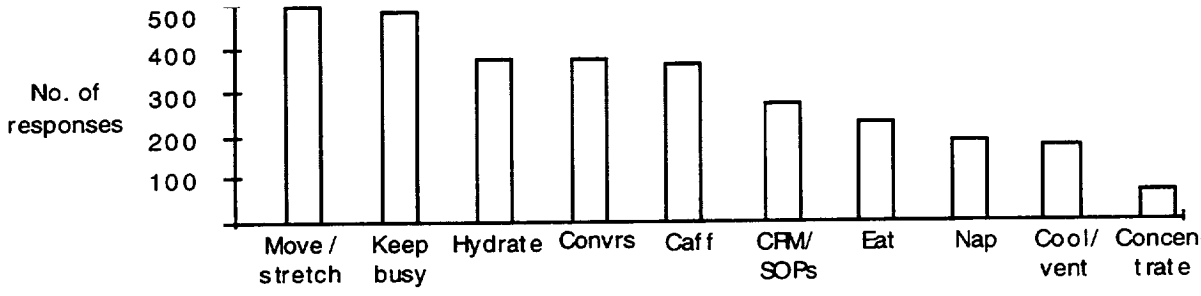


Figure 4. Strategies used by crewmembers to cope with fatigue during flights.

34 individual factors affected their fatigue levels on duty on a 4-point scale from "not at all" to "seriously." Also, they were asked to rate the frequency with which they experienced each factor on a scale from "0 = never" to "4 = very often." Responses from the first part of the question were converted to a numeric scale, assigning a value of 1 to "not at all" and a value of 4 to "seriously." Mean values were calculated for each factor. The factors with the top 10 mean values are shown in figure 6 along with the frequency rating for each factor.

The factors most frequently rated as "seriously" affecting fatigue (i.e., rated 4) were similar to those factors with the highest mean rating. They were: 1) flying 7 or more segments in the same duty day; 2) severe turbulence; 3) sleep loss; 4) time of day of operation; and 5) illness. Regarding frequency, flying 7 or more segments in the same day was reported to occur about a third of the way between "very rarely" and "sometimes" (mean = 1.3). Sleep loss was reported to occur about halfway between "very rarely" and "sometimes" (mean = 1.5). Severe turbulence received an average frequency rating of 1.0, indicating that it occurred "very rarely." Time of day of operation averaged 2.0, indicating "sometimes." Heavy workload was rated as 1.8 on average, indicating a frequency close to "sometimes." Illness was reported as occurring between "never" and "very rarely" (mean = 0.8).

4.6 Work Environment

Subjects were asked to identify safety issues emphasized by their flight departments. The most frequently cited safety issue was Crew Resource Management (CRM) or crew communication (346 responses, or 26% of subjects who responded to the question). Fatigue issues, including duty and rest considerations, were cited second most frequently, with responses from 337 subjects (25%). Standardization, including standard procedures and use of checklists, was identified by 261 responses (20%). Maintenance was emphasized in 253 responses (19%), followed by weather factors (193 responses, 14%) and flight planning (63 responses, 5%). Regulations were cited in 58 responses (4%), while health, including fitness and nutrition, was identified in 57 responses (4%). Fifty-seven others (4%) reported that their flight departments emphasized no safety issues at all. Others identified Controlled Flight into Terrain (CFIT—44 responses, 3%), passenger safety and comfort (33, 2%), and runway length (26, 2%).

Subjects cited various mechanisms for implementing the safety issues identified in the previous question. Training was the most frequently reported tool of implementation (674 responses, or 55% of subjects who responded to the question). Second most common (337, 28%) was practicing standardization, including standard operating procedures (SOPs), use of checklists, and conducting line checks. Meetings and briefings were identified in 239 responses (19%), and 158

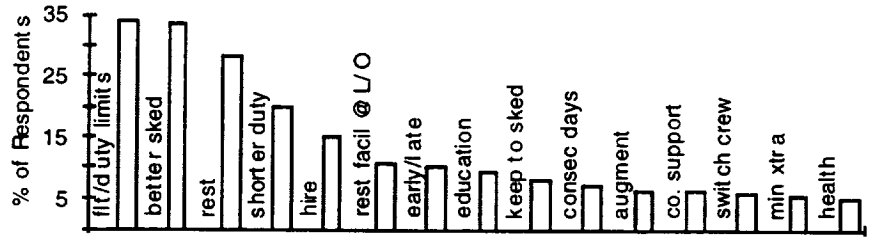


Figure 5. Crewmember recommendations for changes to reduce fatigue in corporate operations.

(13%) cited less formal communications, such as impromptu discussions or electronic mail. Written materials, such as memos, bulletins, or publications, were cited in 145 responses (12%). Scheduling or dispatch departments were identified as mechanisms for implementing safety issues in 111 responses (9%), and 75 responses (6%) specifically identified the setting of flight hours, duty hours, or rest minimums. Company support, in the form of open-door policies or supportive corporate cultures, were identified as a safety mechanism by 47 respondents (4%).

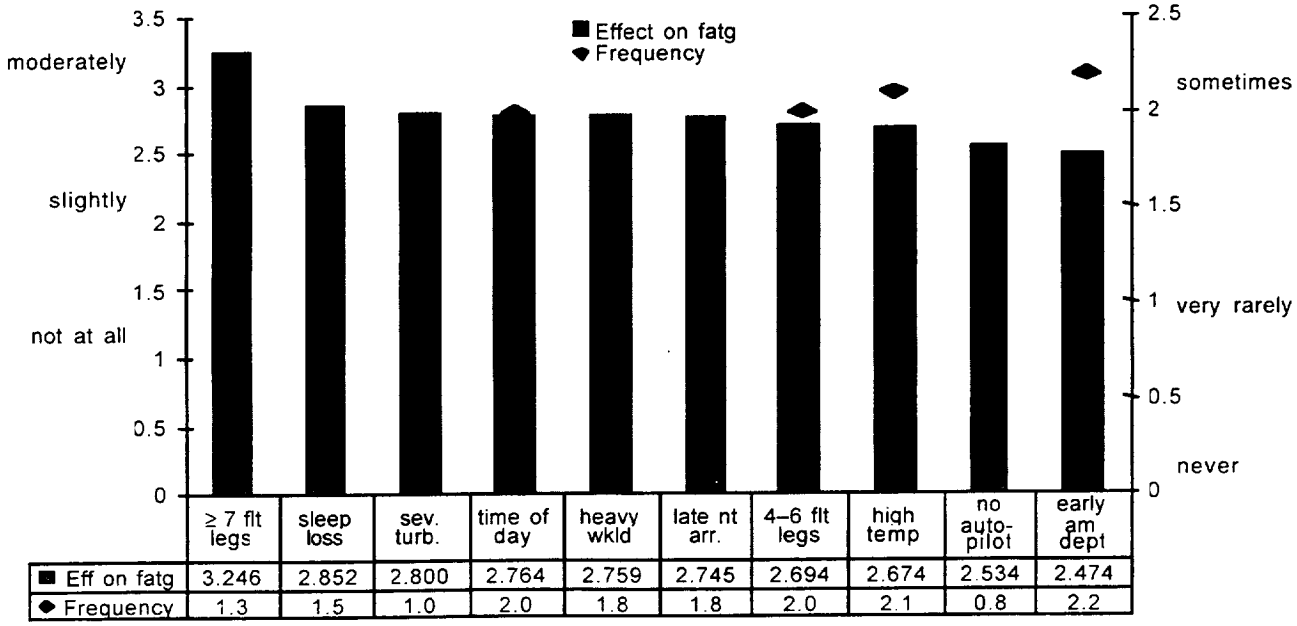
Pilots compared the safety of their flight departments to those of major airlines on a 5-point scale from "much less safe" to "much safer" with a middle rating of "as safe." Compared to the majors, 64% considered their operations "somewhat safer" or "much safer," while another 26% considered their departments "as safe." Three quarters of the corporate pilots reported feeling "secure" or "very secure" about maintaining their jobs.

Overall, pilots rated their flight department management highly, with almost two thirds (64%) describing management as "good" or "very good," while only 16% rated them "poor" or "very poor."

Over three quarters of the group (79%) reported that their flight departments did not offer any training in fatigue issues.

4.7 Management Pilots

Five hundred eighty-seven subjects (about 39% of all subjects) completed some portion of the section for management pilots—pilots who hold both a management position and a flying position. On average, management pilots reported spending 48% of their overall work time on management duties and 53% on flying. A vast majority (93%) reported that, on days when they had flying duties, they also attended to management responsibilities. The group reported that, on a typical day that included both management and flying duties, they spent 72% of the duty day flying and 29% with management duties. On average, a typical day that included only management responsibilities lasted 7.0 h., with a shortest duty day of 3.0 h. and a longest of 10.5 h. In contrast, for a day that included both types of duties, management pilots reported a typical



	≥ 7 flt legs	sleep loss	sev. turb.	time of day	heavy wkld	late nt arr.	4–6 flt legs	high temp	no auto-pilot	early am dept
■ Eff on fatg	3.246	2.852	2.800	2.764	2.759	2.745	2.694	2.674	2.534	2.474
◆ Frequency	1.3	1.5	1.0	2.0	1.8	1.8	2.0	2.1	0.8	2.2

Figure 6. Fatigue factors rated highest by crewmembers.

duty day of 10.0 h., a shortest day of 5.0 h., and a longest day of 15.0 h.

Describing their specific management duties, management pilots most frequently identified responsibilities as chief pilots, supervisors, or all aspects of management (282 responses, 50% of the 563 subjects who responded). Scheduling was another commonly cited duty, with 218 responses (39%). Others reported having responsibilities in training and CRM (92, 16%), operations (87, 15%), financial matters (77, 14%), and personnel issues (50, 9%).

Those management pilots who were involved in scheduling for their departments were asked to rank 7 factors with regard to their priority in scheduling decisions (1 = highest priority). Responses from 418 subjects conveyed that, on average, the top consideration was the pilot's duty time for that work day (mean rank = 2.2), followed by takeoff times during the night or early morning (mean rank = 3.8) and layover rest time (3.9). Availability of equipment ranked 4.0, followed by number of legs flown by the pilot (4.3), maximizing flight department cost efficiency (4.4), and time zones crossed (6.0). Some subjects provided additional written responses, which were categorized as follows: "other duty factors" (25 responses), such as consecutive duty days; passenger requirements (15 responses); and personal considerations (9 responses), such as vacation time. Collectively, these other factors received an average rating of 4.0. Responses were also assessed by calculating the frequency with which each was ranked either 1 or 2. This analysis yielded a different hierarchy of priorities. Again, pilot's duty time for the work day appeared to be the first priority, and was ranked as 1 or 2 by 68% of respondents. However, the next priority was availability of equipment, ranked 1 or 2 by 40%. The collection of "other" categories was ranked 1 or 2 by 34%, followed by maximizing flight department cost efficiency (32%). Takeoff times during the night or early morning were ranked 1 or 2 by 24%, layover rest times 21%, and number of legs flown by the pilot 16%. Time zones crossed was ranked 1 or 2 by less than 1% of respondents.

4.8 Comparative Analyses

To identify relationships among different responses, several comparative analyses were conducted.

An attempt was made to identify relationships between subjects' assessment of fatigue as a concern in corporate aviation and various other factors, such as age, corporate flight experience, aircraft type, department flight/duty limits, typical duty duration, and fatigue training. Only duty duration and fatigue training displayed significant relationships.

A median split of duty day durations (median = 10 h.) revealed that those pilots with longer duty days rated fatigue as a more significant concern (rating = 3.06) than those with shorter duty days (2.91) ($p < .001$). The group with shorter duty duration (< 10 h.) averaged 7.5 h. in a typical duty day, while the group with the longer duty duration (≥ 10 h.) averaged 11.6 h. Also, significantly more of the subjects with longer duty days (77%) characterized fatigue as a "moderate" or "serious" concern than those with shorter duty days (70%) ($p < .01$). Further, post hoc comparisons of duty day durations of less than 10 h., 10–12 h., 12–14 h., and ≥ 14 h. (with the lower limit included in the grouping) demonstrated a general trend that, as duty duration increases, the mean rating of fatigue as a concern increases. The group with the shortest typical duty day (< 10 h.) rated fatigue as a significantly lesser concern (2.91) than those in the 10–12 h. group (3.06) and the 12–14 h. group (3.08) ($p < .01$), but not the ≥ 14 h. group (3.05), possibly due to the much smaller group size and a high level of variability within that group (see fig. 7).

The median split duty day groups were compared as to their reports of whether they have nodded off. A significantly higher proportion

($p < .05$) of subjects with longer duty days reported nodding off (74%) than those with shorter duty days (69%).

A significantly smaller proportion of those subjects who reported that their flight departments offer fatigue training (51%) characterized fatigue as a common occurrence than those whose flight departments offer no fatigue training (64%) ($p < .001$).

5.0 Discussion

5.1 Study Limitations

As with any operational study, certain limitations apply to this investigation. Survey studies, in particular, are limited by the subjective nature of the data. Responses depend on subjects' perception, memory, and understanding of the questions. Additionally, subjectivity plays a well documented role in individuals' perception of their sleep (ref. 19). Individuals often make inaccurate estimates of their sleep latency times, sleep durations, awakenings, and other parameters. Attempts were made to quantify response choices to minimize interpretation of descriptors (e.g., "often—1–4 times/wk."). Also, because much of the information requested was retrospective, subjects were asked to reference their logbooks and time sheets for accuracy. Nevertheless, interpretation of the findings should allow for the limitations of subjective data.

The response rate for the survey was relatively low at 14%. This response rate may reflect that the survey took approximately 1.5 hours to complete because of its extensive length (107 questions). While the return rate was low, the total number of surveys completed and returned represents a substantial data set (N = 1488).

The survey format also has inherent sampling limitations due to the fact that voluntary respondents are a self-selected group. Further, all respondents worked for companies that were NBAA members. If crewmembers from NBAA member companies differ in some regard from other corporate pilots, then this sample would not represent accurately the corporate pilot population. However, both

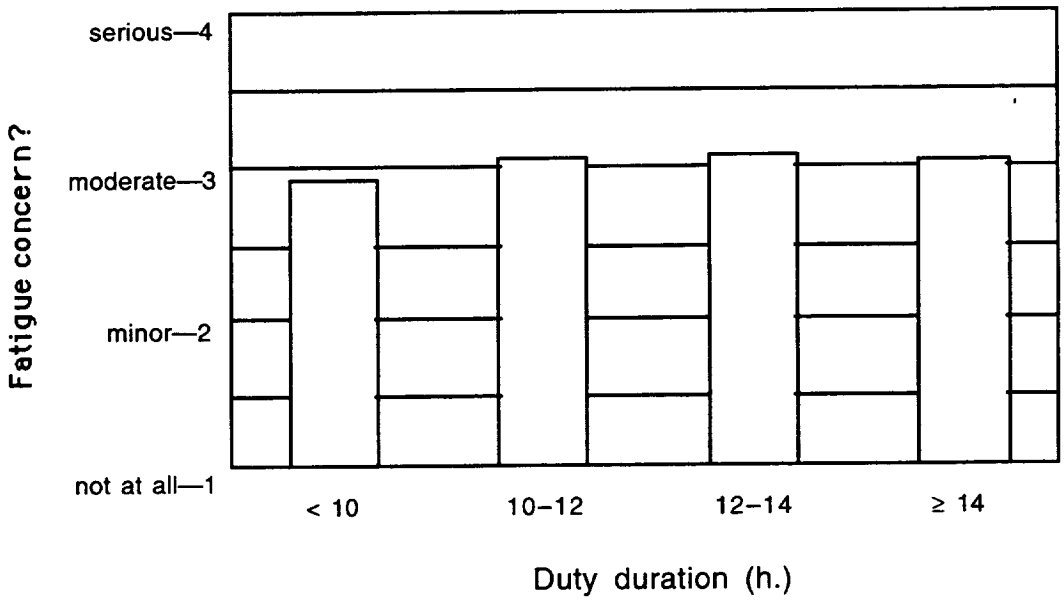


Figure 7. Ratings of fatigue as a concern in corporate operations grouped by duty duration.

industry members and investigators considered the NBAA sample to represent the population in most respects.

5.2 Major Findings

The sample of corporate pilots displayed average sleep parameters, including sleep duration (mean = 7.2 h.), sleep latency (22 min.), few reported sleep problems, and a high average rating of their own ability to sleep (89% "good" or "very good"). Because subjects presented a normal home sleep profile, their descriptions of fatigue during operations may be more likely a result of duty factors rather than any inherent sleep problems unique to these subjects.

A primary concern of the study was that of relevance. Is fatigue a concern in corporate operations, and if so, to what extent? When pilots assessed the extent to which fatigue is a concern in corporate flight operations, almost three-quarters (74%) rated it a moderate or serious concern, while another 24% rated it a minor concern. Only 2% responded that it was not at all a concern. Likewise, when asked how significant a safety issue is fatigue when it occurs, 85% considered it a moderate or serious safety issue, while only 1% considered it no safety issue. A majority identified fatigue as a common occurrence in flight operations, and almost three-quarters of the pilots acknowledged having nodded off during a flight.

Data summarized from several questions examined together portray a common corporate operation: a morning flight to a destination; a relatively long wait while business is conducted; and a return flight at the end of the business day. However, while this is a "common" scenario, corporate flight operations are quite diverse. Survey results indicated that most duty days began in the morning. Asked to report duty start times from the month preceding the survey, pilots identified report times between 0400 and 1159 (early and late morning) almost three times more frequently than all other times combined, with the majority of duty days starting between 0400 and 0759. The average typical duty day was reported to last 9.9 h., and the average typical ground time between flights was reported as 7.0 h. Pilots also reported that the majority of their duty days included fewer than 8 h. of actual flight time, which is the limit set by FARs for many commercial operations (although not for Part 91). Given choices of "< 8 h", "8–12 h," and "> 12 h," pilots reported that in a typical month, over two-thirds of their duty days contained fewer than 8 h. of flight, one-fifth contained between 8 and 12 h., and about one-tenth required more than 12 h. of flight. No range lower than 8 h. was offered in the question, and therefore more specific flight hours per duty day (i.e., under 8 h.) cannot be determined from this question. However, the average number of actual flight hours in a typical month (35.2 h) divided by the average number of duty days in a typical month (13.8 days) suggests a relative average of 2.6 hours of flight per duty day. Short flight times combined with long duty days and long ground times between flights support the possible model of morning flights "out" and evening flights "back," with long waits in between[5].

Fatigue Factors Identified

Responses to questions about subjects' duty days, their most fatiguing duty day in corporate flying, and how specific factors contributed to fatigue during operations help to identify operationally significant factors that affect fatigue, alertness, and performance in the corporate flight environment. Several factors were cited repeatedly by crewmembers as contributing to fatigue during operations. These included various scheduling and operational factors.

Scheduling Factors

As a general issue, scheduling was identified by pilots as a fatigue factor in several ways.

[5] Clearly, corporate operations do not universally follow such a pattern, and operational demands vary considerably among individual flights as well as among flight departments.

Scheduling factors accounted for six of the ten most frequently cited fatigue factors in crewmembers' worst corporate aviation work days, and seven of the ten most common recommendations made by crewmembers to reduce fatigue. Specifically, the second most common suggestion was to improve scheduling, and the ninth most common was to adhere to the schedule as much as possible. When rating the list of 34 items for their contribution to fatigue, five of the ten highest rated items concerned scheduling, and "Company scheduling practices," as an item, received an average rating of 2.3, which corresponds to between "slightly" and "moderately" contributing to fatigue.

Other common recommendations made by crewmembers to reduce fatigue included hiring additional crewmembers, augmenting crews, and switching crews, changes which would broaden scheduling options and increase the number of pilots available to complete a trip.

Specific scheduling issues identified as fatigue factors included long duty days; early morning departures, late night arrivals, and time of day of operations; rest ; multiple flight legs, long breaks between flights, and consecutive duty days. Some scheduling issues may be related to operational requirements, which must be considered.

Long duty days

There is evidence that in many cases long duty days, rather than many flight hours, may present an elemental challenge to crewmember alertness. Excessive flight time was not identified by subjects as a major fatigue factor during their most fatiguing corporate work day, nor did crews report high numbers of flight hours. In contrast, results from several questions indicated that the pilots did consider duty time a significant fatigue factor.

Crewmembers reported that their average typical duty days lasted almost 10 h., their longest duty days were 16 h. on average, and the longest duty days of their flying careers were over 20 h. on average. Duty time was highlighted in responses concerning the most fatiguing corporate duty day, suggestions for reducing fatigue in corporate operations, and safety issues emphasized by flight departments. The most common recommendation for reducing fatigue was to establish flight/duty/rest requirements (within a company, as an industry, or by regulation). The results from median splits of duty times and subsequent post hoc analysis of duty-time ranges showed significant differences in subjects' assessment of fatigue according to the length of their duty days. Those with longer duty days rated fatigue as a more significant concern in corporate flying than those with shorter duty days, and a greater number of those with longer duty days reported having nodded off during flight.

Long duty days can result in acute or cumulative sleep loss, because they may begin early, end late, or both. Other factors identified by subjects, such as multiple flight legs, long waits, and delays, can contribute to long duty periods. When experienced consecutively, even normal duty days can compound the effect and result in a cumulative sleep debt.

Early report times, late arrival times, and time of day of operations

The most common time frame for duty report times according to crewmembers was between 4 a.m. and 7:59 a.m. Early report times were the second most frequently cited factor in crewmembers' most fatiguing work days, and setting later report times was among the most commonly made recommendation to reduce fatigue. "Early morning departures" was among the ten highest rated fatigue factors, and of those ten, was reported to occur most frequently (between "sometimes" and "often").

Early morning departures can lead to sleep loss by truncating morning sleep. Data from short-haul commercial pilots indicated that progressively earlier report times on trip days

led to sleep loss (ref. 2). The study suggested that the pilots could not compensate for earlier wake times by falling asleep earlier, due to the natural tendency of the circadian system to lengthen the body's "day" rather than shorten it. Likewise, corporate pilots may not be able to fall asleep earlier to anticipate an early report time, and therefore may begin early duty days with a sleep debt.

Likewise, late night arrivals may reduce the opportunity for sleep and result in sleep loss. Late night arrivals was the sixth highest rated fatigue factor, with a rating about three-quarters of the way between "slightly" and "moderately" affecting fatigue. Avoiding late night arrivals was among the ten most common recommendations by crewmembers to reduce fatigue.

The time of day of flight operations also was emphasized as a fatigue factor by pilots. It was the fourth highest rated factor at 2.8, and night flights were the fourth most frequently cited factor in pilots' most fatiguing work day. Night flights can lead to sleep loss and circadian disruption. A pilot awake, working through night, will have an acute sleep loss by not obtaining sleep at the normally programmed circadian time. This work pattern requires sleep during the day, when the body is programmed for activity, and will physiologically result in reduced sleep quantity and quality. Also, simply reversing the sleep/wake cycle disrupts the circadian system.

Rest

Increasing rest periods or setting minimum rest requirements constituted the second most common recommendation to reduce fatigue in corporate operations. Providing rest facilities at layover sites was also among the ten most common suggestions.

Rest considerations are related to, and represent the opposite side of, duty issues. FAR Part 91 does not include minimum rest requirements. Sixty-two percent of crewmembers reported that their companies had policies on minimum rest per 24 hours, and fewer than half reported minimum rest between trips.

The duration and timing of rest periods can significantly affect the amount of sleep a crewmember may obtain. "Rest" was not an item on the list of potential fatigue factors, however, "sleep loss" was the second highest rated fatigue factor, with an average rating of 2.9 (almost "moderately" affecting fatigue).

Multiple flight segments

Operational demands often require that trip sequences include multiple flight legs. Crewmembers reported that typically, they fly 3.2 flight segments per duty day, on average, and at most they fly 7.6 flight legs, on average. Flying 7 or more flight segments in the same day was the highest rated fatigue factor, with an average rating of 3.2, between "moderately" and "seriously" affecting fatigue. Flying between 4 and 6 flight segments was the seventh highest rated factor. When crewmembers identified fatigue factors that contributed to their worst work days, multiple flight legs was the third most frequently cited factor. Multiple flight legs also may contribute to long duty days. Additionally, flying multiple flight legs increases the amount of time spent in critical, low-altitude phases of flight.

Long breaks between flights

Crewmembers reported that the typical ground time between flights was 7 h., on average. This figure is consistent with a model of flying to a destination, waiting while business is conducted, and then conducting a return flight. These extended breaks may contribute to long duty days, and rest may not be possible during the breaks. Long breaks were the sixth most frequently cited factor contributing to crewmembers' most fatiguing work days. In recommendations to reduce fatigue in corporate aviation, providing rest facilities at the layover destination was the sixth most common suggestion. The predictability of the flight schedule also may affect the ability of crewmembers to obtain rest during long waits.

Consecutive duty days

The effects of long duty days, sleep loss, and other factors may be compounded by repetition over several days. Less than one-third of the group reported that their companies limited the number of consecutive duty days flown. Consecutive days of work were emphasized as a fatigue factor in crewmembers' descriptions of their most fatiguing work day as well as in their recommendations to reduce fatigue in corporate operations.

Operational Factors

Corporate/executive aviation has specific operational requirements in order to provide service to companies and individuals while maintaining safety and efficiency. While it is critical to fulfill the operational needs, identifying and acknowledging fatigue factors may allow for the development of useful strategies to reduce their effects.

Workload

The role of workload in fatigue is complex and not clearly defined. However, anecdotal evidence and common sense suggest that higher workloads may contribute to fatigue, particularly over the course of a long duty day. It is noteworthy that 96% of all subjects reported that they had additional duties, peripheral to their flight duties, including maintenance, flight planning, baggage handling, aircraft servicing, and dispatch. Multiple flight legs also can contribute to high workload because more time is spent in the task-intensive flight phases of takeoff, climb, approach, and landing. Bad weather can increase workload as well, especially in the already busy phases of takeoff and approach/landing. Further, time spent in non-radar environments (reported as occurring 4.4 times in a typical month) can increase the crew's responsibility for traffic avoidance and general vigilance.

"Heavy workload" was the fourth highest rated fatigue factor, with an average rating of 2.8 (more than three-quarters of the way between "slightly" and "moderately" fatiguing), and "flying without an autopilot" was the ninth highest, with a rating of 2.5 (halfway between "slightly" and "moderately" fatiguing). Workload was highlighted further by crewmember responses concerning their most fatiguing workdays (the eighth most commonly cited contributing factor) and by their recommendations to minimizing extra (non-flight-related) duties as a way to reduce fatigue in corporate operations.

Weather and environmental factors

Weather, turbulence, and high temperatures were identified as fatigue factors in pilots' responses to several questions. The contribution of these phenomena to fatigue may be related to workload, physical discomfort, stress, or other factors. Weather and turbulence accounted for the fifth most frequently identified contributor to crewmembers' most fatiguing work days. Severe turbulence and high ambient temperatures were the third and eighth highest rated fatigue factors, although it is noteworthy that severe turbulence was rated as occurring "very rarely—1–10 times/yr.)." Flying in actual IFR conditions (i.e., IMC) was rated 2.3 as a fatigue factor, which corresponds to an assessment between "slightly" and "moderately" fatiguing. Instrument weather conditions may further exacerbate workload when no autopilot is available.

Time Zones

On average, crewmembers reported that typically 2% of flights crossed more than 6 time zones, 5% crossed between 4 and 6 time zones, and 93% crossed 3 or fewer time zones. Crossing time zones was the seventh most commonly cited factor contributing to pilots' most fatiguing work days, and "Time-zone changes" was rated 2.4 as a fatigue factor, which corresponds to almost half-way between "slightly" and "moderately" fatiguing.

Crossing multiple time zones can result in sleep loss and disruption of the circadian system, which can lead to other symptoms of "jet

lag," including decreased alertness and performance.

Effects of Fatigue

Subjects' responses concerning how fatigue affected pilot performance, what phase of flight was most affected, the significance of fatigue as a safety issue, and related questions indicate some effects of fatigue.

As described previously, 85% of the corporate pilots expressed the opinion that when crew fatigue occurs, it is a moderate or serious safety issue, and over half of the respondents identified approach-and-landing as the flight phase most affected by fatigue, given five choices, and another 5% identified taxi or takeoff. Low-altitude and terminal operations such as takeoff and landing are critical, high-workload phases of flight. In 1995, almost half (49%) of the accidents involving Part 121 operators (including the major airlines), 66% of those involving Part 135 operators (most regional airlines), and 61% of accidents involving Part 91 operators (general aviation, including corporate/executive, business, and personal flying) occurred during taxi, takeoff, approach, or landing (refs. 20 and 21). These statistics emphasize the vital importance of peak alertness and performance during low-altitude and terminal phases of flight.

Specifically, pilots reported that fatigue had the following affects on their performance: slowed and degraded cognitive abilities, especially judgment and decision-making; slowed reaction time; degraded alertness, including loss of situational awareness; inability to concentrate; worsened mood, including complacency and irritability; errors of omission; deteriorated flying skills; and increased commission of errors. These reported effects of fatigue on performance are consistent with established scientific findings (e.g., refs. 13 and 14).

Pilot/Industry Response to Fatigue

With minimal guidance from the FARs on the issues, some industry members—including individual pilots, entire flight departments, and industry groups—have developed strategies to address the challenges of fatigue in corporate flight operations. At the individual level, strategies vary greatly, often tailored to the person's work conditions, physiology, and lifestyle. At the company level, approaches include augmentation, pre-positioning, and developing flight/duty/rest limits and other standard operating procedures. Industry groups have organized efforts in areas such as education, research, and policy recommendations.

Over a third of the subjects reported that their companies pre-positioned crews to manage long-haul requirements, and forty percent reported that their companies augmented flight crews. The most frequently reported criteria for augmentation were: "as necessary" (no official policy), duty-hour limit, flight-hour limit, international flight, number of rest hours, number of flight segments, and consecutive duty days. Crewmembers who described methods of implementing augmentation cited pilot qualifications, pre-positioning crews, and rotating crewmembers through flight deck positions.

Many subjects reported that their flight departments have developed duty or flight limitations, or rest requirements. However, besides daily flight and duty limits, consideration should be given to cumulative effects that can contribute to fatigue. Therefore, weekly, monthly, and yearly limits may help reduce cumulative fatigue, yet fewer than 4% reported monthly duty limits (11% flight time limits) and only 2% yearly limits (9% flight time limits).

Pilots identified personal strategies that they used to cope with fatigue pre-trip, in-flight, and post-trip. The most common strategies identified by pilots emphasized overall health: sleep, diet, exercise, and hydration. Other strategies were common techniques for masking fatigue, such as physical movement, caffeine consumption, washing face and hands

with cool water, and engaging in conversation. Some strategies, such as practicing CRM, following SOPs, and extra flight planning, suggested attempts to compensate for fatigue with the goal of maximizing flight safety. It is noteworthy that many crewmembers reported using alcohol (the most commonly used central nervous system depressant) as a post-trip strategy to relax or fall asleep. Rather than enhancing sleep, alcohol can disrupt sleep and result in the suppression of REM sleep, disrupting both sleep quantity and quality. Therefore, it is typically not an effective sleep aid. Interestingly, almost as many pilots reported avoiding alcohol post-trip as those who reported using it, which suggests that some crewmembers may be aware of the detrimental effects of alcohol on sleep.

Subjects made over 3,000 suggestions for change to reduce fatigue in corporate operations. These suggestions help identify fatigue factors and potentially useful recommendations. The most common suggestion was to set flight/duty/rest limits at some level: within the company, throughout the industry, or through regulation. This idea reinforces the identification of duty and rest times as significant factors in fatigue. The second most recommended change was to improve scheduling, with some subjects suggesting general improvements while others outlined specific preferences. Rest and recovery time were emphasized by many subjects. Others stressed shorter duty days (without necessarily setting limits), which re-emphasizes duty time. Hiring additional crewmembers and procuring rest facilities at layover destinations were other common recommendations. Many pilots expressed that determining departure times earlier and staying on schedule as much as possible would enable them to plan their layover time to maximize rest opportunities and would minimize the stress of an unknown timetable.

5.3 Recommendations

The demands of corporate flight operations are varied and complex, as are the physiological requirements of the human body. With one complex system interacting with another, no simple answer will exist to fully eliminate fatigue from the demands of 24-hour global flight operations. Comprehensive, thoughtful approaches are crucial to address issues of fatigue, alertness, and performance in the industry while providing safe, efficient operations that meet the transportation needs of companies and individuals. These issues can be addressed most effectively by applying current scientific knowledge to each facet of operations, including education and training, hours-of-service and policy-making, scheduling, alertness strategies, design and technology, and research (ref. 22).

Education

The coping mechanisms described by subjects demonstrate that many in the industry—individual pilots as well as flight departments—have already begun to address fatigue issues. However, while some of those strategies may be effective (e.g., naps, caffeine), others may be detrimental (e.g., use of alcohol as a sleep aid). Successful alertness management depends on the systematic use of accurate information.

An integral component of any approach, education can provide scientifically validated information on which to base personal alertness strategies, flight department policies, and industry initiatives. Educating corporate passengers and management, in addition to pilots, is a critical step in developing an approach to fatigue, and it was among the most frequent suggestions made by pilots to reduce fatigue in the industry. The maximum benefit from education may be gained when it is available to all industry members, including policymakers, flight department management, dispatchers, schedulers, maintenance technicians, flight crews, and others. Accurate information on sleep, circadian factors, how flight operations interact with these physiological factors, and countermeasure strategies provides an important foundation for any effective approach.

Flight, Duty, and Rest Guidelines

Flight/duty/rest limitations are other potentially useful tools. Establishing flight duty limits and minimum rest requirements was the change most frequently suggested by subjects to reduce fatigue. Such limitations can be established in various ways, with different effects: while some of the pilots suggested regulating limits, many others recommended setting them within the company or in the industry, independent of regulation. By proactively setting industry limits and voluntarily abiding by them, operators may maintain more flexibility and control than under a regulated approach.

According to the data, many flight departments have already implemented certain limits. However, while many subjects reported daily limits in effect at their companies, these policies, as a group, overlook cumulative flight and duty time, recovery time, and other factors. To be effective, flight, duty, and rest limits should be based on meaningful data from the operational environment. A comprehensive, scientifically-based approach offers the greatest benefit.

Toward this end, the Flight Safety Foundation worked with the NASA Ames Fatigue Countermeasures Program to develop Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation (ref. 23). This document outlines general scheduling considerations based on physiological principles, and then provides specific guidelines to address duty and rest scheduling needs of corporate and business aviation. The document offers corporate flight departments a way to proactively address flight/duty/rest issues that affords valuable operational flexibility.

Scheduling

Several scheduling considerations, including long duty days, multiple flight segments, sleep loss, the time of day of the operation—especially early mornings and late nights, and consecutive duty days were repeatedly identified as significant factors in operational fatigue. Additionally, pilots included in their recommended changes to reduce fatigue that more predictable scheduling and more adherence to schedules would help them plan layover time appropriately for maximum rest.

The fact that several of the primary fatigue factors identified relate to scheduling suggests that corporate flight departments may benefit from re-examining scheduling practices and incorporate available knowledge concerning alertness and fatigue. In particular, duty duration, number of flight segments, very early and very late flight times, consecutive long duty days, and the setting and adherence to schedules may deserve special attention. Augmentation, additional or pre-positioned crews, and crew rest facilities (on-board or at destination) are among the many practices used by corporate flight departments to address their trip requirements while addressing fatigue. Clearly, consideration of these factors must be balanced with operational and economic demands.

Operations

Operational factors, in many cases, may be challenging to address because certain operational requirements are either unchangeable (e.g., time zone changes, weather) or may involve economic choices.

For example, in several questions, crewmembers identified workload as a fatigue factor, specifying additional non-flight-related duties in some cases. Minimizing these peripheral duties may help to reduce fatigue, yet refueling, baggage handling, maintenance, or other duties must still be accomplished and may represent economic challenges to a small flight department. As with other fatigue issues, a balance between safety, operational requirements, and economic considerations will be critical to a successful approach.

These recommendations, based on the data from corporate pilots, address various segments of corporate/executive flight operations,

including flight crews, flight department management, schedulers, and policy makers. The responses from corporate crewmembers reinforce that there are multiple causes of fatigue in corporate flight operations. Likewise, there will be no simple solution. A comprehensive approach that comprises education of operators and flight crews, informed duty policies, improved scheduling, continuous development of countermeasure strategies and technology, and the research necessary to guide and validate these endeavors, will provide maximum benefit to safety and efficiency in corporate flight operations.

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Appendix A

Corporate/Executive Operations Survey

Copy of Blank Survey

Corporate/Executive Operations Survey

Fatigue Countermeasures Program
Flight Management and Human Factors Division
NASA Ames Research Center
Moffett Field, CA

CORPORATE/EXECUTIVE OPERATIONS SURVEY

NASA is studying fatigue, alertness, and performance issues that affect flight crews in corporate/executive operations. Please complete this survey and return it in the enclosed self-addressed, stamped envelope.

DO NOT WRITE YOUR NAME ON THIS SURVEY. This will ensure anonymity for you and your company. This survey will be administered to several US corporate flight departments and will be held in the strictest confidence.

<u>For research purposes only</u>

First, please answer these general questions about your company and flight department:

How many of each type of aircraft does your company flight department operate?

☐ recips ☐ rotorcraft ☐ turbojets ☐ turboprops

How many pilots are employed by your flight department?

☐ pilots employed

Does your company fly strictly North American domestic routes or a combination of North American domestic and international routes? (Check only one.)

☐ N. Amer. dom only ☐ N. Amer. dom + int'l ☐ other (specify) _____

In which company division, department, or structure is your flight department included?

_____

If, by some chance, you know how many people are employed by your company (not just your flight department) please enter the number in the box.

☐ total company employees

GENERAL SURVEY DIRECTIONS:

I. **Please answer all questions, and please be as accurate as possible. All information is confidential and anonymous.**

II. **Please mark boxes and lines as follows:**

Small boxes should get a checkmark or an "x": ☐ Í ☑ or ☒

Large boxes should get a number: ☐ Í 204

Lines should get text: _____ Í kids

III. **Watch for special instructions relating to a question or set of questions.**

A. GENERAL

1. Gender? ☐ male ☐ female

2. Age? ☐ yr

3. Weight? ☐ lb

4. Height? ☐ ft ☐ in

5. In what time zone is your home base? (Check only one.) ☐ Eastern ☐ Central ☐ Mtn. ☐ Pacific ☐ Hawaii ☐ Alaska ☐ other (GMT) _____

6. In what time zone do you live? (Check only one.) ☐ Eastern ☐ Central ☐ Mtn. ☐ Pacific ☐ Hawaii ☐ Alaska ☐ other (GMT) _____

7. How long does it usually take you to travel from your home to your home base? ☐ hr and ☐ min

8. What is your usual mode of transportation from your home to your home base? (Check only one.) ☐ auto ☐ airplane ☐ other—specify _____

9. Do you currently hold another job(s) in addition to your corporate flying job? (If "no," skip to #11.) ☐ yes ☐ no

10. How many hours do you spend at your additional job(s) in a typical month? ____ hr

B. SLEEPING AT HOME

Based on **an average night of sleep at home** (at least 2 days after your return home following a trip), please give one best answer to each of the following questions. **Use your local 24-hour clock.**

11. On average, how many nights of sleep do you get at home between trips? ____ nights

12. On your days off duty, what time do you usually go to bed? ____ time, 24-hr clock

13. On your days off duty, how long after going to bed do you usually fall asleep? ____ hr and ____ min

14. When sleeping at home, how many times on average do you wake up? ____ times

15. If you wake during the night, what most often awakens you? (Check **ONLY** one answer.)
☐ bathroom ☐ can't sleep
☐ children/spouse ☐ noise
☐ other _____

16. If you wake during the night, on average, how long does it take you to go back to sleep? ____ hr and ____ min

17. When sleeping at home, what is the amount of total sleep you get on average? ____ hr and ____ min

18. On your days off duty, what time do you usually get out of bed? ____ time, 24-hr clock

19. How often do you take a nap at home?

never ☐ | rarely 1-10 /yr ☐ | sometimes 1-3 /mo ☐ | often 1-4 /wk ☐ | very often 5-7 /wk ☐

20. On average, how long are your naps?

☐ hr and ☐ min

21. When sleeping at home, how often do you have problems getting to sleep?

never ☐ | rarely 1-10 /yr ☐ | sometimes 1-3 /mo ☐ | often 1-4 /wk ☐ | very often 5-7 /wk ☐

22. How often do you take medication to help you sleep? (If "never," skip to #25.)

never ☐ | rarely 1-10 /yr ☐ | sometimes 1-3 /mo ☐ | often 1-4 /wk ☐ | very often 5-7 /wk ☐

23. If you take medication to help you sleep, please specify the medication and dose.

name: _____ dose: _____

24. Rate the effectiveness of the medication.

not at all effective ☐ | ☐ | moderately effective ☐ | ☐ | very effective ☐

25. How often do you use alcohol to help you sleep?

never ☐ | rarely 1-10 /yr ☐ | sometimes 1-3 /mo ☐ | often 1-4 /wk ☐ | very often 5-7 /wk ☐

26. Overall, what kind of sleeper are you?

very poor ☐ | poor ☐ | good ☐ | very good ☐

27. Do you snore?

yes ☐ | no ☐

28. Do you have a sleep problem? (If "no," skip to #32.)

yes ☐ | no ☐

29. What is your sleep problem?

_____

30. Has it been diagnosed by a physician?

yes ☐ | no ☐

31. Has it ever prevented you from flying a scheduled trip? yes ☐ no ☐

REMEMBER: Give only one best answer (for each factor) based on an average night of sleep at home (at least 2 days after you return from a trip).

32. Please rate the following factors and indicate how much they affect your sleep.

	interferes 1	2	no effect 3	4	promotes 5
a) quality of sleep surface	☐	☐	☐	☐	☐
b) heat	☐	☐	☐	☐	☐
c) cold	☐	☐	☐	☐	☐
d) thoughts running through your head	☐	☐	☐	☐	☐
e) random noise events	☐	☐	☐	☐	☐
f) constant background noise	☐	☐	☐	☐	☐
g) background lighting	☐	☐	☐	☐	☐
h) readiness for sleep	☐	☐	☐	☐	☐
i) comfort of clothing	☐	☐	☐	☐	☐
j) low humidity/dry air	☐	☐	☐	☐	☐
k) high humidity	☐	☐	☐	☐	☐
l) trips to bathroom	☐	☐	☐	☐	☐
m) bed partner	☐	☐	☐	☐	☐
n) privacy	☐	☐	☐	☐	☐
o) ventilation	☐	☐	☐	☐	☐
p) sheets	☐	☐	☐	☐	☐
q) blankets	☐	☐	☐	☐	☐
r) pillows	☐	☐	☐	☐	☐
s) other (specify)_____	☐	☐	☐	☐	☐

33. Please rate the following on the extent to which they **interfere** with your sleep at home.

	strongly interferes 1	2	3	4	no effect 5
a) hunger	☐	☐	☐	☐	☐
b) thirst	☐	☐	☐	☐	☐
c) personal worries	☐	☐	☐	☐	☐
d) respiratory factors (i.e., asthma, allergies, etc.)	☐	☐	☐	☐	☐
e) other (specify)_____	☐	☐	☐	☐	☐

34. From the list in #32, please write the letters of the top three factors that **promote** your sleep at home in rank order.

1. _____
2. _____
3. _____

C. FLYING INFORMATION

35. How many total flight hours did you have when you were hired for your current corporate flying position? ☐ hr

36. How many total flight hours have you logged in your lifetime? ☐ hr

37. What certificates/ratings do you currently hold? (Check all that apply.)
☐ commercial (airplane) ☐ instrument (rotorcraft) ☐ ATP (airplane)
☐ commercial (rotorcraft) ☐ CFI/MEI (airplane) ☐ ATP (rotorcraft)
☐ instrument (airplane) ☐ CFI/MEI (rotorcraft)
☐ other: _____

38. How many years have you been flying corporate aviation? ☐ yr

39. How many hours do you have in the following categories? (All categories are separate and exclusive.)
☐ corporate ☐ military ☐ general aviation ☐ other—specify: _____

40. How many hours do you fly in the following categories in a typical month? (All categories are separate and exclusive.)
☐ corporate ☐ military ☐ general aviation ☐ other—specify: _____

41. List all non-military salaried flying jobs you have had in your aviation career. (e.g., "capt., regional carrier.")
_____
_____
_____

42. With how many different companies (including your present employer) have you held a salaried flying position? ☐ companies

43. Which company aircraft do you currently fly? (Check all that apply.)
☐ helicopters ☐ turboprops ☐ other (specify) _____
☐ recips ☐ turbojets

44. List all company aircraft (make/model) that you currently fly, and your flight hours in each.

make and model	hours
_____	☐
_____	☐
_____	☐

45. How long have you been employed by your present company? ☐ yr and ☐ mo

46. Under which of the following FAR Part(s) do you currently fly in your job? (Check all that apply.) ☐ Part 135 ☐ Part 91 ☐ Other (specify) _____

47. What is your annual salary in your current corporate flying position? $ ☐

48. What is your flight deck position? Capt ☐ F/O ☐

Answer questions 49–61 according to the flying done **ONLY** for your corporate aviation job within the past year.

49. How many hours of actual IFR did you fly in a month (not just filed flight plans, but IMC)?	☐ hr typical	☐ hr fewest	☐ hr most
50. What was the duration of a flight delay?	☐ min typical	☐ min shortest	☐ min longest
51. How frequently did ATC delays occur?	☐ per mo typical	☐ per mo least	☐ per mo most
52. How frequently did delays occur due to weather?	☐ per mo typical	☐ per mo least	☐ per mo most
53. How frequently did company-mandated flight delays occur?	☐ per mo typical	☐ per mo least	☐ per mo most

54. How frequently did mechanical delays occur? ☐ per mo typical ☐ per mo least ☐ per mo most

55. How frequently did you fly into a high density operating area? ☐ per wk typical ☐ per wk least ☐ per wk most

56. How frequently did you fly into a non-radar environment? ☐ per mo typical ☐ per mo least ☐ per mo most

57. In your company, can you be required to wear a beeper (or to be available through other means) and subject to call for duty? (If "no," skip to #62.) yes ☐ no ☐

58. In a typical month, during how many 24-hr periods were you subject to call? ☐ 24-hr periods

59. How many times were you actually called out? (If "0," skip to #62.) ☐ times

60. How much time were you typically given to report for duty when called out? ☐ hr

61. Compared to the time usually allowed for preflight activities, how much time was allowed when you were called out? ☐ much less ☐ somewhat less ☐ same amount

62. What are your aspirations for advancement in your current company? _____

63. What are your long-term aviation career goals? _____

D. DUTY

Please answer the following questions **using your logbook or paysheet**, according to the flying done **ONLY** for your corporate aviation job within the past year.

64. How many duty days did you fly in a month?

☐ days typical ☐ days fewest ☐ days most

65. What was your number of **scheduled** flight hours per month?

☐ hr typical ☐ hr fewest ☐ hr most

66. What was your number of **actual** flight hours per month?

☐ hr typical ☐ hr fewest ☐ hr most

67. How many flight segments did you fly in a duty day?

☐ typical ☐ fewest ☐ most

68. How much time did you have on the ground between flights (time between blocking in and out)?

☐ hr typical ☐ hr fewest ☐ hr most

69. What duties, if any, do you perform in addition to your flying duties? (Please check all that apply, or "none.")

- ☐ maintenance
- ☐ flight planning
- ☐ baggage handling
- ☐ none
- ☐ dispatch
- ☐ safety officer
- ☐ aircraft servicing
- ☐ other _____

70. During the past month, how many times did you report for duty during each of the following time periods?

- ☐ 0000–0359 hr
- ☐ 0400–0759 hr
- ☐ 0800–1159 hr
- ☐ 1200–1559 hr
- ☐ 1600–1959 hr
- ☐ 2000–2359 hr

71. In a typical month, on how many duty days did your actual flying time fall into each range?

☐ <8 hr ☐ 8–12 hr ☐ >12 hr

72. What was the duration of your duty day?

typical: ☐ hr and ☐ min
shortest: ☐ hr and ☐ min
longest: ☐ hr and ☐ min

73. What was the longest duty day you have had in your corporate flying career?

☐ hr and ☐ min

74. In a typical month of flying, how many times did you stay in the following accommodations during your layover rest periods?

☐ times hotel

☐ times other: specify _____

75. Does your operation have a dispatch/ scheduling department?

yes ☐ no ☐

76. What are your flight department's policies on the following? (Please fill in values or check "no limit.")

duty time limit:	☐ hr per day	☐ per mo	☐ per yr	☐ no limit
flight time limit:	☐ hr per day	☐ per mo	☐ per yr	☐ no limit
minimum rest per 24 hours	☐ hr per 24-hr period			☐ no limit
minimum time off between trips	☐ hr between trips			☐ no limit
maximum consecutive duty days	☐ consecutive duty days			☐ no limit

77. To manage long-haul requirements, does your company pre-position crews?

yes ☐ no ☐

78. Does your company augment flight crews? (If "no," skip to #81.)

yes ☐ no ☐

79. What flight deck position is the augmenting crewmember capable of holding?

Capt ☐ F/O ☐

80. Describe your company's crew augmentation policies (e.g., minimum flight/duty time for augmentation, in-flight rostering, etc.)

_____

_____

_____

81. In a typical month, how many domestic and international flights did you fly?

☐ domestic flights per mo ☐ int'l flights per mo

82. These flights represent how many hours per month of domestic and international flying? ☐ hr domestic per mo ☐ hr int'l per mo

83. In a typical month, how many flights involved time-zone changes of the following magnitudes? ☐ flights 0–3 zones ☐ flights 4–6 zones ☐ flights over 6 zones

E. FATIGUE

84. Use the following parameters to describe the sequence of **3 consecutive trips** during which you experienced the most fatigue in corporate flying:

a) **Off-duty time prior to trip 1:** ☐ # days (24-hr periods) ☐ # sleep periods

b) **Trip 1:** ☐ # days (24-hr periods) ☐ cumulative duty time (hr) ☐ avg. layover duration (hr) ☐ total # legs ☐ cumulative flight time (hr)

c) **Off-duty time between trips 1 and 2:** ☐ # days (24-hr periods) ☐ # sleep periods

d) **Trip 2:** ☐ # days (24-hr periods) ☐ cumulative duty time (hr) ☐ avg. layover duration (hr) ☐ total # legs ☐ cumulative flight time (hr)

e) **Off-duty time between trips 2 and 3:** ☐ # days (24-hr periods) ☐ # sleep periods

f) **Trip 3:** ☐ # days (24-hr periods) ☐ cumulative duty time (hr) ☐ avg. layover duration (hr) ☐ total # legs ☐ cumulative flight time (hr)

g) **Off-duty time before next trip:** ☐ # days (24-hr periods) ☐ # sleep periods

85. Regarding fatigue, describe the **work day** during which you've experienced the most fatigue while flying corporate, including the specific factors that made it difficult.

_____

_____

_____

_____

86. In your opinion, to what extent is fatigue a concern in corporate flight operations? ☐ not at all ☐ minor ☐ moderate ☐ serious

87. Is crew fatigue a common occurrence in flight operations?

yes ☐ no ☐

88. When crew fatigue occurs, how significant a safety issue is it?

not at all ☐ minor ☐ moderate ☐ serious ☐

89. In what ways does fatigue affect your flight performance?

_____

_____

90. When your flight performance is affected by fatigue, which phase of flight performance is most affected? (Choose only **ONE** answer.)

☐ taxi
☐ takeoff
☐ enroute
☐ descent
☐ approach/landing

91. List in rank order three strategies (for each heading) that you use to cope with fatigue.

PRETRIP:

1. _____
2. _____
3. _____

IN-FLIGHT:

1. _____
2. _____
3. _____

POSTTRIP:

1. _____
2. _____
3. _____

92. What three changes would you make to reduce fatigue in corporate operations? List the most important first.

1. _____
2. _____
3. _____

93. Have you ever "nodded off" during a flight? (If "no," skip to #95.)

yes ☐ no ☐

94. If this has occurred more than once, on what percentage of flights in a typical month does it occur? ☐ % flights in typical mo

95. Have you ever been on a flight where arrangements were made for one of the pilots to nap in their cockpit seat during the leg? (If "no," skip to #97.) yes ☐ no ☐

96. In a typical month, on what percentage of flights does this occur? ☐ % flights in typical mo

97. Has fatigue ever prevented you from flying a scheduled trip? yes ☐ no ☐

98. For the following question:
    1. Check the box that represents the extent to which each factor affects your fatigue level on duty.
    2. Then, in the far right column, write the number that corresponds to how frequently you experience each factor (based on the Frequency Scale below).
    3. In the "Comments" section at the end of this question, please elaborate on any factors as needed.

Frequency Scale

0=never | 1=very rarely (1-10/yr) | 2=sometimes (1-3/mo) | 3=often (1-4/wk) | 4=very often (5-7/wk)

		not at all	slightly	moderately	seriously	frequency
a)	VFR flight	☐	☐	☐	☐	
b)	IFR flight (actual IMC)	☐	☐	☐	☐	
c)	Light turbulence	☐	☐	☐	☐	
d)	Moderate turbulence	☐	☐	☐	☐	
e)	Severe turbulence	☐	☐	☐	☐	
f)	High ambient temperatures	☐	☐	☐	☐	
g)	Low ambient temperatures	☐	☐	☐	☐	
h)	Icing	☐	☐	☐	☐	
i)	ATC interactions	☐	☐	☐	☐	
j)	Passenger interactions	☐	☐	☐	☐	
k)	Interacting w/ other co. employees	☐	☐	☐	☐	

		not at all	slightly	moderately	seriously	frequency
l)	Flying multiple segments in the same duty day					
	1–3	☐	☐	☐	☐	☐
	4–6	☐	☐	☐	☐	☐
	7 or more	☐	☐	☐	☐	☐
m)	Time-zone changes	☐	☐	☐	☐	☐
n)	Flying without an autopilot	☐	☐	☐	☐	☐
o)	Company scheduling practices	☐	☐	☐	☐	☐
p)	Time of day of operation	☐	☐	☐	☐	☐
q)	Early morning departures	☐	☐	☐	☐	☐
r)	Late night arrivals	☐	☐	☐	☐	☐
s)	FAR flight/duty/rest limitations	☐	☐	☐	☐	☐
t)	Sudden scheduling changes	☐	☐	☐	☐	☐
u)	Heavy workload	☐	☐	☐	☐	☐
v)	Aircraft vibration when flying	☐	☐	☐	☐	☐
w)	Unpressurized cockpit	☐	☐	☐	☐	☐
x)	Noise	☐	☐	☐	☐	☐
y)	Luggage handling	☐	☐	☐	☐	☐
z)	Aircraft servicing	☐	☐	☐	☐	☐
aa)	Company mgmt. responsibilities	☐	☐	☐	☐	☐
bb)	Lack of available nutritious food	☐	☐	☐	☐	☐
cc)	Dehydration	☐	☐	☐	☐	☐
dd)	Illness	☐	☐	☐	☐	☐
ee)	Emotional stress	☐	☐	☐	☐	☐
ff)	Sleep loss	☐	☐	☐	☐	☐
gg)	Boredom	☐	☐	☐	☐	☐
hh)	Age	☐	☐	☐	☐	☐
ii)	Other (specify) _____	☐	☐	☐	☐	☐

Comments detailing any of the above factors: _____

_____

_____

F. WORK ENVIRONMENT

99. What safety issues does your flight department emphasize?

1. _____
2. _____
3. _____

100. Through what mechanisms does your flight department emphasize or implement these safety issues on the job?

1. _____
2. _____
3. _____

101. In your opinion, how safe is your corporate operation compared to the major airlines?

much less safe ☐ | somewhat less safe ☐ | as safe ☐ | somewhat safer ☐ | much safer ☐

102. How do you feel about the long-term job security in your current position?

very insecure ☐ | insecure ☐ | secure ☐ | very secure ☐

103. Rate the quality of your flight department management.

very poor ☐ | poor ☐ | fair ☐ | good ☐ | very good ☐

104. Does your flight department offer any training that addresses fatigue issues?

yes ☐ | no ☐

105. If you answered "yes" to the above question, please elaborate.

_____
_____
_____

106. Please add any comments you consider relevant to this survey.

_____
_____
_____
_____

107. How long did it take you to complete this survey (cumulatively)? (Management pilots: please include the time it takes you to complete section G.)

☐ hr and ☐ min

G. MANAGEMENT PILOTS

Please answer the following questions **ONLY** if you hold both **a management position and a flying position** in your company.

108. What percentage of your overall work time do you spend in each role?

☐ % management ☐ % flying

109. On days during which you have flying duties, do you also attend to management duties?

yes ☐ no ☐

110. On a typical day during which you have both management and flying duties, what percentage of your duty day is spent in each role?

☐ % management ☐ % flying ☐ not applicable

111. What is the duration of a duty day that includes ONLY management duties?

☐ hr typical ☐ hr shortest ☐ hr longest

112. What is the duration of a duty day that includes BOTH management and flying duties?

☐ hr typical ☐ hr shortest ☐ hr longest

113. In what aspects of management are you involved?

_____

_____

_____

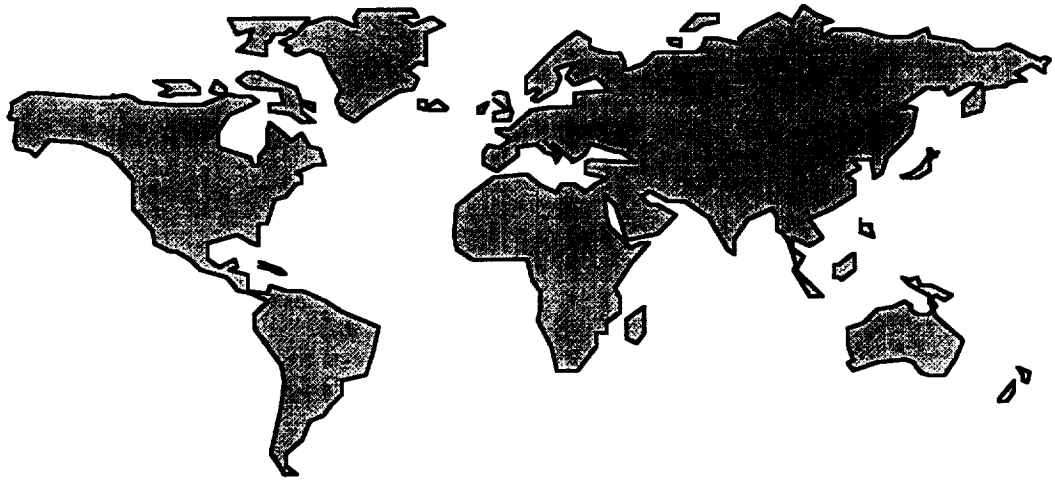
114. If you are involved in scheduling, please rank the following categories in the order of their priority in your company's scheduling decisions (1 = highest priority). Please use each # (1 through 8) **ONLY** once.

_____ a) number of legs flown by pilot
_____ b) pilot's duty time for the work day
_____ c) takeoff times during the night/early morning
_____ d) time zones crossed
_____ e) layover rest time
_____ f) availability of equipment
_____ g) maximizing flight department cost efficiency
_____ h) other: _____

Appendix B

Corporate/Executive Operations Survey

Survey Results



Corporate/Executive Operations Survey

Fatigue Countermeasures Program
Flight Management and Human Factors Division
NASA Ames Research Center
Moffett Field, CA

CORPORATE/EXECUTIVE OPERATIONS SURVEY

NASA is studying fatigue, alertness, and performance issues that affect flight crews in corporate/executive operations. Please complete this survey and return it in the enclosed self-addressed, stamped envelope.

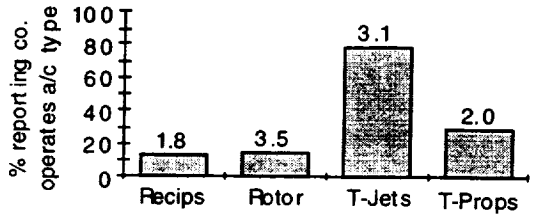
DO NOT WRITE YOUR NAME ON THIS SURVEY. This will ensure anonymity for you and your company. This survey will be administered to several US corporate flight departments and will be held in the strictest confidence.

<u>For research purposes only</u>

First, please answer these general questions about your company and flight department:

How many of each type of aircraft does your company flight department operate?

1.8	3.5	3.1	2.0
recips	rotorcraft	turbojets	turboprops



How many pilots are employed by your flight department?

10.6 pilots employed

Does your company fly strictly North American domestic routes or a combination of North American domestic and international routes? (Check only one.)

In which company division, department, or structure is your flight department included?

_____

If, by some chance, you know how many people are employed by your company (not just your flight department) please enter the number in the box.

28,200 total company employees

GENERAL SURVEY DIRECTIONS:

I. **Please answer all questions, and please be as accurate as possible. All information is confidential and anonymous.**

II. **Please mark boxes and lines as follows:**

Small boxes should get a checkmark or an "x": ☐ Í ☑ or ☒

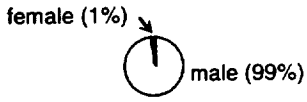
Large boxes should get a number: ☐ Í 204

Lines should get text: _____ Í kids

III. **Watch for special instructions relating to a question or set of questions.**

A. GENERAL

1. Gender?

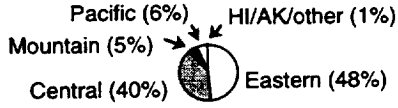


2. Age? 45.2 yr

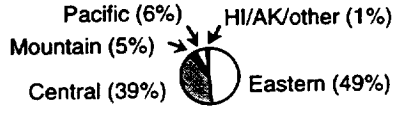
3. Weight? 185 lb

4. Height? 5 ft 11 in

5. In what time zone is your home base? (Check only one.)

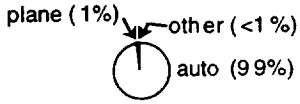


6. In what time zone do you live? (Check only one.)



7. How long does it usually take you to travel from your home to your home base? 32.9 min

8. What is your usual mode of transportation from your home to your home base? (Check only one.)



9. Do you currently hold another job(s) in addition to your corporate flying job? (If "no," skip to #11.)

10. How many hours do you spend at your additional job(s) in a typical month?

57.3 hr

B. SLEEPING AT HOME

Based on **an average night of sleep at home** (at least 2 days after your return home following a trip), please give one best answer to each of the following questions. **Use your local 24-hour clock.**

11. On average, how many nights of sleep do you get at home between trips?

4.2 nights

12. On your days off duty, what time do you usually go to bed?

22:40
time, 24-hr clock

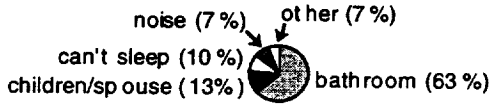
13. On your days off duty, how long after going to bed do you usually fall asleep?

21.9 min

14. When sleeping at home, how many times on average do you wake up?

1.5 times

15. If you wake during the night, what most often awakens you? (Check **ONLY** one answer.)



16. If you wake during the night, on average, how long does it take you to go back to sleep?

13.5 min

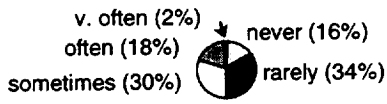
17. When sleeping at home, what is the amount of total sleep you get on average?

7.3 hr

18. On your days off duty, what time do you usually get out of bed?

07:08
time, 24-hr clock

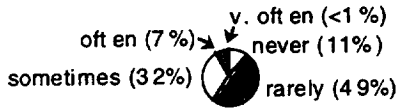
19. How often do you take a nap at home?



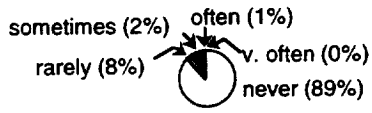
20. On average, how long are your naps?

49.3 min

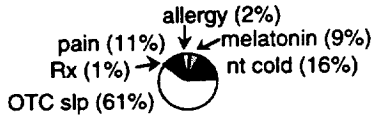
21. When sleeping at home, how often do you have problems getting to sleep?



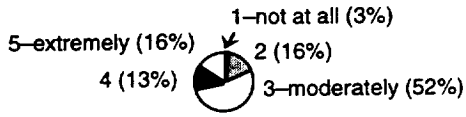
22. How often do you take medication to help you sleep? (If "never," skip to #25.)



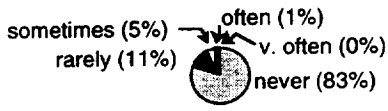
23. If you take medication to help you sleep, please specify the medication and dose.



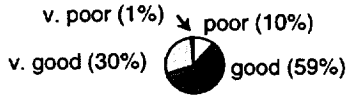
24. Rate the effectiveness of the medication.



25. How often do you use alcohol to help you sleep?

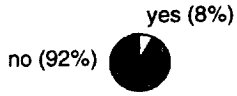


26. Overall, what kind of sleeper are you?



27. Do you snore?

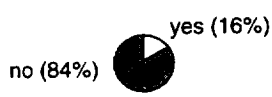
28. Do you have a sleep problem? (If "no," skip to #32.)



29. What is your sleep problem?

_____

30. Has it been diagnosed by a physician?



31. Has it ever prevented you from flying a scheduled trip?

yes (1%)

no (99%)

REMEMBER: Give only one best answer (for each factor) based on an average night of sleep at home (at least 2 days after you return from a trip).

32. Please rate the following factors and indicate how much they affect your sleep.

	interferes 1	2	3	4	promotes 5
a) quality of sleep surface	91	258	295	427	416
b) heat	506	634	173	122	37
c) cold	128	311	322	485	227
d) thoughts running through your head	563	703	171	33	5
e) random noise events	254	698	504	39	8
f) constant background noise	180	415	660	139	80
g) background lighting	223	587	633	80	3
h) readiness for sleep	47	227	295	484	420
i) comfort of clothing	45	185	305	458	275
j) low humidity/dry air	59	249	604	337	226
k) high humidity	434	621	365	44	8
l) trips to bathroom	191	639	619	22	4
m) bed partner	55	292	729	219	179
n) privacy	34	186	634	351	270
o) ventilation	34	185	263	652	339
p) sheets	8	100	516	598	254
q) blankets	14	141	509	616	197
r) pillows	46	174	230	593	431

33. Please rate the following on the extent to which they **interfere** with your sleep at home.

	strongly interferes 1	2	3	4	no effect 5
a) hunger	60	335	468	303	312
b) thirst	126	514	417	265	157
c) personal worries	362	576	335	141	58
d) respiratory factors (i.e., asthma, allergies, etc.)	66	217	355	155	656

e) other (specify)_____

34. From the list in #32, please write the letters of the top three factors that **promote** your sleep at home in rank order.

1. _____
2. _____
3. _____

C. FLYING INFORMATION

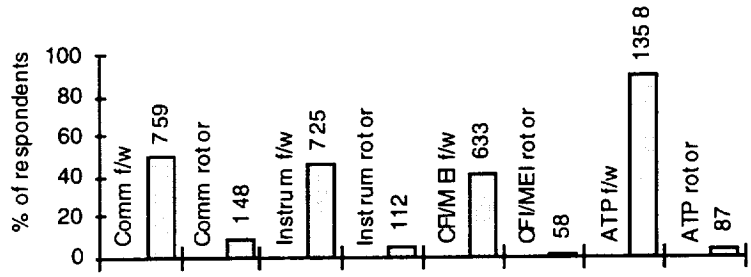
35. How many total flight hours did you have when you were hired for your current corporate flying position?

5580 hr

36. How many total flight hours have you logged in your lifetime?

9750 hr

37. What certificates/ratings do you currently hold? (Check all that apply.)



38. How many years have you been flying corporate aviation?

14.9 yr

39. How many hours do you have in the following categories? (All categories are separate and exclusive.)

5900	1490	2500	839
corporate	military	general aviation	other—specify:

40. How many hours do you fly in the following categories in a typical month? (All categories are separate and exclusive.)

39.4	0.6	3.7	0.5
corporate	military	general aviation	other—specify:

41. List all non-military salaried flying jobs you have had in your aviation career. (e.g., "capt., regional carrier.")

_____

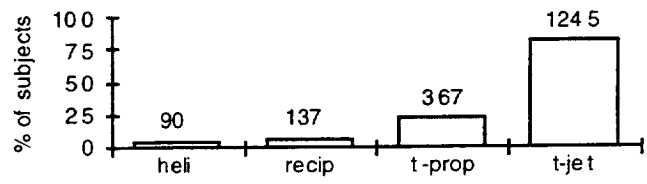
_____

_____

42. With how many different companies (including your present employer) have you held a salaried flying position?

3.4 companies

43. Which company aircraft do you currently fly? (Check all that apply.)

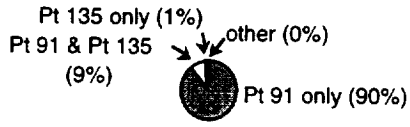


44. List all company aircraft (make/model) that you currently fly, and your flight hours in each.

make and model	hours

45. How long have you been employed by your present company? 9.8 yr

46. Under which of the following FAR Part(s) do you currently fly in your job? (Check all that apply.)



47. What is your annual salary in your current corporate flying position? $ 65,500

48. What is your flight deck position?

Answer questions 49–61 according to the flying done **ONLY** for your corporate aviation job within the past year.

49. How many hours of actual IFR did you fly in a month (not just filed flight plans, but IMC)?	4.8 hr typical	1.1 hr fewest	10.5 hr most
50. What was the duration of a flight delay?	16.8 min typical	4.1 min shortest	75.8 min longest
51. How frequently did ATC delays occur?	2.4 per mo typical	0.5 per mo least	5.5 per mo most
52. How frequently did delays occur due to weather?	1.4 per mo typical	0.2 per mo least	3.7 per mo most
53. How frequently did company-mandated flight delays occur?	2.1 per mo typical	0.6 per mo least	4.3 per mo most

54. How frequently did mechanical delays occur?

0.3	per mo	0.1	per mo	1.4	per mo
typical		least		most	

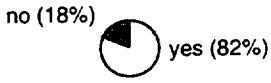
55. How frequently did you fly into a high density operating area?

3.8	per wk	1.4	per wk	8.2	per wk
typical		least		most	

56. How frequently did you fly into a non-radar environment?

4.4	per mo	1.8	per mo	8.1	per mo
typical		least		most	

57. In your company, can you be required to wear a beeper (or to be available through other means) and subject to call for duty? (If "no," skip to #62.)



58. In a typical month, during how many 24-hr periods were you subject to call?

15.6 24-hr periods

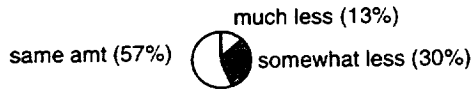
59. How many times were you actually called out? (If "0," skip to #62.)

1.8 times

60. How much time were you typically given to report for duty when called out?

3.7 hr

61. Compared to the time usually allowed for preflight activities, how much time was allowed when you were called out?



62. What are your aspirations for advancement in your current company?

_____

_____

_____

63. What are your long-term aviation career goals?

_____

_____

D. DUTY

Please answer the following questions **using your logbook or paysheet**, according to the flying done **ONLY** for your corporate aviation job within the past year.

64. How many duty days did you fly in a month?

typical	fewest	most
13.8 days	6.9 days	20.1 days

65. What was your number of **scheduled** flight hours per month?

typical	fewest	most
33.4 hr	14.4 hr	52.7 hr

66. What was your number of **actual** flight hours per month?

typical	fewest	most
35.2 hr	15.0 hr	55.5 hr

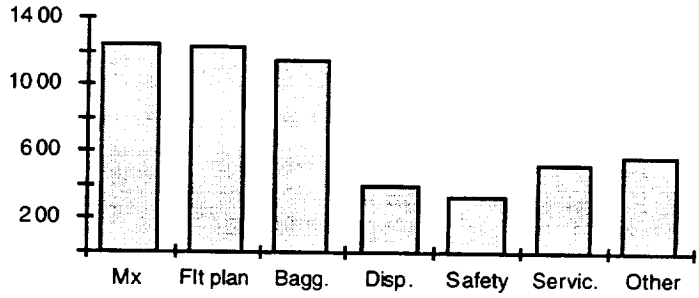
67. How many flight segments did you fly in a duty day?

typical	fewest	most
3.2	1.2	7.6

68. How much time did you have on the ground between flights (time between blocking in and out)?

typical	fewest	most
7.0 hr	2.0 hr	26.0 hr

69. What duties, if any, do you perform in addition to your flying duties? (Please check all that apply, or "none.")



70. During the past month, how many times did you report for duty during each of the following time periods?

0.3 0000–0359 hr	5.5 0800–1159 hr	1.7 1600–1959 hr
7.1 0400–0759 hr	2.1 1200–1559 hr	0.4 2000–2359 hr

71. In a typical month, on how many duty days did your actual flying time fall into each range?

<8 hr	8–12 hr	>12 hr
11.1	3.3	1.7

72. What was the duration of your duty day?

typical: 9.86 hr
shortest: 4.06 hr
longest: 16.0 hr

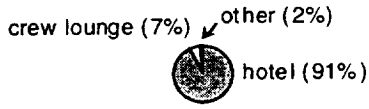
73. What was the longest duty day you have had in your corporate flying career?

20.2 hr

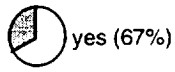
74. In a typical month of flying, how many times did you stay in the following accommodations during your layover rest periods?

5.5 times hotel

8.5 times other: specify



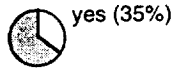
75. Does your operation have a dispatch/ scheduling department?



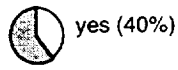
76. What are your flight department's policies on the following? (Please fill in values or check "no limit.")

duty time limit:	14.8 hr per day	145 per mo	1930 per yr	☐ no limit
flight time limit:	9.7 hr per day	96 per mo	995 per yr	☐ no limit
minimum rest per 24 hours	9.4 hr per 24-hr period			☐ no limit
minimum time off between trips	11.2 hr between trips			☐ no limit
maximum consecutive duty days	7.2 consecutive duty days			☐ no limit

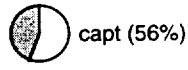
77. To manage long-haul requirements, does your company pre-position crews?



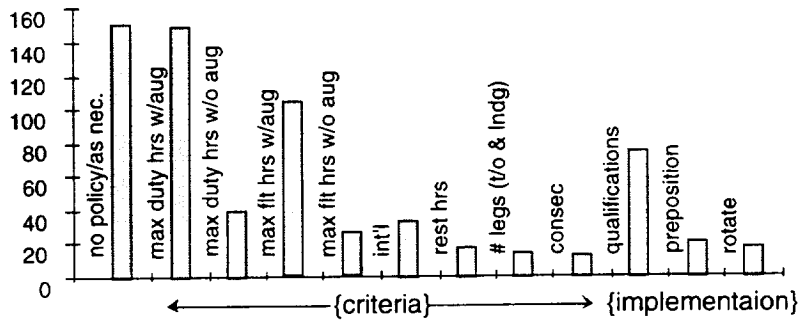
78. Does your company augment flight crews? (If "no," skip to #81.)



79. What flight deck position is the augmenting crewmember capable of holding?



80. Describe your company's crew augmentation policies (e.g., minimum flight/duty time for augmentation, in-flight rostering, etc.)



81. In a typical month, how many domestic and international flights did you fly?

18.5 domestic flights per mo

1.0 int'l flights per mo

82. These flights represent how many hours per month of domestic and international flying?

35.0 hr domestic per mo

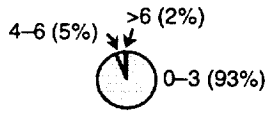
6.2 hr int'l per mo

83. In a typical month, how many flights involved time-zone changes of the following magnitudes?

14.5 flights
0–3 zones

0.7 flights
4–6 zones

0.3 flights
over 6 zones



E. FATIGUE

84. Use the following parameters to describe the sequence of **3 consecutive trips** during which you experienced the most fatigue in corporate flying:

a) **Off-duty time prior to trip 1:** 2.4 # days (24-hr periods) 2.3 # sleep periods

b) **Trip 1:** 2.5 # days (24-hr periods) 25.5 cumulative duty time (hr) 9.4 avg. layover duration (hr)
6.2 total # legs 10.7 cumulative flight time (hr)

c) **Off-duty time between trips 1 and 2:** 1.6 # days (24-hr periods) 1.7 # sleep periods

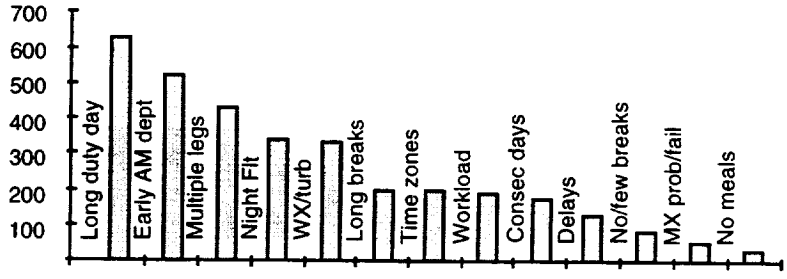
d) **Trip 2:** 2.1 # days (24-hr periods) 20.9 cumulative duty time (hr) 9.2 avg. layover duration (hr)
5.3 total # legs 8.6 cumulative flight time (hr)

e) **Off-duty time between trips 2 and 3:** 1.5 # days (24-hr periods) 1.8 # sleep periods

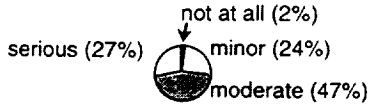
f) **Trip 3:** 1.9 # days (24-hr periods) 19.1 cumulative duty time (hr) 8.0 avg. layover duration (hr)
5.0 total # legs 8.1 cumulative flight time (hr)

g) **Off-duty time before next trip:** 2.5 # days (24-hr periods) 2.8 # sleep periods

85. Regarding fatigue, describe the **work day** during which you've experienced the most fatigue while flying corporate, including the specific factors that made it difficult.

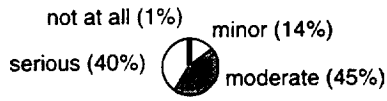


86. In your opinion, to what extent is fatigue a concern in corporate flight operations?

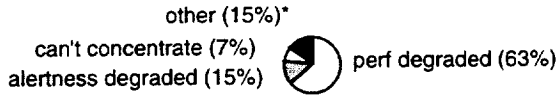


87. Is crew fatigue a common occurrence in flight operations?

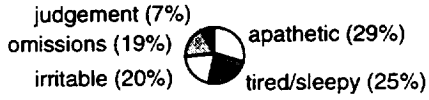
88. When crew fatigue occurs, how significant a safety issue is it?



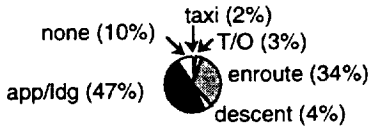
89. In what ways does fatigue affect your flight performance?



**"other (15%)" factors:



90. When your flight performance is affected by fatigue, which phase of flight performance is most affected? (Choose only **ONE** answer.)



91. List in rank order three strategies (for each heading) that you use to cope with fatigue.

PRETRIP:

1. _____
2. _____
3. _____

IN-FLIGHT:

1. _____
2. _____
3. _____

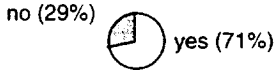
POSTTRIP:

1. _____
2. _____
3. _____

92. What three changes would you make to reduce fatigue in corporate operations? List the most important first.

1. _____
2. _____
3. _____

93. Have you ever "nodded off" during a flight? (If "no," skip to #95.)



94. If this has occurred more than once, on what percentage of flights in a typical month does it occur?

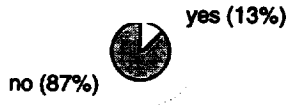
4.4 % flights in typical mo

95. Have you ever been on a flight where arrangements were made for one of the pilots to nap in their cockpit seat during the leg? (If "no," skip to #97.)

96. In a typical month, on what percentage of flights does this occur?

4.0 % flights in typical mo

97. Has fatigue ever prevented you from flying a scheduled trip?



98. For the following question:
    1. Check the box that represents the extent to which each factor affects your fatigue level on duty.
    2. Then, in the far right column, write the number that corresponds to how frequently you experience each factor (based on the Frequency Scale below).
    3. In the "Comments" section at the end of this question, please elaborate on any factors as needed.

Frequency Scale

0=never | 1=very rarely (1-10/yr) | 2=sometimes (1-3/mo) | 3=often (1-4/wk) | 4=very often (5-7/wk)

		not at all	slightly	moderately	seriously	frequency
a)	VFR flight	712	577	117	11	1.4
b)	IFR flight (actual IMC)	184	672	515	62	2.0
c)	Light turbulence	680	671	90	2	1.7
d)	Moderate turbulence	315	585	507	30	1.5
e)	Severe turbulence	267	282	502	451	1.0
f)	High ambient temperatures	106	441	715	182	2.1
g)	Low ambient temperatures	462	720	223	33	1.5
h)	Icing	349	644	371	70	1.4
i)	ATC interactions	333	728	337	44	2.1
j)	Passenger interactions	521	651	240	31	1.8
k)	Interacting w/ other co. employees	560	666	191	20	1.8

		not at all	slightly	moderately	seriously	frequency
l)	Flying multiple segments in the same duty day					
	1–3	[illegible]	[illegible]	[illegible]	[illegible]	2.3
	4–6	77	420	768	143	2.0
	7 or more	[illegible]	[illegible]	[illegible]	[illegible]	1.3
m)	Time-zone changes	168	631	499	129	2.0
n)	Flying without an autopilot	[illegible]	[illegible]	[illegible]	[illegible]	0.8
o)	Company scheduling practices	250	634	394	161	1.8
p)	Time of day of operation	[illegible]	[illegible]	[illegible]	[illegible]	2.0
q)	Early morning departures	230	511	490	212	2.2
r)	Late night arrivals	[illegible]	[illegible]	[illegible]	[illegible]	1.8
s)	FAR flight/duty/rest limitations	534	479	237	96	1.2
t)	Sudden scheduling changes	[illegible]	[illegible]	[illegible]	[illegible]	1.6
u)	Heavy workload	104	367	737	229	1.8
v)	Aircraft vibration when flying	[illegible]	[illegible]	[illegible]	[illegible]	1.1
w)	Unpressurized cockpit	733	257	218	81	0.5
x)	Noise	[illegible]	[illegible]	[illegible]	[illegible]	1.7
y)	Luggage handling	638	628	149	17	1.9
z)	Aircraft servicing	[illegible]	[illegible]	[illegible]	[illegible]	1.5
aa)	Company mgmt. responsibilities	515	530	302	56	1.6
bb)	Lack of available nutritious food	[illegible]	[illegible]	[illegible]	[illegible]	1.4
cc)	Dehydration	339	548	422	122	1.3
dd)	Illness	[illegible]	[illegible]	[illegible]	[illegible]	0.8
ee)	Emotional stress	252	494	455	236	1.2
ff)	Sleep loss	[illegible]	[illegible]	[illegible]	[illegible]	1.5
gg)	Boredom	243	645	414	131	1.5
hh)	Age	[illegible]	[illegible]	[illegible]	[illegible]	1.0
ii)	Other (specify) _____					

Comments detailing any of the above factors: _____

_____

_____

F. WORK ENVIRONMENT

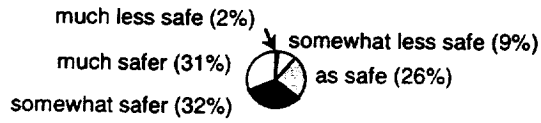
99. What safety issues does your flight department emphasize?

1. _____
2. _____
3. _____

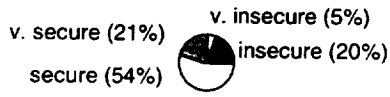
100. Through what mechanisms does your flight department emphasize or implement these safety issues on the job?

1. _____
2. _____
3. _____

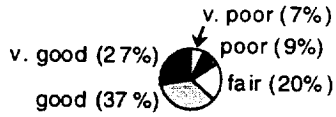
101. In your opinion, how safe is your corporate operation compared to the major airlines?



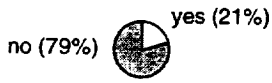
102. How do you feel about the long-term job security in your current position?



103. Rate the quality of your flight department management.



104. Does your flight department offer any training that addresses fatigue issues?



105. If you answered "yes" to the above question, please elaborate.

_____
_____
_____

106. Please add any comments you consider relevant to this survey.

_____
_____
_____
_____

107. How long did it take you to complete this survey (cumulatively)? (Management pilots: please include the time it takes you to complete section G.)

1.5 hr

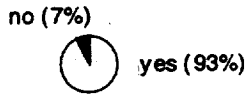
G. MANAGEMENT PILOTS

Please answer the following questions **ONLY** if you hold both **a management position and a flying position** in your company.

108. What percentage of your overall work time do you spend in each role?

48.2 % management 52.8 % flying

109. On days during which you have flying duties, do you also attend to management duties?



110. On a typical day during which you have both management and flying duties, what percentage of your duty day is spent in each role?

29.1 % management 71.6 % flying ☐ not applicable

111. What is the duration of a duty day that includes ONLY management duties?

7.0 hr typical 3.0 hr shortest 10.5 hr longest

112. What is the duration of a duty day that includes BOTH management and flying duties?

10.0 hr typical 5.0 hr shortest 15.0 hr longest

113. In what aspects of management are you involved?

_____

_____

_____

114. If you are involved in scheduling, please rank the following categories in the order of their priority in your company's scheduling decisions (1 = highest priority). Please use each # (1 through 8) **ONLY** once.

		Respodents rating the item 1 or 2
4.3	a) number of legs flown by pilot	16%
2.2	b) pilot's duty time for the work day	68%
3.8	c) takeoff times during the night/early morning	24%
6.0	d) time zones crossed	<1%
3.9	e) layover rest time	21%
4.0	f) availability of equipment	40%
4.4	g) maximizing flight department cost efficiency	32%
4.0	h) other: _____	34%

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13. ABSTRACT *(Maximum 200 words)*

Corporate flight crews face unique challenges including unscheduled flights, quickly changing schedules, extended duty days, long waits, time zone changes, and peripheral tasks. Most corporate operations are regulated by Part 91 FARs which set no flight or duty time limits. The objective of this study was to identify operationally significant factors that may influence fatigue, alertness, and performance in corporate operations. In collaboration with the National Business Aircraft Association and the Flight Safety Foundation, NASA developed and distributed a retrospective survey comprising 107 questions addressing demographics, home sleep habits, flight experience, duty schedules, fatigue during operations, and work environment. Corporate crewmembers returned 1,488 surveys. Respondents averaged 45.2 years of age, had 14.9 years of corporate flying experience, and 9,750 total flight hours. The majority (89%) rated themselves as "good" or "very good" sleepers at home. Most (82%) indicated they are subject to call for duty and described an average duty day of 9.9 h. About two-thirds reported having a daily duty time limit and over half (57%) reported a daily flight time limit. Nearly three-quarters (71%) acknowledged having "nodded off" during a flight. Only 21% reported that their flight departments offer training on fatigue issues. Almost three-quarters (74%) described fatigue as a "moderate" or "serious" concern, and a majority (61%) characterized it as a common occurrence. Most (85%) identified fatigue as a "moderate" or "serious" safety issue.

14. SUBJECT TERMS
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