

AFIT/GTM/LAL/97S-8

COMPARISON OF EFFECTS OF CHANGE
FROM 8 TO 12 HOUR SHIFTS ON
AIR FORCE AIRCRAFT MAINTENANCE WORKERS

THESIS

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Daniel Overland

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Abstract

This study examined the effects of converting from an 8 hour shift system to a 12 hour system on aircraft maintenance personnel. The squadron had converted its 24 hour operations from an 8 hour shift schedule to a 12 hour shift schedule in stages, changing one group first and then another. A smaller third group of workers remained on 8 hour shifts. Individual differences in job related outcomes and situational constraints were measured for all three groups. Results showed that changing from 8 to 12 hour shifts affected worker well being and morale, as indicated by an increase in hospital visits after the switch to 12 hour shifts and the difference in levels of morale between 12 hour shift personnel and those remaining on 8 hour shifts.

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I. Introduction

Issue

Force reductions and a fast paced operations tempo are making it necessary for military leaders to consider a number of alternative methods for completing the mission. One approach is to stretch limited manpower by lengthening workshifts to ensure the workload can be accomplished. Recently a large Aircraft Generation Squadron in the Eastern United States converted much of its maintenance work force from a five-day, 8-hour work day schedule to a 2-3-3-2 schedule with 12 hour shifts. The objective was to stabilize work schedules and maintain adequate supervision. The 12-hour shifts made it possible for the unit to continue to support a busy flying schedule after substantial manpower reductions had occurred. However, there was good reason to expect the use of 12 hour shifts might have negative effects on personnel. Previous research has shown longer work shifts to be associated with decreased productivity, and increased accidents and absenteeism (Folklyard & Monk, 1979:486, Laundry & Lees, 1991:904). Squadron and wing leadership became concerned about the impact of the 12 hour shift schedule on the motivation, morale, and well-being of unit members.

The objective of this research is to better understand the effects of extended work shifts on workers' well being, attitudes, and situational constraints affecting performance. The Air Force already recognizes the impact of extended working hours on aircrew performance. Palmer and others (1996:5) reported a large portion of Class A mishaps were related to fatigue from sleep deprivation. Clearly when crews were expected to perform complicated maneuvers after 20 - 24 hours of duty, their performance is degraded, jeopardizing their personal safety and the mission.

Fatigue also directly affects support personnel. Previous research strongly supports the contention that longer workshifts have a direct impact on worker health, attitudes, and performance. A better understanding of the effects of 12 hour shifts may help supervisors and managers more safely and effectively utilize their personnel during normal and contingency operations.

Purpose

This research investigated the effects of extended shift length on, worker attitudes, health, and accidents to determine the costs of 12-hour operations and potentially identify areas which will demand additional attention.

II. Background

The use of 12 hour or extended shifts may have a wide range of organizational and individual consequences. Research on shiftwork falls into two broad categories: the effects of shiftwork on organizational goals, such as efficiency, productivity, safety issues and absenteeism, and the effects on the individual, social issues, health and well being, and general attitudes toward their job (Alluisa 1982:176). The military has primarily been concerned with the effects of extended work periods on aircrew and soldier effectiveness (Haslam, 1980 and Palmer, et al. 1996).

The conversion from 8 to 12 hour shifts is expected to lead to an increase in productivity per worker (Pierce & Dunham 1992:1086) been associated with increased efficiency (Williamson, Gower & Clarke 1994:228). Although overall efficiency may increase, research indicates individual workers' efficiency decreases as the workday progresses. Worker performance has been found to be significantly degraded when working a 12 hour shift as compared to an 8 hour shift (Rosa, 1991:115). As a result, work which requires complex cognitive skills, such as flying and repairing high tech equipment, should not be considered for longer shifts (Duchon & Smith, 1993:38, Nicholson & Stone 1982:33). On the other hand, work scenarios which require limited reasoning and a fairly low level of physical activity may be well suited for longer shifts.

Research has been done which attempt to correlate extended shifts with increased mishaps. Laundry and Lees (1987) conducted a study in a large manufacturing setting which attempted to assess the differences in number and type of accidents which occurred between workers who switched from an 8 to 12 hour shift system. They found use of 12

hour shifts had no direct relation to on-the-job injuries or off-the-job injuries (1987:166). Williamson, Gower & Clarke (1994) also failed to find increases in injuries. These studies limited their findings to specific work situations and results may differ across work scenarios.

Extended shifts have been shown to have significant effects on the worker. Increased occurrences of health problems, a factor which can contribute to poor performance and increased absenteeism, have been found in relation to longer shifts and compressed work schedules. Williamson, Gower & Clark (1994) also examined absenteeism. They reported increases in sick leave taken, regular vacation taken, and increased number of errors associated with longer work shifts and condensed work schedules. The authors theorize the increase in the amount of leave taken and errors were a result of a change in mental states, possibly due to fatigue, sleep loss, and disruption of circadian rhythms (1994:296). Ferrer and others (1995:572) suggest that the desynchronization effect of longer shift length and abnormal schedules will indeed have physiological effects, often resulting in severe health problems. Other studies report an increase in reported symptoms such as headaches, gastric upset, alcohol problems, and diarrhea.

The common factor thought to induce these symptoms is fatigue and stress (Lees & Laundry, 1989). "Stress is in the eye of the beholder" (Hogan and Hogan, 1982:150), therefore if the squadron members perceived the situation to be stressful, it was, despite its true nature. Workers on extended shifts often complain of symptoms of fatigue and attention deficit (Rosa, Colligan, & Lewis, 1989:26-30). Rosa and Colligan (1988:314-315) support the theory that longer shifts cause greater fatigue. Although workers report

greater feelings of fatigue associated with longer shifts, they have been reported to prefer longer shifts because it condenses their work week, giving them more time off (Budnick and others, 1994:1295).

III. Method

Subjects

The survey was administered to a large and heavily tasked aircraft generation squadron on the Eastern seaboard. Enlisted maintenance personnel comprise the majority of the squadron. The squadron is tasked with all base level aircraft maintenance, including assigned and transient aircraft. The squadron also supports world wide mobility taskings which detract from home station manpower strengths.

Completion of the survey was voluntary and all members were invited to participate. A total of 411 members (roughly 55% of the squadron) elected to participate in the ½ hour long survey. However attrition of results due to incomplete demographic data or unusable responses resulted in only 392 usable survey sets, of which incomplete responses eliminated portions of the individual's data from being considered in certain measures.

The majority (92.8%) of respondents were male. A total of 222 of those surveyed were first term airmen and 83.3% had worked in the same section 6 months or longer.

Measures

The instrument was designed to measure a set of situational constraints, employee attitudes, and other outcomes of 12-hour shiftwork suggested by previous Air Force sponsored research. The entire survey can be found in Appendix A.

Situational Constraints. This portion of the survey consisted of 57 questions which measure the individuals reaction to 14 different constraints which they encounter in the course of executing their duties. These constraints have been identified in previous Air Force studies (O'Conner, et al. 1984, Pettit 1995). The correlations among constraints and worker outcomes provide additional evidence about the impact of work constraints on the maintenance workforce. Results are only described for the six situational constraints that were most strongly related to the eight worker outcomes. They include *scheduling constraints* that make it more difficult to accomplish task assignments, *time constraints* which occur when there is not enough time to complete all task assignments, *cooperation constraints* that involve a lack of cooperation from other members of the unit when it is needed, *information constraints* that occur when workers do not have all the information needed to complete their tasks, *personnel constraints* that involve the lack of adequate skilled manpower to complete tasks, and *policy constraints* which involve rules and regulations that interfere with task accomplishment. Descriptions of the constraints are available in Appendix B.

Specific Satisfaction. Hackman and Oldham, (1975). Designed to measure how satisfied the individual is with pay, job security, social, supervisory, and growth. The alpha coefficients were: 0.82, 0.73, 0.69, 0.85, 0.81, respectively (N = 392). The possible responses ranged a seven point Likert scale from Strongly Disagree to Strongly Agree.

Supervision. Camman, et al. (1979). These questions come from Module 5 of the Michigan Organizational Assessment Questionnaire. The questions actually used are

from two sub-scales of the module: Production Orientation and Competence (one item). The items were combined for a composite score ($\alpha = .87$, $N = 389$)

Anxiety and Stress. House and Rizzo, (1972b). The authors designed this scale to measure “the existence of tensions and pressures growing out of job requirements, including the possible outcomes in terms of feelings or physical symptoms” (1972b:481). The sub-scales included are Job Induced Tension ($\alpha = .77$, $N=380$), and General Fatigue and Uneasiness ($\alpha = .69$, $N=380$). The possible responses were True or False.

Shift Satisfaction. A total of 17 questions were written measure the workers' satisfaction with the 12 hour shift schedule (5 items, $\alpha = .75$, $N = 382$) for satisfaction with family and social life (4 items, $\alpha = .73$, $N = 384$), safety (3 items, $\alpha = .73$, $N = 380$) and fatigue (3 items, $\alpha = .77$, $N = 381$). Two questions were also included to measure the respondent's intention to reenlist in the Air Force ($\alpha = .72$, $N = 382$).

Demographic Data. Respondents were asked their age, sex, race, level of education, time in the service, time in section, skill level, and rank.

Hospital Visits. The number of hospital visits for each member were obtained by counting the number of times the records had been checked out each month. Frequency of checkout is directly associated with a visit to the hospital. Each time the member visits the hospital, the record is checked out.

Safety Data. Safety data is maintained by the squadron's safety representative. Accident data is maintained for all reportable accidents occurring on and off duty.

Performance Data. Performance data, in the form of workload, is maintained at the base level. Workload for each section is maintained on a monthly basis.

Procedures

Surveys were administered on site by the author. Because several functional areas within the squadron continued to work on 8-hour shifts, five days a week, it was possible to compare 8-hour and 12-hour shift workers' attitudes and outcomes. Additional data regarding safety incidents were obtained from the squadron safety representative.

The Red section which began in February of 1996, had 135 respondents. The Blue section began 12 hour shifts in July of 1996 and had 187 respondents. Seventy other members remaining on 8 hour shifts completed the survey. Preliminary analysis indicated the two groups, Red and Blue, were nearly homogenous demographically (Appendix C). The 8 hour shift group differs from the two 12 hour groups in its composition. The 8 hour group had a higher percentage of Staff Sergeants and Master Sergeants and above. They also had a larger percentage of members who have been in the service 6-10 years and a larger percentage of 7 skill level workers.

Hospital records of those who responded were examined to determine the number of times the member had visited the hospital. Data was available for a period beginning 24 months before administration of the survey and continuing for 6 months following administering of the survey. A total of 252 records of 391 were available.

Analysis Approach

Data analysis involved comparing the reactions of maintainers who worked 12 hour shifts with those of members working 8 hour shifts. The responses of first-term airmen (SRA and below) were analyzed separately from the responses of career airmen

(SSgt and above) because a previous study (Pettit, 1996) had shown that higher ranking airmen were less affected by work constraints.

Analysis of Variance (ANOVA). Specific outcomes examined include motivation, safety, work schedule problems, morale, productivity, tension and fatigue. Group means on individual outcomes, environmental predictors, and individual predictors were compared using Analysis of Variance (ANOVA) procedures. Environmental predictors include the fourteen situational constraints outlined earlier and the role of the supervisor. The individual predictors were time in service, time in section, skill level, age, rank, section member works, education level and shift worked.

Comparison of Means. Analysis of hospital records and accident records also lends insight to the effects of predictor variables on individual well-being. Well-being is reflected in the number of hospital visits of a member and self reported fatigue, and potentially in accidents. The mean number of hospital visits for 8 and 12 hour shift workers were compared using the student's *t-test*. Also, mean number of visits were compared between the Red and Blue groups for the period between February and July of 1996. This was the period of time when the Red group was working 12 hour shifts and the Blue was working 8 hour shifts.

Correlation Coefficients. Correlation tables were established relating individual outcomes with individual predictors and job predictors. Those correlations with p-values less than or equal to 0.05 were considered significant.

IV. Results

Table 1 shows the mean responses of first-term airmen on eight outcome variables. First term airman on 8 hour shifts reported higher levels in 5 of the 8 outcomes measures.

Table 1. Comparison of outcomes for first term airmen on 8 and 12 hour shifts

Worker Outcomes	Means		Difference between the Means
	8 Hour Shift	12 Hour Shift	
Morale	3.92*	4.32	p<.05
Motivation	3.51*	3.15	p<.01
Tension	1.39*	1.47	non-significant
General fatigue	1.34*	1.46	p<.05
Feeling tired	4.54*	5.85	p<.01
Safety	3.77*	3.95	non significant
Work schedule problems	3.97*	4.91	p<.01
Productivity	5.56*	5.40	non significant

Notes: N=39 for 8-hour shift workers, N=151 for 12-hour shift workers.

*Indicates a better or more positive score.

The results for career airmen are very similar to those for first-term airmen (Table 2). There were significantly different scores in motivation, safety, work schedule problems and fatigue between first-term and career airmen on 8 hour shifts compared with those on 12 hour shifts.

Table 2. Comparison of outcomes for career airmen working 8 and 12 hour shifts.

Worker Outcomes	Means		Difference Between the Means
	8 Hour Shift	12 Hour Shift	
Morale	3.69*	3.89	non-significant
Motivation	3.87*	3.47	p<.01
Tension	1.50	1.48*	non-significant
General fatigue	1.30*	1.41	p<.01
Feeling tired	4.35*	5.66	p<.01
Safety	3.56*	4.11	p<.01
Work schedule problems	3.71*	4.98	p<.01
Productivity	5.62*	5.41	non significant

Notes: N=39 for 8-hour shift workers, N-114 for 12-hour shift workers.

*Indicates a better or more positive score

One hypothesis in this research is that productivity, motivation, and other worker outcomes will decrease as situational constraints increase. The correlations between the worker outcomes and situational constraints shown in Tables 3 and 4 address this issue. The greater the correlation (positive or negative) the stronger the association between a constraining factor and an outcome variable. Situational constraints are expected to have stronger relations to outcomes when workers are more fatigued and have less energy available to overcome them. Tables 3 and 4 contain correlations for first-term airmen and career airmen, respectively.

Table 3. Comparison of correlations for first-term airmen on 8 and 12-hour shifts.

Constraints	Schedule		Time		Cooperation		Information		Personnel		Policy	
	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour
Worker Outcomes												
Morale problems	-.48*	.20*	.37	.24	-.39*	.28*	-.39*	.30*	-.37*	.34*	-.54	.33
Motivation†	-.16	.03	.06*	-.34*	.05	-.07	.08	.04	-.01	-.10	-.15	.02
Tension	-.37*	.14*	.32	.24	-.26*	.21*	-.32*	.22*	-.19*	.21*	-.21*	.17*
Fatigue	-.20*	.19*	.24	.19	-.17	.16	-.27*	.14*	-.17*	.20*	-.16	.16
Feeling tired	-.40*	.16*	.42	.23	.27	.20	.31	.24	.40	.40	.37	.23
Safety concerns	-.11*	.30*	.26	.38	.26	.40	.25	.30	-.30*	.37*	-.23	.31
Schedule problems	-.61*	.17*	.53	.23	.47	.28	-.35	.26	.55	.36	.50	.22
Productivity†	-.04	-.15	.11*	-.67*	-.06	-.15	-.02	-.13	-.15	-.05	-.36	-.18

Note: † indicates a variable for which higher scores are better. Lower scores represent lower levels of constraints or more positive outcomes for all other variables.

* indicates correlations are statistically different between 8 and 12 hour shifts, $p < 0.05$

Differences in correlations for the 8-hour shift workers and 12-hour shift workers are consistent with the hypothesis that situational constraints would affect workers on 12 hour shifts more than workers on 8 hour shifts. For instance, the correlation between outcomes and the scheduling constraint for the 12-hour shift workers indicate that morale problems, fatigue, feeling tired at work, safety problems, and dissatisfaction with work schedules increased when scheduling constraints made it more difficult to accomplish task assignments. Increases in scheduling constraints were also associated with decreased productivity. Correlations with time constraints indicate morale, tension, fatigue, feeling tired at work, safety concerns, and dissatisfaction with work schedules increased as the amount of time available to complete assigned tasks was reduced. Workers' motivation

and self-reported productivity also decreased as time constraints increased. Results for the other constraints follow the same general pattern.

Table 3 suggests that the relationship between the situational constraints and outcomes (i.e., morale, tension, fatigue, feeling tired at work, safety concerns, and dissatisfaction with work schedules, and productivity) is different for the 8-hour and 12-hour shift workers. For example, Table 3 shows that the correlation between motivation and time constraints (i.e., lack of adequate time to complete assigned tasks) differed significantly for 8-hour shift workers ($r = .06$) and 12-hour shift workers ($r = -.34$). The motivation of 12-hour shift workers decreased when there was less time for them to accomplish assigned tasks, but the motivation of 8-hour shift workers was relatively unaffected.

The broad range of significantly different correlations for first term airmen indicates this group reacts much stronger to an increase in constraints. Schedule constraints have the most significant impact on first term airmen. The positive relationships between Schedule and the worker outcomes will result in increased morale problems, tension, fatigue, feeling tired, safety concerns and the concern the worker has with their own schedule. The worker outcome variables Morale Problems and Tension are significantly different for nearly all of the constraint variables.

The difference in the effect of Personnel constraints on 4 of the 7 individual outcomes (Table 3) for the 8 and 12 hour shifts, is different than what was expected. The implementation of 12 hour shifts was supposed to offset the effects of fewer personnel, eliminating the impact on tension, fatigue, morale and safety outcomes. Instead,

differences in correlations for first term airmen indicate switching from 8 to 12 hour shifts were less effective than anticipated.

The correlations in Table 4 show that worker outcomes were related to situational constraints for career airmen. There are fewer significantly different correlations between 8 and 12 hour shifts for career airmen than there were for first term airmen (Table 3). The constraint variable Schedule differs significantly between 8 and 12 hour shifts when correlated with Morale problems, safety concerns and productivity. Morale and Safety Concerns are positively correlated for workers on 12 hour shifts. As the constraints of schedule increase, morale problems and concern for safety will increase.

Table 4. Comparison of correlations for career airmen on 8 and 12 hour shifts

Constraints	Schedule		Time		Cooperation		Information		Personnel		Policy	
	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour	8 Hour	12 Hour
Worker Outcomes	.08*	.40*	.32	.23	.28	.36	.18	.35	.36	.39	.14	.38
Morale Problems	.08*	.40*	.32	.23	.28	.36	.18	.35	.36	.39	.14	.38
Motivation†	.13	-.24	-.04	-.20	.02	-.21	-.09	-.15	-.04	-.09	-.07	-.18
Tension	.20	.15	.27	.26	.31	.20	.41	.13	.41	.26	.39	.13
Fatigue	-.01	.11	.14	.12	.00	.05	.03	.12	.05	.19	.02	.12
Feeling tired	.18	.24	.41	.18	.26	.16	.22	.24	.42	.26	.20	.27
Safety concerns	-.22	.10	.10	.10	.15	.27	-.08	.07	.11	.29	-.21*	.13*
Work Schedule	.23	.32	.40	.26	.27	.34	.29	.26	.42	.31	.27	.25
Productivity†	-.66*	-.24*	-.06	-.29	-.01*	-.35*	-.27	-.19	.01	-.22	-.32	-.22

Note: † indicates a variable for which higher scores are better. Lower scores represent lower levels of constraints or more positive outcomes for all other variables.

* indicates correlations are statistically different between 8 and 12 hour shifts, $p < 0.05$

A strong relationship between the use of twelve hour shifts and increased hospital visits is evident. Figure 1 is a 6 month moving average of the number of hospital visits for all three subject groups. The data was smoothed for a better visual representation of the data. Significance testing was done based upon monthly averages using raw data. Figure 1 shows the corresponding increase of hospital visits for the Red section as they began 12 hour shifts in February 1996 (denoted by a vertical line). The difference between the time period 5 months prior and the period 5 months following was significantly different ($T = -3.202, p < 0.05$). Note the other shifts had a corresponding increase at the same time, however, the magnitude of the increase in hospital visits by members of the Red section was larger than the increase for the Blue or 8 Hour groups. The Blue section exhibited a similar phenomenon as they began 12 hour shifts (also denoted by a vertical line). However, the pre- and post-treatment means did not differ significantly ($T = 1.464, p < 0.05$). The magnitude of the increase for Blue was not as large as that of the Red section. The 8 hour shift members exhibited some increase in hospital visits in both instances.

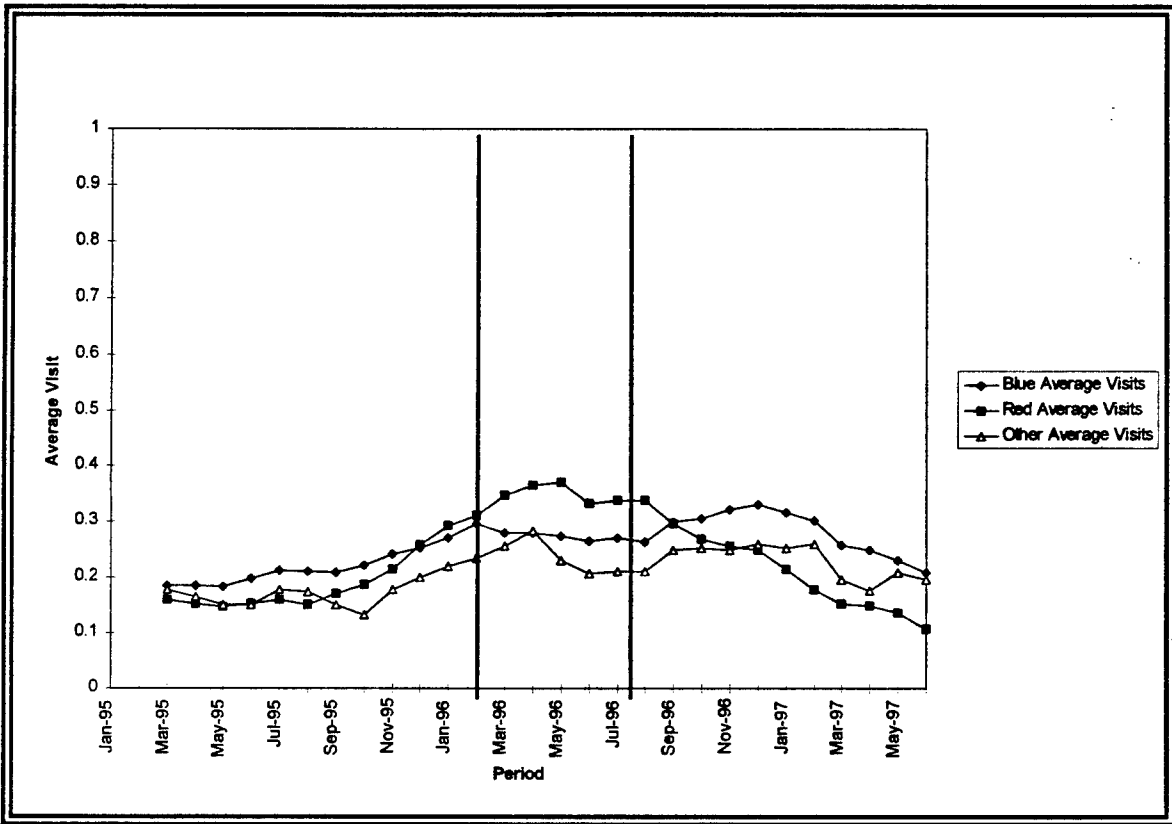


Figure 1. Quarterly Average of Hospital Visits by Work Section

Figure 2 is a graphical depiction of the difference in average hospital visits between the Red and Blue sections during the 5 months when Red was working a 12 hour shift schedule and Blue was not. Notice the high peak of visits by members of the Red section one month into the 12 hour shift schedule.

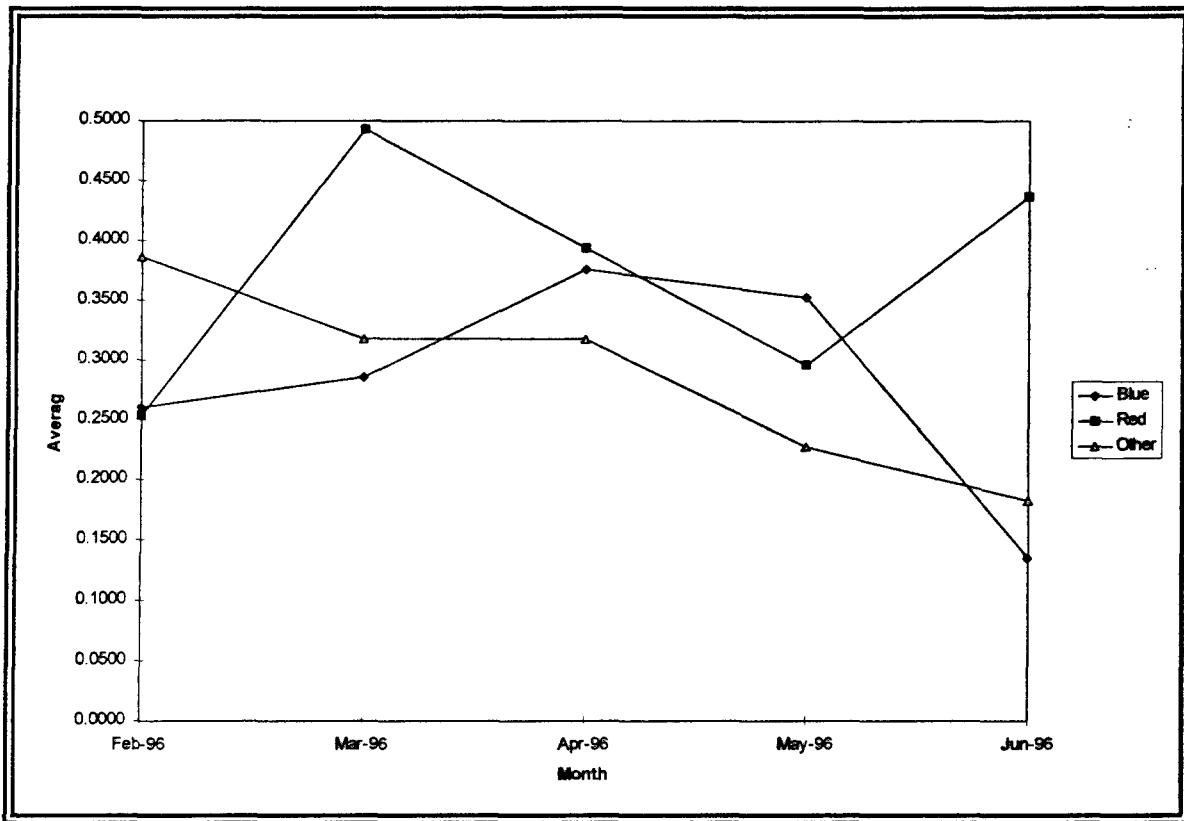


Figure 2. Comparison of Average Hospital Visits During 5 Month Period

The noted difference ($T = -4.77, p < 0.05$) between the two sections which are nearly homogenous, when one section is working 12 hour shifts and the other not, indicates a significant impact of the new shift system on worker health and well-being.

Figure 3 depicts the same data as Figure 1 with the addition of a time series of sorties generated. Sortie generation is sum of sorties generated for home station departures, training missions and enroute departures. Because of the significant variability of the data, this data was smoothed using a 6 month moving average for better representation. All data analysis was conducted prior to smoothing. The sorties generated are scaled on the left Y-axis and the average hospital visits scaled on the right Y-axis. Both groups had a peak in activity during the last months of 1995. This peak is

due, most likely, to the build up for Operation Joint Endeavor. The peak in activity is prior to the switch to 12 hour shifts by the Red section. The amount of activity decreased in subsequent months corresponding to the beginning of 12 hour shifts for the Red Section. Workload is also low when the Blue Section began 12 hour shifts in July.

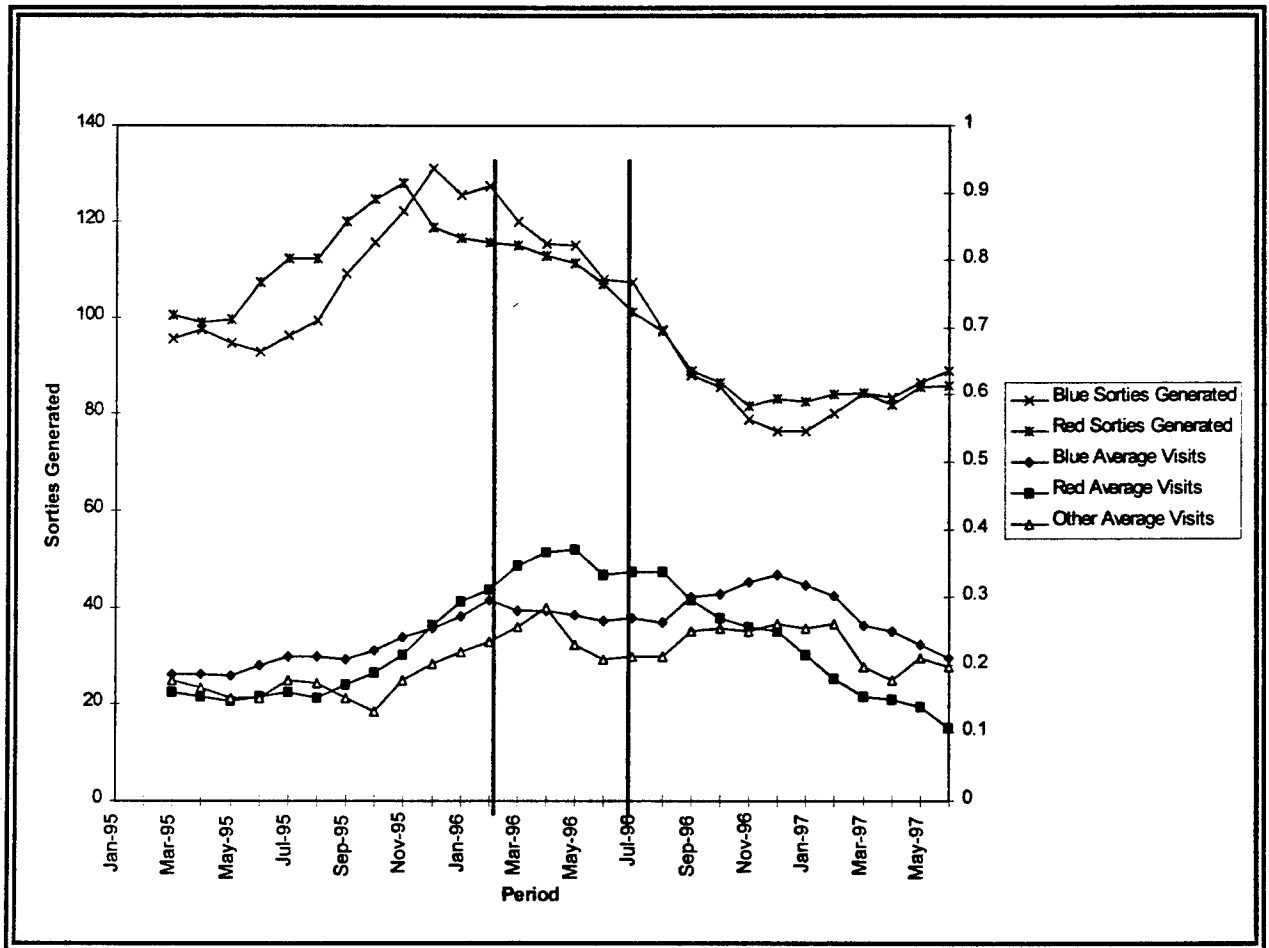


Figure 3. Hospital Visits and Sorties Generated by Section

In order to rule out the possibility that the peak in workload caused a lag affect on hospital visits the effect of the longer shifts on hospital visits was tested using a 2x2 ANOVA. The independent variables were Group (Red|Blue) and Shift Length (8|12). Differences due workload were controlled by including workload as a covariate in the

ANOVA (Stevens, 1992). Therefore the increase in hospital visits cannot be attributed to the increase in workload (Table 5).

Table 5. Two Factor ANOVA for Effect on Hospital Visits

ANOVA								
			Sum of Squares	df	Mean Square	F	Sig.	B
VISITS	Covariates	Workload	2.9E-02	1	2.9E-02	2.992	.090	1.1E-03
	Main Effects	(Combined)	5.8E-02	2	2.9E-02	3.035	.057	
		Group	5.3E-03	1	5.3E-03	.558	.459	
		Change to 12 Hour	4.6E-02	1	4.6E-02	4.804	.033	
	2-Way Interactions	Group *						
		Change to 12 Hour	6.2E-03	1	6.2E-03	.642	.426	
	Model		7.8E-02	4	1.9E-02	2.030	.103	
	Residual		.508	53	9.6E-03			
	Total		.586	57	1.0E-02			

^a. All effects entered simultaneously

The number of accidents also appears to be affected by the conversion to 12 hour shifts (Figure 4). The first quarter of 1996 exhibited a substantial increase in accidents from the same time the previous year. The data do not appear to be seasonal in nature, therefore the high peak is most likely due to the shift change. The peak coincides with the Red section's switch to 12 hour shifts. After the Blue section's change in shift schedule, the number of accidents exhibited a rising trend.

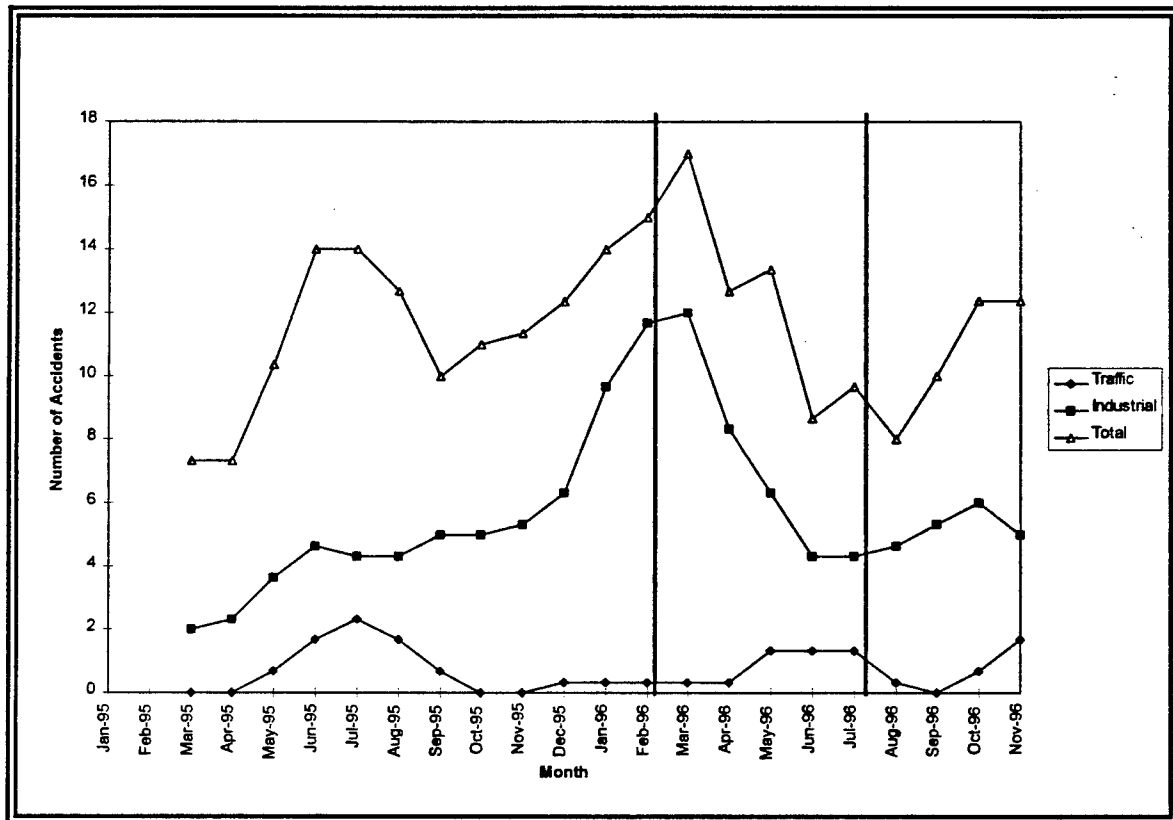


Figure 4. Total Number of Accidents Experienced by Entire Squadron
 Note: The 4th Quarter Average only includes October and November of 1996.
 December data was not available.

V. Analysis

There is a strong indication workers assigned to 12-hour shifts were less motivated, more fatigued and reported experiencing more problems with work schedules than workers assigned to 8-hour shifts. The increased feelings of fatigue and tiredness at work are consistent with previous research.

First-term airmen on 12 hour shifts had lower morale than those on 8-hour work schedules. This may be due to a lack of adaptation techniques possessed by the younger work force. It may be they may lack the appropriate coping mechanisms to deal with the idiosyncrosis of shiftwork and its potential affects. Career airmen who worked 12 hour shifts did not appear to fare much better, although it might have been expected that career airman would have enough exposure to the shift system to improve their ability to adapt.

Several situational constraints are correlated with worker outcomes for both 8-hour shift workers and 12-hour shift workers. For first term airmen, there are strong correlations between Schedule and Morale, Tension, Feeling Tired, Safety and Schedule Problems (Table 3). Even more interesting is the difference between 8 and 12 hour shift workers. The correlations for 8 Hour workers are negative while the 12 Hour workers are all positive. The negative correlation indicates the 8 hour workers feel less constrained by their schedule. The difference ($Z = 2.1, p < 0.05$) indicates a strong disparity between the two shifts. Similar conclusions are drawn for other constraints. In general, Morale seems to be the most affected by 12 hour shifts. The morale of members on 12 hour shifts appeared to be affected more strongly by situational constraints, suggesting that

work conditions affect attitudes more when workers are more fatigued or under additional stress.

Fatigue and Tension also correlate strongly with situational constraints. The correlation between Cooperation and Morale, Tension, and Fatigue was significantly greater for 12 hour shifts. The same is true for Information correlated with Morale, Tension, Fatigue and Schedule Problems. Policy is correlated with the same variables. This suggests first term airmen feel uninformed, feel little cooperation from their coworkers and new policies as a barrier to effective performance. They also experience lower morale, more tension and more fatigue.

The increase in fatigue can be due to differing factors. One possible factor is members were more fatigued due to a larger workload. Figure 4 charts both hospital visits and workload. The increase in workload does not coincide with the increase in hospital visits. In fact, the workload decreased over time after 12 hour shifts were begun by the Red section.

The most obvious factor is the increased level of fatigue from working extended shifts. Figure 1 shows a plateau effect for the Red section for the periods following the change. Approximately a year after the change, the number of hospital visits declines to a level below that at which it started. This is most likely due to a learning effect by both the worker and management (Kreitner and Luthens, 1984:170). Eventually the worker begins to implement adaptation techniques to compensate for the initial shock of fatigue. The fact that the Blue shift exemplified similar characteristics, but to a lesser degree would seem to indicate learning across groups. If this theory holds true in future

research, managers may use this knowledge to make substantial change gradually, or at least in segments, allowing for a learning effect throughout the organization.

However, dissatisfaction with the current work schedule contradicts past research which found the majority of workers prefer shorter work weeks (Budnick and others 1994:1295). The difference may stem from the method by which management approached the changeover from 8 to 12 hour shifts. Often, organizations in the civilian sector have union representation for workers, or the workers have a voice in the shift schedule. Either of these two scenarios offer *worker buy in* for the change. The strong correlations between the situational constraint Policy and the individual outcomes Morale, Tension, Fatigue and Safety Concerns indicates those on 12 hour shifts feel Policy has an important affect on their jobs. In the organization examined for this study, management dictated the trial change for the Red section and the subsequent change for the Blue section. According to squadron leadership, this decision was implemented from the top down, with no input from the work sections.

VI. Recommendations

The use of 12 hour shifts did not seem to ease the problems that were expected to be solved by the change. Supervisors should be aware that situational constraints appear to affect workers on 12 hour shifts more strongly than those on 8 hour shifts, regardless of rank. It appears lack of an adequate schedules, enough time to get the job done, cooperation, and needed information have greater impact on mission accomplishment when 12 hour shifts are used (Table 3 and Table 4). The data suggests some of the negative impact of 12 hour shift work is associated with problems in communication, scheduling, and cooperation that could be addressed by supervisors. Paradoxically, reduced manpower in the supervisory ranks may make it more difficult to make improvements in these areas.

It may be possible to reduce the effect of some constraints by obtaining additional equipment or increased vehicle support. The larger problem is when maintenance personnel resources are already straining to keep up with the day-to-day mission, they can not be expected to have much surge capacity when it is required in wartime or contingency situations.

Analysis also shows unanticipated costs in time and money occurred. The cost of lost man-hours should be considered prior to implementing a change. Data showed increases in hospital visits were associated with the change on shift schedule. According to hospital administration staff the average cost of a member visiting the family practice

clinic is \$114.* The cost of an emergency room visit is approximately \$125. This is the cost of the actual visit only and does not include items such as x-rays or prescriptions or lost man-hours for the member. The member must normally visit the hospital during duty hours. On average, the time spent in the hospital is 2 hours. This does not include travel time to and from the hospital. This is time the member is not at work and others must compensate for the absence. Since the member is being paid during this time, the military is essentially incurring an additional cost.

The average cost of a trip to the hospital for a Senior Airman with 3 years in the Air Force comes to about \$140. This includes the wages paid to the individual while they are at the doctor. On average, the 12 hour group had 20% more visits to the hospital than the 8 hour group each. A conservative estimate is that the increased visits will result in an additional \$16,000 per month in medical costs and time lost due to switching to 12 hour shifts.

There appears to be a correlation between the introduction of 12 hour shifts and increases in accidents (Figure 4). Maintenance personnel are continuously taxed, even at peacetime workloads. Surge operations and contingency operations at deployed locations should deserve extra attention from management. It is during these operations when the effects of longer shifts, and disrupted circadian rhythms have the greatest potential for breaches in safety and increased detriment to health.

Currently the Air Force possesses no regulations or guidelines for the permissible duty day of maintenance or other task-critical ground personnel during contingency

* This data is for the location of this study only. Cost and time estimates may vary by location.

operations. Further study is necessary as the Air Force continues to reduce the number of personnel available during these operations.

The manner in which change is implemented may also be very important. Changing one group at a time appears to have benefited this unit through a learning affect. The experience of the Red section appears to have helped the Blue section transistion with fewer health complaints. The first group to change should be small in nature, assuming group size does not influence the learning curve.

VII. Conclusion

As the military continues to reduce its active members without reduction in workload supervisors must make a concerted effort to keep the safety and well being of their personnel a primary concern. This study compliments past research showing longer shifts have a detrimental effect on the worker, by showing the effects on worker health and well being, as reflected in the increasing number of hospital visits.

Military operations often require 24 hour coverage. The proper implementation of a shift system which provides adequate coverage to the mission will be critical for successful operations. The military has acknowledged that extended workdays have a detrimental effect on performance by mandating maximum crew duty days for aircrew members. Additional consideration should be given the non aircrew personnel. Their tasks are critical in the maintenance of complicated weapons systems, and no less critical than that of those performing aircrew duties. In today's high technology military, fatigue and stress will likely result in increase accidents, decreased motivation and an increase in lost time. Dropping a 500 pound bomb at the wrong time is just as critical for a forklift operator as it is for an F-16 pilot.

Longer shifts appear to have a significant impact on the workforce. Further research is necessary to fully explore the effects of extended shift length on morale, efficiency and performance in a military setting.

Appendix A. Sample Survey

**HQ AMC SPONSORED
WORK PERFORMANCE RESEARCH STUDY**

WORK ENVIRONMENT FACTORS SURVEY II

for

AERIAL PORT PERSONNEL

1. Please write your name, rank, office symbol, and score sheet number in the spaces provided below.
2. Read the INFORMATION ABOUT THIS RESEARCH STUDY and PRIVACY ACT information.
3. Enter your name on the computer score sheet provided with this booklet.
4. Complete the survey using the computer score sheet provided.

The success of this project depends on the accuracy of the information you provide. Please do your best to be honest. Your responses will be kept confidential.

Number: _____ Name: _____ Rank: _____

Office Symbol: _____ Section: _____

Score Sheet Number: _____ Current Shift: _____

FOR OFFICIAL USE ONLY

INFORMATION ABOUT THIS STUDY

Thank you for participating in this research project. Your participation in this survey is strictly VOLUNTARY. Your work experience will make an important contribution to the goals of this research project.

Confidentiality of your responses: This information is being collected for research purposes only. No one in your unit, base, or MAJCOM will EVER be allowed to see your responses. You are welcome to discuss this questionnaire with anyone you choose, but please wait until they have had a chance to participate.

PRIVACY ACT STATEMENT

In accordance with AFR 12-35, paragraph 8, the information below is provided as required by the Privacy Act of 1974.

Authority: 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by AFR 30-23, USAF Survey Program.

Purpose: To evaluate the influence of different types of constraints on the performance of Air Force members.

Routine Use: To increase understanding of factors affecting work performance. No analyses of individual responses will be conducted. Reports summarizing trends in large groups of people may be published.

Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not participate in this survey or who does not complete any part of the survey.

BACKGROUND INFORMATION

This information will be used to develop a profile of the participants in this study. Your responses will be kept completely confidential. Please record your answers on the computer sheet provided.

-
1. What is your sex? (choose one):
 - (a) Male
 - (b) Female
 2. What is your race? (choose one):
 - (a) White
 - (b) Black
 - (c) Hispanic
 - (d) Asian
 - (e) Other
 3. How old are you? (choose one):
 - (a) Less than 20 years
 - (b) 20-25 years
 - (c) 26-30 years
 - (d) 31-40 years
 - (e) more than 40
 4. Highest education level completed?
 - (a) Did not complete High School
 - (b) High School Diploma or GED
 - (c) 2-Year College Degree
 - (d) 4-Year College Degree
 - (e) Other
 5. How long have you worked for the Air Force?
 - (a) Less than 2 years
 - (b) 2 to 5 years
 - (c) 6 to 10 years
 - (d) 11 to 15 years
 - (e) more than 15 years
 6. What is your present grade?
 - (a) E-1 or E-2
 - (b) E-3 or E-4
 - (c) E-5
 - (d) E-6
 - (e) E-7 or higher
 7. How long have you worked in the same work center?
 - (a) Under 2 months
 - (b) 2-3 months
 - (c) 4-5 months
 - (d) 6 months or longer
 8. What is your skill level? (choose one):
 - (a) 1
 - (b) 3
 - (c) 5
 - (d) 7

Describing Your Job

Listed below are a number of items which may or may not describe your present *job situation* in the Air Force. We are interested in the extent to which each of these statements describes *your particular job situation*. In this section we want to know about your job and not about your attitudes toward that job. Thus, as you complete this questionnaire, think about the job environment you work in, not how you feel about it or what you do in it.

Using the scale below, rate how accurately each statement describes your present job situation in the Air Force. Write the number which represents your rating on the computer score sheet. As you read through the list, you will note that some of the statements are similar. However, no two of them are exactly alike or have exactly the same meaning. You should simply respond to them as they come and not feel any special need to check back to make answers agree. Please be sure to respond to all of the items.

1	2	3	4	5
Not at all Accurate	Somewhat Accurate	Fairly Accurate	Very Accurate	Completely Accurate

- | | |
|--|--|
| <p>9. The Air Force frequently does not provide me with the necessary tools and/or equipment when needed.</p> <p style="text-align: center;">_____</p> | <p>18. It often takes me too long to do my job because I have to deal with "red tape."</p> <p style="text-align: center;">_____</p> |
| <p>10. I often must work with and depend upon others who are not well trained.</p> <p style="text-align: center;">_____</p> | <p>19. I often cannot get my job done because policies, procedures, and instructions are changed without enough advance notice.</p> <p style="text-align: center;">_____</p> |
| <p>11. I frequently cannot get necessary materials, supplies, and/or parts when I need them.</p> <p style="text-align: center;">_____</p> | <p>20. I cannot get the transportation I need to do my job when I need it.</p> <p style="text-align: center;">_____</p> |
| <p>12. The information I must have in order to do my job is often not available.</p> <p style="text-align: center;">_____</p> | <p>21. I frequently do not have enough of the right tools and/or equipment to do my job.</p> <p style="text-align: center;">_____</p> |
| <p>13. I am frequently given unscheduled activities to work on which keep me from getting my job done.</p> <p style="text-align: center;">_____</p> | <p>22. The Air Force has not provided me with enough training to do my job.</p> <p style="text-align: center;">_____</p> |
| <p>14. I never have enough time to finish my duties without rushing.</p> <p style="text-align: center;">_____</p> | <p>23. The information I need to do my job is frequently wrong when I receive it.</p> <p style="text-align: center;">_____</p> |
| <p>15. The cooperation I am supposed to get from others frequently does not help me get my job done.</p> <p style="text-align: center;">_____</p> | <p>24. The Air Force does not provide me with the necessary materials, supplies, and/or parts when I need them.</p> <p style="text-align: center;">_____</p> |
| <p>16. My job is typically harder to do because I have to make up for a shortage of capable personnel in my unit.</p> <p style="text-align: center;">_____</p> | <p>25. My work doesn't get done because my schedule often gets changed without enough advance notice.</p> <p style="text-align: center;">_____</p> |
| <p>17. I am often hampered in doing my job by bad weather conditions (too hot, etc.).</p> <p style="text-align: center;">_____</p> | |

26. The cooperation I am supposed to receive frequently does not come when I need it.

27. I typically am not given the time I need to do my job.

28. I often find that I have too much work to do in order to make up for a lack of qualified personnel in my unit.

29. My job is frequently made more difficult by bad weather conditions (too hot, too cold, too wet, etc.).

30. My job is often made harder because I am not given enough advance notice about major changes in policies, procedures, and/or instructions.



31. I often cannot finish my job on time because of "red tape."

32. The required forms I need to complete to get my job done are often not available.

33. I often have to wait for a long time to get the transportation I need to do my job.

34. I often have to follow the instructions of others even though I am in a better position to know what should be done.

35. I frequently must work with faulty or damaged tools and/or equipment.

36. The lack of qualified people in my unit typically makes it difficult for me to get my job done.

37. I am not usually given enough training to handle new duties which are added to my job.

38. I frequently get job information from others which is inconsistent.

39. I am frequently provided with the wrong materials, supplies, and/or parts.

40. Long time delays keep me from getting my job done.

41. I frequently receive inconsistent policies, procedures, and instructions which make it difficult to do my job.

42. Too much "red tape" frequently keeps me from getting my job done on time.

43. I often cannot obtain the forms I need to get my job done.

44. Continually having to get the approval of others often keeps me from getting my job done.

45. The Air Force often provides me with tools and/or equipment which are poorly designed for getting my job done.

46. It is hard for me to get the help from others that I need to do my job.

47. My job is often made harder because I must follow specific policies, procedures, and instructions which I know to be wrong.

48. I must work with and depend upon others who are poorly trained to do their jobs.

49. I frequently have to wait on others to do their jobs before I can finish my own work.

50. Bad weather conditions (too hot, too cold, too wet, etc.) make doing my job more difficult.

51. There are frequent delays in getting the transportation I need in order to do my job.

52. The tools and/or equipment I must work with are often broken.

53. The cooperation I receive from others is often so poor that it doesn't help me get my job done.

54. The information I need to do my job is often incorrect when I receive it.

55. The inconsistent policies, procedures, and instructions I often receive make it difficult for me to get my job done.

56. The proper forms I need to do my job are often not available.

57. I am often not able to do my job well because I am not allowed to make those job decisions I can make best.

58. The equipment I am given is poorly designed for getting my job done.

59. The replacement materials, supplies, and/or parts I receive are often the wrong ones.

60. I often do not have the information I must have at work when it is needed.

61. I often cannot get my work done because I am not told of schedule changes far enough ahead of time.

1	2	3	4	5
Not at all Accurate	Somewhat Accurate	Fairly Accurate	Very Accurate	Completely Accurate

62. I often have to wait too long to get the help I need to do my job. _____
63. The incorrect policies, procedures, and instructions I often receive make it difficult for me to get my job done. _____
64. I frequently have trouble getting cooperation from others who are supposed to help me do my job. _____
65. The information I get from others which I need to do my job is often inconsistent. _____

This section consists of a number of words that describe different feelings that people experience. Your responses to these questions will help us understand your reactions to recent changes in the Air Force. For each word, indicate on your score sheet the extent that you have felt this way during the 8 weeks.

1	2	3	4	5
Very Slightly or Not at All	A Little	Moderately	Quite a Bit	Extremely

- | | | | | | |
|----------------|-------|------------------|-------|----------------|-------|
| 66. Interested | _____ | 73. Hostile | _____ | 80. Nervous | _____ |
| 67. Distressed | _____ | 74. Enthusiastic | _____ | 81. Determined | _____ |
| 68. Excited | _____ | 75. Proud | _____ | 82. Attentive | _____ |
| 69. Upset | _____ | 76. Irritable | _____ | 83. Jittery | _____ |
| 70. Strong | _____ | 77. Alert | _____ | 84. Active | _____ |
| 71. Guilty | _____ | 78. Ashamed | _____ | 85. Afraid | _____ |
| 72. Scared | _____ | 79. Inspired | _____ | | |

Using the scale below, rate how **accurately** each statement describes your present job situation in the Air Force. Write the number which represents your rating on the computer score sheet. As you read through the list, you will note that some of the statements are similar. However, no two of them are exactly alike or have exactly the same meaning. You should simply respond to them as they come and not feel any special need to check back to make answers agree. Please be sure to respond to all of the items.

1 	3 	5
Very Little	A Moderate Amount	Very Much
86. To what extent do you find out how well you are doing on the job as you are working?		89. To what extent do you receive information from your superior on your job performance?
87. How much are you left on your own to do your own work?		90. To what extent are you able to do your job independently of others?
88. To what extent are you able to act independently of your supervisor in performing your job function?		

Please complete the following questions as you did the previous ones.

1 	3 	5
A Minimum Amount	A Moderate Amount	Very Much
89. The feedback from my supervisor on how well I am doing.		93. The feeling that I know whether I am performing my job well or poorly.
90. The freedom to do pretty much what I want on my job.		94. The control I have over the pace of my work.
91. The opportunity to find out how well I am doing my job.		
92. The opportunity for independent thought and action.		

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neither agree no Disagree	Slightly Agree	Agree	Strongly Agree

95. My supervisor demands that people give their best effort.

98. My supervisor maintains high standards of performance.

96. My supervisor insists that subordinates work hard.

99. My supervisor is competent.

97. My supervisor demands that subordinates do high quality work.

How satisfied are you with the following aspects of your job? Please answer the following questions using the following scale.

1	2	3	4	5	6	7
Extremely Dissatisfied	Dissatisfied	Slightly Dissatisfied	Neutral	Slightly Satisfied	Satisfied	Extremely Satisfied

100. The amount of job security I have.

107. The amount of support and guidance I receive from my supervisor.

101. The amount of pay and fringe benefits I receive.

108. The degree to which I am fairly paid for what I contribute to this organization.

102. The amount of personal growth and development I get in doing my job.

109. The amount of independent thought and action I can exercise in my job.

103. The people I talk to and work with on my job.

110. How secure things look for me in the future in this organization.

104. The degree of respect and fair treatment I receive from my boss.

111. The chance to help other people while at work.

105. The feeling of worthwhile accomplishment I get from doing my job.

112. The amount of challenge in my job.

106. The chance to get to know other people while on the job.

113. The overall quality of supervision I receive in my work.

Please answer the following questions True or False.

1 = False

2 = True

114. My job tends to directly affect my health.

115. I would consider myself in good or excellent health.

116. I work under a great deal of tension.

117. I have felt fidgety or nervous as a result of my job.

118. I would consider myself in fair health.

119. If I had a different job, my health would probably improve.

120. I do not have very good health.

121. I wake up with stiffness or aching in joints or muscles.

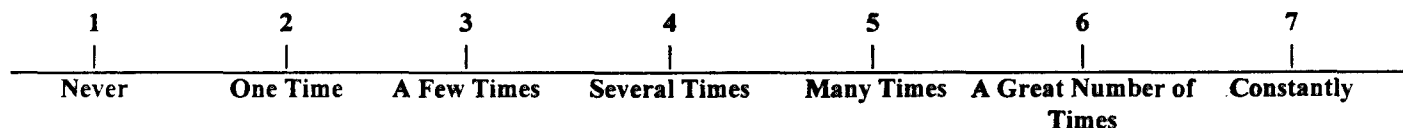
122. Problems associated with my job have kept me awake at night.

123. I seem to tire quickly.

124. I have felt nervous before attending meetings in the company.

125. I often "take my job home with me" in the sense that I think about it when doing other things.

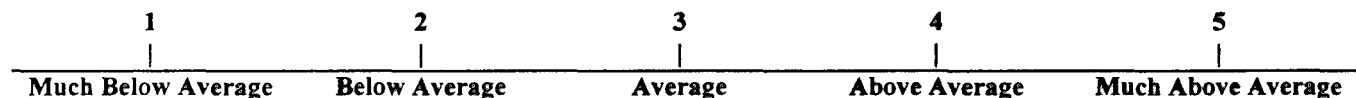
Again, use the following scale to answer the next series of questions.



In the last few years (1994 to the present) how many times has a supervisor or commander...

- 126. sent you a letter of appreciation?
- 127. recommended you for an award (even if you didn't get the award)?
- 128. offered you a more important job?
- 129. put you in charge of a project?
- 130. recommended you for a Professional Military Education (PME) program (even if you didn't actually attend it)?
- 131. recommended you for some other type of training (even if you did not actually attend it)?
- 132. nominated you for an Airman or NCO of the Quarter Award (or a monthly or yearly award)?
- 133. recognized your good work at a Commander's Call or another group meeting?
- 134. recommended you for a special duty assignment (even if you didn't get it)?
- 135. tried to help you get an assignment that would help your career (even if you didn't get it)?
- 136. nominated you for early promotion to the next rank (even if you didn't get it)?
- 137. recommended you for a medal or ribbon (even if you didn't get it)?

Please use this scale for the questions below.



Compared with the performance of other people at work, how effective are you in...

- 138. getting along with others at work
- 139. applying technical knowledge to real-world problems
- 140. staying motivated
- 141. helping others get tasks done
- 142. respecting others
- 143. maintaining your physical fitness
- 144. encouraging others to do better

- 145. using common sense to solve a problem
- 146. overcoming obstacles to get the job done
- 147. getting others to cooperate
- 148. seeing a task through to completion
- 149. performing technical tasks skillfully
- 150. maintaining good working relationships
- 151. taking the initiative to make improvements in work processes
- 152. helping a coworker with his tasks
- 153. treating others fairly

Please use the following scale for the remaining questions.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Slightly Disagree	Neither agree no Disagree	Slightly Agree	Agree	Strongly Agree

- | | |
|---|---|
| <ul style="list-style-type: none"> 154. I rarely make errors at work. 155. My section has experienced a high number of accidents. 156. I am frequently tired at the end of my shift. 157. I wish I could work the opposite shift. 158. I enjoy being in the Air Force and Plan to reenlist. 159. They expect too much work from my section. 160. I have time to exercise. 161. Changes are made with little regard for the welfare of squadron members. 162. I plan on continuing m career choice. | <ul style="list-style-type: none"> 163. I often feel worn out and tired on the job. 164. I spend too much time at work. 165. I would like to work in a different section. 166. I have time to conduct my personal business. 167. I do no spend enough time with my family. 168. After my shift is over, I have enough energy to participate in my favorite activities. 169. I enjoy working my current schedule. 170. My coworkers frequently make errors in work |
|---|---|

Thank you very much for completing this survey. Again, be assured your responses will be held in strict confidentiality and are for research purposes.

Appendix B. Situational Constraints

- **Training** – The individual lacked training necessary to do their job
- **Materials and Supplies** – Individual lacked necessary materials and supplies
- **Time** – Individual lacked sufficient time to do their job
- **Tools and Equipment** – Individual was unable to perform job due to lack of proper tools and equipment
- **Planning/Schedule of Activity** – individual could not complete job due to having to wait for others
- **Cooperation from Others** -- Individual was unable to obtain the help from others needed to complete the job
- **Personnel** – There was an insufficient number of people present to get the job done
- **Physical Working Conditions (Weather or Climate)** – Work environment was too hot, too cold, or had too much precipitation
- **Policies and Procedures** – Individual was constrained due to uncertainty concerning correct policies or procedures
- **Red Tape** – Some aspect of the rules and regulations interfered with job completion
- **Transportation** – Individual could not get to the job site
- **Job Relevant Authority** – Individual could not do job because of a lack of needed authority
- **Job Related Information** -- Individual did not have enough or had wrong information
- **Forms** – Lack of proper forms interfered with individual completing jobs.

This listing is taken from the study conducted by O'Conner, et al., 1984. In this study all alphas were within the range of 0.70 to 0.91.

Appendix C. Demographic Information

Rank	Red	Blue	Other
E1 or E2	1.3	1.6	3.8
E3 or E4	55.8	49.6	36.5
E5	23.4	20.3	28.8
E6	11.7	10.6	11.5
E7 or Higher	7.8	13.8	15.4
Missing	0	4.1	3.8

Education Level	Red	Blue	Other
No HS Diploma	0	0	0
High School Diploma	71.4	68.3	51.9
2-Year College	20.8	19.5	28.8
4-Year College	0	6.5	1.9
Other	7.8	1.6	13.5
Missing	0	4.1	3.8

Sex	Red	Blue	Other
Male	94.8	87.8	86.5
Female	5.2	7.3	9.6
Missing	0	4.9	3.8

Time In Service	Red	Blue	Other
Less than 2 Years	10.4	4.1	3.8
2 to 5 Years	41.6	39	17.3
6 to 10 Years	15.6	17.9	34.6
11 to 15 Years	14.3	13.8	17.3
15 or More Years	18.2	21.1	23.1
Missing	0	4.1	3.8

Race	Red	Blue	Other
White	81.8	78	84.6
Black	5.2	5.7	3.8
Hispanic	6.5	4.9	3.8
Asian	2.6	1.6	3.8
Other	3.9	4.1	3.8
Missing	0	5.7	3.8

Skill Level	Red	Blue	Other
1	0	0	0
3	18.2	18.7	3.8
5	46.8	36.6	46.2
7	32.5	32.5	42.3
9	2.6	6.45	3.8
Missing	0	5.7	3.8

All values are expressed as percentages.

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Vita

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