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AVIATION SAFETY

Serious Problems Continue to Trouble the Air Traffic Control Work Force



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Resources, Community, and
Economic Development Division

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The Honorable Guy V. Molinari
Ranking Minority Member
Subcommittee on Investigations and Oversight
Committee on Public Works and Transportation
House of Representatives

The Honorable Glenn M. Anderson
Chairman, Committee on Public Works
and Transportation
House of Representatives

This report responds to your request that we survey the Federal Aviation Administration (FAA) air traffic work force—consisting of controllers, supervisors, and facility managers—to determine how those directly involved in air traffic control feel about their working conditions and other aspects of the air traffic control system. It updates our 1985 survey and previous evaluation¹ of the problems facing the air traffic control work force. The current survey represents the overall work force views at FAA's 84 largest facilities on various issues including the adequacy of staffing, training of new controllers, morale, and safety of the air traffic control system. Overall, 5,098 of 6,469 questionnaires were returned. This report combines responses to specific questions in our three questionnaires; the detailed responses to these questionnaires are contained in a separate GAO report.²

Results in Brief

Controllers and supervisors are troubled by working conditions and other aspects of today's air traffic control system that affect their ability to maintain the safety of the air traffic system. In contrast, facility managers viewed conditions much more favorably. Overall, controller, supervisor, and facility manager views of working conditions did not differ significantly from our 1985 survey results. Specifically,

¹Aviation Safety: Serious Problems Concerning the Air Traffic Control Work Force (GAO/RCED-86-121, Mar. 6, 1986).

²Aviation Safety: Conditions Within the Air Traffic Control Work Force (GAO/RCED-89-113FS).

- Controllers and their supervisors saw a shortage of developmental and full performance level (FPL) controllers.³ Controllers are concerned that they typically handle too much traffic during peak periods of operation and, during these periods, are often required to work too long without a break. Managers agreed that there was a shortage of controllers. However, they did not believe controllers handle too much traffic or work too long without a break.
- A majority of controllers believed the quality of several essential areas of training for developmentals is inadequate. Facility managers do not agree.
- Over 40 percent of controllers—the largest response group—viewed their own morale as low. Most managers did not perceive controllers' morale to be low.
- Controllers and supervisors predominantly agreed that several factors, such as the amount of traffic work load, hindered their ability to maintain system safety.
- Controllers, supervisors, and facility managers agreed that FPL staffing is lower than needed and airlines' scheduling practices and use of hubs hinder the flow of traffic.

The Flight Safety Foundation, an independent international membership organization dedicated solely to the improvement of flight safety, evaluated our questionnaire results and provided its views on safety. The Foundation concluded that the air traffic control system is not unsafe but the margin of safety—that undefined limit beyond which the system would no longer be safe—remains essentially unchanged from 1985 and is less than desirable.

FAA has planned or undertaken several nationwide initiatives to address work force concerns. These include plans for improving its recruitment and hiring techniques, “revolutionizing” the way it trains air traffic controllers, and using a pay demonstration project to attract personnel to hard-to-staff facilities.

Background

Our 1985 survey of the air traffic control work force showed essentially that FAA had not met its target number of FPL controllers at many major facilities and air traffic growth had caused controller work load to reach

³A developmental controller is one who is undergoing training. Developmentals control traffic as they become proficient in a defined area. A full performance level controller is fully certified to operate all positions in a defined area.

a point where controllers were stretched too thin. Despite FAA assurances to the contrary, controllers and their supervisors expressed serious concerns about their ability to maintain the proper margin of safety.

At that time, we asked the Flight Safety Foundation to compare our survey findings to its 1981 evaluation of air traffic control system safety. The Foundation concluded that conditions within the controller work force had changed since its 1981 evaluation and that although the 1985 system was not unsafe, it did not provide the same level of safety as before the FAA controllers' 1981 strike.

The volume of air traffic has increased every year since the strike, but controllers still number about 1,800 fewer than before the strike: 14,437 as of September 1988 as compared with 16,244 prior to the strike. Further, the number of FPLs—the core of experienced controllers—in fiscal year 1988 was about 3,300 short of the prestrike number. Flight operations in fiscal year 1988 exceeded 80 million, compared with 60 million in fiscal year 1982.

Controllers and Their Supervisors Share Mutual Concerns

Controllers expressed their concerns about various working conditions, including too few controllers, too much work, overtime, inadequate quality of developmental training, and low morale. Additionally, they viewed airlines and pilots as contributing to controller difficulty and, from an air traffic system perspective, rated factors that make it difficult to keep the air traffic system safe. Supervisors shared many of these concerns. Work force views on working conditions differed at centers and terminals.⁴ Flight Safety Foundation, our consultant, found that working conditions overall appeared to have worsened more at terminals than at centers.

Shortage of Controllers

In 1988, 85 percent of controllers perceived a shortage of FPLs and 67 percent perceived a shortage of developmental controllers. Similarly, 77 percent of supervisors said that the number of FPLs was too low and 63 percent saw the current number of developmentals as too few to meet future controller needs. As a result of the shortage, controllers said they

⁴A network of 20 centers in the contiguous United States provides for control and separation of aircraft between destinations and over oceanic routes. Terminal facilities control aircraft within the area of one or more airports.

were personally limited in several areas. For example, 80 percent of controllers said their ability to take annual leave on short notice (2 weeks or less) was “moderately” to “very greatly” limited.

Handling Too Much Traffic and Working Too Long Without a Break

Sixty-five percent of controllers believed they typically handled too much traffic during peak periods. Surveyed supervisors said that 2,040 radar controllers under their supervision (about 38 percent) handled too much traffic.

In addition, a majority of controllers (59 percent) said they were typically required to work too long without a break during peak periods. FAA’s work period guideline states that controllers normally receive a break after 2 hours continuously at one air traffic control position. On the basis of responses, 32 percent of controllers typically exceeded FAA’s 2-hour limit and 87 percent had exceeded the limit at least once in the previous month.

Overtime Concerns

About 80 percent of the controllers surveyed had worked overtime during the previous 12 months. Of these, about 38 percent responded that it was more than they wanted. When all controllers (both those working and not working overtime) provided their views on the overtime situation at their facilities, the most predominant view (49 percent) was that too little overtime was allowed to cover needs for training, leave, and other duties. Only 24 percent of all controllers viewed the amount of overtime as appropriate at their facilities.

Quality of Developmental’s Training and Talents Faulted

A majority of FPL controllers were concerned with the quality of training provided developmentals. They rated the quality of 4 of 10 aspects of this training as less than adequate: using backup systems, controlling traffic in bad weather, emergency procedures, and holding patterns. Many supervisors (ranging from 41 to 47 percent) rated these same four aspects the worst. The six other aspects of developmental training, including handling heavy traffic (see app. II), were judged less than adequate by 17 to 44 percent of controllers and by 16 to 37 percent of supervisors. Further, 31 percent of controllers surveyed viewed developmental training involving live traffic as inadequate while 14 percent of supervisors shared this view.

Many FPL controllers expressed concerns about developmental controller talents, stating that work attitude (45 percent), overall skill level (40

percent), and ability to learn (31 percent) were worse at the time of the 1988 survey than 3 years previously. Supervisors also cited developmentals' work attitude (35 percent), skill level (28 percent), and ability to learn (18 percent) as worse than 3 years ago.

Low Morale

Forty-three percent of controllers said their own morale was low while 29 percent said their morale was high. Thirty-six percent of their first-line supervisors said their own morale was low and 38 percent said their morale was high. Managers, however, viewed controller/supervisor morale as high. The Flight Safety Foundation viewed this disparity of controller/supervisor and management views as a serious problem.

Airline Practices and General Aviation Viewed as Contributing to Controller Difficulty

The difficulty of a controller's job can be increased by the number of aircraft to be handled simultaneously, as when airlines schedule several aircraft to depart or arrive at the same time. Controllers and supervisors voiced equally strong (93 percent) concerns that airlines' scheduling practices hinder traffic flow. Controllers (76 percent) and supervisors (80 percent) similarly believed that airlines' use of hubs hinders traffic flow. In addition, controllers (46 percent) and supervisors (41 percent) rated general aviation pilots less than adequate in their communication performance, i.e., their ability to follow air traffic control instructions, use correct phraseology, and keep unnecessary communication to a minimum.

Current Safe System Difficult to Maintain

Most controllers and supervisors rated the overall safety of the air traffic control system as "adequate," "good," or "excellent"; however, some controllers (16 percent) and supervisors (8 percent) rated the system as "poor" or "very poor."

On the basis of their observations and experiences, controllers cited several factors as hindering FAA's ability to maintain system safety: the amount of traffic work load, controller morale, the number of FPLs available, hardware reliability, and software reliability. Supervisors predominantly agreed that those factors hindered the maintenance of system safety.

Controllers' Views Differ at Centers and Terminals

Differences exist in controllers' views at centers and terminals. (See app. III.) For example:

- Thirty-seven percent of center controllers, compared with 21 percent of terminal controllers, responded that they were typically required to continuously work a control position longer than 2 hours.
- Center controllers rated developmental controller training as less adequate in terms of (1) the quality of 8 of 10 distinct aspects of training, such as handling heavy traffic, and (2) the extent that developmental controllers were “probably” or “definitely” not provided with sufficient training involving live traffic before being certified on a position. Center controllers also rated developmental controllers’ overall skill level, ability to learn, and work attitude as worse today than 3 years previously to a greater degree than did terminal controllers.
- Terminal controllers were personally affected to a greater degree than were center controllers by the shortage of controllers in such areas as taking annual or sick leave or obtaining required training.
- Terminal controllers rated, to a greater degree than did center controllers, six of eight factors that can hinder FAA’s ability to maintain system safety. For example, terminal controllers said that hardware (69 percent) and software (71 percent) reliability hindered system safety compared with 58 percent and 46 percent, respectively, of center controllers.
- The majority (57 percent) of terminal controllers rated general aviation pilots’ communication performance as less than adequate, compared with 39 percent of center controllers who shared that view.

General Disagreement Between Managers and Controllers

In contrast to previously discussed controllers’ views, facility managers see work load, overtime, training, morale, and safety very differently than do controllers. However, most facility managers agreed with controllers that (1) FPL staffing is lower than needed (71 percent) and (2) airlines’ scheduling practices (95 percent) and use of hubs (89 percent) hinder the flow of traffic.

Facility managers do not believe that controllers are overworked. Few managers (5 percent) said controllers handle too much traffic, few managers (7 percent) said FPLs work too long without a break, and most managers (70 percent) said the amount of facility overtime was appropriate.

Further, managers generally viewed training as adequate. No manager rated developmentals’ on-the-job training overall as less than adequate. A few managers rated certain aspects of developmental training as less than adequate (1 to 10 percent depending on the aspect). For example, 2

percent of managers said that the quality of on-the-job training for controlling traffic in bad weather was less than adequate. Similarly, only one manager (1 percent) said that developmental controllers were not provided with sufficient facility training involving live traffic before being certified. Few managers viewed developmental controller talents as being worse than 3 years previously (3 to 12 percent depending on the talent).

Facility managers generally viewed the morale of controllers (56 percent) and supervisors (65 percent) as high; few saw controller and supervisor morale, 4 percent and 3 percent, respectively, as low.

No facility manager rated the overall safety of the air traffic system as less than adequate. Facility managers saw only one operational factor—the current amount of traffic work load—as predominantly hindering FAA's ability to maintain a safe system.

No Substantial Change in Work Force Views

We measured the change in responses between 1985 and 1988 for each comparable question and classified the change from "little to none" to "substantial." (See app. IV for our method of measuring and classifying the extent of change.) Overall, no substantial change occurred; some minor change did occur, involving both worsening and improvements of work conditions. Examples of minor improvement areas in 1988 include handling too much traffic, too few FPLs, and working more overtime than controllers wanted. Examples of worsening areas include controller views on the quality of training that developmental controllers get before beginning on-the-job training and supervisory views on both the overall system safety and quality of on-the-job training for controlling traffic in bad weather. Complete details on all survey questions are contained in our fact sheet *Aviation Safety: Conditions Within the Air Traffic Control Work Force* (GAO/RCED-89-113FS).

Flight Safety Foundation Sees Little Improvement in System Safety

We asked the Flight Safety Foundation to evaluate our 1988 survey results and provide its views on the safety of the air traffic control system, relative to their 1985 views. According to the Foundation, the most striking result of its comparison of the 1985 and 1988 GAO reviews was the similarity of the responses. Although some shifting of emphasis and areas of concern occurred, the air traffic control system appeared to have changed little, and the 1988 responses offered no basis for altering its 1985 assessment of the system's safety. While the system is not

unsafe, according to the Foundation, the margin of safety remains essentially unchanged from 1985 and is less than desirable.

The Foundation concluded the following:

- The survey results suggest that improvements have occurred in a few areas since 1985 but problems similar to those identified in 1985 remain and, in some cases, have worsened. Conditions overall at terminals appear to have worsened more than at centers in such areas as high traffic levels/work load, personnel shortages, overtime, work attitudes/morale, hardware, and software. This suggests that terminals merit FAA's special attention to ensure that their performance and safety are not degraded as traffic levels increase.
- Hardware and equipment, in particular, were problems at terminal facilities.
- A substantial difference exists between controllers' views of their morale and facility managers' views of work force morale. While this difference is impossible to interpret with certainty, it does suggest a continuing communications gap between FAA facility management and the controllers—and, to a certain extent, the supervisors.

Further, since 1981, a vast difference has existed between the perceptions of managers and those of controllers regarding work force morale and working conditions, representing a serious work force problem. This, in the view of the Foundation, is a significant contributor to a less than desirable margin of safety.

FAA Initiatives Affecting Air Traffic Work Conditions

FAA has planned or undertaken several nationwide initiatives to increase its work force and improve working conditions. Some of these initiatives resulted from our previous air traffic work force reports. FAA plans to improve its recruitment and hiring techniques by establishing a national recruitment team and upgrading its advertising and recruitment materials. In September 1988, FAA streamlined its hiring process for air traffic controllers, which should reduce its hiring time. The FAA Administrator also announced a series of initiatives aimed at "revolutionizing" the way FAA trains air traffic controllers by using state-of-the-art technology and training methods. In addition, a pay demonstration project, to begin in June 1989, is planned to provide up to 20-percent bonus pay to FAA staff performing safety-related functions at hard-to-staff facilities in such areas as Chicago, Los Angeles, and New York. These are long-term initiatives that will require time to bring about needed changes.

Conclusions

The 1988 perceptions of controllers, supervisors, and managers show little change since our 1985 survey. Whatever changes FAA has made over the years, little overall movement in work force attitude has occurred. In addition, a contrast of controllers' and facility managers' views illustrates the vast differences that exist in their perceptions of the work environment. The gap is also evident to a lesser extent between supervisors and managers.

The Flight Safety Foundation evaluated the views of the working conditions and morale and found the margin of safety to be less than desirable and essentially unchanged from 1985. In saying "less than desirable," the Foundation is not saying the system is unsafe.

While no quantitative assessment of safety can be realistically made, the results shown in this survey do provide a unique perspective of the air traffic control system. It shows how the people who control air traffic and operate the system view the relative health of that system. This survey shows that controllers and supervisors collectively see problems in many areas that FAA facility management does not recognize. Despite the facility managers' response, FAA headquarters has recognized the need for improvement and has planned or undertaken initiatives that will require time to bring about needed changes.

Objective, Scope, and Methodology

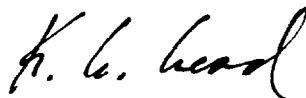
Our objective was to survey the air traffic work force to determine how prevalent those directly involved in air traffic control felt certain problems were. To make this determination, we conducted three mail surveys of (1) full performance level and developmental level controllers certified on at least one radar position, (2) first-line supervisors of controllers, and (3) facility managers at 84 facilities. Additional information on our scope and methodology is in appendix I.

To assist us in assessing the impact of current working conditions on system safety, we asked the Flight Safety Foundation to provide (1) its conclusions on the survey data and (2) its views on the safety of the system.

Appendix I of this report also provides background on controller staffing and traffic volume. Appendix II provides work force views on working conditions and other aspects of the air traffic control system. Appendix III contrasts responses for center and terminal controllers for selected questions. Appendix IV contains our method of measuring

changes in perceptions between our 1985 and 1988 surveys. Appendix V lists the facilities included in our survey. A list of related GAO products on air traffic control work appears at the end of this report.

FAA provided comments on the development of our questionnaires. However, as you requested, we did not obtain its official comments on a draft of this report. As arranged, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time we will send copies to the Secretary of Transportation; the Administrator, FAA; and other interested parties. If you have any questions about this report, please call me on (202) 275-1000. Major contributors to this report are listed in appendix VI.



Kenneth M. Mead
Director, Transportation Issues

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Abbreviations

ATA	air traffic assistant
FAA	Federal Aviation Administration
FPL	full performance level (controller)
GAO	General Accounting Office

Background, Objective, Scope, and Methodology

Background

One of the Federal Aviation Administration's (FAA) primary missions is to provide a national aviation system that ensures the safe and efficient use of the nation's airspace. FAA establishes policies for the use of this airspace and provides a service—air traffic control—to promote the safe, orderly, and expeditious flow of air traffic.

Air traffic control specialists—controllers—are directly responsible for ensuring that aircraft are properly separated and that takeoffs and landings are as safe as possible. As of September 30, 1988, FAA had a total of 14,437 controllers working traffic.

The Environment of Air Traffic Control

The air traffic control system includes air route traffic control centers, terminal facilities at airports, and flight service stations. Air route traffic control centers, or en route centers, provide for control and separation of aircraft flying between destinations and over certain oceanic routes. A network of 20 centers is located in the contiguous United States. The principal function of terminals is to control aircraft within the area of one or more adjacent airports. Flight service stations provide pilots with preflight and in-flight information on weather and routes.¹

At the end of fiscal year 1988, about 43 percent of FAA's controllers were involved with en route center control of air traffic and 57 percent were involved with airport terminal control.

Controller Work Force

FPL controllers are required to be certified on several operating positions within a center or terminal facility. For example, an FPL is required to be certified on all positions—both radar and data—within a given area in a center. Developmental controllers include not only all graduates from the FAA Academy receiving on-the-job training at field facilities but also other experienced FPLs that transferred to new facilities and require training and certification on all positions within a given area in a center or terminal.

Other staff besides controllers are essential to the orderly flow of air traffic:

- Traffic management coordinators staff the units responsible for monitoring the volume and flow of air traffic to a facility.

¹Flight service stations, staffed by flight service station specialists, are not included in the scope of this report.

**Appendix I
Background, Objective, Scope,
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- Large air traffic facilities are staffed with air traffic assistants (ATA) who assist controllers by handling flight progress strips.²
- First-line or area supervisors are responsible for supervising both controllers and ATAS.

Since November 1987, FAA, on the basis of a GAO recommendation,³ has defined the controller work force as only those personnel who actually control air traffic. As a result, first-line supervisors and traffic management coordinators, who are required to spend 10 percent of their time controlling air traffic, are now included in the definition, while ATAS and students at the FAA Academy are excluded.

Table I.1 shows the controller work force as of July 31, 1981, (before the controllers' strike) and for fiscal years 1985 through 1988.

Table I.1: The Controller Work Force

	July 31, 1981	Fiscal years			
		1985	1986	1987	1988
Controllers					
FPLs ^a	13,205	8,315	9,528	9,798	9,858
Developmentals ^b	3,039	4,217	3,761	4,186	4,579
Subtotal	16,244	12,532	13,289	13,984	14,437
Air traffic assistants	0	1,466	1,514	1,449	c
First-line supervisors	d	d	d	d	1,999
Total	16,244	13,998	14,803	15,433	16,436

^aIncludes traffic management coordinators.

^bPrior to FY 1988, includes all persons undergoing initial screening and training at the FAA Academy and other persons in special programs, such as upward mobility.

^cThe 1,295 assistants were not included in the controller work force.

^dPrior to FY 1988, supervisors had been excluded from the definition.

Air Traffic Activity

Table I.2 shows air traffic activity from fiscal years 1981 through 1988.

²Flight progress strips are paper strips with flight plan data that must be moved to appropriate operating positions as an aircraft progresses in its flight. Prior to the August 1981 controller strike, these duties were performed by controllers.

³FAA Staffing: FAA's Definition of Its Controller Work Force Should Be Revised (GAO/RCED-88-14, Oct. 23, 1987).

Table I.2: Air Traffic Activity

Fiscal year	Volume in millions of flight operations ^a		Total
	Terminals	Centers	
1981	37.2	29.5	66.7
1982	31.7	27.9	59.6
1983	34.0	29.4	63.4
1984	37.3	31.6	68.9
1985	38.7	32.7	71.4
1986	40.5	34.2	74.7
1987	43.3	35.8	79.1
1988	44.2 ^b	36.2 ^b	80.4^b

^aAt terminals, flight operations mean just instrument operations. At centers, operations represent total Instrument Flight Rules aircraft handled.

^bFAA had not yet finalized the data as of March 1, 1989.

Objective

The Ranking Minority Member, Subcommittee on Investigations and Oversight, House Committee on Public Works and Transportation, and the Chairman, House Committee on Public Works and Transportation, requested that we update and replicate our previous evaluation⁴ of the air traffic control system. To accomplish this, we mailed separate questionnaires to air traffic controllers, first-line supervisors of controllers, and facility managers at the 84 largest air traffic control facilities. The following sections provide details on our scope and methodology in designing and administering the questionnaires and estimating the overall results.

Scope

Our 1988 survey included the 84 largest air traffic control facilities, consisting of all 20 air route traffic control centers in the continental United States and all 64 of the largest terminal facilities (level 4 and 5), in March 1988, the survey selection period. Appendix V shows the specific facilities included in the 1988 survey, in addition to those included in our 1985 survey. Ten more facilities were included in 1988 because (1) the volume of their air traffic had increased, resulting in FAA's including them in the group of largest facilities, or (2) FAA had reorganized some facilities by splitting them into two distinct components.

To assist us in assessing the impact of current working conditions on system safety, we asked the Flight Safety Foundation to provide (1) its conclusions on the survey data and (2) its views on the safety of the

⁴(GAO/RCED-86-121, Mar. 6, 1986).

system. The Foundation had evaluated the safety of the air traffic system for FAA immediately after the 1981 controllers' strike and appraised the safety of the air traffic system in 1986 by using, in part, our 1985 survey results.

The complete responses to all survey questions are contained in our fact sheet, Aviation Safety: Conditions Within the Air Traffic Control Work Force (GAO/RCED-89-113FS). We performed our review from November 1987 to December 1988, in accordance with generally accepted government auditing standards.

Methodology

Between May 2 and August 5, 1988, we surveyed the air traffic control work force. Specifically, we mailed similar, but not identical, questionnaires to (1) full performance level controllers and developmental level controllers certified on at least one radar position, (2) first-line supervisors of controllers, and (3) facility managers. The topics of the survey included work load, staffing, overtime, training, system safety and air traffic control operations, operational error detection, and retirement.

To meet our objective, we replicated questions from the 1985 survey. To gain further insight into a variety of issues, such as working conditions, safety, and morale, we added questions to the 1988 survey. In developing the questionnaires, suggested changes were provided by the Ranking Minority Member, FAA, the National Transportation Safety Board, and the controllers' union. Individual controller, supervisor, and manager comments were considered during our questionnaire pretesting at nine specific FAA facilities.

We designed three separate questionnaires for each of the three work force components for both the 1988 and 1985 surveys. Each questionnaire was designed to gain a unique perspective of the air traffic work force: controllers directly work and control air traffic primarily using radar; first-line supervisors represent a manager's view and also reflect personal observations from directly working and controlling traffic; facility managers represent the perspective of FAA field management.

Research Design

To establish the universe of controllers, we used an FAA computer file, containing names and home addresses, of all controllers (GS-2152 series) employed at the 84 largest facilities as of March 23, 1988. Since some of

the controllers on this file were not radar qualified, we developed criteria in consultation with FAA to identify qualified controllers. This procedure identified 7,742 air traffic controllers; however, the criteria to screen FAA's file for radar-certified controllers were inexact. Therefore, we included a screening question in the questionnaire to more precisely identify full performance level controllers and developmental controllers who were certified on at least one radar position.

We used a similar selection and screening process for first-line supervisors and identified 1,196.

We sent questionnaires to all facility managers at the 84 largest facilities. FAA provided a list of the facility managers' names and addresses. At four terminals (Chicago, Dallas-Fort Worth, Denver, and St. Louis), FAA has one manager overseeing two facilities, or organizational components—the control tower and the terminal radar approach control, or TRACON, facility. Thus, questionnaires were sent to 80 facility managers.

Sample, Universe, and Return-Related Data

The largest FAA facilities in the air traffic control system consist of air route traffic control centers, which control flights between airports, and terminal facilities. Because a center has a considerably greater number of controllers and supervisors than does a terminal, we used a stratified sample at centers for selection; at terminals, all controllers and supervisors were sent questionnaires. The number of controllers and supervisors sampled at each center was large enough to yield a sampling error of no more than 5 percent at the 95-percent confidence level for each center.

Table I.3 shows universe, sample, and return-related data for the 1988 survey.

**Appendix I
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Table I.3: Universe, Sample, and Return-Related Data for the Three Questionnaires Used in the 1988 Survey

Return Rate in Percent

Questionnaire and location	Size		Responses		Not returned		Return rate ^b
	Universe	Sample	Eligible	Ineligible ^a	Incorrect address	No response	
Controllers							
Terminals	2,451	2,451	1,699	152	32	568	75.5
Centers	5,291	2,824	1,859	333	25	607	77.6
Total	7,742	5,275	3,558	485	57	1,175	76.6
Supervisors							
Terminals	478	478	393	16	3	66	85.6
Centers	748	636	546	24	2	64	89.6
Total	1,196	1,114	939	40	5	130	87.9
Managers							
Terminals	60	60	57	0	0	3	95.0
Centers	20	20	19	0	0	1	95.0
Total	80	80	76	0	0	4	95.0

^aIneligibles represent respondents who were (1) either not full performance level controllers or developmentals certified on at least one radar position or (2) were not first-line supervisors.

^bReturn rates were calculated by dividing the total of all responses by the applicable sample size.

Table I.4 compares universe, sample, and return rates for the 1988 and 1985 surveys.

Table I.4: Universe, Sample, and Return Rates for the 1988 and 1985 Surveys

Return Rate in Percent

Category	Universe		Sample size		Return rate	
	1988	1985	1988	1985	1988	1985
Controllers	7,742	6,248	5,275	4,472	76.6	73.4
Supervisors	1,196	1,150	1,114	1,052	87.9	81.4
Managers	80	74	80	74	95.0	93.2

Survey Results

We used stratified sampling at centers and assigned appropriate weights to sampled cases prior to analyzing the survey results. Thus, responses shown for centers and overall represent weighted estimates. We calculated sampling errors for the estimates and considered these in performing analyses and drawing conclusions concerning differences between centers and terminals and between controllers and facility managers. The estimates presented in this report are subject to sampling errors of

not more than ± 2.5 percent at the 95-percent confidence level. Our fact sheet, Aviation Safety: Conditions Within the Air Traffic Control Work Force (GAO/RCED-89-113FS) contains overall results of the three surveys, including centers and terminals.

Questionnaire Procedures

The 1988 questionnaires were developed using the 1985 questionnaires as our starting point. We added and deleted questions on the basis of suggestions provided by Representative Molinari, FAA officials, the National Transportation Safety Board, union officials, and members of the air traffic control work force. We conducted pretests with a total of 36 individuals at 9 facilities: 4 centers (Cleveland, Jacksonville, Oakland, and Seattle) and 5 terminal facilities (Cleveland, Jacksonville, Oakland TRACON, Orlando, and Seattle TRACON).

During each session, an individual respondent filled out a questionnaire in the presence of two GAO observers. The GAO observers timed the respondent and observed reactions to questions and question flow. Afterwards, the observers debriefed the respondent to identify ambiguities, incorrect use of technical language, potential bias, or other problems in question wording or questionnaire format.

Questionnaires for controllers and supervisors were mailed to the respondents' home address. If a home address was not available, questionnaires were mailed to controllers at the facilities where they worked. Questionnaires for the facility managers were also mailed to each facility.

Because of the sensitive nature of some questions, respondents were promised confidentiality to encourage a reply. The only exception to this pledge was one section of questions on facility information in the 1988 facility manager questionnaire. The facility managers were informed that information in this section could be specifically identified to their facilities.

In order to maintain confidentiality, a control number was written on each questionnaire to identify the respondents without using their names and to facilitate follow-up mailings. The nonconfidential section of the managers' questionnaire was detached and processed separately so that no identification remained on the confidential questions.

On June 6, 1988, we sent follow-up letters to all nonrespondents. The letters also included a second copy of the questionnaire in case the

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respondent could not locate the original. We subsequently phoned some facility managers to clarify facility staffing information.

The Work Force Views on Working Conditions and Other Aspects of the Air Traffic Control System

Controllers' views on staffing, work load, overtime, training, air traffic operations, and safety are illustrated and discussed in more detail in this appendix. Comparisons with 1985 survey results are also shown and discussed.

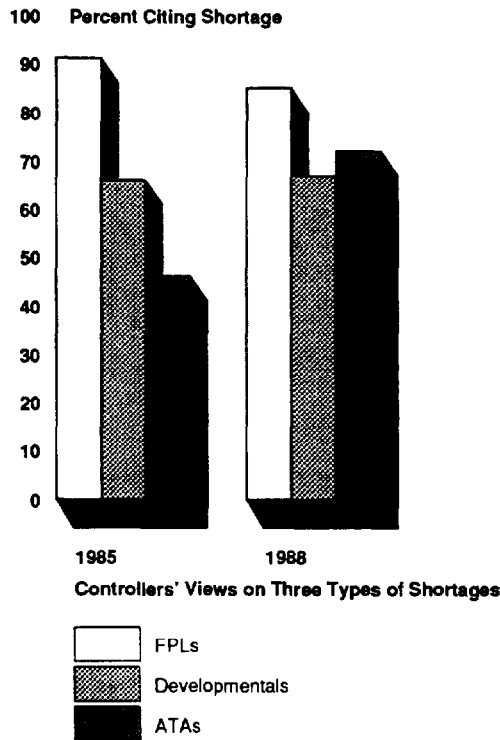
Staffing

Controllers' views in 1988 on the shortage of FPL and developmental controllers were similar to the views expressed in 1985. (See fig. II.1.) The predominant view in those two surveys is that the number of FPLs is lower than needed. The majority of controllers also perceived a shortage of developmentals in both 1985 and 1988. In addition, a greater percentage of controllers in 1988 than 1985 believed there is a shortage of air traffic assistants. Air traffic assistants are not trained to and do not control air traffic. They perform less skilled tasks of mainly a clerical nature.¹

¹The assistant's job was created subsequent to the air traffic controllers' strike in 1981; the job eliminated some clerical tasks for controllers so that they could concentrate on the function of controlling traffic. FAA is considering eliminating this job and reassigning the tasks to controllers.

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**Figure II.1: Condition—Shortage of
 Controllers and Assistants**



ATA = air traffic assistant

As shown in table II.1, in 1988, 85 percent of controllers believed the number of FPLs was either somewhat or much lower than needed; 3 years earlier 91 percent shared this belief. In addition, 72 percent of controllers said that the number of air traffic assistants was either somewhat or much lower than needed. This is an increase from the 46 percent of controllers who shared this view in 1985.

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Table II.1: Condition—Shortage of FPLs and Assistants

Controllers' view of current staff available	Percent of responses	
	1985	1988
FPLs		
Much higher than needed	0	0
Somewhat higher than needed	1	1
Appropriate number	7	14
Somewhat lower than needed	44	48
Much lower than needed	47	37
ATAs		
Much higher than needed	5	2
Somewhat higher than needed	8	3
Appropriate number	42	23
Somewhat lower than needed	35	37
Much lower than needed	11	35

Table II.2 shows that 67 percent of controllers surveyed in 1988 believe there are too few developmental controllers to meet future controller needs, a view that had been initially expressed by 66 percent of controllers surveyed in 1985.

Table II.2: Condition—Too Few Developmental Controllers to Meet Future Needs

Controllers' view of developmental controllers	Percent of responses	
	1985	1988
Much too many	1	1
Somewhat too many	4	3
Appropriate number	30	29
Somewhat too few	44	45
Much too few	22	22

Table II.3 shows the percentage of controllers that were personally limited in certain areas to a "moderate," "great," or "very great" extent in the last 12 months by the shortages of controllers.

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Table II.3: Condition—Controllers Personally Limited “Moderately” to “Very Greatly”

Ability to	Percent of response
Take first 2 weeks of annual leave	25
Take the rest of annual leave	44
Take annual leave on short notice (2 weeks or less of notice)	80
Take needed sick leave	24
Refuse scheduled overtime	38
Get required training	39
Get or provide team briefings	33
Take needed personal breaks	48
Take “duty familiarization” airline trips	59

Work Load

Surveyed controllers considered two elements of work load—traffic handled during daily peak periods and length of time during those periods with no break—as excessive. However, facility managers’ views of these work load elements differed sharply, as being not at all excessive.

Controllers’ View: Handling Too Much Traffic

Controllers’ views of the traffic handled during typical peak periods in 1988, as shown in figure II.2, were very similar to the views expressed in 1985. The predominant view at both times was that controllers were handling “somewhat more” traffic than they should be handling.

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Figure II.2: Condition—Handling Too Much Traffic

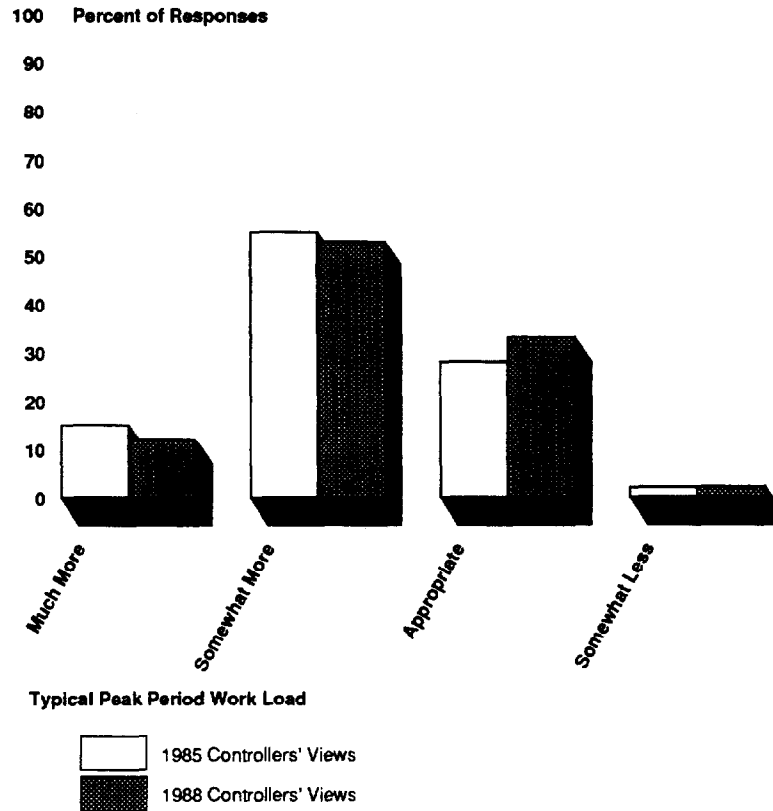


Table II.4 shows specifically that a total of 65 percent of the controllers surveyed believed that they are required to handle “somewhat more” or “much more” traffic during daily peak periods than they should be handling. In 1985, 70 percent of the controllers surveyed shared this belief.

Table II.4: Condition—Handling Too Much Traffic

Controllers' view of amount of traffic handled	Percent of responses	
	1985	1988
Much more than should be handling	15	12
Somewhat more than should be handling	55	53
Appropriate level	28	33
Somewhat less than should be handling	2	2
Much less than should be handling	0	0

Many of the 1988 controllers who believed that their work load was too extensive cited (1) airline schedules (90 percent), (2) inadequate flow

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control² procedures (86 percent), (3) sector configuration (complexity) (84 percent), and (4) the shortage of radar controllers (79 percent) as either a “major reason” or “somewhat of a reason” for the heavy work load. This was similar to 1985 results.

In addition, we asked controllers how often, if ever, they took certain actions while working daily peak traffic periods. Table II.5 shows the percentage of responses provided.

Table II.5: Condition—Controllers “Occasionally” to “Very Often” Taking Certain Actions With Aircraft

Action	Percent of responses
Provide another aircraft with instructions without waiting for first aircraft to acknowledge receipt of its instructions	57
Drop track before target leaves area of jurisdiction	40
Use inefficient vector patterns	42
Decline to provide weather advisories	52
Decline to provide traffic advisories	71
Decline user requests for services (direct routes, altitude changes, etc.)	86

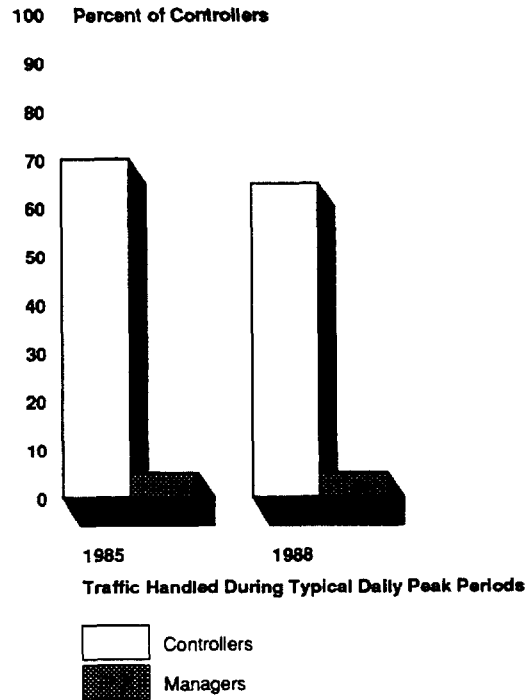
Disparity: Handling Too Much Traffic

One disparity of views between controllers and managers, as shown in figure II.3, concerned the amount of traffic handled by controllers during daily peak periods. In 1988, a total of 65 percent of controllers believed they were handling either “somewhat more” (53 percent) traffic or “much more” (12 percent) traffic than they should be. Managers gave percentage estimates of controllers handling too much traffic. Our aggregation of the managers’ responses showed that managers believed only 5 percent of controllers handled too much traffic. A similar disparity was evident in 1985.

²Flow control is an FAA, centrally managed, national program designed to control aircraft departures and en route flows on the basis of weather conditions and capacity at arrival airports.

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Figure II.3: Disparity—Controllers Handle
Too Much Traffic



Controllers' View: Working
Too Long Without a Break

FAA believes it is desirable to have some relief periods away from operational positions during the course of a workday. In recognition of this, FAA tries to provide controllers a break after spending up to 2 hours on the same control position. The controllers' view of the typical time spent continuously working an air traffic control position without a break in 1988 was very similar to the view expressed in 1985. (See fig. II.4.) The predominant view of both questionnaires is that controllers are working too long without a break during daily peak periods.

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Figure II.4: Condition—Working Too Long Without a Break

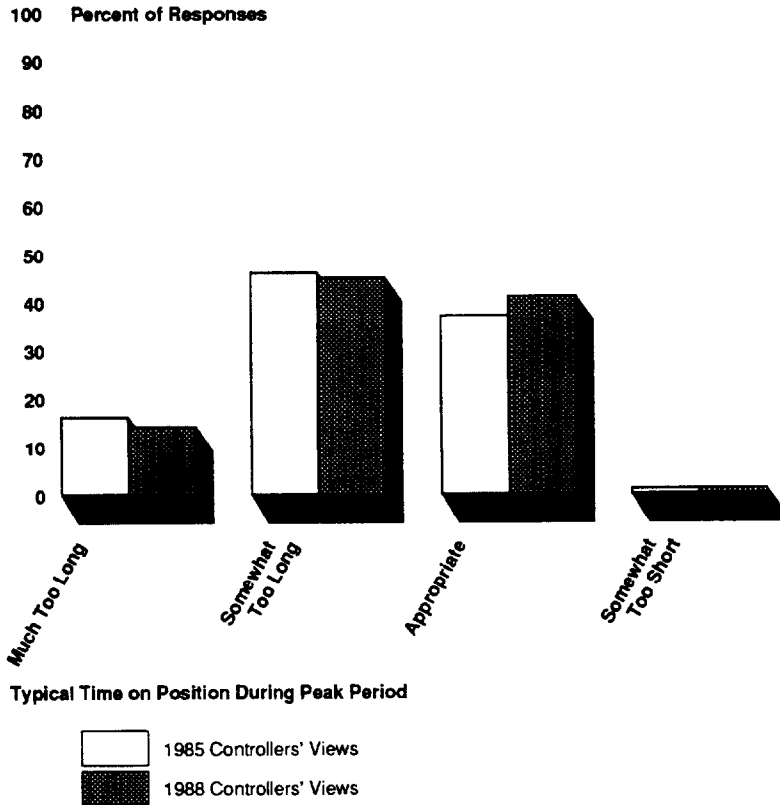


Table II.6 shows that a total of 59 percent of controllers believe that they are working either “much too long” or “somewhat too long” without a break during peak periods. Similarly, 62 percent of controllers surveyed in 1985 shared this belief.

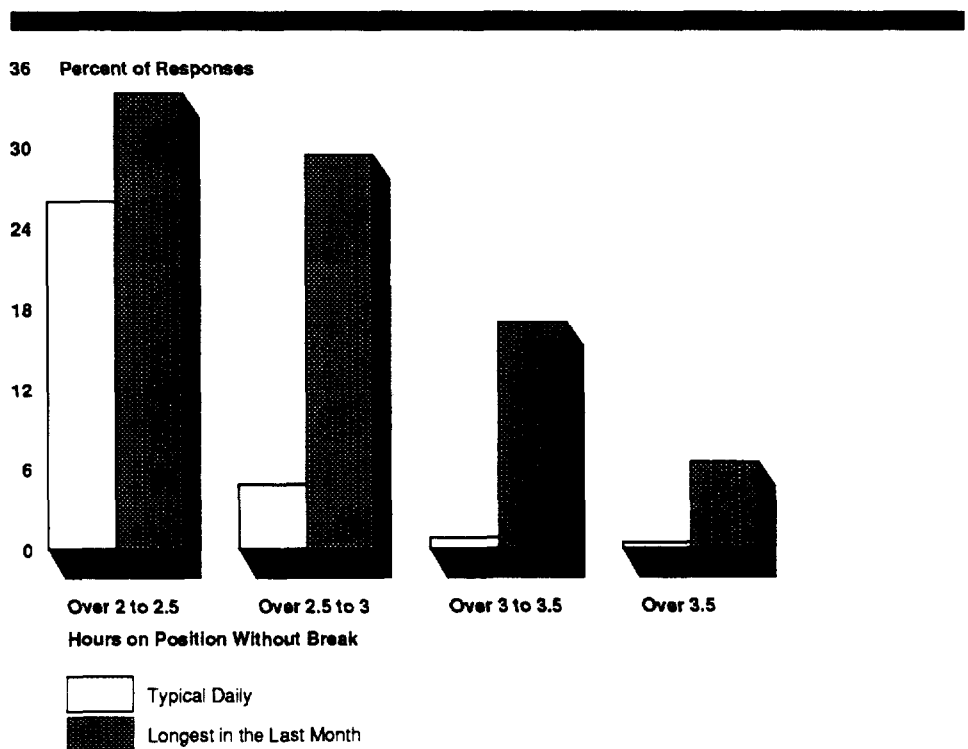
Table II.6: Condition—Working Too Long Without a Break

Controllers' view of time continuously working a position without a break	Percent of responses	
	1985	1988
Much too long	16	14
Somewhat too long	46	45
Appropriate	37	41
Somewhat too short	1	1
Much too short	0	0

Controllers' View: Working
 More Than 2 Hours on
 Position

Figure II.5 shows the extent that controllers said they were spending more than 2 hours on an air traffic control position without a break during peak periods under two distinct circumstances: (1) typical daily (32 percent) and (2) the longest continuous period on position in the last month (87 percent). FAA's air traffic handbook states that controllers normally should not be required to spend more than 2 consecutive hours at the same control position.

Figure II.5: Condition—Working
 Continuously for More Than 2 Hours
 During Peak Periods



Based on the responses controllers provided, 32 percent of controllers are typically controlling traffic in excess of 2 hours during peak traffic periods. Further, 87 percent of controllers worked in excess of 2 hours at least once in the last month. Table II.7 details the excess time on position and shows the extent controllers said they typically worked in excess of 2 hours, as well as those who worked that long at least once in the last month.

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Table II.7: Condition—Working Continuously for More Than 2 Hours During Peak Periods

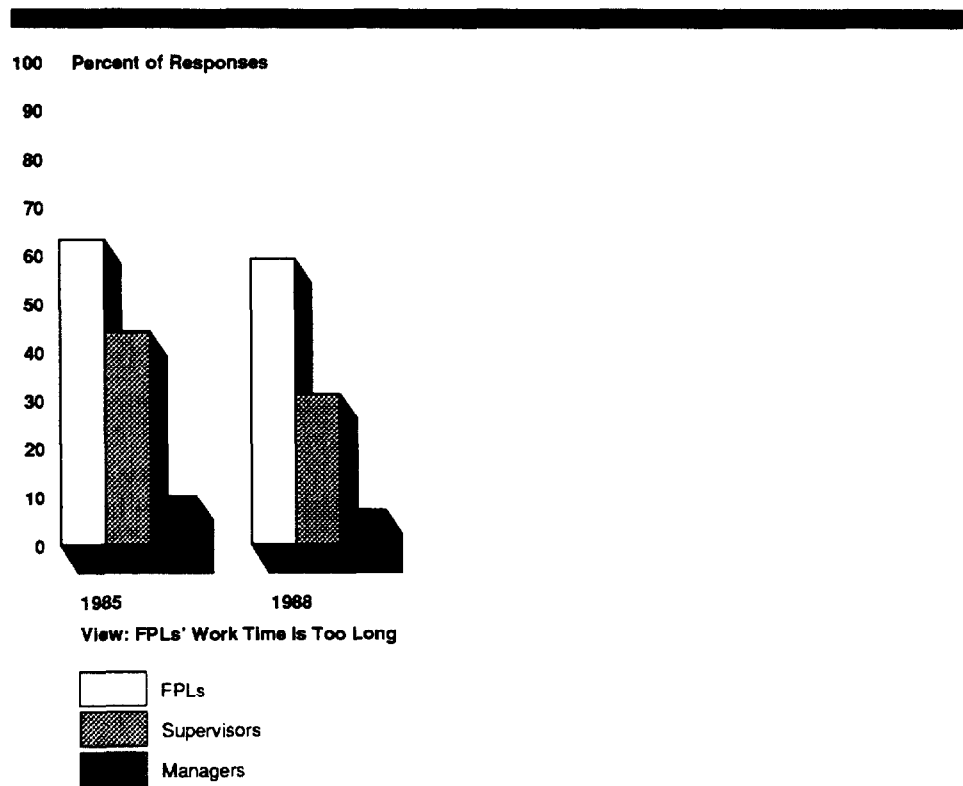
Hours on position without break	Percent of controllers' responses	
	Typical daily	Longest in last month
Over 2 to 2.5	25.9	34.0
Over 2.5 to 3	4.8	29.4
Over 3 to 3.5	.8	16.9
Over 3.5 to 4	.3	4.3
Over 4	.1	2.1
Total	31.9	86.7

Disparity: Working Too Long Without a Break

Figure II.6 shows a disparity in the view that FPLs' work time is too long during daily peak periods. In 1988, 59 percent of FPLs said the amount of time they were typically required to continuously work an air traffic control position without a break during peak periods was at least somewhat too long. This contrasts with 7 percent of facility managers who said the amount of time FPLs continuously work was somewhat too long. In 1985, 62 percent of FPLs and 10 percent of managers shared this view. Thirty-one percent of supervisors responded that FPLs under their supervision worked too long without a break in 1988 compared with 44 percent of supervisors who shared that view in 1985.

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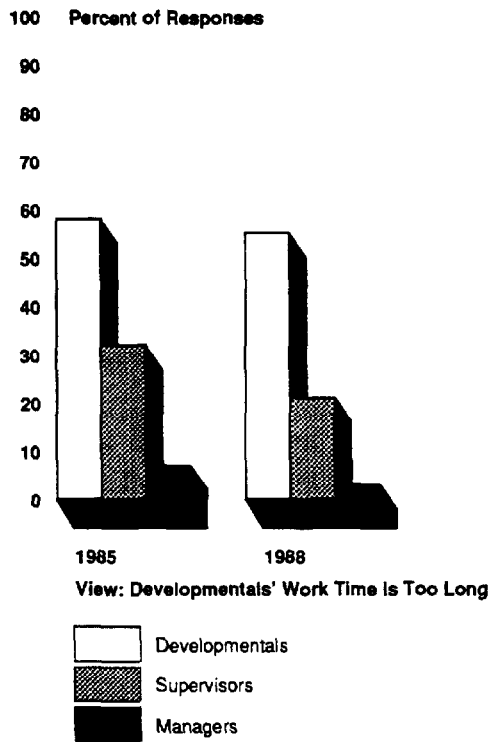
Figure II.6: Disparity—FPLs Work Too Long During Peak Periods Without a Break



A similar disparity—that developmentals typically work too long during daily peak periods—is illustrated in figure II.7. In 1988, the greatest disparity in this case is between the developmental controllers (55 percent) and the facility managers (3 percent). In 1985, 58 percent of developmentals and 7 percent of managers shared this view. Twenty-one percent of supervisors responded that radar-certified developmental controllers under their supervision worked too long without a break in 1988 compared with 32 percent of supervisors who shared that view in 1985.

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Figure II.7: Disparity—Developmentals
Work Too Long During Peak Periods
Without a Break



Overtime

Controllers' views of overtime provided two distinct perspectives: (1) a description of the actual situation at their facilities and (2) a personal perspective of the amount of overtime they wanted to work. In describing the actual overtime situation at their facilities, 49 percent of controllers said too little overtime is allowed to provide sufficient coverage for controllers to train, take leave, and do other duties. Another 17 percent of controllers said too much overtime was assigned so that personnel were overworked. The remainder had the following views:

- 24 percent said overtime assignments were appropriate,
- 4 percent said overtime was not assigned or needed, and
- 7 percent described other situations.

Controllers' Overtime Views Similar to 1985 And Slightly Improved

Controllers' preferences for the amount of overtime they wanted to work are illustrated in figure II.8. In 1988, 38 percent of controllers who worked overtime in the last year said they were working more overtime than they wanted, compared with 46 percent of controllers who previously shared this view. In 1988, the predominant view, held by 41 percent of controllers who worked overtime, was that controllers were working about as much overtime as they wanted to work. Table II.8 shows controllers' personal perspective of the amount of overtime they wanted to work.

Figure II.8: Condition—Overtime Views Similar to Those in 1985

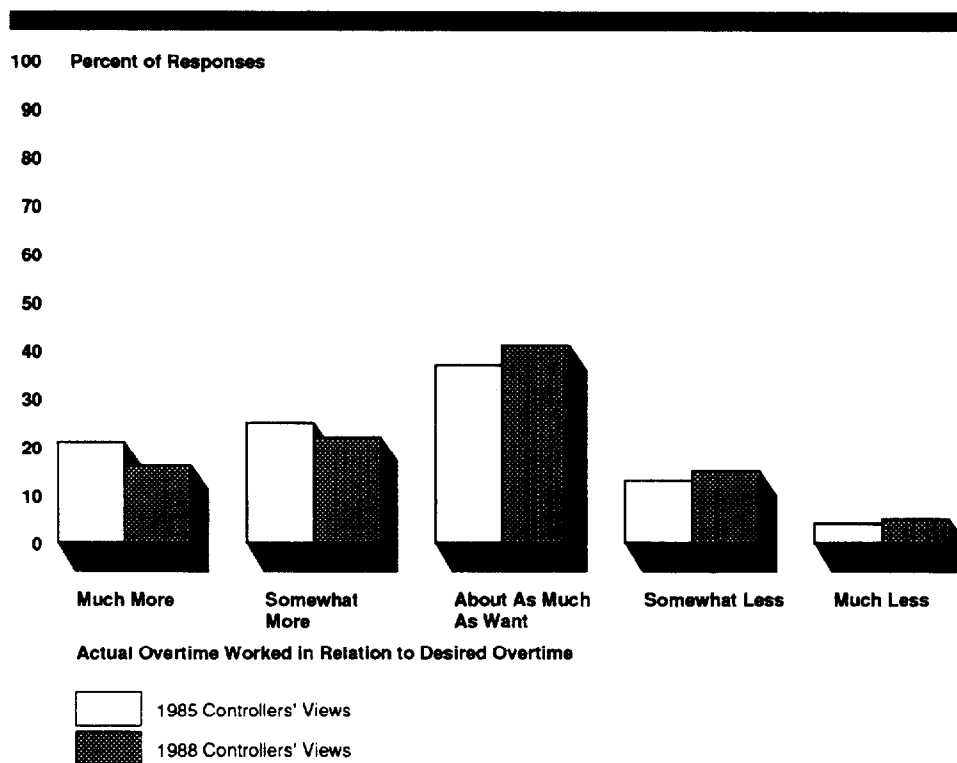


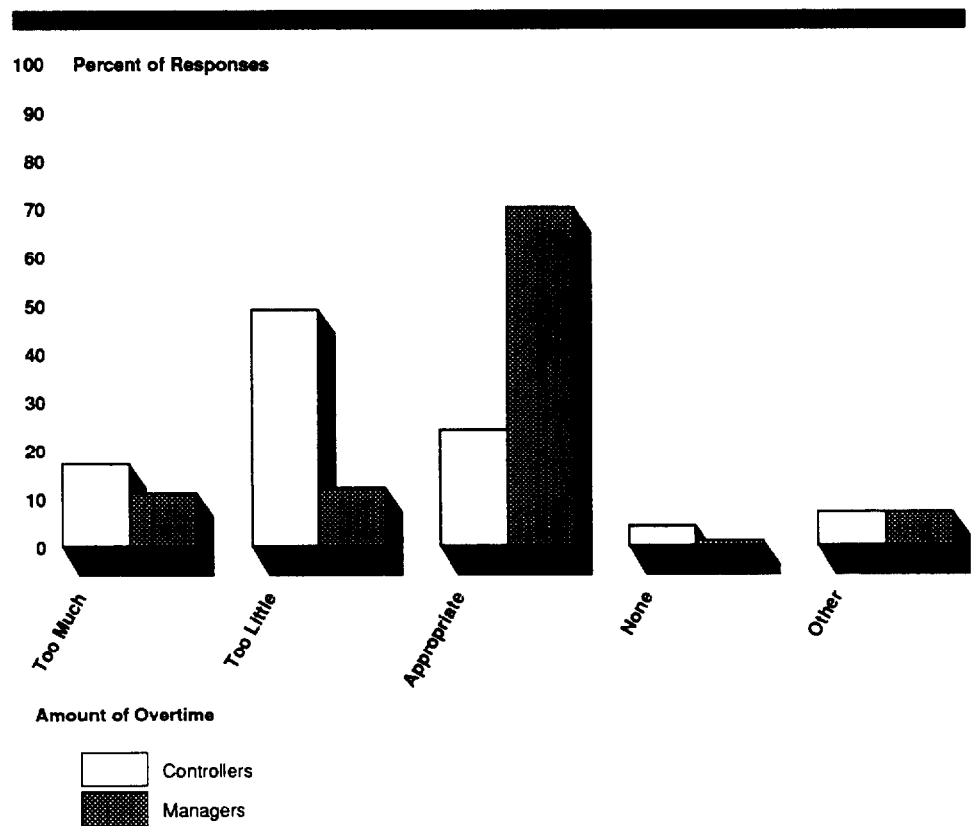
Table II.8: Condition—Overtime Views Similar to Those in 1985

Controllers' view: overtime worked vs. desired	Percent of responses	
	1985	1988
Much more than wanted	21	16
Somewhat more than wanted	25	22
About as much as wanted	37	41
Somewhat less than wanted	13	15
Much less than wanted	4	5

Disparity: Overtime

The 1988 questionnaires illustrated a disparity of views (see fig. II.9) between the controllers and managers about whether overtime assignments at facilities were appropriate. While 70 percent of managers said that overtime assignments at their facilities were appropriate, only about 24 percent of controllers shared this view.

Figure II.9: Disparity—Current Facility Overtime Condition



Training

Training is critical to an individual's successful performance as an air traffic controller and to the safety of the nation's air traffic system. In both the 1985 and 1988 questionnaire results, a majority of controllers rated the quality of 4 of 10 aspects of training for developmental controllers as either "less than adequate" or "poor." In addition, over 60 percent of the controllers held the opinion that developmental controller training received prior to their on-the-job training was inadequate and almost 30 percent of controllers considered facility on-the-job training to be less than adequate.

Controllers' View:
 Inadequate Quality of
 Various Aspects of
 Developmentals' Training

As shown in table II.9, the majority of controllers in both 1985 and 1988 rated the quality of training that developmentals receive in 4 of 10 aspects as "less than adequate" or "poor." Those aspects include training in using backup systems, controlling traffic in bad weather, emergency procedures, and holding patterns.

Table II.9: Condition—Quality of Developmental Training and the Extent Considered Inadequate

Training aspect	Percent of controllers responding "less than adequate" or "poor"	
	1985	1988
Using backup systems	58	61
Controlling traffic in bad weather	55	57
Emergency procedures	54	56
Holding patterns	54	56
Operational characteristics of types of aircraft	42	44
Flow control procedures	39	39
Handling heavy traffic	37	34
Direct routings (expediting traffic)	29	28
Control techniques	31	27
Phraseology	18	17

FAA's ability to provide developmentals with quality training may be affected by the number of developmental controllers at their facilities. The following summarizes controllers' views on FAA's ability to provide training and the existing number of developmentals:

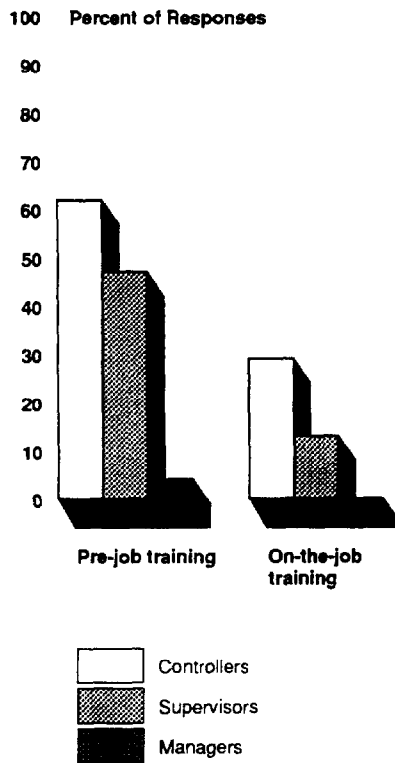
- 27 percent said that their facilities already had more developmentals than can now be trained,
- 31 percent said they have about the right number of developmentals to train now, and
- 42 percent said they could train more developmentals if they had more.

Disparity: Inadequacy of
 Developmentals' Training

As shown in figure II.10, a disparity of views exists on the adequacy of training that developmentals receive both prior to beginning on-the-job training and during that training at the developmentals' facilities. The disparity is greatest between controllers and facility managers but is also evident between supervisors and managers. For pre-job training 62 percent of controllers, 47 percent of supervisors, and 4 percent of managers considered such training as less than adequate. For facility on-the-job training, 29 percent of controllers, 13 percent of supervisors, but no managers considered such training as less than adequate.

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Figure II.10: Disparity—Developmental
 Training Considered Less Than
 Adequate



Air Traffic Control Operations

Air traffic control operations, as listed in our questionnaire, included morale, certain items that may help controllers perform their duties, airlines' scheduling practices and use of hubs, and pilot communication performance. Controllers' and supervisors' views of their own morale varied widely from managers' view of that morale. Further, controllers and managers differed widely in their views on what helps controllers perform their duties as air traffic controllers.

Controllers, supervisors, and managers agree that airlines' scheduling practices and use of hubs hinder traffic flows. In addition, the supervisors' view of pilots' communication performance closely approximated the controllers' view.

Disparity: Work Force's Morale

Figure II.11 shows a disparity in how controllers view their own morale compared with how managers view controller morale. Managers predominantly viewed controller morale as high, whereas controllers

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predominantly viewed their own morale as low. Only 4 percent of managers said controller morale was low compared with 43 percent of controllers who said their morale was low. In contrast, 56 percent of managers said controller morale was high, whereas 29 percent of controllers said their morale was high.

Figure II.11: Disparity—View of Controller Morale

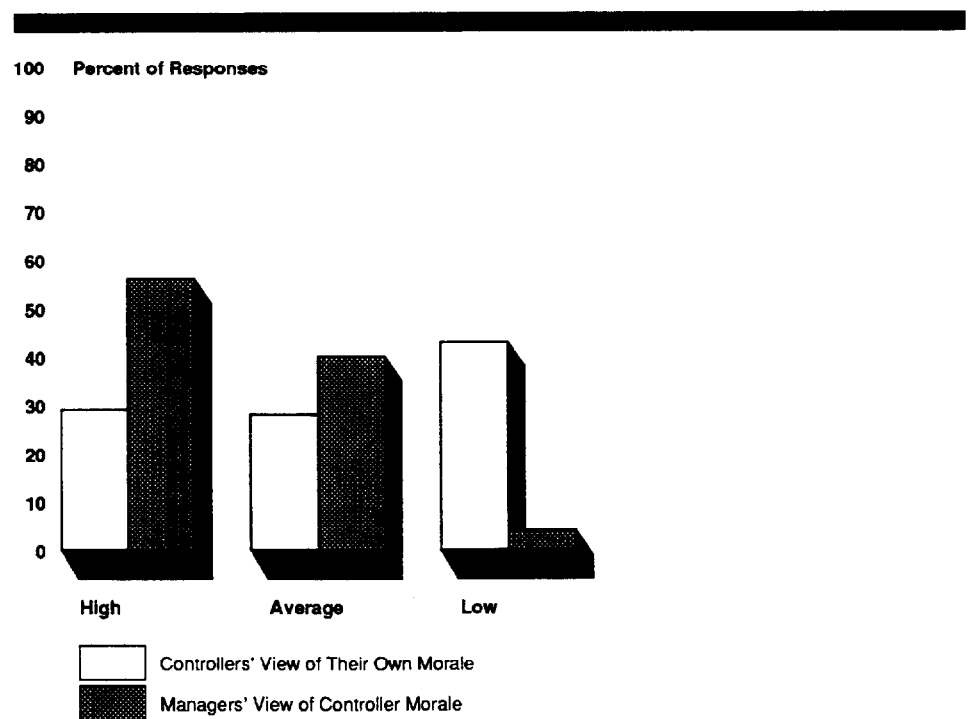
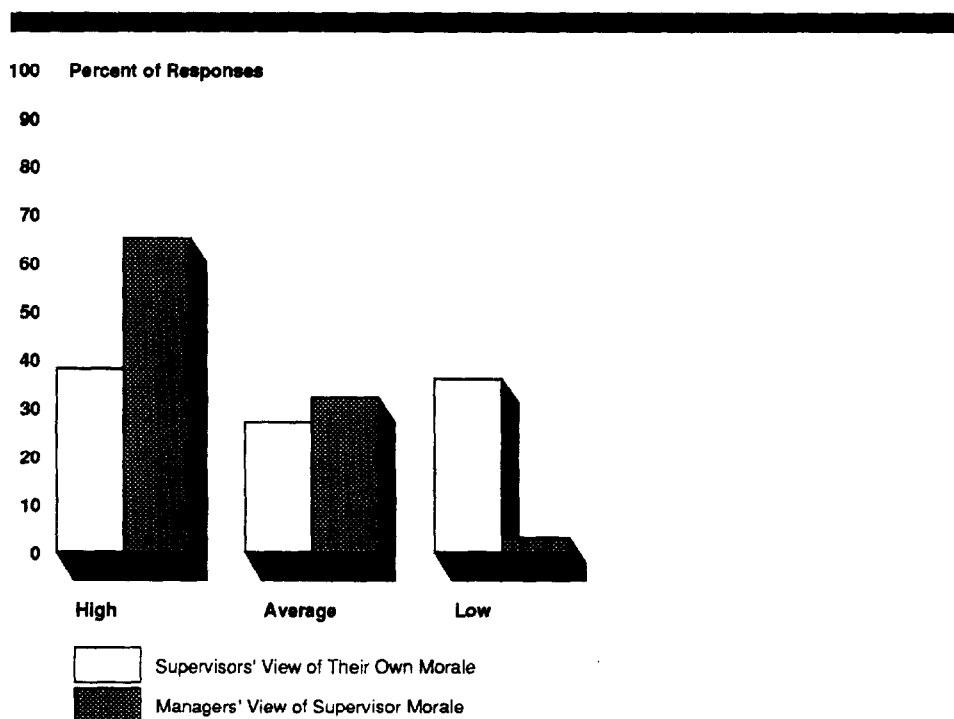


Figure II.12 shows a disparity in how supervisors viewed their own morale compared with how managers viewed supervisor morale. While 36 percent of supervisors said their morale was low, only 3 percent of managers saw it as low. In contrast, 65 percent of managers said supervisor morale was high, while 38 percent of supervisors said their morale was high.

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Figure II.12: Disparity—View of
 Supervisor Morale



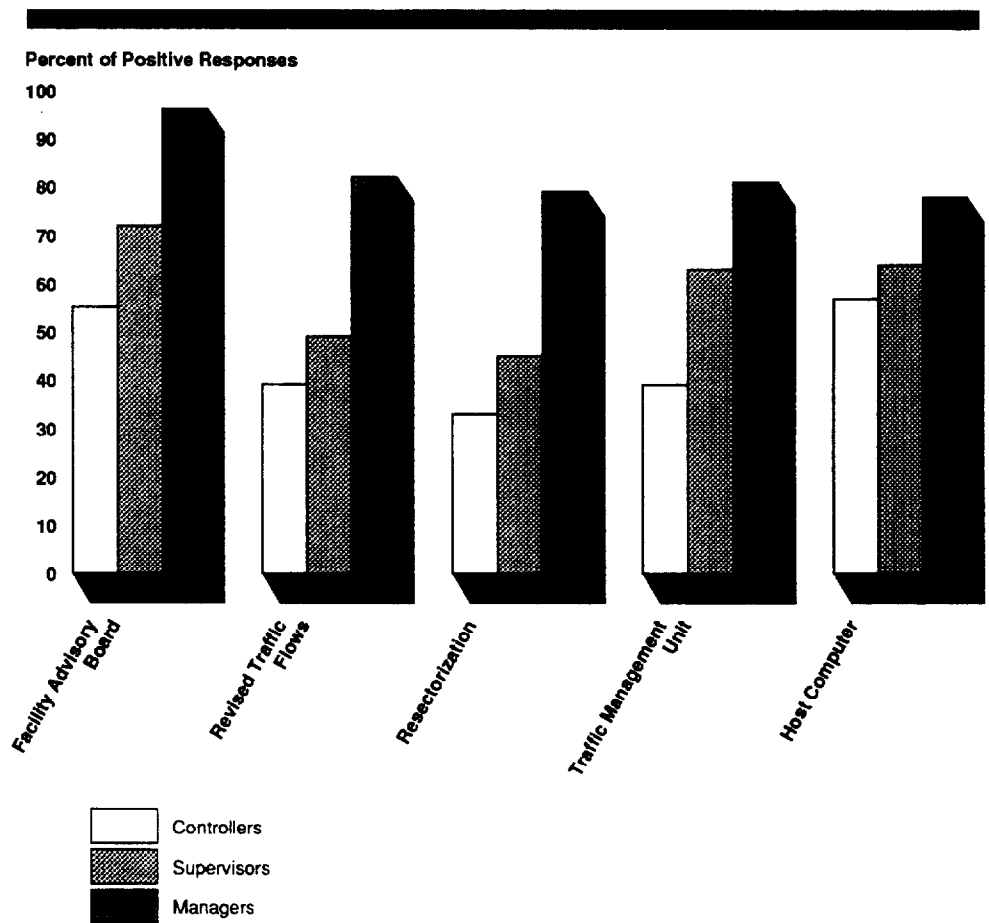
Disparity: What Helps
 Controllers Perform Their
 Duties

Figures II.13 and II.14 show two contrasting views of what helps controllers perform their duties. Figure II.13 shows the positive responses that controllers, supervisors, and managers provided on five items, indicating the extent to which controllers, supervisors, and managers believed each item was helping controllers perform their duties as air traffic controllers. Figure II.14 shows the negative responses provided on the same five items, indicating the extent each group believed each item was hindering controllers. For both figures, the disparity is greatest between controllers and managers. Supervisors' views fell between controllers' and managers' views.

When viewed from the perspective of what helps controllers perform their duties, managers viewed the help that certain items provide as being much greater than do the controllers. In contrast, when viewed from the perspective of items that hinder controllers, managers saw few negatives, whereas controllers and supervisors saw a greater extent of hindrance for controllers performing their duties.

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Figure II.13: Disparity—Items That Help Controllers in Performing Duties



Notes:

Facility Advisory Boards provide recommendations to facility management on procedural, technical, operational, and personnel matters that will improve both working conditions and the quality of services provided to the users of the air traffic system.

Revised traffic flow is a broad term encompassing revisions to the flow of air traffic that controllers handle.

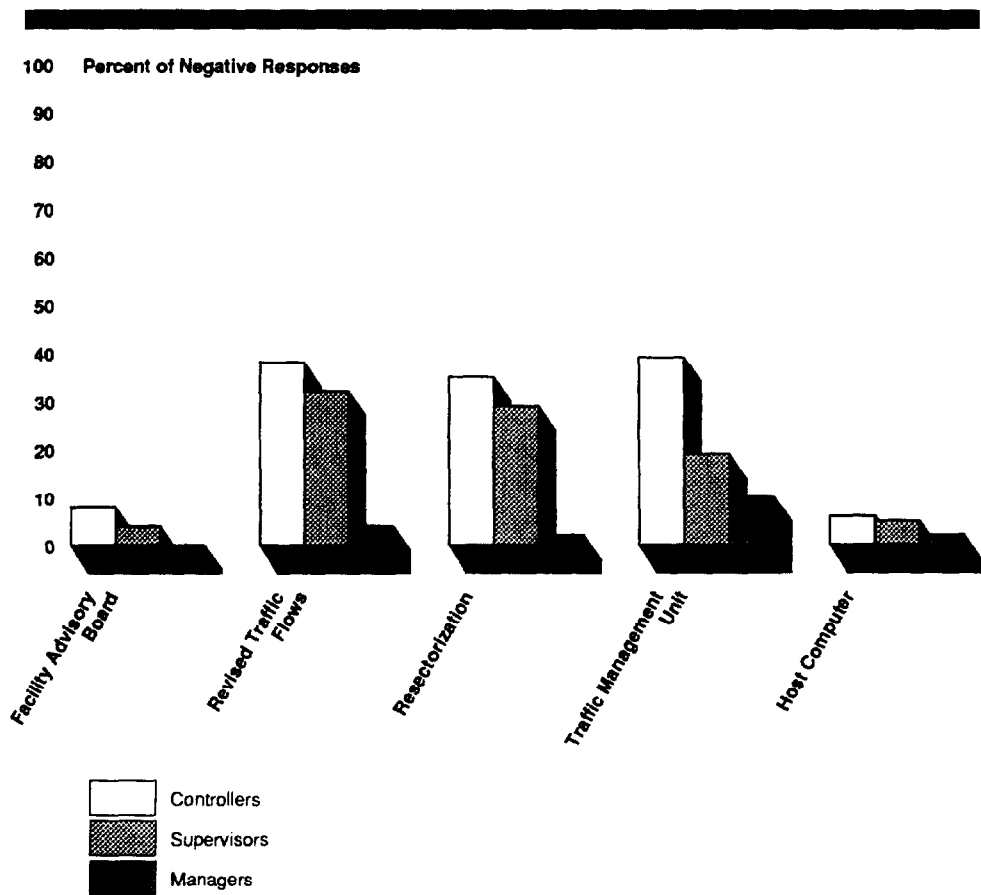
Resectorization involves the reconfiguration of designated airspace sections, called sectors, within which a controller has responsibility and authority for the separation of aircraft.

Traffic Management Units are responsible for monitoring traffic flow and ensuring that safe levels of air traffic are not exceeded.

Host computers are new high speed computers designed to enhance flight safety and efficiency

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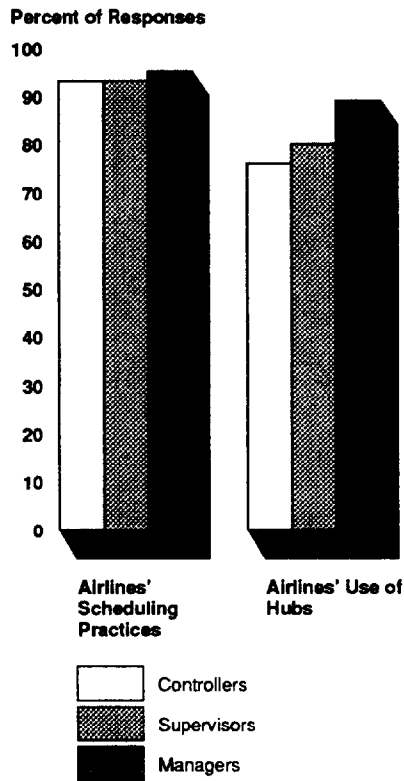
Figure II.14: Disparity—Items That Hinder Controllers in Performing Duties



Controllers' View: Airlines' Scheduling Practices and Use of Hubs Are Hindrances

Figure II.15 shows very strong agreement among controllers, supervisors, and managers that airlines' scheduling practices hindered the flow of traffic. Ninety-three percent of both controllers and supervisors held this view as did 95 percent of facility managers. Similarly, strong agreement existed that airlines' use of hubs hindered the flow of traffic; 76 percent of controllers, 80 percent of supervisors, and 89 percent of facility managers shared the view about hubbing use.

Figure II.15: Airlines' Scheduling Practices and Use of Hubs Hinder Traffic Flow



Controllers' View: Inadequate Pilot Communication Performance

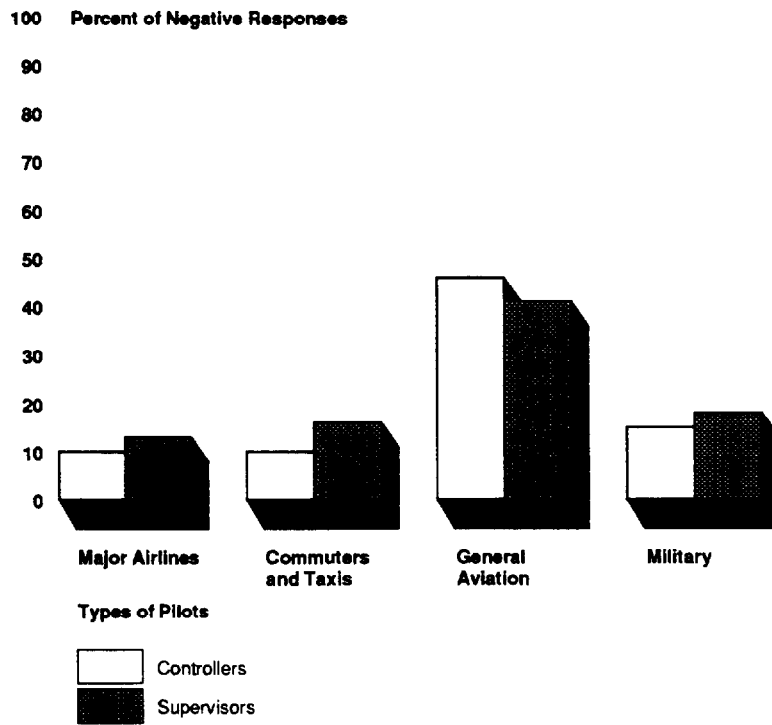
Figure II.16 shows the extent that controllers and supervisors³ rated pilots' communication performance as inadequate. We defined communication performance as (1) following air traffic control instructions, (2) using correct phraseology, and (3) keeping unnecessary communication to a minimum. Controllers and supervisors both rated general aviation pilots' typical communication performance as the worst among a group of four types of pilots (major airlines, commuters and taxis, military, and general aviation). Specifically, 46 percent of controllers and 41 percent of supervisors rated the typical communication performance of general aviation pilots as "less than adequate" or "poor."

³Supervisors were asked for their opinion on pilot communication performance because they spend part of their time working traffic. On the basis of what supervisors told us in 1988, 19 percent of their time is spent working traffic.

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Major airline pilots' communication performance was rated the best by both controllers and supervisors. However, 10 percent of controllers and 13 percent of supervisors rated major airline pilots' performance as "less than adequate" or "poor."

Figure II.16: Extent Pilot Communication Performance Rated Inadequate



Safety

Most controllers rated system safety as "adequate," "good," or "excellent"; however, about 16 percent continue to rate the system as "poor" or "very poor." Controllers cited in varying degrees eight factors that they believed hinder FAA's ability to maintain system safety.

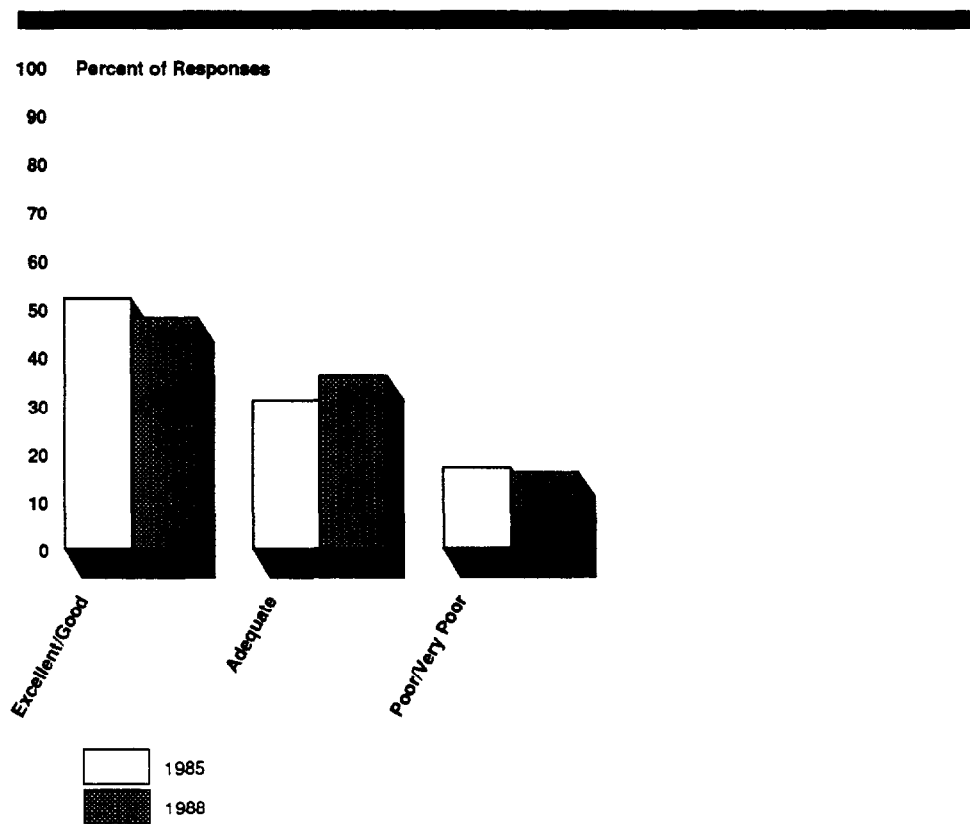
Controllers' View: Safety Has Not Improved

Figure II.17 shows that controllers' overall view of safety remains basically the same as in 1985. In 1988, 16 percent of controllers viewed system safety as "poor" or "very poor"; in 1985, 17 percent of controllers shared this view. Further, in 1988, 48 percent of controllers viewed

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safety as being “good” or “excellent”; in 1985, 52 percent of controllers shared this view.

Figure II.17: Controllers' Overall View of Safety Has Generally Not Improved



Controllers' View: Factors That Hinder System Safety

Figure II.18 shows the first four (which most hindered safety) of eight factors that controllers determined either “hinder somewhat” or “strongly hinder” the maintenance of air traffic control system safety today:

- the amount of traffic work load,
- controller morale,
- the number of FPLs, and
- hardware reliability.

Figure II.18 also shows the extent that supervisors and managers cited each factor as hindering somewhat or strongly hindering system safety.

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Figure II.18: Four Factors That Most Hinder System Safety

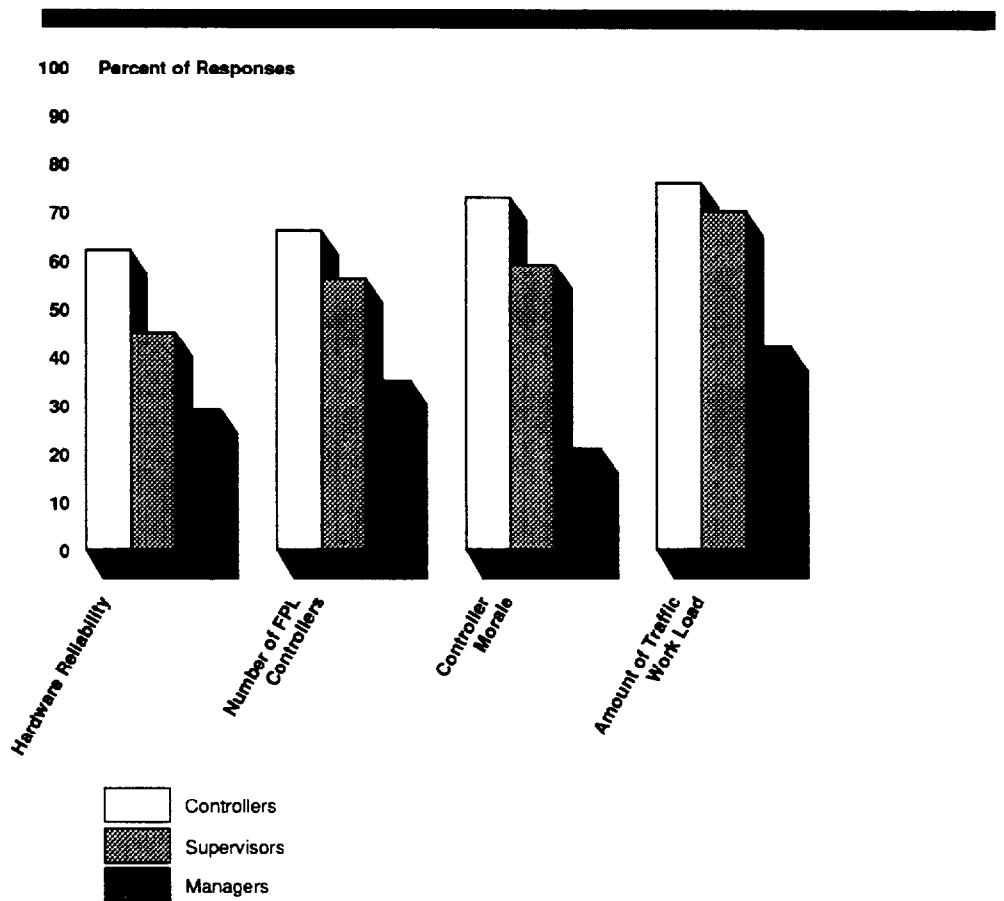


Table II.10 shows the specific response rate that controllers, supervisors, and managers provided to indicate the extent that the identified factors hinder system safety.

Table II.10: Factors That Most Hinder System Safety

Factor	Percent of response		
	Controllers	Supervisors	Managers
Hardware reliability	62	45	29
Number of FPLs	66	56	35
Controller morale	73	59	21
Amount of traffic work load	76	70	42

Figure II.19 shows the extent that four additional factors hinder system safety. These factors were cited by close to one of every two controllers

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and by at least two of every five supervisors as hindering the maintenance of system safety.

Figure II.19: Additional Factors That Hinder System Safety

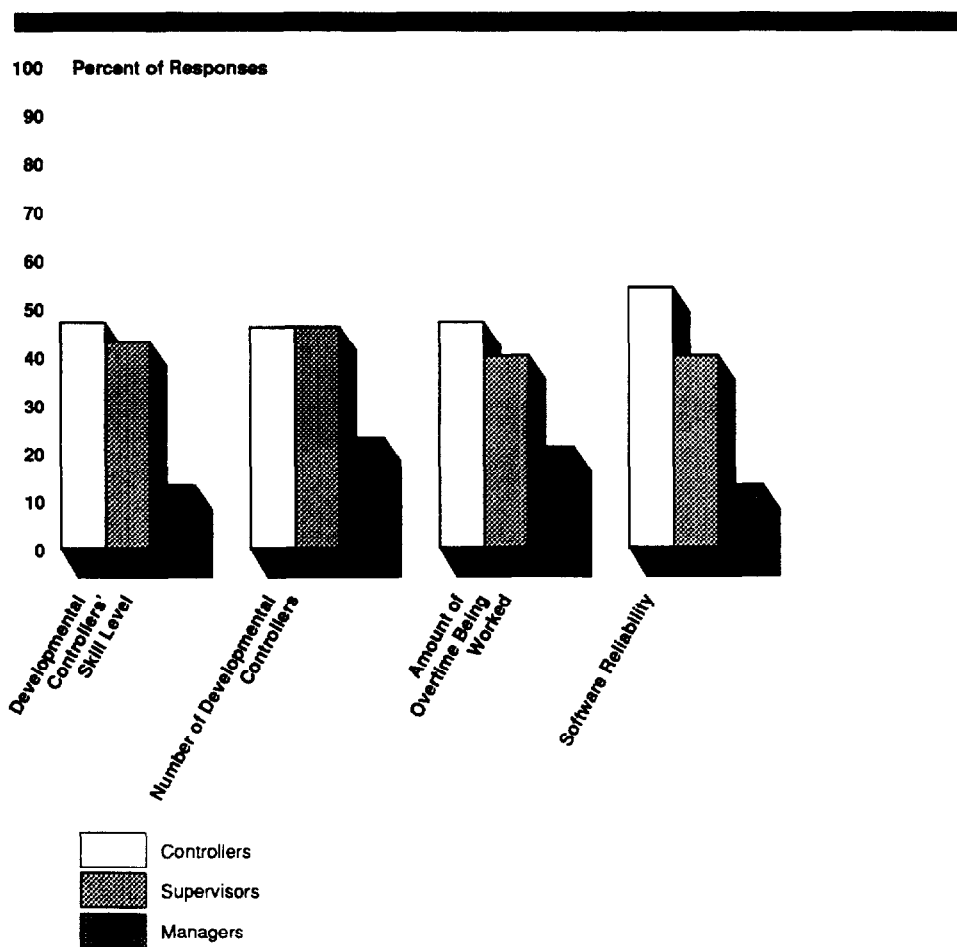


Table II.11 shows the specific response rate by which controllers, supervisors, and managers indicated the extent that the identified factors hinder system safety.

**Appendix II
The Work Force Views on Working
Conditions and Other Aspects of the Air
Traffic Control System**

**Table II.11: Additional Factors That
Hinder System Safety**

Factor	Percent of response		
	Controllers	Supervisors	Managers
Developmental's skill level	47	43	13
Number of developmentals	46	46	23
Amount of overtime being worked	47	40	21
Software reliability	54	40	13

Center Versus Terminal Controllers' Views on Selected Questions

To identify differences in controllers' views at centers and terminals, we used a criterion of identifying differences of more than 5 percent from the overall result and limited the selection to points raised in this report.¹ The following differences were identified:

Table III.1: Center and Terminal Views on Training Quality

Area of training	Extent quality rated inadequate		
	Overall	Centers	Terminals
Extent in Percent			
Aspect of developmental's on-the-job training at facility			
Using back-up systems	61	64	53
Controlling traffic in bad weather	57	62	48
Emergency procedures	56	60	49
Holding patterns	56	52	63
Operational characteristics of aircraft types	44	49	36
Flow control procedures	39	42	35
Handling heavy traffic	34	38	28
Direct routings (expediting traffic)	28	28	28
Control techniques	27	29	24
Phraseology	17	19	15
	Extent "probably" or "definitely" not provided sufficiently		
Developmental's training with live traffic before certified on position	31	35	22
	Extent rated worse than 3 years previously		
Developmental's talents			
Work attitude	45	50	38
Overall skill level prior to on-the-job training	40	37	29
Aptitude or ability to learn controller duties	31	35	22

¹Our fact sheet Aviation Safety: Conditions Within the Air Traffic Control Work Force (GAO/RCED-89-113FS) lists complete responses for all survey questions, overall and by centers and terminals.

**Appendix III
Center Versus Terminal Controllers' Views on
Selected Questions**

Table III.2: Center and Terminal Views on Staffing

Personal ability limited by controller shortage	Extent limited "moderately" to "very greatly"		
	Extent in Percent		
	Overall	Centers	Terminals
To take first 2 weeks of annual leave each year	25	18	36
To take the rest of annual leave	44	41	52
To take annual leave on short notice (2 weeks or less)	80	78	86
To take needed sick leave	24	21	29
To refuse scheduled overtime	38	34	48
To get required training	39	38	40
To get or provide team briefings	33	30	36
To take needed personal breaks	48	46	51
To take "duty familiarization" airline trips	59	58	64

Table III.3: Center and Terminal Views on System Safety

Factor	Extent factor hinders system safety		
	Overall	Centers	Terminals
Number of developmentals available	46	44	50
Number of FPLs available	66	64	71
Amount of traffic work load	76	76	76
Amount of overtime being worked	47	44	52
Hardware reliability	62	58	69
Software reliability	54	46	71
Controller morale	73	73	74
Skill level of developmentals	47	52	40

Method of Measuring Changes in Perceptions

We measured the change in responses between the 1985 and 1988 questionnaires provided by controllers, supervisors, and managers for 169 questions that could be directly compared between the 2 years' questionnaires. Table IV.1 shows the number of comparable questions by area for each of the three questionnaires and in total. Complete details on all survey questions are contained in our fact sheet, Aviation Safety: Conditions Within the Air Traffic Control Work Force (GAO/RCED-89-113FS).

Table IV.1: Number of Comparable Questions in 1985 and 1988 Surveys

Questionnaire area	Comparable questions			
	Controllers	Supervisors	Managers	Total
Work load	17	21	20	58
Staffing	7	7	9	23
Overtime	1	0	2	3
Training	12	12	15	39
System safety	1	1	1	3
Error detection	9	9	8	26
Retirement	8	8	0	16
Strike recovery	0	0	1	1
Total	55	58	56	169

We then classified the change in responses into one of four categories: little to none, minor, moderate, or substantial. We used the following criteria to make the "extent-of-change" classifications.

Each question in the survey asked the respondents to check the one response that best described their perception or viewpoint regarding the question asked. For most questions, there were five possible responses. We gave a value, 1 through 5, to each response. (For questions with three, four, or some other number of responses, we assigned values accordingly.) For example, if a respondent checked the middle response for a question with five possible answers, that answer counted 3. We then summed the values for all responses and calculated the mean response for that question.¹ We compared the mean responses between comparable questions for 1985 and 1988 as the first step in determining the extent of change between questionnaires.

¹Five of the 169 questions asked the respondent for a percentage response rather than a categorical answer, for example, percent of time supervisors work traffic. In these instances, we converted the response to a categorical answer before computing the mean response.

We defined the extent-of-change classifications as follows. If the difference between the mean responses was 1 or more (equivalent to all respondents changing their answer one or more categories), we defined the change as "substantial." If the difference between mean responses was 0.5 to less than 1, we defined the change as "moderate." If the difference was 0.1 to less than 0.5, we defined the change as "minor"; and if less than 0.1, "little to none."

Had the entire controller and supervisor work force been surveyed, as was the case for facility managers, we would have used the means difference and the extent-of-change definitions described above to immediately classify the change into one of the four categories. However, controllers and supervisors at center facilities comprised a statistical random sample from a larger population. Thus, mean responses are estimates, and estimates derived from random samples have some degree of statistical sampling error associated with them. We therefore computed sampling errors and performed appropriate tests of statistical significance before finally classifying the extent of change in the mean responses.

Statistical significance of the difference between two sample means is defined as the probability that the observed difference (in the sample) represents a true change. However, if the difference is not statistically significant, the observed difference is attributed to normal random sampling variation. In this case, there is no basis to conclude that a true difference exists. A predetermined level of probability is used to make the decision between significant and not significant. We used a 95-percent probability as our significance criterion.

When the difference between the mean responses for comparable questions from 1985 to 1988 was not statistically significant, we classified the extent of change as "little to none." When the difference was statistically significant, we performed additional tests to determine the appropriate extent-of-change category, as follows.

For differences between the mean 1985 and 1988 responses that were statistically significant, we computed a statistical confidence interval around the mean difference.² The extent-of-change category into which

²Confidence intervals were calculated at the 95-percent level of statistical confidence. That is, there is less than 1 chance in 20 that the true, but unknown, difference between mean responses would not fall within the interval.

Appendix IV
Method of Measuring Changes in Perceptions

we classified the difference depended on the lower and upper bound of this interval.

If the confidence interval was completely contained within one of the extent-of-change categories, we placed the question into that change category. For example, a confidence interval for the mean difference of 0.22 to 0.38 would place the question into the “minor” change category, which includes changes anywhere from 0.1 to less than 0.5.

However, if the confidence interval overlapped two change categories, we selected either the lower or upper bound of the interval and placed the question into the change category containing that bound. For example, an interval of 0.08 to 0.24 for the mean difference would overlap the “little to none” and “minor” categories. We selected the bound, lower or upper, that would be more favorable to FAA. By “favorable,” we mean that the difference in mean responses indicated greater operational improvement (or less operational degradation) between 1985 and 1988.

A favorable condition could be represented by either the lower or upper bound of the confidence interval depending on (1) how the question was phrased, (2) how the question was scaled (lowest category being negative and the highest category being positive or vice versa), and (3) whether the mean response increased or decreased from 1985 to 1988.

Table IV.2 shows the results of measuring and classifying responses provided by controllers, supervisors, and managers.

Table IV.2: Results of Question Comparability

Area	Extent of change				Total
	Not substantial				
	Little to none	Minor	Moderate	Substantial	
Work load	30	26	2	0	58
Staffing	7	12	4	0	23
Overtime	0	3	0	0	3
Training	24	14	1	0	39
System safety and operations	1	2	0	0	3
Error detection	7	16	3	0	26
Retirement	10	6	0	0	16
Strike recovery	0	1	0	0	1
Total	79	80	10	0	169

The 84 Major Air Traffic Control Facilities Included in GAO's Survey

Air route traffic control centers

1. Albuquerque	8. Houston	15. Minneapolis
2. Atlanta	9. Indianapolis	16. New York
3. Boston	10. Jacksonville	17. Oakland
4. Chicago	11. Kansas City	18. Salt Lake City
5. Cleveland	12. Los Angeles	19. Seattle
6. Denver	13. Memphis	20. Washington, D.C.
7. Fort Worth	14. Miami	

Terminal facilities

1. Atlanta	23. Indianapolis	44. Ontario TRACON
2. Austin Tower ^a	24. Jacksonville	45. Orlando
3. Baltimore-Washington	25. Kansas City	46. Pensacola
4. Boston	26. Kennedy Tower	47. Philadelphia
5. Burbank	27. LaGuardia Tower	48. Phoenix
6. Charlotte	28. Las Vegas	49. Phoenix TRACON
7. Chicago O'Hare ^o	29. Los Angeles	50. Pittsburgh
8. Chicago TRACON ^b	30. Los Angeles TRACON	51. Portland TRACON ^c
9. Cleveland	31. Lubbock	52. Sacramento
10. Columbus	32. Memphis	53. St. Louis ^b
11. Dallas-Fort Worth ^b	33. Miami	54. St. Louis TRACON ^b
12. Dallas-Fort Worth TRACON ^b	34. Milwaukee	55. Salt Lake TRACON ^c
13. Dallas-Love Tower ^a	35. Minneapolis	56. San Antonio
14. Dayton	36. Nashville ^a	57. San Diego
15. Denver ^o	37. Newark	58. San Francisco
16. Denver TRACON ^b	38. New Orleans	59. Santa Ana
17. Detroit	39. New York TRACON	60. Seattle TRACON ^c
18. Dulles Tower ^a	40. Norfolk	61. Tampa
19. Edwards Air Force Base	41. Oakland Tower ^a	62. Washington National
20. Fort Lauderdale	42. Oakland TRACON	63. West Palm Beach
21. Hebron ^a	43. Oklahoma City	64. Windsor Locks
22. Houston		

Note: TRACON = Terminal radar approach control facility.

^aFacility upgraded subsequent to 1985 survey and now included in FAA's list of largest facilities (level 4 and 5).

^bFacility reorganized subsequent to 1985 survey to include separate tower and TRACON activity; each organizational unit is sufficiently large to be separately included in FAA's list of largest facilities.

^cFacility reorganized subsequent to 1985 survey to include separate tower and TRACON. Towers (Portland, Salt Lake City, and Seattle) no longer included in our survey since FAA deleted them from its list of largest facilities.

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Related GAO Products

Aviation Safety: Conditions Within the Air Traffic Control Work Force
(GAO/RCED-89-113FS).

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Aviation Safety: Serious Problems Concerning the Air Traffic Control Work Force (GAO/RCED-86-121, Mar. 6, 1986).

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