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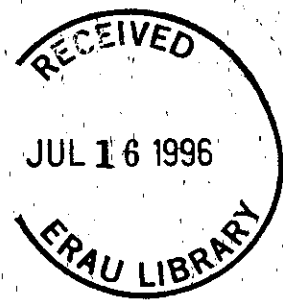
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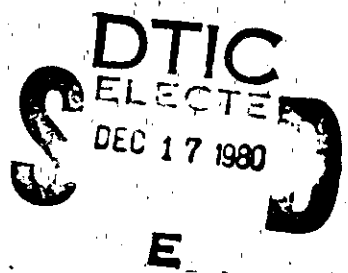
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STRESS, ANXIETY, AND THE AIR TRAFFIC CONTROL SPECIALIST: SOME CONCLUSIONS FROM A DECADE OF RESEARCH

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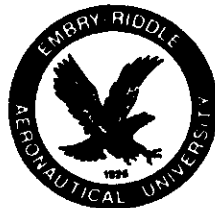
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16. Abstract It is often assumed that air traffic control specialists (ATCSs) endure a high degree of work-related stress and that they may be near the limits of their ability to cope with such stress. This paper summarizes a decade of research evaluating possible stress effects of work on ATCSs. Studies were conducted at a variety of large and small air traffic facilities. A visit of several days to each facility was part of an interdisciplinary research effort involving physiological and biochemical, as well as psychological, assessments. The principal psychological measure was the State-Trait Anxiety Inventory (STAI). The STAI and other questionnaires were administered at the beginning and end of three to five different work shifts scheduled at a facility. The findings showed that controller groups scored significantly below college student norms on both the A-state (current anxiety level) and A-trait (anxiety proneness) measures of the STAI. Results with mood adjective checklists were similar. The findings also showed that anxiety levels (1) increased across an 8-hr work shift and (2) were higher on shifts rated 'difficult' than they were on 'easy' shifts. The establishment of adult norms for the STAI was undertaken to provide a better comparison for ATCS data. Results of those efforts indicated that ATCSs had lower anxiety scores than the normal adult population. Moreover, A-state scores increased from the beginning to end of work shifts for employees in a variety of non-air-traffic jobs (e.g., engineers), just as they did for ATCSs. Thus, ATCSs are well within normal limits on every indicator of psychological states used in these studies and appear to experience less anxiety than is the average in other work settings.		
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STRESS, ANXIETY, AND THE AIR TRAFFIC CONTROL SPECIALIST:
SOME CONCLUSIONS FROM A DECADE OF RESEARCH

I. Introduction.

When stressful occupations are discussed, particularly in the popular press, it is common for the air traffic control specialist (ATCS) to be identified as belonging to a professional group under intense stress (9,23). As one author put it: "The job of juggling airliners and making snap decisions on which lives depend exacts a steep toll in stress-related diseases, nightmares, and acute anxiety" (26). In a recent book on occupational stress, Kasl (22) notes that air traffic control work is one of those vocations that seems intuitively to be stressful.

This paper reviews a series of field studies conducted with ATCSs to assess possible stress effects in their work. The studies are presented in chronological order to provide some indication of how results from one investigation influenced the conduct of the next one. The presentation is also designed to show the development of the perspectives needed to assess most properly the presence or absence of work stress in this occupation.

Attempts to document the presence of unusual stress in the air traffic setting date from the middle 1960's (10,11,17); however, concerted efforts to study this issue did not get underway until the last part of that decade. The Civil Aero-medical Institute (CAMI) began its program of stress research in 1968, an effort which continued throughout the 1970's.

II. Procedure.

Most of the CAMI studies were multidisciplinary in scope and involved psychological, physiological, and biochemical assessments of the state of the ATCS. The format of these studies followed the same general pattern in each investigation. Volunteers were solicited from the crews working at each facility with the understanding that they would be involved with the project for up to 10 days. For the psychological portion of the studies, each participant filled out one or more assessment questionnaires at the beginning and again at the end of each work shift under consideration. The questionnaires varied across studies and each will be discussed in the context of the specific study in which it was used. The major physiological measure, heart rate, was recorded throughout the work shifts under investigation by the use of miniature tape recorders. These instruments permitted the participants to remain ambulatory throughout the work shift while providing continuous electrocardiographic (ECG) recordings. On occasion, blood pressure and the galvanic skin response were also measured. The biochemical measures were derived primarily from urine samples collected before, during, and after the work shifts under consideration. In some of the earlier CAMI studies there was also collection of blood samples after at least one work shift. Since the concern of the author in these studies was with the psychological domain, that will be the main focus of this paper; however, the physiological findings from the studies will be highlighted as well.

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III. Results and Discussion.

Study I. Chicago's O'Hare Tower: An "Ulcer Factory?". The first CAMI study, was undertaken at the control tower and radar room for Chicago's O'Hare International Airport, the world's busiest airport (50). Twenty-two ATCSs agreed to participate in the study although CAMI researchers were limited to assessing them only on the evening (1600-2400) and night (0000-0800) shifts. In this study Malmstrom's Composite Mood Adjective Check List (CMACL) was used (25). The CMACL was basically a collection of items from the Zuckerman (55), Clyde (5), and Nowlis (37) checklists and comprised 80 adjectives, each rated on a 9-point scale of "not at all" to "definitely" descriptive of one's current feelings. Each participant completed the CMACL immediately before and after five evening and five night shifts. Since limited normative data and no control subjects for the CMACL were available, the only meaningful comparisons that could be drawn from this part of the study were between evening and night shifts and from the beginning to the end of the work periods. Not surprisingly, the CMACL factors related to fatigue (Concentration, Fatigue, Vigor, and Sleepiness) showed significant increases across work shifts and were higher on night than on evening shifts. On the other hand, there was the rather surprising finding that the mean scores on every indicator of anxiety (the Nowlis Anxiety Scale, the single word "anxious," and the Zuckerman Affect Adjective Check List) were all very low on the scale. The mean on the 9-point scale was between the second and third points, where the first point indicated "not at all" descriptive and the ninth point indicated "definitely" descriptive of one's current feelings. It was also found that the anxiety scores tended to be higher after than before work, a finding to be repeated in every study conducted by CAMI.

The physiological measures from the O'Hare subjects (15) showed that heart rates were generally somewhat above those expected in the general population and were higher during the busier evening shift than the slower night shift. Galvanic skin response and blood pressure measures were generally not remarkable.

The biochemical assessment revealed that phospholipid concentrations were apparently somewhat elevated. The findings from the analyses of urinary metabolites were quite complicated. In comparison to control subjects (biomedical technicians simply observing the ATCSs work), the ATCSs had higher levels of physiological arousal, particularly during heavy work periods. Taken together, these findings were not entirely consistent with what had been expected. While there probably was some notable physiological arousal, psychologically, there was no evidence of reaction to significant stress.

Study II. A Comparison of ATCS Stress at Chicago's O'Hare and at Houston. The next study was conducted at the tower and radar facilities for Houston Intercontinental Airport (34,50). The volume of air traffic at this facility was about 60 percent of that for O'Hare International Airport. Test procedures were much the same as those followed in the previous study except that day shifts (0800-1600) were studied instead of evening shifts. For the psychological measures the CMACL was used again, and the State-Trait Anxiety Inventory (51) and a questionnaire on shift-difficulty were added. The STAI is a standardized measure of both A-trait, the propensity to experience anxiety, and A-state, the moment-to-moment level of anxiety. Physiological measurements were restricted to ECGs and biochemical analyses were conducted on urine and blood. In this study the control subjects

(again biomedical observers) contributed both psychological and physiological/biochemical measurements.

A total of 16 ATCSs and 4 biomedical observers completed the research tasks. The data from the CMACL indicated that, as a group, the Houston ATCSs showed the same general pattern as the O'Hare controllers. Scores related to fatigue were higher at the end of shifts than at the beginning and were higher for night than day shifts. The trend for anxiety indicators in the CMACL to be higher at the end of work shifts than at the beginning was also found but was not as pronounced as in the O'Hare study.

Compared to the control subjects who had observed them, Houston ATCSs were less fatigued, more vigorous, and less anxious. The comparisons with ATCSs at Chicago's O'Hare International Airport showed the overall degree of positive affect to be somewhat higher in Houston. However, most of this effect was due to the difference in scores between the day shift measures at Houston and the evening shift measures at O'Hare, especially on scales related to fatigue. On the night shifts, the situation was reversed, with the O'Hare ATCSs showing the lesser feelings of fatigue even though they were considerably busier during this shift than were the Houston ATCSs.

The STAI scores followed the trend of the CMACL data in that scores on the A-state scale increased significantly from before to after work on both day and night shifts. The use of the STAI also permitted comparison to normative groups, whereas this was not possible with the CMACL. The normative group most closely matching the air traffic sample was that of college undergraduates who had the lowest mean score of any of the available normative groups (high school students, surgical patients, prisoners). According to the college student norms, the mean A-state score for the Houston ATCSs was at the 42nd percentile. The A-trait scale (anxiety proneness) was at the 24th percentile. These findings tended to affirm the CMACL results that the expressed levels of anxiety reported by ATCSs were certainly within normal limits and were at relatively low levels. These data are inconsistent with the presence of any unusual emotional stressors.

Physiological measures showed that heart rates were generally higher during the day shift than during the night shift for the Houston ATCSs. The heart rates of Houston ATCSs during the day shift were lower than the heart rates obtained from evening shifts at O'Hare. The night shifts did not differ. Preshift measures of heart rate also showed that the ATCSs at O'Hare had the higher mean rate. This suggests that some of the differences observed between these two facilities may relate to different baseline levels of physiological arousal rather than to differences in the work situation itself.

The urine analyses for Houston ATCSs showed epinephrine and norepinephrine to be higher during day shifts than during night shifts. The comparison with O'Hare ATCSs showed that the two facilities differed primarily on night shift measures where the greater workload at O'Hare is reflected in the higher level of catecholamine excretion. Plasma phospholipids were also found to be higher for O'Hare than for Houston ATCSs.

These findings, taken with those from O'Hare, suggested that the belief that ATCSs are typically under intense stress was at least questionable. In fact, from the psychological perspective, the most notable finding was the lack of evidence indicating the presence of emotional stress.

Study III. ATCS Job Attitudes as Possible Indicators of Stress. During this time some job attitude research was conducted by CAMI researchers that further increased doubts about the presence of any unusual psychological or emotional stressors in air traffic work. One study (46) asked 614 ATCSs at 17 busy towers what they liked and disliked about their work. Stress was never specifically mentioned as a negative feature of air traffic work, nor was it implied. These ATCSs complained about management, shift schedules, equipment, and noncontrol tasks, but not about stress. To the contrary, as a group they found the challenging, fast-paced, constantly changing nature of air traffic work much to their liking. Interestingly, these data were collected just about the time (1968) of the first major labor conflict between ATCSs and management in the Federal Aviation Administration (FAA), a time when concern over stress in ATCSs was becoming well publicized.

Job
Satisfaction

Study IV. A Followup of ATCS Job Attitudes. A second attitude study (42) was conducted 4 years later and again was coincidentally in sequence with a second major labor upheaval in the air traffic system. In this study, 792 ATCSs from 18 large facilities answered an extensive questionnaire about their work. The findings were essentially the same as those for the first study: Most of the dislikes concerned management and various aspects of working conditions, while various aspects of job challenge and the work itself were most often mentioned as positive features. Over 92 percent of the respondents reported that they were satisfied with their work as air traffic controllers, a percentage well above the usual value of 80 percent found in most other occupations. Furthermore, when asked to specifically rate their liking for various aspects of their work, these ATCSs generally reported that they liked heavy and moderate density traffic, the difficulty of the work, and the constant traffic change. They did not like night shifts, light traffic, and management. Again the data seemed inconsistent with the notion that these people were exceedingly stressed.

Study V. Houston Revisited: A Comparison of Different Shift Schedules. The next CAMI stress study (29) again took place at Houston, 1 year after the first study at that facility. The reason for returning was that the facility changed from a straight 5-day rotation of shifts (5 day shifts followed by 5 evening shifts followed by 5 night shifts with 2 days between each change) to a short rotation schedule called the 2-2-1 (2 day shifts followed by 2 evening shifts followed by 1 night shift and then 2 days off).

The type of shift schedule employed had relatively little effect on the scores from the psychological measures. The CMACL measures related to fatigue showed a modest tendency to increase with the shorter turnaround schedule, while other measures, including the STAI, were unchanged; otherwise, the findings were the same as in the first Houston study. Physiological and biochemical measures either showed no difference between the two shift schedules or slightly favored the shorter schedule.

Study VI. Air Traffic Work Demands and STAI Scores: A Sensitive Measure. At this point the psychological data seemed clearly to contradict the notion that significant psychological or emotional stress was a factor in air traffic work. However, limitations in the design of the previous studies, often due to real-world situational and administrative constraints, left many questions unanswered. One of these was the question of the sensitivity of the measures, particularly the STAI, to stress in the air traffic situation. To answer this question comparisons were made of the STAI data from the Houston ATCSs with data from a total of 62 additional ATCSs from (i) an extremely busy general aviation tower (Opa Locka, Florida, a nonradar tower primarily serving light and business aircraft) and (ii) an air route traffic control center (ARTCC), a radar facility controlling high-altitude cross-country traffic (48). Ratings of the difficulty of each day or night of work were also obtained. The A-state score was found to increase over twice as much across shifts rated "difficult" as for shifts rated "easy." Thus, it appears that the STAI was in fact sensitive to variations in arousal associated with perceived changes in demand or difficulty.

The physiological and biochemical measures showed personnel at the general aviation tower to be under greater physiological arousal during work than were personnel at the ARTCC or the Houston tower, and at about an equal level of arousal with the O'Hare ATCSs (35).

Study VII. Validation of Findings From Houston. The next study was designed to replicate and clarify findings from the two studies comparing shift rotation schedules at the Houston tower (31). The earlier comparisons of the two schedules, the 5-day and 2-2-1, at the Houston facility had been hampered by a variety of problems, including the fact that no assessment of evening shifts was available for the 5-day schedule. This new study was conducted at two large ARTCCs, one on the 5-day and the other on the 2-2-1 schedule, and covered all shifts at each facility.

The findings from the STAI in this study again showed (i) no difference in shift schedules, (ii) low A-trait and A-state scores compared to scores of college students, and (iii) the significant increase in A-state from the beginning to the end of work. The biochemical assessment (only biochemical measures were taken in this study) appeared to favor the 2-2-1 schedule to some degree, although no impressive differences were found.

Study VIII. Some Effects of Automation on ATCS Stress Indicators. About this time, the middle 1970's, computer assistance for ATCSs was beginning to be a factor in the air traffic work situation. The system being brought on-line was designed to enhance radar targets and to handle information concerning aircraft that up until then was either committed to memory or noted by hand. The ATCS remained the decision maker but now possessed a rather sophisticated memory aid. In order to assess the impact of the introduction of the new computer systems on ATCSs, a CAMI research team visited two busy terminal radar facilities (Los Angeles and Oakland, California) on the west coast of the United States (30). Data were first collected before the installation of the new computer systems, then again some 5 months after the systems were in full operation. There were no differences in the psychological measures (STAI) taken before and after installation of the computers. Surprisingly, the biochemical indices showed several statistically significant increases after the installation of the computer systems, primarily in catecholamine excretion. However,

baseline (resting) levels of these metabolites also increased significantly between the two assessments. This suggests that the observed increases in catecholamine excretion cannot be clearly attributed to the addition of the new equipment but may have been due to other unspecified factors outside the purview of this review.

Up to this point, no concerted effort had been made to relate the psychological and physiological measures obtained from ATCSs; primarily because most other investigators had been unable to show correspondence between these types of data (24). However, the development of a new biochemical stress index (35) provided a fresh opportunity to integrate the two sets of data. This was attempted with the records from Los Angeles and Oakland. Unfortunately the index, which integrates catecholamines and steroid secretion into a single index adjusted for baseline values of each metabolite, was not related in any way to the psychological measures.

Study IX. Stress Data From ATCSs at Facilities With Low Workloads. The last multidisciplinary assessment of stress was conducted at several smaller facilities with relatively low levels of activity (32). The by-now often-replicated finding that A-state increases significantly across work shifts was again confirmed, as were the relatively low scores of ATCSs (compared to STAI norms) on both scales of the STAI. The mean STAI scores for these ATCSs did not differ from the overall mean for the ATCSs from busier facilities; however, the levels of the biochemical indices were generally lower than for most other facilities. An analysis of the level of epinephrine excretion at the various tower facilities studied to this point as a function of traffic volume yielded a straight linear relationship and a correlation of .96 (Spearman rank-order). Measures of norepinephrine and steroids showed no such relationship to traffic volume. This makes it rather clear that epinephrine excretion is a workload, rather than an emotional, indicator in these studies (32).

Study X. STAI Scores for ATCSs vs. Workers-in-General. An issue that continued to be of concern was the proper perspective in which to place the data from the psychological assessments. There is some evidence that reported anxiety levels may diminish across age (4). If so, then the apparently low scores of ATCSs compared to scores of college students may have only been an artifact of a developmental process. One piece of information was available to suggest that this possibility did not explain the CAMI data. A study of anxiety in 15 student pilots showed that the 7 ATCSs in the course scored significantly lower on A-trait than did a group of 8 noncontroller professionals, all as old as or older than the ATCSs (49). However, the small number of participants in that study makes the comparison less than conclusive.

What was needed was (i) normative data from the STAI on adults and (ii) knowledge as to whether the increase in A-state from the beginning to the end of work was a function of air traffic work in particular or of work-in-general. To meet these needs, the STAI was given to over 1,900 men and women of varying ages employed in a wide variety of non-air-traffic occupations. Over 1,800 of these participants provided complete data to permit the establishment of age-related norms (see Table 1). The mean A-trait and A-state levels are lower for this sample than for college undergraduates. However, these mean scores are still significantly higher than the mean scores obtained in our several studies of ATCSs. It can now be confidently stated that ATCSs do indeed score below the population-in-general on the STAI.

TABLE 1. STAI (Form Y) Means and Standard Deviations For Normal Adults

Age:	25 - 29		30 - 34		35 - 39		40 - 44		45 - 49		50 - 54		55 - 59		60 - 69	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
A-trait																
Mean	36.6	39.4	34.8	35.7	35.2	34.8	34.9	36.0	35.3	33.7	34.2	32.4	34.0	32.0	33.0	30.7
SD	10.3	11.4	9.2	8.9	9.3	9.1	8.7	8.7	9.2	9.4	9.0	7.5	8.8	9.0	8.5	7.5
N	57	46	147	61	192	68	260	80	307	55	197	50	131	38	53	19
A-state																
Mean	36.8	39.5	36.1	35.0	36.2	36.4	35.6	36.3	36.5	35.9	34.6	32.6	35.0	31.5	32.1	32.4
SD	9.6	12.1	10.5	10.0	9.7	11.7	9.9	10.5	11.0	11.9	10.1	7.3	11.0	9.4	8.9	10.4
N	57	46	147	62	193	69	259	80	305	55	199	50	131	38	53	22

TABLE 2. STAI A-trait and A-state Scale Means and Standard Deviations (SD) for ATCSs,

ATCS Instructors, Non-ATCS Adult Men, and Male College Undergraduates

Group	N	A-TRAIT		A-STATE	
		Mean	SD	Mean	SD
ATCSs	198	30.3	6.6	31.1	7.5
Instructors	92	32.8	8.9	33.8	10.1
Non-ATCSs	1,303	35.8	10.4	35.1	9.2
College Undergraduates ^a	253	37.7	9.7	36.4	9.7

^aTaken from Spielberger et al. (51)

STAI scores from a major portion (1,303 men) of the people who provided data for the normative sample in Table 1 were used in a comparison with (i) 198 ATCSs who had provided both A-trait and A-state data in our field studies and (ii) an additional sample of 92 former ATCSs who had become instructors in the air traffic training program (47). The mean scores for these instructors on both the A-trait and A-state scales of the STAI fell at an intermediate level between the ATCS and the non-ATCS groups. All the differences in A-trait and A-state between the instructors and ATCSs were statistically significant; however, the differences between instructors and non-ATCSs were significant only for the A-trait scale. In other words the instructors reported higher levels of psychological arousal than did active ATCSs but lower-to-equal levels with non-ATCSs. Similarly, a biochemical study (27) of instructors also showed elevated excretion of epinephrine (but not norepinephrine or steroids) for instructors in comparison with ATCSs. These studies, taken together, further support the conclusion that working air traffic has no unusual arousal value as an occupation, since those away from actual air traffic had higher indices of arousal, both psychological and physiological, than did active ATCSs. The difference in arousal levels between ATCSs and instructors may reflect a higher degree of competitiveness in those ATCSs chosen to be instructors. Since these positions were seen at that time as important opportunities to open avenues for advancement, there was often considerable competition for them. This suggests the possibility that those who applied for instructor positions might be more of the Type A personality (more ambitious, striving, hard-driving, and competitive (20,39) than is true of most ATCSs.

Finally, the increase in A-state from the beginning to the end of work that had been found in virtually all of the studies of ATCSs was also found for 88 non-air-traffic employees (from the sample in Table 1) who had completed A-state scales at the beginning and end of from 1-3 workdays (see Table 3). Although the size of the increment was somewhat greater for ATCSs than for non-ATCSs, scores for the former included more variable working shifts and more replications per subject (and scores at both the beginning and end of work were clearly lower for ATCSs). In any event, these comparisons indicate that the increment in arousal during work is more of a general characteristic of work itself than the result of stressors unique to a particular work setting.

TABLE 3. STAI A-state Scale Means at the Beginning and End of Work for ATCSs and Non-ATCS (Scores are based on several replications for each subject.)

Group	N	Beginning	End
ATCSs	210	30.2	35.0
Non-ATCSs	88	33.1	37.0

Related Research. There are several other researchers who have conducted similar investigations with ATCS. Grandjean, Wotzka, and Kretzschmar (14) obtained reports of fatigue and mood from Swiss ATCSs. They found response patterns similar to those in CAMI's O'Hare and Houston studies (50): Self-ratings of fatigue were higher, and

mood self-ratings were lower, at the end than at the beginning of work. Hibler (18) expanded upon CAMI studies of shift difficulty and anxiety (48) to include ratings by military ATCSs of difficulty and anxiety during shifts, and confirmed that A-state levels were higher for difficult shifts and that A-state scores generally increased across shifts. The mean A-trait and A-state scores for the military ATCSs were similar to those obtained in CAMI studies of civilian ATCSs. In another study, Caplan, Cobb, French, Harrison, and Pinneau (3) found anxiety levels among a group of midwestern ATCSs to be intermediate in comparison to 22 other occupations. Rose, Jenkins, and Hurst (38) reported that more than 80 percent of a group of ATCSs participating in an evaluation of health change scored low (over one standard deviation below the mean for college students) on the Tension/Anxiety Scale of the Profile of Mood States (28). Thus, those researchers who have made comparable measures of psychological states have obtained results highly consistent with CAMI findings.

Related work in the physiological area has been limited to two main studies. Schad, Gilgen, and Grandjean (39) found that six Swiss ATCSs excreted higher levels of catecholamines while doing air traffic work than when providing general supervision or doing clerical work. Rose et al. (38) considered heart rate and blood pressure in their health change study. The heart rate values they obtained from ATCSs in the northeastern region of the United States tended to be lower than the rates obtained from both the O'Hare (33) and Houston (29) studies. On the other hand, the mean blood pressures obtained by Rose et al. were considerably higher than those obtained at O'Hare. The meaning of these differences in physiological/biochemical findings is not readily apparent.

Though not directly comparable to CAMI research, there have been other investigations of the health consequences of air traffic work that have implications for the assessment of stress in ATCSs. The findings from these studies have been mixed. Two studies, by Cobb and Rose (8) and Rose et al. (38), suggest that ATCSs are at higher risk than men-in-general for hypertension; however, Booze (1) found hypertensive diagnoses to be well below expectancy in a review of health records for 25,000 ATCSs. Dougherty (10) found no difference between ATCSs and non-ATCSs in the prevalence of ECG abnormality. The evidence that the air traffic system is an "ulcer factory" (26) is also equivocal. Dougherty, Trites, and Dille (11) and Hauty, Trites, and Berkley (17) found a higher incidence of self-reported gastrointestinal symptoms by ATCSs than by non-ATCS personnel. The Cobb and Rose (8) and Rose et al. (38) studies both reported higher than expected incidence of ulcers in their samples of ATCSs. However, Singal, Smith, Hurrell, Bender, Kramkowski, and Salisbury (40) found no evidence that ulcers were above expectancy at the O'Hare facility, nor did Booze (1) in his survey of medical records from ATCSs. Neuro-psychiatric problems were commonly reported in both the Rose et al. (38) and Booze (1) studies. However, it was not possible to determine (i) if the rates were above expectancy in the Rose et al. study because of the lack of comparable norms, or (ii) if the high rate in the survey by Booze occurred only after introduction of a special benefits program for ATCSs who were separated from their work for medical or administrative reasons. Reaching a general conclusion about these diverse results is difficult; perhaps they are best summarized as suggesting that some ATCSs at some air traffic facilities may be at higher risk for health change, particularly cardiovascular problems, but this is probably not true for the ATCS work force in general.

IV. Conclusions and Methodological Problems.

In coming to conclusions about the entire body of data just reviewed, it must be kept in mind that a number of questions are still unresolved. One important issue concerns the use of volunteers in these kinds of stress studies. As Singal et al. (40) point out, "This . . . is a particularly crucial methodologic problem in studies of psychiatric and psychosomatic disorders since the psychologic and sociologic characteristics associated with the disorders in question may be among the very determinants of whether someone volunteers for the study." These characteristics may influence physiological responsiveness as well (12). Unfortunately, there is no clear resolution to the volunteer problem; physiological and biochemical measurements involve various degrees of inconvenience or discomfort and cannot be routinely required of employees for research purposes. Psychological measurements cannot be effectively demanded of employees since they usually require the cooperation of the respondent. The best resolution at this time consists in obtaining as many participants as possible at a variety of facilities and gathering as many unobtrusive measures as possible through medical records and the like.

A problem unique to the psychological aspects of these investigations is that of response sets. Since self-report data are sensitive to the approach taken by the participant to the research, the participants' cooperation must be relied upon to obtain reasonably veridical reports of their psychological states. When programs and benefits may depend on research findings, the probability that dissimulation will occur may be increased. Because of the potential for this problem, screening procedures for "fake bad" response sets were developed for both the CMACL (41) and for the STAI (43). When these scoring procedures were applied to the records of participants in CAMI research, it was found that all but one of the ATCSs scored within the valid range. This was also the experience in the Rose et al. (38) study, in that the validity indicators on the California Personality Inventory were generally within acceptable limits. A few of their participants were found to be more defensive than expected, but on the whole it was concluded that the respondents answered openly and honestly.

Another issue that presents some problems for the clear-cut interpretation of these various findings is that of the rotation of work shifts. The research literature on shift work suggests that there may be a variety of negative psychological, social, and health consequences associated with working rotating shift schedules (16,36). Since the busier air traffic facilities require 24-hr coverage, while smaller facilities generally do not, shift work and workload are confounded to some degree. Furthermore, comparisons of data from ATCSs with data from normative populations generally do not take work schedule into account. Thus, for example, symptomatic differences between ATCSs and non-ATCS airmen in the Cobb and Rose (8) study may have been partly a function of a lower percentage of shift workers in the non-ATCS group.

Finally, there is the problem of uncontrolled personal variables. There is available a considerable amount of information about the kinds of people who choose air traffic work. As a group, they have been found to score in the upper 20 percent of the population on intellectual assessments (6,53) but are usually not collegiately educated (7). On the 16 Personality Factor (16PF) test, ATCSs tend to be average on most of the factors. They differ substantially from men-in-general on only 4 of the 16

factors: intelligence, group-conformity, tough-mindedness, and compulsivity (21, 38,44). In comparison, airline pilots differ substantially from men-in-general on 11 of the 16PF scales. ATCSs score within the normal range on all scales of the California Personality Inventory with relative elevations on the factors associated with dominance and relatively lower scores on factors measuring mature socialization and respect for authority (38,54). On the Strong Vocational Inventory Blank (2), ATCSs score like men-in-general on all but a few scales mostly concerned with technical supervisors (45). These findings suggest that ATCSs form a unique occupational group only on a few personality dimensions. However, it is possible that those dimensions may be related to their psychological and physiological responses to air traffic work. Rose et al. (38) did find that ATCSs who were Type B personalities seemed at higher risk for hypertension than were those who were more competitive, an interesting reversal of the usual sort of findings (20). The problem is to discern to what extent the incidence of hypertension or other physical or psychological problems results from the work, not the person. In other words, it is quite possible that ATCSs who contract hypertension or other problems may be likely to do so in any work circumstance. Only the development of carefully matched control groups can resolve this question.

Although the problems just discussed require further research, it is clear from presently available evidence that the ATCSs appear remarkably free of emotional distress. According to Spielberger's (52) process theory of anxiety, this means that ATCSs perceive little, if any, threat in their work or the responsibilities associated with that work. The physiological data obtained in ATCS research suggest normal physiological responses to varied workloads. The extent to which high workloads are related to negative consequences for ATCSs is uncertain. There is some evidence (19) linking increased physiological responsiveness with cardiovascular and gastrointestinal problems; however, the extent to which this correlation is a function of the individual's response style as opposed to the effects of workload or other aspects of the work itself has not yet been determined. According to Rose et al. (38), the types of health change data that they obtained are suggestive of an interaction between individual predispositions to certain disorders and characteristics of the work setting. They suggest that it is not the work itself, but the context in which the work is conducted, that is the important factor interacting with predisposing factors in the individual ATCS.

In conclusion, there is little evidence to support the notion that ATCSs are engaged in an unusually stressful occupation. This is not to say that ATCSs never encounter unusual stress on the job; however, it does appear that this is the exception rather than the rule. ATCSs appear both well qualified and well suited for air traffic work. The demands of air traffic work do not appear to place unusual stress on ATCSs; this professional group appears quite capable of handling requirements of the job without distress. The notion that this occupational group is being pressed to the psychological and physiological limit is clearly unjustified.

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