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A SAFETY APPRAISAL
OF THE
AIR TRAFFIC CONTROL SYSTEM
REPORT NO. FSF-ATC 1142-1-82U

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FAA Headquarters

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The Flight Safety Foundation is an international membership organization established in 1945 dedicated solely to the improvement of flight safety. As a non-profit and independent foundation, it serves the interests of the public and the aviation community by actively supporting and participating in the development and implementation of programs, policies and procedures affecting aviation safety. It stimulates research into the ways and means of eliminating accident-inducing practices and factors through in-depth appraisals of actual and potential problem areas in flight and ground safety and by developing possible solutions to these problems. As a vehicle of information interchange, it cooperates with other national and international organizations and individuals working in the aviation safety field in keeping all segments of the aviation community aware of the principles of accident prevention and abreast of the technological and practical advances being made to attain them.

*Issues examined related
safety, management, fatigue,
morale and retention.*

FOREWORD

In August 1981, the FAA Administrator, Lynn Helms, requested the Flight Safety Foundation to evaluate the safety of the U.S. Air Traffic Control system during the period following the August 3 strike of air traffic controllers. The evaluation was to provide the Administrator with an independent and objective appraisal of the strengths and weaknesses of the existing air traffic control system during the period of approximately late-August to mid December 1981, and to inform the Administrator of the findings of this appraisal as they developed.

Presented in the following pages are the results of this 120-day appraisal conducted by the Flight Safety Foundation. An appraisal of safety of any technology is a demanding task, for there are no absolute measures that one can use to describe the safety of a system. Safety has been defined as absence of risk; however, any human endeavor entails some measure of risk, so an appraisal of safety becomes a matter of judgment, requiring careful balancing of a multitude of factors by experienced people from a variety of backgrounds within the arena of interest. The collective safety oriented experience among the task force was comprised of practical controller experience in enroute and terminal area situations; user experience, including private, corporate, air transport and military pilots; management experience; human factors research experience; and weather information management experience.

With this collective background and experience, the foundation's appraisal considered matters that history has shown lead to accidents or unacceptable risks to human life and property. Management's actions and attitudes about safety, quality and serviceability of equipment and the skill, knowledge and attitudes of operating personnel were addressed. Our report specifically addresses these matters in the post-August 3rd time frame.

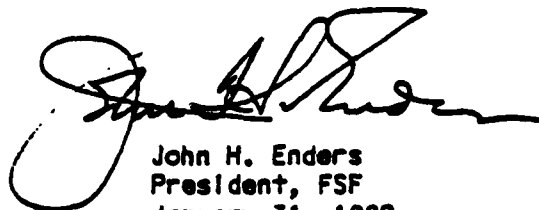
A comment must be made concerning FAA's attitudes concerning this effort. The study was done directly for the FAA Administrator. There was no question but that he believed the reconstructed ATC system was safe. But he wanted an independent view -- a view completely free of any ties or obligations to FAA and its responsibilities. From the outset of this effort, FAA maintained a "hands-off" policy, while at the same time cooperating fully in allowing the foundation complete freedom in selecting task force members, in determining site visits,

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conducting interviews with operating controllers and management personnel, as well as furnishing data and other information as requested. At no time was there any effort on the part of FAA to influence our contacts with the working ATC system. The openness and cooperation received at every level in FAA facilitated the work of the task force.

Acknowledgment must be made of the support of the user community in providing us with its views of the ATC system operation, as well as the opportunity for staff and task force members to observe the system from the cockpit. In particular, the foundation acknowledges the valued observations of several non-U.S. air carriers that operate regularly into U.S. airspace.

The findings, conclusions and recommendations presented in the following pages are those of the Flight Safety Foundation, based upon information gathered during this particular period of time. This report is presented without any prior comment or critique by FAA.



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President, FSF
January 31, 1982

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ACRONYMS

ALPA	- Air Line Pilots Association
ARTCC	- Air Route Traffic Control Center
ASRS	- NASA Aviation Safety Reporting System
ATC	- Air Traffic Control
DOD	- Department of Defense
FAA	- Federal Aviation Administration
FSF	- Flight Safety Foundation, Inc.
GA	- General Aviation
GAR	- General Aviation Reservations Program
IFR	- Instrument Flight Rules
NASA	- National Aeronautics and Space Administration
NMAC	- Near Mid-Air Collision
NOTAM	- Notice to Airmen
NTSB	- National Transportation Safety Board
OJT	- On The Job Training
STAGE III	- Provides Radar Separation Between Participating VFR and IFR Traffic Operations in a TRSA or TCA.
TCA	- Terminal Control Area
TDY	- Temporary Duty
TRACON	- Terminal Radar Approach Control
TRSA	- Terminal Radar Service Area
UCR	- Unsatisfactory Condition Reports
VFR	- Visual Flight Rules

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SUMMARY AND OVERVIEW

At the request of the Federal Aviation Administration (FAA), the Flight Safety Foundation (FSF) conducted a safety appraisal of the United States air traffic control system. The study was performed because of concerns that the Administration's termination of over 11,000 striking air traffic controllers' employment may have derogated aviation safety. The task before the FSF was to appraise the strength and weaknesses of FAA's subsequent actions on safety and to provide this information to the FAA Administrator in a timely manner.

The premise guiding FSF's study was that, prior to August 1981, the ATC system was intrinsically safe. Changes potentially affecting safety and calling for assessment included controller qualifications, controller workload and fatigue, and user patience and cooperation in the face of FAA constraints limiting traffic activity.

To assess these changes, the FSF formed a Task Force of 16 aviation safety and ATC operational experts drawn from the USAF, NASA and private industry. The Task Force members collectively visited over 70 ATC facilities and interviewed approximately 500 controllers and supervisors. The Task Force members spent more than 500 hours

observing controllers on duty. The Task Force also assessed ATC operations from a user's perspective by riding air carrier and some corporate aircraft jumpseats, by interviewing pilots and other operators, by flying in the system and by soliciting perceptions of non-U.S. airlines operating into U.S. airspace.

The Task Force field visit activities proceeded in two phases. A detailed inspection was performed over the period September 14 through October 9, 1981. During the period November 16 through December 11, 1981, about fifty percent of the facilities were revisited.

To supplement the Task Force activity, the FSF reviewed other information bearing on ATC operations. Included were operational error records and statistics, traffic activity statistics, NASA Aviation Safety Reporting System (ASRS) reports, near mid-air collision (NMAC) and mid-air collision statistics.

From these efforts, a number of findings emerged bearing directly on ATC system safety. These are presented in this section.

General.

We found a positive spirit of cooperation existing between pilots and controllers. An overwhelming majority of pilots interviewed reported that the ATC system is "better than before" and "it's a pleasure to fly." To pilots using the ATC system, the most noticeable effect of

the reduced controller workforce is the occasional need to delay departures. They stated that ATC services are being provided professionally and courteously.

From our interviews with working controllers and supervisors, reports were received that for some period prior to August 3, 1981, unprofessional and unsafe practices were taking place. For example, controllers who had no intent to strike were allegedly "set up." Aircraft were maneuvered so that they would be in potential conflict when they entered the "uncooperative" controller's airspace. We also received reports that the work environment was one of bickering, abusiveness and continual harassment of controllers and supervisors.

In contrast, we found the current work environment to be one of cooperation and camaraderie. Most controllers and supervisors indicated that it was now a pleasure to come to work. Some who are nearing retirement eligibility, and had planned to retire, indicated they are now planning to stay on. We found during the first phase of our field visits a nearly unanimous feeling that, if the striking controllers returned, those who had remained would leave. During the revisits, some controllers expressed sentiments about bringing the "good" controllers back but acknowledged the lack of any viable selective process under which this could be accomplished.

Controller Qualifications.

From our observations and interviews and from our review of objective information about ATC operations, we find that ATC services are being provided in a professional and correct manner for the levels of traffic handled.

If controller qualifications or proficiency were inadequate, one indicator of this condition would be an increased frequency of instances of loss of safe separation between controlled aircraft. Analysis of operational error data reveals a decrease in potential and actual conflicts when compared to pre-strike data. The decrease in near mid-air collision reports reveals a similar trend.

Associated with controller qualifications is the training of new controllers. We observed extensive on-the-job training of the assigned military controllers, particularly at major terminals. The capability and willingness of the military controllers were lauded by those at the facilities to which they had been assigned. During our first phase of visits, some had been checked out on data and clearance delivery positions. During the second phase, some had been checked out on radar, ground and local control positions. When on-position training was observed, it was being provided under proper supervision.

Controller Workload and Fatigue.

The assessment of controller workload and fatigue has been a complex task for the FSF and its Task Force. Confounding such an assessment is the fact that both workload and fatigue are subjective. With today's technical state of the art, a given controller's perceptions are the simplest measure of whether or not either workload or fatigue is critical. Our approach was both direct and indirect. We asked controllers if they were overworked, tired or fatigued, and we looked at systemwide phenomena that could influence perceptions of, or indicate, overwork and fatigue.

The FAA's actions to regulate traffic volume were found to be largely effective in smoothing traffic flow and limiting excessive traffic management workload. The efforts to reduce traffic peaks and the establishment of hourly quotas helped to alleviate the conditions prevailing pre-August 3rd. We found, however, that these procedures do not always work efficiently or effectively. Some additional workload is introduced to provide required release times or in-trail spacing. We did not find that such workload was excessive. Controllers frequently expressed the opinion that more traffic could be handled.

We observed periods of heavy traffic. Even with the reduced work force, these surges of traffic were handled effectively because of the willingness of controllers to help one another. Controllers reported

they now had substantial latitude in imposing local restrictions to ensure that traffic or optional services did not exceed manageable levels. There were no reports by controllers of management pressure to handle more traffic than they considered feasible.

A significant workload factor in the current system is providing on-the-job training (OJT). Although considered an onerous task, the working controllers expressed preference for it as opposed to the conceivable alternative of bringing back the striking controllers.

We found variations between facilities in their approach to utilizing military controllers. Several facilities took no military controllers at all, because the chief felt the investment in training time would be wasted. Some facilities used the military controllers in less demanding positions and invested little time in their training. This practice led to some personnel dissatisfaction. Other facilities invested fully in training and are, over the short term, benefiting from the military controllers' capabilities. These three approaches occurred in the face of the same circumstances. The perception was that their qualification would take four-to-eight months and, immediately after August 3rd, the military controllers' tour of duty was not predictable but was estimated to range from 6 to 12 months. We found instances where military controllers would accept FAA employment if offered but thought that such opportunities were frustrated by the constraints of Federal hiring practices.

During our first phase of facility visits, we found no evidence of a plan to match the trainee production potential of the FAA Training Academy with the individual facility's capacity to provide the additional classroom and OJT required for the new controllers. During our second phase of visits, we found that new trainees and furloughed pilots were on board and being trained.

Quite commonly, we found that controllers were working six-day weeks. Their general view was that such a work period was preferable to a return to the pre-August work atmosphere. Many controllers wanted to earn the overtime pay. A few controllers expressed concern as to how long operations could be sustained under current staffing levels and did not wish to work longer hours. We found the more common problem relating to an extended work week and restricted leave policy was the disruption of the individual controller's life styles and avocations. We did not find evidence of overwork or fatigue.

Controller dedication and pilot cooperation were found to be the overriding factors in explaining why ATC operations have been able to sustain the current traffic levels. Supervisors now working control positions had been qualified controllers. Although initially rusty in practicing the art of air traffic control, they have now fully regained their former proficiency and enjoy handling air traffic. They like the work environment. They like the spirit of cooperation existing between themselves and pilots. They wish to retain this atmosphere. The non-supervisory working controllers share these sentiments. They have

pride in themselves, their accomplishment and their profession. They do not want the President, the Secretary of Transportation or the FAA Administrator to weaken their commitment.

We received comments about circumstances that are potentially destructive to the current positive atmosphere. Foremost was a concern over pay compensation for hours worked. Many working controllers are at, or near, the top of the government's Civil Service pay scales. For these individuals, earned overtime pay was either limited or not forthcoming at all. Many facility managers were also working long hours without extra compensation. The recent increase in the pay cap will alleviate some of these problems. However, some controllers nearing retirement eligibility may find the proposed pay levels insufficient to justify their continued government employment. The potential loss of these individuals would pose a significant staffing problem to some facilities in the immediate future.

User Cooperation and ATC Services.

We have noted earlier the positive attitudes of users operating within the ATC system and the general effectiveness of flow control and quota procedures to provide a moderately paced controller workload. The aviation users have gone to great lengths to support the Administration's actions and limit or otherwise regulate their flight operations.

We are concerned, however, about certain safety implications of limited ATC services. We have found, from our observations and from controllers' comments, classes of VFR operations posing a threat to IFR traffic. High performance aircraft are making greater use of high VFR altitudes. Although technically legal, such operations place significant demands on all pilots to detect visually other aircraft for collision avoidance purposes.

Similarly, we have found in some facilities an inability to provide either Stage III or TCA services to VFR aircraft. Aircraft operators so affected may either operate at the boundaries of controlled airspace or ignore the boundaries. Either of these actions increases the potential for mid-air collisions.

Management.

Through interviews with controllers, supervisors and facility chiefs, it was evident that, prior to the strike, the basic management structure and policies were cause for irritation and created confusion. This, in turn, had a direct effect upon the safety of the system. First line supervisors indicated that their decision-making in regard to discipline was often not supported at higher management levels, and therefore, the supervisor became non-effective. Many policy decisions were not fully explained to the working controller and this caused confusion and a perceived lack of direction and leadership. There appeared to be an excessive number of supervisory levels. This tended

to impede direct lines of communication.

Although undocumented, there were many reports that prior to the strike there was controller-to-controller harassment that involved live traffic and caused less-than-standard separation. Supervisors at all levels were apparently unable to stop the harassment. This caused a breakdown in the effectiveness of management and contributed to a lack of discipline.

There appeared to have been a lack of communication between controllers and supervisors due to the perceived notion that supervisors were selected, not for their management qualifications, but for reasons other than merit. Supervisors were not respected by the working controller, primarily because they were not required to control traffic. FAA recognized this fact and took action during the past year to ensure that facility management personnel were qualified and controlled traffic. This proved invaluable to continued safe operations beginning August 3rd. By this timely action, not only was the system able to continue operation, but an improved relationship now exists between management and controllers. This spirit of cooperation directly affects the continued safe operation of the ATC system.

CONCLUSIONS

1. SAFETY

Recognizing that safety is the byproduct of many interacting forces, this appraisal evaluated personnel proficiency, stress, workload, cooperation, aircraft separation and other factors. We conclude that, on an overall basis, the present ATC system has an equivalent level of safety to the pre-strike system. It is probable that safety margins have been increased in the IFR system. There may be a decrease in safety margins to all users because of reduced services and the resultant increase in VFR operations.

2. MANAGEMENT

The Task Force concludes that the FAA has an excessive number of management levels that have impeded the flow of upward and downward communications through the organization. Although downward communications have improved since the strike, many personnel in the lower echelons feel that upward communications have not.

In the past, concessions in the union contract were perceived to have stripped supervisors at all levels of much of their authority. This resulted in a lack of discipline, which undermined morale and affected

system safety. The Task Force found that working controllers perceive that this situation has improved significantly since the strike.

3. FATIGUE

Predictions of severe controller fatigue have not been realized to any significant extent. The excellent morale and working relationships that presently exist reduces those factors contributing to working stress and fatigue. The controller group appears willing, and able, to work more than a 40-hour week for a reasonable period. Individual controllers prefer varying working conditions based upon days worked, hours on position, relief and vacation opportunities. We conclude that there is no immediate safety need to reduce all controllers to a 40 hour week.

4. MORALE

Controller morale is consistently high. This high morale, together with their individual pride in performing a difficult task under trying circumstances, is responsible for controllers ability to handle relatively large traffic volumes with fewer people. There are many personnel policy issues that will determine the extent to which this high morale will be retained and, along with it, the positive effect on system safety.

5. CONTROLLER PROFICIENCY

No evidence was found to support allegations of unqualified personnel controlling traffic. Existing performance standards at the operational facilities have not been compromised. Controller proficiency is judged to vary now as it did before the strike. We believe that there are fewer sub-marginal controllers than before and perhaps fewer superior controllers than before. On average, the present controller staff is judged to have equivalent proficiency when compared to the pre-strike staff.

6. FACILITY STAFFING

Traffic volume has been reduced to a level generally compatible with available controller capacity. Some reduction in services, such as tower closings, has been made to allocate personnel to higher priority assignments. Controller abuse of sick leave has been virtually eliminated. These factors partially relieve facility staffing problems. Furloughed pilots hired on a temporary basis as flight data assistants are performing in a highly satisfactory manner. Many of them display an exceptional aptitude for higher levels of ATC responsibility that is not being tapped. There are no short cuts being taken in the restaffing process that would adversely affect safety. Many facilities are understaffed with respect to their training requirements when new controllers and academy graduates come on line.

Transfer of controller staff among facilities, as well as transfer of sector responsibilities between Centers, can ease the imbalances now in the system.

7. EQUIPMENT

Equipment malfunctions, computer outages and interruption have declined significantly. Whether or not past incidents were attributable to system overload, equipment misuse or nuisance complaints prior to the strike, such instances are now less frequent. Airways facility personnel continue to attend to problems in a timely manner.

8. TRAFFIC VOLUME AND FLOW CONTROL

Airspace user cooperation is good in general. However, users will continue to challenge the capacity of the system. Until staffing can be increased with properly qualified individuals, safety considerations require the FAA to maintain control of traffic flows. Flow control procedures need to be refined to even out inequities in the traffic system. The system is operating inefficiently due to the lack of feedback in the control loop. A delicate balance must be maintained between restoring services and controller working conditions. The FSF Task Force has observed that one weakness of the present system is the operation of some aircraft within the ATC system without altitude encoding transponders.

9. REHIRE

After careful consideration of many conflicting factors, the FSF and its Task Force conclude that the FAA should not rehire the striking controllers. This conclusion is based upon the perceived severe negative impact on system safety that would result from their inclusion in the controller work force. Inter- and intra-facility cooperation, coordination and mutual trust are absolute requirements for a safe and efficient air traffic system. The severely strained personal relations between many of the striker and non-striker groups make such cooperation, coordination and trust virtually impossible. The consequences pose an unacceptable risk.

RECOMMENDATIONS

The Individual Controller

- (1) To maintain a safe operating environment, the government should stand firm in refusing to bring the striking controllers back into the ATC system.
- (2) FAA should review and strengthen, where applicable, controller hiring and proficiency standards.
- (3) FAA should employ innovative scheduling to ensure that controllers are allowed reasonable annual leave and adequate free time for personal affairs.
- (4) FAA should develop a standardized program for qualifying controllers based on performance and not dependent on time-in-grade.
- (5) FAA should maintain the current facility classification and controller grade structure without regard to traffic count during the period of rebuilding the controller workforce.
- (6) FAA should review personnel functions to ensure that a high level of operational currency of staff and supervisory personnel is established and maintained.

- (7) FAA should broaden the present criteria and ease the administrative requirements to facilitate hiring furloughed pilots desiring to become controllers.
- (8) Government should relax the maximum age restrictions for controller applicants to make full use of available personnel with relevant aeronautical experience and to assist in a timely rebuilding of the ATC system.

Management and The ATC System

- (1) FAA should establish improved management controls, including a new look at controller/management relations, to assure that flight safety will not be compromised by the lack of proficiency and discipline.
- (2) FAA should improve communications between all levels of field personnel and FAA headquarters.
- (3) FAA should provide flow control procedures that are more responsive to the real time, dynamically varying acceptance rates of both the airports and the enroute segments.
- (4) FAA should improve the process of fully publicizing all ATC services so that, as they become available, the system can be most

effectively utilized.

- (5) FAA should review the design of TCAs from the standpoint of safety and current utilization.
- (6) FAA should restore normal IFR services to all qualified and equipped users as soon as practicable.
- (7) FAA should act to reduce pressures of VFR traffic on the system by:
 - (a) reaccommodating VFR operations in TCAs as soon as practical.
 - (b) reinstating Stage III service as soon as practical.
 - (c) reinstating VFR flight following as soon as practical,and
 - (d) reopening control towers where traffic warrants as soon as practical.
- (8) FAA should maintain IFR traffic volume restrictions, allowing levels to increase only as controller staffing permits.
- (9) FAA should establish advisory groups at the local level to enhance communication and cooperation with users.

ATC Operational Analysis

- (1) FAA should utilize an outside independent organization to periodically conduct an ATC system safety analysis of proficiencies, equipment, procedures and working conditions.
- (2) The FAA should establish an "Inspector General" or safety audit office to evaluate ATC facility operational safety.
- (3) The FAA should publicize and actively encourage the submission of ASRS reports.
- (4) NASA should perform continuing analyses of ASRS safety reports and issue periodic reports to the FAA Administrator of its findings on ATC-related safety matters.
- (5) FAA should explore the possibility of broadening the requirements for general aviation altitude encoding transponders to include more of this segment of aviation.

BACKGROUND

Following the August 3, 1981, strike of over 11,000 U.S. air traffic controllers, the Federal Aviation Administration imposed a number of operational constraints to maintain orderly operation of the U.S. Air Traffic Control System (ATC). The system was structured to conform to the traffic handling capacity of the remaining work force, made up of non-striking controllers, qualified supervisors and other staff. Military controllers were detailed to many ATC facilities. Among the features of the restructured system were a limiting and rescheduling of airline traffic, restrictions on VFR services, the regulation of IFR operations through the flow control process, elimination of certain services, reduction in operating hours or closing of towers, some reassignments among the controller work force and the imposition of longer than usual duty periods. These changes had been contemplated in agency contingency planning during the months prior to the strike, with primary consideration given to maintaining safe operations.

As in any drastic revision of normal operating practices, questions arose as to the effects of such revisions. Questions regarding the safety of the restructured system were raised by the public, by the striking controllers and their international colleagues and by the aviation community itself. In mid-August, the FAA Administrator requested the Flight Safety Foundation (FSF) to perform an independent evaluation of the safety of the restructured air traffic control system. The FSF was asked to provide the Administrator with an

objective appraisal of the strengths and weaknesses of the existing air traffic control system from a safety standpoint. The FSF study was to focus on the operation of the present system and not to be concerned with potential improvements for a rebuilt ATC system of the future. Similarly, the FSF was not to focus on issues that led to the strike. These matters were the province of a management Task Force also formed by the Administrator.

APPROACH

To provide the Administrator with an appraisal of the existing ATC system from a safety standpoint, the following approach was adopted:

General.

Two types of information were collected and analyses performed:

- (1) The quality of ATC service was examined by analyzing reports of incidents, operational errors, near mid-air collisions, ASRS and other operational data. To the extent that data was available, statistical comparisons were made between pre-strike and post-strike operations. Data for this task were obtained from FAA, NASA, DOD, ALPA and domestic and international operators utilizing U.S. airspace.

- (2) A Task Force of selected ATC and operational specialists was employed to examine ATC services, controller work force attitudes, and pilot and operator attitudes. The Task Force methodology incorporated field facility inspections and interviews, observations during air carrier and corporate aircraft jumpseat rides and interviews with pilots and other operators and by personal flights.

Management and Personnel Organization.

The responsibility for the safety appraisal of the ATC system resided with the Flight Safety Foundation. The Task Force was comprised of 16 ATC and flight operations experts. The Task Force members and their affiliations and pertinent experience are presented in Appendix A. The Task Force's responsibilities were to advise the FSF concerning the study's design and approach, to conduct field inspections, to aid in the interpretation and analyses of data and to assist in the formulation of findings, conclusions and recommendations.

Schedule.

The FSF performed the ATC appraisal over the period from August 19 to December 31, 1981, followed by a one month's preparation and delivery of the final report to the Administrator on January 31, 1982.

Reporting.

Since the critical area of air traffic safety was the subject of the study, the following reporting requirements were established:

- (1) Immediate telephone reports to the Administrator of unsafe conditions observed, followed up within 24 hours by written reports.
- (2) Weekly written progress reports to the Administrator.
- (3) Preliminary final report containing findings, conclusions, recommendations and other observations to the FAA Administrator, December 31, 1981.

In addition to these reports, a comprehensive interim oral briefing of findings to date was presented to the FAA Administrator and his staff on October 19, 1981.

Task Force.

The major thrust of the FSF ATC safety appraisal was oriented towards investigating the performance of the controller at work. The Task Force members talked with over 1,000 controllers, supervisors and facility managers and interviewed approximately 500 of them in depth. They also plugged-in and observed controller on-the-job performance. FSF staff also interviewed FAA HQ ATC personnel. Over 500 hours were spent in this activity.

The Task Force members visited more than 70 facilities. The duration

of a facility visit varied from one-half to two days. The facilities are listed in Appendix B. The general practice was to visit a facility with a two-man team, with at least one of the team members possessing experience as a controller. The team members selected at random those individuals who were interviewed and those who were observed on position.

The teams also requested that an announcement be made by facility management of their visits. They could then interview controllers and supervisors who expressed voluntary interest in talking with them. The team members encountered no reluctance on the part of controllers, supervisors or managers to discuss either pre- or post-strike ATC operations.

Beyond the broad study guidelines established at their organizational meeting, the Task Force members approached the field investigations independently, guided by their individual styles and aptitudes. Some teams adopted an unstructured interview approach, while others used questionnaires to guide their interviews. Regardless of the approach, consistent results were obtained by the teams.

THE INDIVIDUAL CONTROLLER

At the start of this project, the Task Force was primarily concerned with ATC system capabilities affected by controller performance as it related to qualifications, stress, workload and fatigue. As the study progressed, other factors, including actions of the FAA, its management, the union and its members, emerged as having a direct bearing on the appraisal of ATC safety.

Qualifications and Proficiency.

To perform their task, the controllers must be technically and medically qualified. After August 3rd, allegations were made that medically unqualified personnel were performing control functions. Such allegations had subsided by the time the Task Force began its field work. Direct inquiries were made at several facilities. No evidence was found to support the allegations.

Technical qualification, or proficiency, refers to the controller's capacity to handle air traffic and perform the ancillary functions of traffic management. Basic controller proficiency involves the natural ability of a controller to perform his, or her, given assignment and should include the capability to handle peak traffic loads at their positions.

An attempt to rate the controller work force's proficiency level was made by interview and by direct observations. From these interviews, observations and discussions with supervisory and management personnel, quantitative estimates of pre- and post-strike proficiency levels were obtained. Three levels of controller proficiency were defined by this Task Force. They were:

- (1) Sub-marginal controllers - those who should not have been accepted within the controller group due to an inability to perform controller duties at an acceptable minimum performance level.
- (2) Weak controllers - those who are capable of efficiently handling only non-peak traffic loads but otherwise are proficient controllers.
- (3) Good/excellent controllers - those who are capable of handling peak traffic and strive to do a professional job.

Sub-marginal controllers were reported to have constituted, before the strike, approximately 10 percent of the controller staff. These personnel were reported to have slipped through the FAA screening, training and evaluation process by a variety of means:

- Too lenient evaluations by friends and associates.
- Intimidation by the union to accept their personnel, or overzealous affirmative action.

- Complexities and inadequacies of the disciplinary and removal procedures. It became easier to retain the individual than fight the system.

Sub-marginal controllers are reported to represent a small fraction of the current work force and no more than five percent.

Prior to August 3rd, weak controllers were reported to have constituted an additional 10-to-25 percent of the staff. These satisfied minimum FAA standards but did not meet the higher standards of busy facilities. Currently, they are represented in about the same proportion, 10 to 25 percent of the staff.

Good/excellent controllers represented the remainder prior to August 3rd, from approximately 40-to-70 percent (sometimes even greater), depending upon location. Good/excellent controllers are reported to currently represent about 70-to-85 percent of the work force.

Prior to August 3rd, each level of controller proficiency included troublemakers - those who disturbed normal ATC services by refusing to cooperate with other controllers, who harassed other controllers or who unnecessarily refused services to pilots. Troublemakers were reported to have constituted, before the strike, 10-to-30 percent of the staff, depending on the facility. These were the staunch union activists. Controllers and supervisors agree that very few remain in the current system. The virtual elimination of the troublemaker category by

itself, suggests a more safe and orderly ATC system.

The identification of controller proficiency levels as described here has never been previously reported. Other research, (Rose, Jenkins and Hurst 1978) investigated the question of competency and its relationship to controller health changes. They used a questionnaire in which the controller was asked to nominate other controllers for the most competent team. They found that about 40 percent of the potentially eligible controllers were rarely or never nominated. The inference can be drawn that these represent the weak or sub-marginal controller identified here.

Stress

The Task Force teams received comments at every facility about pre-strike conditions. Many of these conditions relate directly to FAA's capacity to provide safe ATC services. The contextual framework for the discussion is stress; that is, the effect of external forces on the ability of a controller to do his, or her, job.

Much has been said about stress as it relates to the air traffic controller. A recent study (Rose, et al., 1978) examined the health changes of controllers and job stresses. Several of the conclusions are relevant to the strike of August, 1981. Touching on one area specifically, the report states, ". . .we feel that some union activities may inadvertently have contributed to the alienation and

divisiveness controllers experience in the ongoing adversarial relations with the agency."

The Task Force members found, through personal interviews with post strike working controllers, many examples of pre-strike activities that were disruptive to the FAA's daily operations. A few examples of reported pre-strike activities are:

- (1) Union activists harassed non-sympathetic co-workers. While many of these activities were designed only to cause emotional strain, other extreme activities compromised safety. Set-ups, for example, were designed to create a potential operational error or deviation.
- (2) Union activists would frequently refuse to cooperate with other controllers by not accepting handoffs, not answering the interphone and not cooperating in ATC intersector coordination.
- (3) By refusing to train non-sympathetic personnel, some union activists intimidated developmental controllers into joining the union.
- (4) There was constant complaining about the inadequacies of the radio, radar and computer equipment. Supervisory and airway facility maintenance personnel were inundated with complaints

on every shift, only to find that many were without basis.

- (5) Unsatisfactory Condition Reports were submitted and union grievances filed in such great volume as to overly burden supervisory and management personnel in paperwork, meetings and conferences to the detriment of operational supervision.
- (6) Sick leave was abused, and supervisory personnel were pressured to call in overtime replacements. Some union members would then turn down overtime, the alleged intent being to affect individual shift staffing.
- (7) Union activists would refuse to provide ATC services, such as VFR advisories or direct routings, whenever they decided to take such action, even though conditions would have permitted it.

Clearly, such conditions increased tension and stress. The efficiency of those controllers affected was decreased by their concern over when the next problem would occur. Adversary relationships among the work force emerged.

In contrast, no hostility was reported present in any facility that the Task Force teams visited. A cooperative environment was observed, and a desire to work together was expressed during many of the interviews.

Relations with the pilot groups were found to be excellent. Pride of accomplishment was evident in all of the facilities visited. This improved environment forms a cornerstone for safe and efficient ATC operations. We believe that the maintenance of such an atmosphere is of paramount importance to the continued safe operation of the ATC system.

The future status of the striking controllers was the most stressful factor observed by the Task Force. The Task Force members received many comments that expressed personal and professional concerns about the possibility of the striking controllers returning to work. There was concern over the actions of various groups to bring the striking controllers back. The nearly unanimous sentiment was that none of the strikers should be returned. During the revisits, some controllers expressed the view that there were some "good controllers out there;" however, they could not envision a selection process that would return only the "good" controllers. They want the President, the Secretary of Transportation and the FAA Administrator to hold to the position taken at the beginning of the strike.

The Task Force was surprised by the number of negative reports on pre-strike working conditions. We are very concerned that such negative conditions were allowed to develop. The question of why these circumstances developed was not a matter before us. We note, however, that FAA does not have an organizational element, independent of the Air Traffic Service, to monitor the performance of the ATC system. We

note further that the FAA has not previously provided for an independent safety audit of its ATC operations. The practice of operational auditing is widespread in industry and in some government agencies.

In addition to the situations mentioned, the Task Force received comments about other circumstances conducive to lowering morale. Although matters of pay and compensation are beyond the scope of this study, the foremost concern was the pay cap limitation being encountered by high grade personnel. Some facility managers have worked many hours without extra compensation. Other personnel have worked long hours with the overtime pay limited by the pay cap. The new pay bills may alleviate some of these problems.

Another concern requiring FAA attention is that some facilities have a high proportion of controllers nearing retirement eligibility. Their retirement in the near future would pose staffing problems of some magnitude.

Workload.

While stress is an important consideration because it can have both a positive and negative effect on controller performance, of equal importance is workload. There is an abundance of factors that contribute to controller workload. Broadly stated, anything related to the air traffic controller's job that causes or reduces fatigue or

stress or in any manner affects the individual capability to do the job is a workload factor. A number of these factors are listed:

- (1) The volume of traffic handled by a controller or team of controllers over a period of time, such as one hour or one shift.
- (2) Traffic load peaks, including the level, duration and frequency of peaks.
- (3) Area of responsibility, including geographical, navigational and procedural complexities and constraints, associated with the area.
- (4) Coordination requirements and level-of-difficulty with which coordination can be performed.
- (5) Equipment performance, including radio, interphone, radar and automation equipment.
- (6) Teamwork/cooperation within a given facility, as well as between facilities.
- (7) Cooperation by the users of the air traffic services.
- (8) Duty hours.

(9) Attitude toward the job.

The last two factors have a major influence on both perceived and actual workload. Particularly in a non-physical job such as air traffic control, one can usually work longer periods without fatigue as long as the job is enjoyed. On the other hand, if the job is disliked, the effects of fatigue may be felt much earlier. Duty hours cannot be divorced from workload. There is a point beyond which fatigue will result when even a simple job is worked without adequate periodic breaks and time away from the job.

While variations were found in the level of workload between individual facilities and between positions within a single facility, these findings represent an overview of workload. Some exceptions to the workload conditions which were found to prevail at most facilities or operating positions are noted in the following summary:

- (1) At most facilities, the daily and busy-hour traffic densities have been reduced as a result of flow control. There have been some instances reported where traffic is periodically as high as that prior to August 3, 1981. Such cases are not the rule.
- (2) Since sectors or positions-of-operation are now frequently combined, the volume of traffic controlled by a single

controller can be greater than that which was controlled during a given shift prior to August 3rd. However, as the result of flow control and increased in-trail spacing, instantaneous traffic peaks and in-flight holding have been reduced.

- (3) The combining of sectors or positions of operations at most air traffic control facilities has permitted the system to operate under the present reduced staffing situation. The sector or position combinations employed are the same as those which were usually used during periods of light to moderate traffic prior to the strike. In some instances, procedures have been simplified as a result of combining sectors and increasing the control position's altitudes or geographical area of responsibility. An individual flight will frequently remain under a controller's or team's control jurisdiction for longer periods of time.

- (4) While the amount of coordination required has remained the same or increased as the result of flow control and in-trail spacing requirements, there has been a reduction in the workload associated with coordination within most enroute sectors and TRACONS. The opposite condition exists at towers, where departure release coordination has increased workload and at certain low altitude enroute sectors where in-trail spacings are initially established.

- (5) Overall equipment performance appears to have improved since the strike. This results in less equipment-induced interruptions and irritation to the controller, as well as reduced maintenance workload.
- (6) The impact of teamwork and cooperation cannot be overstressed. The vast majority of personnel within a facility are now, for the first time in a number of years, working together as a team. Dedication to the job and the team is probably the most important factor today in permitting the air traffic system to function as well as it has with a massive loss of personnel. This teamwork and cooperation has substantially improved the work environment, eased job pressure and, in general, enhanced group job performance.
- (7) The air traffic control facilities are generally experiencing a high level of cooperation from the users of the ATC system. This, in turn, facilitates the job of the air traffic controller. Pilots are more inclined to accept air traffic clearances rather than question the reason for the clearance. Radio transmissions are reduced.
- (8) Duty hours have been substantially increased. The workweek has increased at many facilities to 48 hours. In addition,

the work hours actually spent controlling traffic during an eight-hour day have increased almost one hundred percent. Most facilities provide for a lunch break of about thirty minutes and two fifteen-minute rest breaks during an eight-hour shift. The controller is therefore, on the average, at a control position up to seven hours a day, six days a week. Extended annual leave is generally not available. The capability to grant limited leave was reported in most facilities.

(9) The attitudes of the controllers toward their jobs are perceived to be generally excellent. They believe they are doing a good job and have a high measure of self pride. The general attitude is that they prefer the working conditions of today over those prevailing before August 3, 1981.

(10) Evidence of fatigue was not found. Many controllers indicated that they could continue to perform their duties under current circumstances indefinitely. Some others indicated they could only continue for about six months to a year.

Although there were complaints about not having adequate leave, most complaints were associated with missing scheduled recreational events, family affairs, etc., or with having insufficient time for outside business concerns or

avocations. Most facilities and controllers were doing all they could to adjust working hours to permit individual leave for long standing commitments or emergencies.

Utilization of Human Resources.

During this period of greatly reduced staffing, it is imperative that human resources be utilized in an optimum manner. Relocation of personnel during this period, while necessary, must be handled carefully to maintain the level of morale that has contributed to keeping the system functioning safely. Every effort must be made to provide those controllers, civil and military, who have been temporarily assigned to other locations, with adequate time at home. Well defined programs for these temporary relocations must be established to eliminate the uncertainty presently associated with such assignments. Where military controllers are involved, the program must be of sufficient duration to assure facility management that it is worth their time to train these controllers for maximum utilization. Assignments to more mundane positions has not contributed to high morale, nor will it produce the desired effects on the entire ATC System.

It has been observed that, at some facilities, the most proficient controllers are continuously being assigned to the most demanding positions. This situation creates the potential for a reduction in the morale and increased fatigue of these individuals, because of the

additional stress. This could eventually affect the safety of the system.

Despite considerable pressure to increase the number of qualified controllers because of the severe staffing problems created by the strike, we found no instances of compromising either the qualifications or the required performance standards among the working controllers or their supervisors. However, the impact of the strike on the controller training capability at operating facilities is just beginning to be felt and will reach its peak in the coming months. The Task Force believes that this training capability will be strained to its utmost. It is therefore particularly important that all controller training be done efficiently and effectively.

While we have not performed an in-depth evaluation of the FAA's controller training program, several training related problems are apparent. We believe that present training requirement formats are too rigid and that considerably greater efficiency can be achieved by a better tailoring of required training to the specific task or tasks required.

The considerable emphasis upon on-the-job-training (OJT) requires the utilization of a large number of fully qualified controllers who are also required to operate the system. Many facilities are understaffed in this regard. Therefore, it is important that the flow of developmental controllers be carefully coordinated with OJT training

capability at the individual facilities.

The Task Force further believes it is important that FAA management review and, where necessary, strengthen hiring and proficiency standards. Hiring standards have not always produced individuals well suited for a highly demanding job, and there are qualitative differences between facilities.

The present capability to utilize the available skills and personnel resources can be improved. Previous practices and policies have not always made this possible. The FAA now recognizes the inefficiencies inherent in such policies as time-in-grade requirements for promotion, and we strongly believe that a standardized program for qualifying controllers based on performance and ability should be developed.

The FAA is to be commended for using furloughed pilots in a manner which utilizes their skills and previous training. The pilots are making a significant contribution to the system. Their use also illustrates the advantages in a system which has rational flexibility. We believe even greater flexibility is desired. Present criteria should be further broadened, and present administrative policies preventing optimum use of these exceptionally well qualified individuals should be eased. This includes, but is not limited to, selective modification of the arbitrary age cut-off for career controller personnel.

THE AIR TRAFFIC CONTROL SYSTEM

The loss of the striking controller work force introduced other changes affecting operations within the national airspace system. In this section, changes beyond those immediately affecting the working controllers are examined. Included are discussions on user perceptions of the ATC system, availability of ATC services and flow control.

User Perceptions.

Pilots regularly flying in the ATC system are capable of judging how well that system is performing. Information concerning perceptions of how the ATC system is functioning was obtained through interviews and voluntary statements from the spectrum of users of the ATC services. This included private pilots, commuter/air taxi pilots, corporate and airline pilots and flight departments, military pilots and officials and pilots of non-U.S. airlines operating into U.S. airspace.

The FSF staff and Task Force members availed themselves of opportunities to ride air carrier and corporate aircraft jumpseats. First hand observations were obtained about the quality of ATC communications and other services reaching the cockpit and flight crew responses to these ATC services and communications.

The information obtained from all users can be paraphrased from the

responses to a set of six questions used in direct interviews by one Task Force member with a group of 57 captains of commuter, regional and national airlines:

- (1) What do you think of overall safety in the ATC system today as compared with pre-strike conditions?

It is significant that most pilots volunteered an answer to this question before any detailed discussion took place. Note that none of the 57 pilots felt that the ATC system is less safe than it was prior to the strike:

25 pilots reported the system "as safe or safer",
19 pilots believed the system to be "definitely safer",
and
13 pilots believed the system to be "much safer."

Other pilots (military, general aviation and airline pilots outside the group of 57) made similar comments. None perceived a reduction in safety. A few expressed some apprehensions about the bad weather situations expected during the winter. Others were concerned with the long-term effect of current work schedules on individual controllers.

- (2) Have you seen any evidence of hesitation, confusion, unfamiliarity with procedure or asking for repeats on the

part of controllers since August 3rd?

Some pilots reported they had recognized inexperience reflected in control instructions immediately after the strike began. Three different pilots reported that they had noticed a hesitant or confused response to a question, but in each case another voice was on the circuit within a few seconds to clarify it. These pilots assumed that these were cases where a controller was receiving "on the job training." In each of these cases, the pilot said derogation of safety was not an issue.

Many pilots made comments such as, "We get the feeling we're talking to the real professionals. In the last year or so, we often had the feeling that the vectors and special orders we were getting were not really necessary. Today we are getting more vectors and speed directives than before, but the result is a free flowing traffic situation."

- (3) Have you experienced any situations where the loading of radio circuits, or any other factor, gave evidence of excess control workload?

Approximately 25 percent of the pilots in the 57-pilot group believed the radio circuits at such places as Chicago and LaGuardia are loaded to near capacity during peak hours.

They were all essentially in agreement that the same situation existed before the strike. None of the 57 airline pilots or the other pilot groups reported being aware of any situation indicating that controller workload had reached the point where safety would have been compromised.

- (4) Have you been involved in congested traffic situations in the air or on the ground that might have caused a lowering of safety in the ATC system?

The airline pilot group, and the other military and civil pilots, all reported gate holds and ground delays before departure at many airports. They do not believe this has adversely affected safety, and, in most cases, they expressed a preference for holding on the ground.

We have found only a very few cases where holding pattern operations have been necessary. Several pilots reported making 360 degree turns as part of the vectoring and speed control directives used by controllers to meet the in-trail restrictions. Generally good weather during the late summer and fall helped the strict flow control practices and assisted in holding arrival delays to a minimum. As wider-spread winter weather situations develop, pilots expect more in-flight delays. (The controllers have generally expressed little or no apprehension over bad weather effects

on traffic control.)

- (5) Is the morale situation between pilots and controllers better or worse as this might affect safety?

The airline pilot group was essentially unanimous in saying that the relationship between pilots and controllers has gone from a badly deteriorated situation before August 3rd to one of cooperation and a sense of teamwork. This perception is shared by all pilots with whom FSF staff and Task Force members have talked.

Prior to the strike, non-U.S. air carriers operating into the U.S. had complained about difficulties in communicating with U.S. controllers, especially in busier terminal areas. Recent responses from non-U.S. air carriers report an improvement in controller helpfulness and cooperation since the strike.

One U.S. pilot put it this way: "We let the controllers know that we understand they are working under difficult circumstances. We accept the vectors and speed control they give us without question, because we know they are doing these things to get the orderly flow of traffic needed to keep workload down. The controllers appreciate this. And they, in turn, seem glad to handle the occasional request we

throw at them for a better altitude or whatever."

- (6) Are you getting as many VFR traffic advisories as you got before August 3rd?

Some military and civil pilots, and the controllers, stated there has been a reduction in VFR traffic advisory services. One airline captain, who flies in and out of LaGuardia, said, "We are getting fewer VFR advisories on the average. In the peak traffic periods, it seems that the VFR advisories drop to near zero."

Other areas of concern mentioned by various users included the limitations on ATC services. One example was the reduced capability for obtaining local traffic advisories and weather information at those places where towers have been closed. Some operators complained of not being able to obtain Stage III service.

There was early concern expressed about user cheating through unauthorized use of a "T" designation on call signs to obtain preferential clearances. This practice has apparently disappeared. In general, the users' comments and observations indicate that, as the new system has settled down, procedural errors have diminished and ATC services have improved.

Users perceive that the ATC system is working better than ever. They

assign a somewhat indeterminate, but positive, increment to system safety since August 3rd. However, these perceptions may be influenced both by the fact that there is less traffic in the system and by the more frequent approval of requested clearances or routings. The very real cooperative spirit among competent professionals that has returned to the system, both on the ground and in the cockpit, contributes to the improvement of the safety of the system.

ATC Services.

Prior to the strike, FAA offered all qualified and equipped users the option of filing an IFR flight plan regardless of the weather conditions. Some might contend that in good weather this is a waste of ATC services. Others believe that IFR operations provide a reduced exposure to mid-air collisions by separation from other IFR traffic and adds another trained professional, the controller, in the operational loop. For some years, all air carrier turbojets have been required to operate under IFR. Such an operational requirement assumes that a safety benefit results.

To deny IFR service is to remove an option from the pilot. If the pilot cannot file IFR, he has legal right to revert to the basic minimums for VFR flight. Operations at 17,500 MSL at 475 knots IAS with five statute miles visibility are legal and are being reported as occurring routinely. Operations at 250 knots IAS below 1200 feet AGL with one statute mile flight visibility are legal.

Subsequent to the strike, some TCA's have prohibited VFR operations for at least part of the day. If all VFR aircraft follow the regulations and stay outside the TCA, the collision hazard is increased in two areas. For those aircraft circumnavigating the perimeter of the TCA, there is increased collision exposure from other VFR flights with the same plan of action and from IFR aircraft arriving and departing the TCA. For those aircraft operating below the floor of the TCA, there is the increased exposure to a concentration of VFR traffic. We have received reports that there is also an increased frequency of VFR aircraft transgressing the boundaries of TCAs.

Prior to the strike, Stage III service was guaranteed wherever advertised. Stage III was at pilot option, not controller option. Subsequent to the strike, Stage III service has been unavailable at some facilities or may be terminated at controller option.

Since the strike, the FAA has suspended VFR flight following service in numerous locations. This is a reduction in a safety service. When the FAA removed this service by a Notice to Airmen (NOTAM), it removed a controller-discretionary service based on the controller's workload.

It became necessary to close some VFR control towers. While it is recognized that there is some traffic level below which a tower is not required, the tower controller's presence and expertise lend a sense of order and discipline to the operation.

Flow Control.

Without an on-the-scene appraisal revealing more accurate information, a perspective is created suggesting that the centralized national flow control function is the key to keeping 75-to-85 percent of the pre-strike volume of air traffic moving. From the controller's viewpoint, the effectiveness of quotas is difficult to determine. One reason may be that facilities have no method of differentiating between quota traffic and those "beating the system." Controllers may also prefer to provide service, not deny it.

Facility personnel state that reduced flight schedules, reservation systems and rescheduling have been helpful. However, the fact that one airline alone at one airport schedules 22 departures during a five-minute span or has 16 planned arrivals in a two-minute span should prompt some reexamination of scheduling practices.

Several factors make it difficult to visualize the positive effects of quota methods. The varying degrees of reduction in ATC capacities across the country preclude the application of a flow control formula on a uniform basis. Moreover, these capacities are constantly changing and outpacing any centralized analysis. As a result, the facilities have instituted, or resurrected, restrictions based on the system's real-time capacities. These restrictions vary extensively with individual facility capacity factors, thus creating non-uniform and

Inconsistently applied restrictions throughout the system. For example, one particular ARTCC borders seven other ARTCCs, each of which applies restrictions to prevent overloading its respective capacities or exceeding the flow demands of the next center, sector or approach control. These are frequently and spontaneously changed when a relief controller's capacity differs from that of his, or her, predecessor's capacity.

Notwithstanding ground delay and unanticipated maneuvering to achieve enroute sequencing and spacing, pilots interviewed say they are saving fuel. In our analysis of controller workload, we find that some traffic peaks continue to exist. Ground delays based on demand/capacity formulas appear excessive. These delays, in part, are created by airline scheduling practices. The concentrations dispose ATC to fit departures into the elongated in-trail concept.

Arrival delays have been minimized as the direct result of the flow control concept and the cooperation between pilots and controllers to make it work. In practice, the peaks are flattened somewhat by release times and thus become less discernible in the enroute structure. However, the daily significant traffic period has been increased by approximately 2.5 hours. This has produced a more constant workload over a longer period of time with less slack periods or valleys. From the enroute controller's viewpoint, the resulting workload is less than that before the strike.

Controller dedication and pilot cooperation keep the traffic moving. This is accomplished by individual ATC facilities on a real-time basis. Notwithstanding that flow control is applying a demand/capacity flow in attempts to manage the most critical areas, effects of those efforts are suspect and may even be counter productive. This is largely because of an inability to spontaneously recognize and react to constantly changing conditions.

The current central flow control formula does not reasonably cope with the true traffic picture in all areas of the country. Facility capacity variances preclude the establishment of uniform applications of flow control. Adjustments in airline and other flight schedules to prevent bunching, plus reductions in the number of flights, helped initially. The system is now being tested with increases in air traffic, which might outpace the ATC system capacity as it is being rebuilt.

ATC OPERATIONAL ANALYSIS

A limited analysis of ATC operational information was performed to supplement the Task Force field visits. Included were FAA traffic activity statistics to provide a means for normalizing relevant events to pre- and post-strike conditions, NASA ASRS reports pertaining to ATC problems, FAA synopses of operational errors and pre- and post-strike statistics pertaining to near mid-air collisions and to mid-air collisions. The results of the analysis of this information are presented in this section.

Traffic Activity.

Daily traffic activity statistics were obtained from the FAA for the period August 3, 1981, to November 30, 1981, for the enroute (ARTCC) structure. These data are shown in Figure 1. To be noted from Figure 1 is the steady increase in traffic activity from August 3rd to September 2nd and an apparent stabilization of traffic levels by about September 20th. The introduction of the General Aviation Reservation (GAR) program on October 19th led to a short-term decline, after which traffic levels again returned almost to the stabilized post-strike levels.

In Figure 2, daily traffic handled statistics for a typical post-strike week (October 10-17) are shown. Also shown are average pre-strike

(July 1981) daily traffic handled statistics. From these data it is apparent that the ATC enroute system is handling about 84 percent of the pre-strike traffic levels (507,000 operations/week vs. 601,000).

The composition of a typical post-strike week's traffic activity by user category is shown in Figure 3. Of interest is the marked increase in general aviation (60-70 percent) and military (300 percent) operations for the normal work days of the week over weekend traffic activity. Even though ATC staffing is reduced by some amount because of reduced weekend traffic activity, these statistics suggest unused capacity in the system. Operators who have discretion over when flight operations occur could take advantage of this unused capacity. Such steps would be equivalent to hourly quotas to reduce traffic surges.

A similar terminal area analysis was not conducted as the information was not readily available from FAA.

Operational Errors.

Synopses of operational errors were obtained from FAA for the period August 3 to November 29, 1981. Records indicating the dates and locations of operational errors for the two-year period preceding the strike were also obtained for purposes of comparison. In Figures 4 and 5, the number of operational errors, pre- and post-strike, are presented for enroute centers and terminal areas respectively.

The marked decline in reported operational errors since August 3rd is apparent.

Using average daily traffic levels for pre-strike conditions, statistical tests were performed on the reported center operational errors, pre- and post-strike. Other research has shown a linear relationship between the number of operational errors and traffic activity levels (Lyman, 1981). When using traffic handled as the basis for comparison, operational errors were reported significantly less frequently. These results are shown in the following table.

Comparison of ARTCC Operational Errors

For September through November

	<u>Pre-Strike*</u>	<u>Post-Strike</u>
Traffic Handled	7,812,000	6,591,000
Operational Errors	49.5	24

* - Average for comparable post-strike period (1979 and 1980)

During facility visits, the ATC study Task Force members received reports from some controllers alleging that operational errors were not being reported in all instances. Some latitude in reporting was being taken as a function of the extent to which separation standards were violated. The FSF does not believe that the operational error rate statistics alone are a direct indicator of system safety. This finding was reported to the Administrator in mid-October. Using only November

traffic levels and operational error frequencies, no statistically significant difference is observed. Even without traffic level data to provide a basis for comparison, an inspection of terminal area operational error data suggests the same tendencies.

NASA Aviation Safety Reporting System (ASRS).

To augment the operational error synopses provided by FAA, the FSF obtained safety reports submitted to the NASA ASRS concerning ATC-related matters. Due to the ASRS report processing practices, information covering only the period August through October were available. The purpose in obtaining ASRS reports was to gain a descriptive, qualitative insight into ATC operational errors. ASRS reporters typically will give a subjective estimate of whether or not workload, fatigue or other human factors are at issue. Other ATC-related safety record keeping programs do not provide this information (Kinney, 1978).

For the three month period (August through October, 1981) 127 safety reports were submitted to ASRS by individuals in which ATC was judged to be the predominant operational factor. Of these, 70 were submitted by pilots or other crew members, 54 by controllers or supervisors and 3 by observers unclassified as to role. Of the 127 ATC-related reports, there were 42 unique occurrences which could possibly be classified as operational errors, and 18 of these appear to correspond with FAA operational error synopses.

During the period of August through October, 1980, ASRS received 427 ATC-related reports, including 342 from controllers and 85 from pilots. For the same 3-month period in 1981, the number of ATC-related reports was down to 38 controller reports and 50 from pilots. Using the 1980 ratio of pilot and controller reports as a reference, approximately 200 controller reports could be reasonably expected to have been submitted during the same period in 1981. Given the significant decline in controller ASRS participation, a question exists as to whether the kinds of controller errors reported represent those actually occurring in the ATC system.

Even with this caveat, the ASRS reports were reviewed to identify conditions that would bear on current operations. In August, two reports were submitted indicating concern about supervisory personnel unfamiliarity and proficiency. Two others, also submitted in August, indicated concern about how long operations could be sustained under current staffing levels. Comments such as these were not received after August. One report was submitted in October and refers to the under-reporting of operational errors.

When considered as a group, the controller reports reveal no human error conditions that could be viewed as different from those occurring pre-strike. Human errors related to judgment, attention and communications occur in the same proportions. The controllers' reports evinced little concern about overwork or fatigue.

Near Mid-Air Collisions.

Records of reported near mid-air collisions (NMAC) are maintained by FAA and by NASA ASRS. Statistical information from both of these sources was obtained for review.

The FAA maintains two sets of records. One is described as unconfirmed, when a NMAC report has been received but not verified. The confirmed records contain those occurrences in which the reported circumstances could be verified by contacting the participants. NASA ASRS NMAC reports might be considered unconfirmed, as they do not receive the official sanction of a confirmed NMAC because the FAA does not perform the follow-up investigation; nor do the confidentiality provisions of the NASA ASRS permit third party verification. Both reporting systems are voluntary, and the decision to report an NMAC is at the discretion of any individual participant or observer. Given the current heightened sense of awareness by the flying community to potential ATC problems, one should expect that NMAC reports would be relatively reliable safety indicators, even though submitted voluntarily. In Figures 6 and 7, FAA unconfirmed and NASA ASRS NMAC reports are presented for comparable pre- and post-strike time periods. Over the August - November, 1980 period, the FAA received 174 unconfirmed NMAC reports, NASA ASRS received 162. For August - November, 1981, they received 92 and 75 respectively. There is approximately a fifty percent decrease in the number of reported NMACs

In both programs.

An analysis not performed, but of potential interest, is a study to compare the airspace distribution of NMACs pre- and post-strike. For example, have NMAC frequencies declined generally throughout the system or more specifically in positive control areas where traffic flow restrictions are in place?

Mid-Air Collisions.

Actual mid-air collisions are extremely infrequent events. For example, in 1980, of the total number of aircraft accidents involving fatalities, only 15 were mid-air collisions. During the period of FSF's ATC safety study, two mid-air collisions occurred involving fatalities. The legal responsibility for investigating these accidents to establish probable cause resides with NTSB. The FSF is unaware of any NTSB findings suggesting deficiencies attributable to post-strike ATC operating practices.

From the analysis of traffic activity statistics, operational error statistics, NASA ASRS reports and NMAC reports, a consistent pattern of improvement in indices commonly associated with ATC safety was found. Where appropriate bases for comparison exist, i.e., operational error frequencies, we find significant improvements. From these findings, the conclusion can be reached that the ATC system is comparably as safe as pre-August 3, 1981.

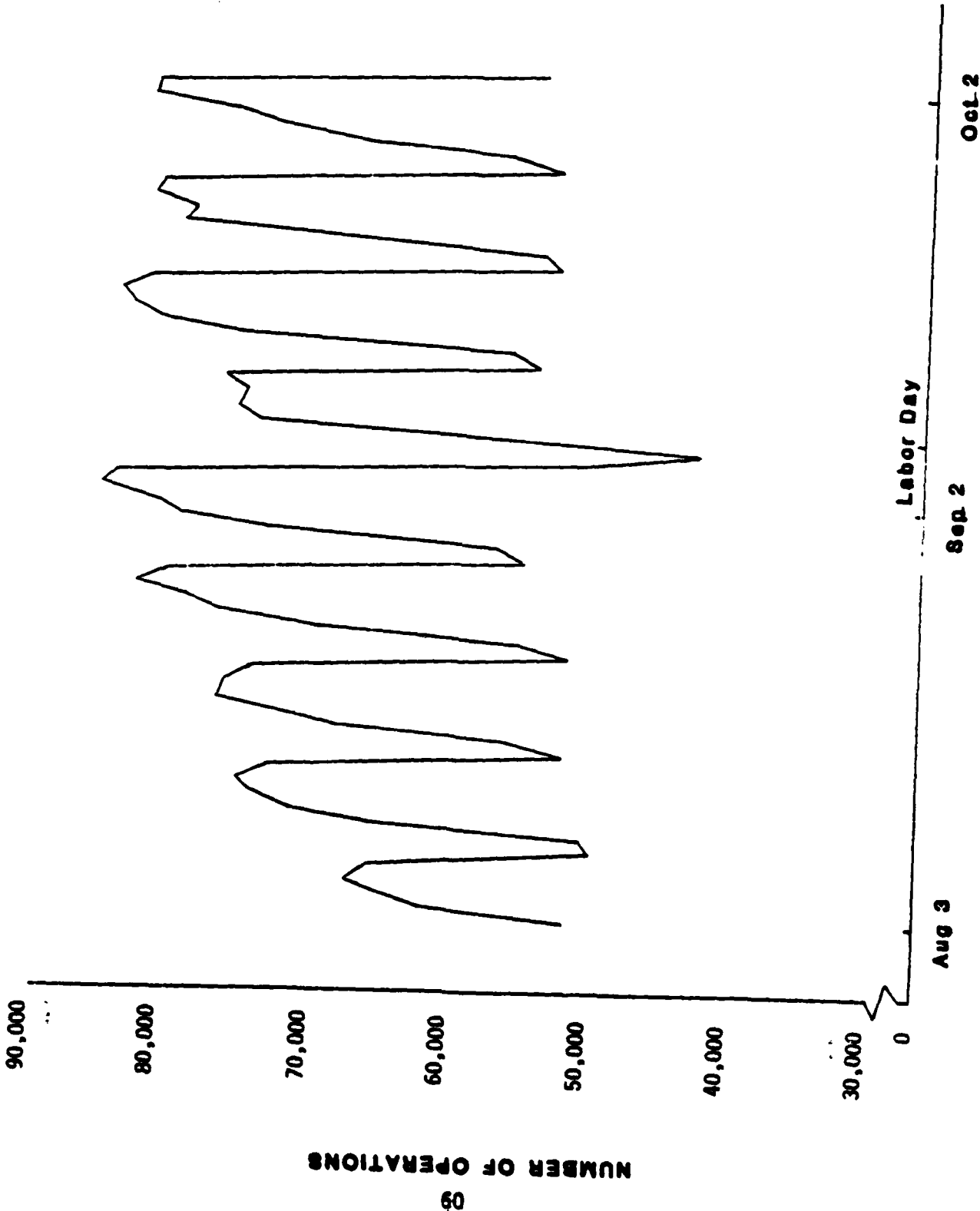


Fig.1 TOTAL ENROUTE TRAFFIC HANDLED

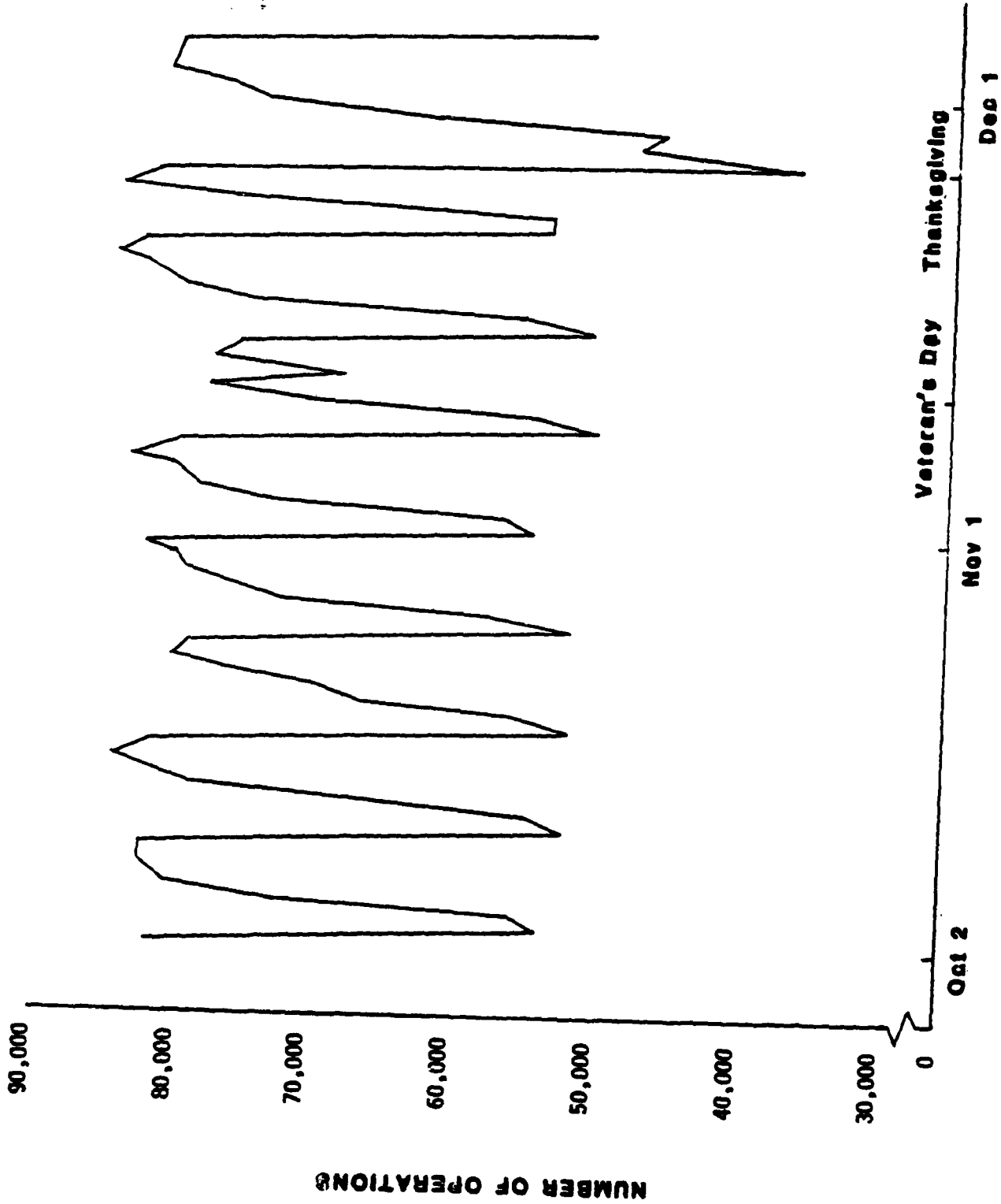
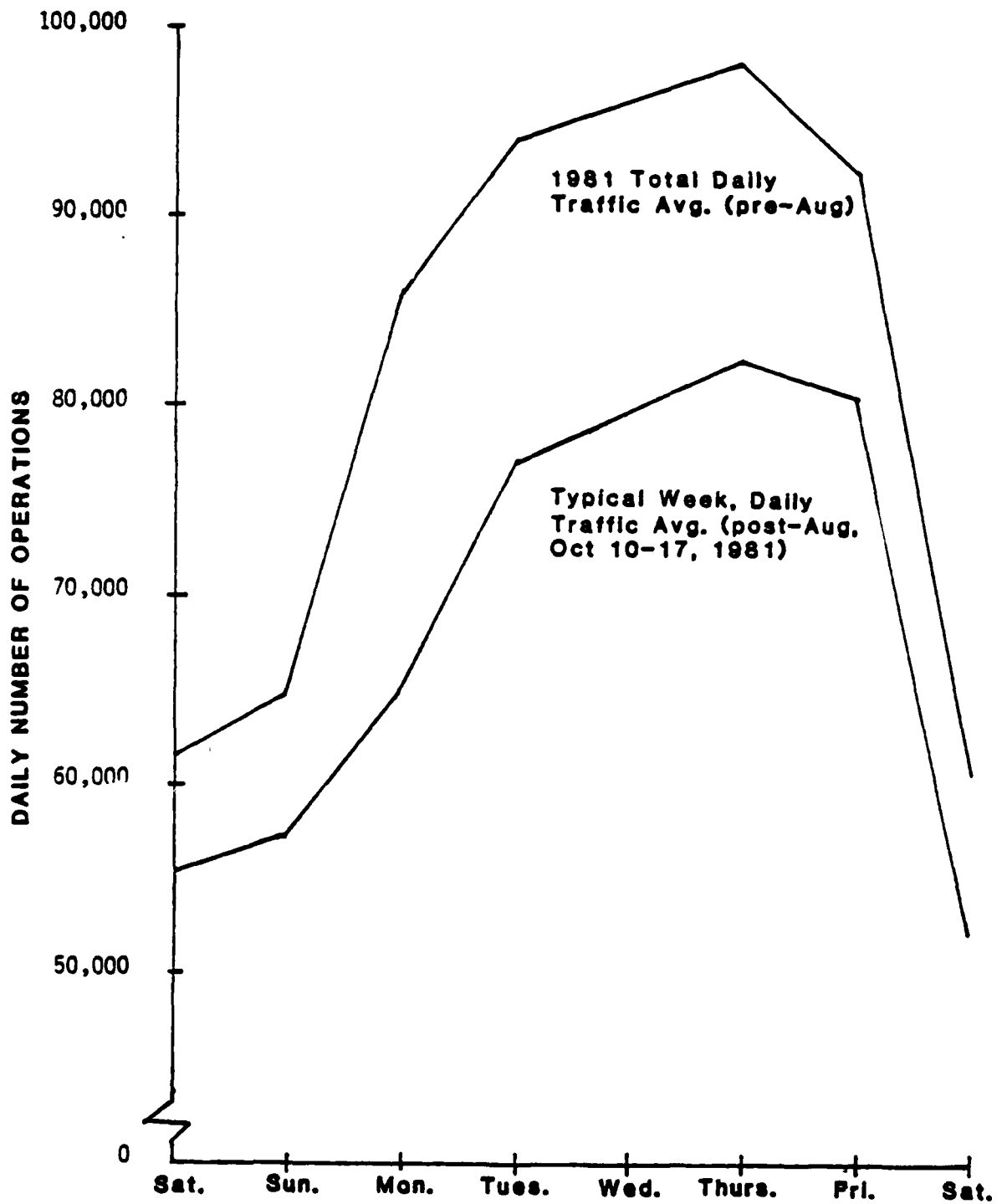
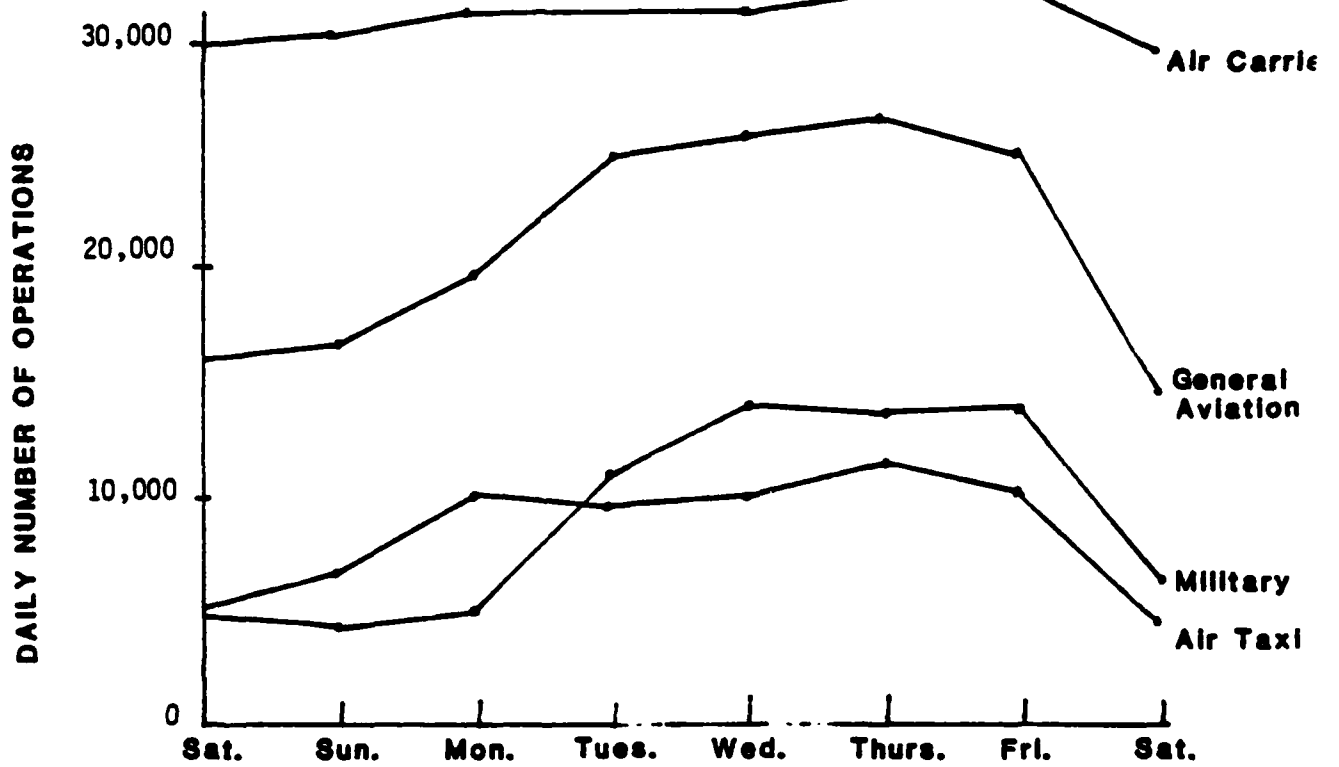


Fig. 1(cont'd) TOTAL ENROUTE TRAFFIC HANDLED



**Fig.2 TYPICAL TRAFFIC ACTIVITY ENROUTE AIRSPACE
(pre & post August, 1981)**



**Fig.3 TRAFFIC BY USER CATEGORY
(October, 10-17, 1981)**

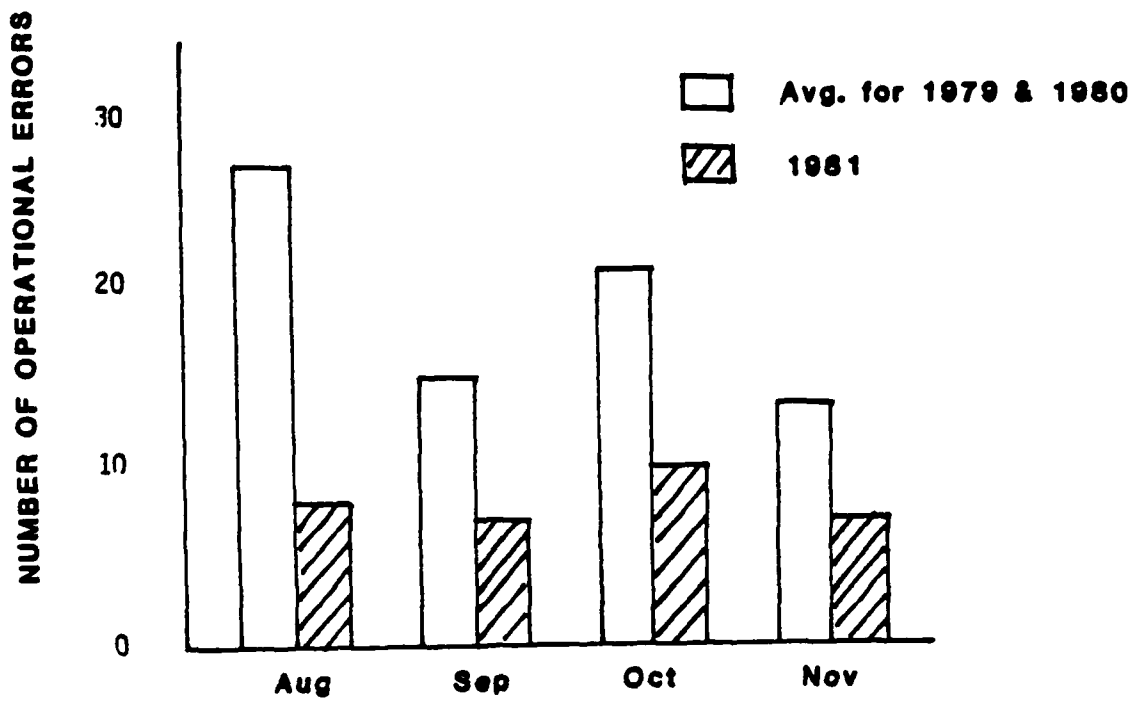


Fig.4 CENTER OPERATIONAL ERRORS

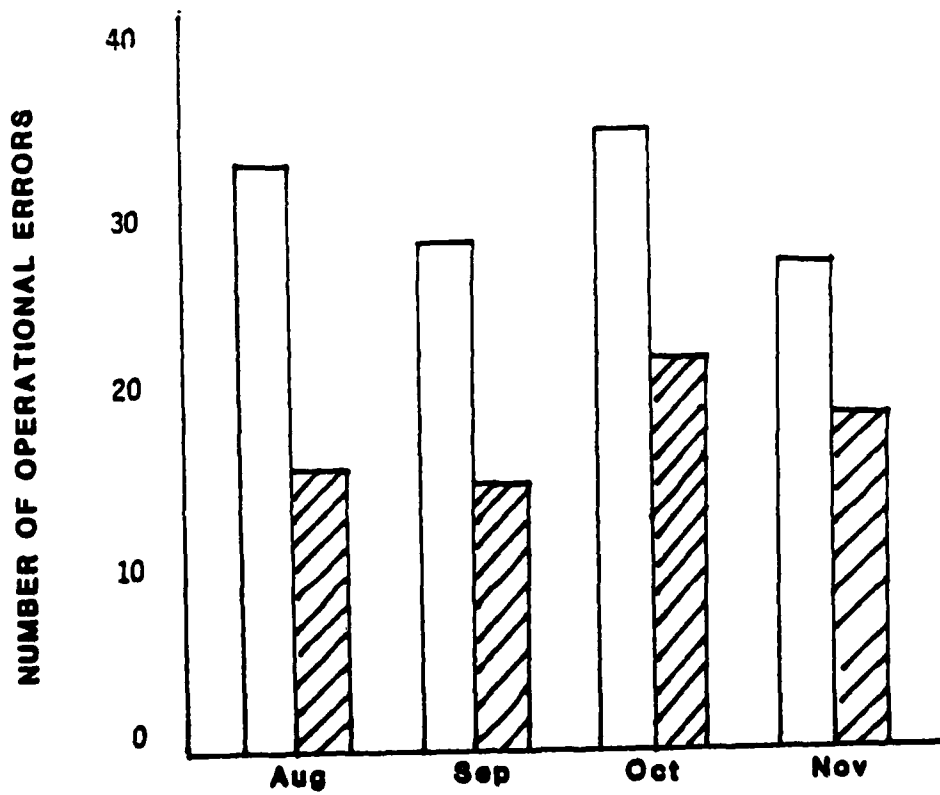


Fig.5 TERMINAL AREA OPERATIONAL ERRORS

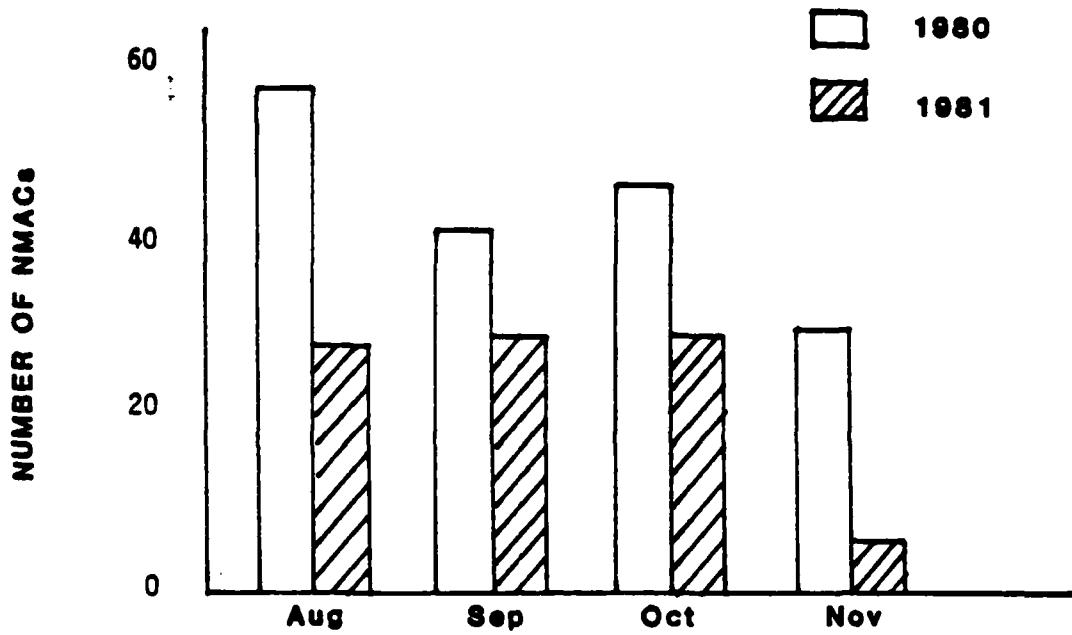


Fig.6 NEAR MID-AIR COLLISION REPORTS (FAA)

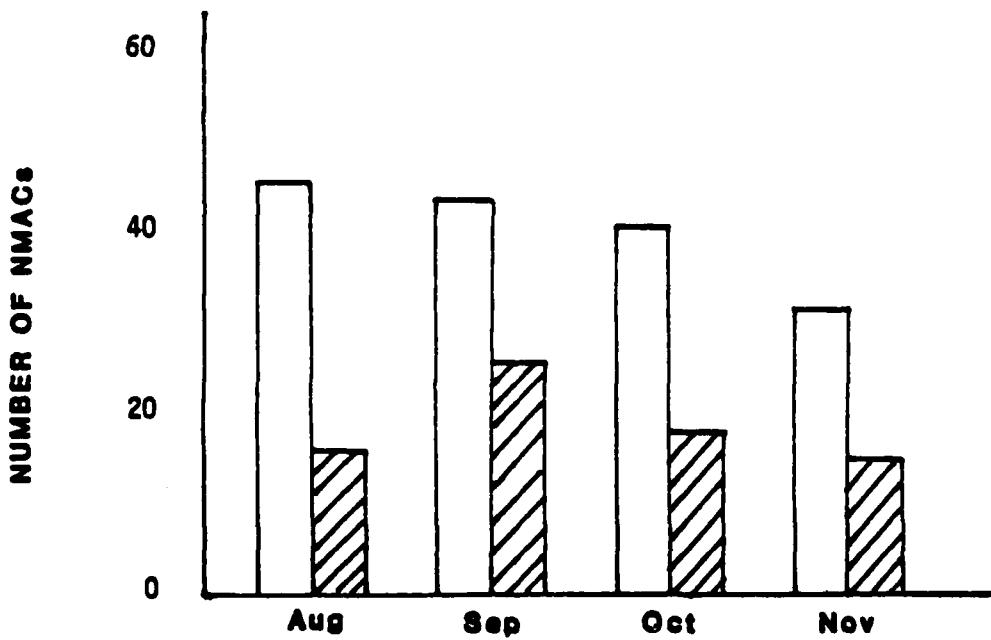


Fig.7 NEAR MID-AIR COLLISION REPORTS (NASA)

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Appendix A. Task Force Members

James R. Banks

ATC Consultant, USAF Air Defense Command, HQ, Air Force Communications Command, Scott AFB. Past President, Air Traffic Control Association (ATCA).

Ricardo Cassell

Retired air traffic controller and research specialist. Former CAA/FAA tower and center controller, former FAA R&D Program Manager.

John W. (Jack) Connolly

Director, Government Affairs, Aiden Electronics Co., formerly, special assistant to Administrator, NOAA, on aviation weather services. Coordinated establishment of forecaster services within ARTC Centers.

Jack Doswell

Professional pilot and instructor, manager/pilot for business aviation. Former pilot with U.S. Special Air Mission. Aviation users representative on ATC matters.

H. O. (Tad) Evans

Director, General Motors Air Transport. Formerly pilot with American Airlines and U.S. Army Air Corps.

Donald L. George

Analyst, NASA ASRS. Retired controller and team supervisor, Washington National Tower.

Col. John T. (Tom) Halley

Division Chief, HQ, Air Force Inspection and Safety Center, Norton AFB. 5000 hours flight time in fighter aircraft.

W. S. (Mike) Hunter

Retired CAA/FAA controller and manager. Commercial pilot. Co-founder and past President, Arizona Pilots Association. AOPA representative on ATC matters. Aviation Safety Consultant.

Lt. Col. Doyle W. Krauss

Assistant Director, Air Traffic Services, Tactical Air Command, Langley AFB. Military pilot and controller experience both terminal and en-route operations.

Louis M. McNair

B-727 captain for a major airline. ALPA Air Safety Award for ATC and accident investigation. Former member, FAA Air Traffic Procedures Advisory Committee.

Harry W. Orlady

Retired Captain, B-747, United Airlines. President, Orlady Associates, concerned with human and aeromedical aspects of aviation safety.

William Reynard

Chief, Aviation Safety Reporting Office, NASA Ames Research Center. Pilot, formerly Director, Special Courses AOPA Air Safety Foundation, and vice president, operations, National Aviation Trades Association.

Samuel P. Saint

Retired Captain, American Airlines. Consultant to government and industry on aviation and ATC operational matters.

Harry Schmidt

Principal, Aero Analysis. Consultant on aviation management and planning. ATC system and capacity analyses. Former engineering test pilot.

Austin Stephanoff

Retired CAA/FAA controller and team supervisor, Cleveland ARTCC.

Tirey K. Vickers

Director, ATC planning, Airways Engineering Corp. Formerly CAA/FAA controller and tower chief. ATC research and development and airport planning. Editor, Journal of Air Traffic Control.

Appendix B. Facilities Visited

AIR ROUTE TRAFFIC CONTROL CENTERS

ALBUQUERQUE	KANSAS CITY
ATLANTA	LOS ANGELES
BOSTON	MEMPHIS
CHICAGO	MIAMI
CLEVELAND	MINNEAPOLIS
DENVER	NEW YORK
FORT WORTH	OAKLAND
HOUSTON	SALT LAKE
INDIANAPOLIS	SEATTLE
JACKSONVILLE	WASHINGTON

TERMINAL AREA FACILITIES

ALBANY	EL TORO TRACON	NORFOLK
ALBUQUERQUE	FORT LAUDERDALE	O'HARE
ATLANTA	FULTON COUNTY	OHIO STATE
BALTIMORE	HAGERSTOWN	ONTARIO
BAY TRACON(SFO)	INDIANAPOLIS	OPA-LOCKA
BOEING FIELD	JACKSONVILLE	PHILADELPHIA
BOSTON	JOHN F. KENNEDY	PHOENIX
CHARLOTTE	LAGUARDIA	REGIONAL TRACON (DFW)
CLEVELAND	LAS VEGAS	SALT LAKE CITY
COLUMBIA	LINDBERG	SAN CARLOS
COLUMBUS	LOS ANGELES	SAN DIEGO TRACON
CUYAHOGA COUNTY	LOVE FIELD	SAN FRANCISCO
DALLAS FORT WORTH	MCCLELLAN RAPCON	SAN JOSE
DENVER	MIAMI	SEATTLE
DETROIT	MINNEAPOLIS/ST. PAUL	ST. LOUIS
DULLES	MORRISTOWN	TUCSON
EDWARDS TRACON	NEW YORK TRACON	WASHINGTON, D.C.
	NEWARK	WESTCHESTER

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