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FAA Response to User Consensus Views and Recommendations

New Engineering and Development Initiatives - Policy and Technology Choices

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DECEMBER 1979

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Prepared by

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Washington, D.C. 20591

Report No. FAA-EM-79-8

FAA Response to User Consensus Views and Recommendations

New Engineering and Development Initiatives -

Policy and Technology Choices

Based on Consensus Views of User/Industry Representatives, published March 1, 1979, and subsequent formal user community comments

Prepared by

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

Washington, D.C. 20591

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INTRODUCTION

Twenty-one months ago the Federal Aviation Administration (FAA) asked the aviation community for its ideas on the directions we should take in engineering and development.

That effort, which we called "New Engineering and Development Initiatives -- Policy and Technology Choices", led to a document published last March which summarized the user community views. This document represents FAA's response.

Many of the user recommendations will take more time to study and to carry out, so this is only an initial response. We will continue to interact with the users. In fact, one of the recommendations makes it clear that users hope to continue taking part in E&D planning.

Most of the user community's recommendations survived not only the initial process in which many organizations and many experts participated, but also the more formal process in which FAA asked the community to comment on the recommendations.

One major user organization played an important role in creating the consensus document, but then said it didn't wish to be bound by its recommendations, and wanted to deal with specific issues. Indeed, it would have been too much to expect unanimous long-term consensus from a group as diverse as the aviation community. A consultative process such as this has its limitations. At best, the result is a snapshot in time which cannot take account of future technical advances, policy alternatives or unfulfilled technical promises. But it is of great value nonetheless. The process of actual system change, of course, allows the user community, FAA and the Congress to deal with particular issues as they mature from engineering and development and reach implementation decisions.

The users made many recommendations and comments. We have tried to boil them down to 53 basic areas, and to provide an initial response to each recommendation.

The most important points to be drawn from the user recommendations are:

- The user community by and large supports the thrust of FAA's current E&D program.

- It urged more emphasis on particular areas, such as improving FAA's weather services and greater concentration on human factors activities.

- It backs a major modernization of en route and terminal air traffic control.

- It feels that many needs can be met by speedier introduction of products currently in the E&D process.

- The users generally support the FAA's approach to the problem of Aircraft Separation Assurance.

- The users made many recommendations on the need for more airport capacity, fewer delays, and fuel conservation, while stressing the importance of retaining optimum freedom of the airspace.

The user community, somewhat to FAA's disappointment, were not able to devise major new approaches which could, by a bold stroke, eliminate aviation's problems. But there were findings and recommendations which are of crucial importance:

- The users are ready to accept a far higher level of automation in the ATC process than they seemed to be only a few years ago. They wish to move into more automation in an evolutionary rather than a revolutionary way, and they recognize that ATC automation and the computer replacement effort require high priority and major funding.

- The users recognize the importance of DABS and the data link as critical elements of the total ATC system upgrading program.

- The users recommended de-emphasizing the use of en route primary radar as a traffic control tool in favor of the use of primary radar for weather detection. The consensus was that aircraft surveillance should be by an all-beacon system, but the users stopped short of agreement on requiring altitude-reporting transponders in all controlled airspace.

- The users strongly encouraged further work which would permit aircraft (especially aircraft operating in low density airspace) to accept more responsibility for separation. It remains a matter of great interest to the community to be safe in poor weather and good, without being a full-time participant in the ATC system.

- The users reconfirmed the historic view that ATC clearance generation should continue as a ground system function, but that ATC clearance execution should continue to be an airborne function.

- The users support the traditional design philosophy of ATC; namely, that navigation, communication and surveillance functions should be kept as independent as possible to avoid common mode failures.

FAA is already responding to many of the recommendations within the limits of available manpower and funding. The users recommended greater effort in a number of areas, and FAA is requesting increases in its budget for the coming years in order to respond. Work is underway or getting underway with respect to virtually every recommendation made by the user community. FAA will report on progress to the user community, and will continue to solicit informed opinion and judgments.

There are, of course, areas where the user responses pose paradoxes:

- While the user community recognizes that there are limitations to airport capacity and presses FAA to major effort in this area, there is virtually no meaningful agreement on non-technological approaches to achieving higher capacity.

- While the users recognize the problems of growth and the fact that risks are likely to rise with increases in aircraft density, there is little enthusiasm for changing the price of entry into the system in terms of increased carriage of airborne hardware, or even new procedures which could be restrictive.

- The users feel strongly that changes or new devices should provide immediate benefits to those who carry them -- even if those equipped are few, while not accepting the possibility of any limitation to those who do not carry the new devices.

These matters are finally left for FAA to resolve.

Throughout our FAA responses we have discussed a series of major programs. We have established planning dates for implementation of a number of these, subject to final decision-making and approval to implement. Each change will be preceded by a thorough test program and opportunity for aviation community comment. The plans for ATC system development and their implementation impacts will be fully examined by elements of U.S. aviation.

Future FAA programs and priorities will, to a significant degree, be guided by the users' recommendations. Aviation safety will be the essential consideration. Although we will not always agree with the recommendations, we will continue working with the user community to achieve the highest level of safety and efficiency in our National Airspace System.

The fact that substantial consensus was achieved is evidence of the intelligence and diligence displayed by the user community throughout the consultative process.

Langhorne Bond
Administrator

THE REVIEW PROCESS

As planned at the beginning of the New Engineering and Development Initiatives process, FAA received the Consensus Views of User/Aviation Industry Representatives as compiled by Economics & Science Planning, Inc. consensus document on March 1, 1979. This document consisted of the five Topic Group reports, each of which was specifically approved by the topic groups themselves, and an Introduction and Summary prepared by the contractor and approved by the five topic group chairmen as accurate and representative of user consensus. FAA then transmitted the complete consensus document to the user community and solicited formal comment from individual users and user organizations for the purpose of determining the degree to which the consensus reached by the participants represented the collective views of the user community. A number of comments have been received and, where possible, these have been incorporated in the consensus views. Where the comments are contrary to FAA's understanding of the user consensus, these comments have been noted in the following material.

As a next step, in order to make the consensus views actionable, the March 1 consensus document and the comments subsequently received have been summarized by FAA and classified into nine categories -- General Recommendations, Productivity and Automation, Terminal Capacity, Freedom of Airspace, Safety, Weather, FAA Response and Implementation, Environment, and Economic Incentives. The following material thus represents in summary form, FAA's understanding of the consensus reached. The FAA response follows each recommendation. Specific user comments outside that consensus are underlined. FAA comments on certain minority views of the users are bracketed. The bracketed numbers after each recommendation refer to the Topic Group number and paragraph in the March 1, 1979 report in which the recommendation appeared.

While FAA has tried to summarize the consensus and user views scrupulously, and is using this summary as a basis for presenting its response, it is recognized that the base document remains highly valuable and useful as a more detailed reflection of user thinking. It has been used by FAA people and others in responding to the recommendations, and is in no way superseded by this summary.

I. GENERAL RECOMMENDATIONS

The users of the air traffic control system, during preparation of their report on New Engineering and Development Initiatives, provided general guidance on Air Traffic Control policies and the E&D programs and products needed to support these policies. This overall guidance frequently applied to more than one of the specialized topic groups that were organized to address the variety of issues facing FAA, and is therefore presented first:

1. Control Philosophy

ATC clearance generation should continue as a ground system function to achieve safe and efficient movement of air traffic; ATC clearance execution should continue to be an airborne function; automatic control of aircraft flight from the ground is not appropriate. Depending on the results of future E&D activities, clearances may delegate more separation responsibilities to the pilot. Finally, if feasible, the future ATC system should provide automatic clearance generation and communication primarily via data link, while maintaining voice for unequipped aircraft, as a backup capability, and for "party-line" information where this proves important.
(TG 1, 3.1 and 5.1 (2))

FAA Response

FAA agrees with the recommendations regarding continued reliance on ground-based generation and pilot execution of ATC clearances and envisions no developments in the foreseeable future which would prompt its pursuing a ground-based system for piloting aircraft. While systems, such as Beacon Collision Avoidance System (BCAS), Discrete Address Beacon System (DABS)/Data Link, Automated Traffic Advisory and Resolution Service (ATARS) and Cockpit Display of Terminal Information (CDTI), are primarily intended to enhance safety by providing the pilot more timely and accurate information by more efficient means, the latter two systems could lead to increased ATC delegation of separation responsibilities. For example, the pilot could be responsible during Instrument Meteorological Conditions (IMC) for maintaining his separation interval on the final approach course or departure interval off the active runway. Additionally, these systems will assist the pilot in maintaining visual separation from traffic during VFR weather when accepting such clearance from ATC. Other applications in the en route environment may also prove feasible.

FAA believes that the future ATC system should provide automatic clearance generation and communication via data link, in order to make best use of new

technology to achieve higher capacity, as well as to enhance safety by providing for an improved clearance delivery system. FAA recognizes the importance of and probable continued need for voice communications and for "party line" information where this proves important.

2. Importance of Human Factors

Human performance and interface with evolving ground and airborne equipment requires E&D beyond current FAA efforts so as to maintain safety levels while improving productivity. E&D should define the needs of a controller to manage an automated control process and to maintain proficiency and alertness.

Pilot actions are cited more than any other factor in accidents for all aviation sectors. Nevertheless, additional cockpit information may be valuable to achieve closer separations, expedite traffic and monitor automated clearances. Pilot and controllers confidence in automation is crucial for automation to benefit productivity.
(TG 1, 3.8 and 5.2 (3))
(TG 4, 9.1 (1 and 4))

FAA Response

FAA fully agrees. With respect to the first paragraph, the underlying problem of defining the optimum role for human beings and computers in an automated process represents a major challenge. There is a broad consensus, supported by data, that human beings are poor monitors of highly mechanized or automated processes in which the monitoring process is passive. The establishment of the optimum role for human beings in the future air traffic control process represents an important, if not the most crucial, element in FAA's effort to introduce automated decision making into air traffic control.

While pilot actions are cited more than any other factor in accidents for all aviation sectors, the reasons are diverse. In the systems area, FAA is concentrating on research and development of systems that can enhance the performance of pilots and reduce error proneness by designing systems that take the best advantage of human capabilities. Many other areas are subjects for research and scrutiny by FAA and NASA, including examination of training methods and better understanding of medical and physiological factors.

The recommendation notes that additional cockpit information may be valuable to achieve closer separation, expedited traffic, and monitoring of automatic clearances. FAA's efforts, in collaboration with NASA, to establish both the capabilities and the limitations of CDTI are directly responsive to this recommendation.

FAA agrees that pilot and controller confidence in automation is crucial for automation to benefit productivity. Many factors will influence the development of such confidence, including establishment of the optimum role of man in an automated system, the establishment of confidence that automated systems will be highly reliable, confidence in the value of separate and essentially independent backup systems, and the development of techniques and systems that assure controllers and pilots the automated process is, in fact, functioning correctly. These problems are under study by FAA, and will be reported as they proceed.

3. Independence of Navigation, Communication and Surveillance Functions

There is no challenge to the basic current design philosophy of ATC, namely that navigation, communication and surveillance functions should be independent. While DABS is the basis of the future surveillance system and is also the desired data link for transmitting clearances, weather and traffic information, voice communications should be continued for the foreseeable future as an independent communications channel. The continued independence of the basic ATC functions was supported by specific recommendations that FAA should not consider down-linking of air derived data either to enhance ATARS or to be the basis for more closely spaced IFR approaches to parallel runways. The basic surveillance system should be sufficiently accurate to provide the desired service independent of air-derived information.
(TG 1, 5.1 (2))
(TG 4, 7.2 and 7.5)

FAA Response

While the principle of independence of functions is vitally important, full independence is not always achievable. For example, while for over-ocean operations an independent surveillance system would be desirable, aircraft densities are such that the traditional method of providing the control system with aircraft derived position information has proven satisfactory and may continue for some time to come. Similarly, vertical separation by the air traffic control system is achievable by utilization of information available only in the cockpit, since independent determination of aircraft heights has not proven to be practical to date, and the safety of the system, based on use of air-derived altitude information, has been very good. Finally, the availability of an air-to-ground data link may permit the traffic control system to benefit from information available only in the cockpit, such as certain information relating to weather, localized winds aloft, etc.

The key principle of segregation of functions, where practical, remains valid and important.

4. Need for Evoluntionary Development

All users recognize the need for evolutionary development of the ATC system -- not as an excuse for slow development -- but as a recognition of the limits to change in a system that operates in real time with many lives at stake and with massive investments in the training and proficiency of hundreds of thousands of people and investments in equipment valued at tens of billions of dollars. For example, DABS, the new surveillance system has been designed to be compatible with ATCRBS, the present surveillance system. In a similar fashion the transition path for replacing existing center and terminal hardware and software must include the ability to add new functions to existing automation during the process of replacement and should result in a system designed for continuing evolution. The requirement for evolution of the system may inhibit certain approaches; for example, airborne collision avoidance systems that are compatible with present ATCRBS installations are preferable to those that are not compatible even though certain incompatible approaches could provide superior technical performance.
(TG 1, 3.2 and 3.10)
(TG 4, 3.6 and 4)

FAA Response

FAA agrees, but cautions that evolutionary change cannot be considered absolute. While evolutionary change is in many, if not most instances, the only practical course, there are cases where the benefits from new techniques or new technology may outweigh advantage of the evolutionary process. In some cases, the evolution or transition may need to be achieved by the concurrent provision of several services. For example, the proposed transition from the existing Instrument Landing System (ILS) to the Microwave Landing System (MLS) is likely to introduce new and unique capabilities that cannot be obtained from the existing and highly valuable ILS. In this case, technological and operational advantages of the new system are likely to be such that FAA and the users will agree that a new system must be introduced to obtain long-term benefits not available from the current system. Similarly, should it be proven that a new navigation capability can provide a dramatically improved service at reasonable cost to users and to the Nation, the key to acceptability will be the development of a successful transition plan to permit long-term benefit to be gained from the new technology, while causing the least disadvantage to those not equipped. FAA tries to approach these technology innovations with clear recognition of the need for evolutionary implementation, and attempts to quantify the benefits and disbenefits in the context both of individual users and the national welfare.

5. Criteria for Equippage

Users agree that no way has been found to permit operation with safety in controlled airspace without requiring cooperative devices on all participating aircraft. Therefore a significant number of aircraft are currently equipped with transponders and altitude encoders. The government, however, should not expect users to purchase new avionics whose major function is only to reduce ground system costs. ATC concepts which provide additional capabilities and benefits for the equipped aircraft, regardless of the extent of the equippage, are preferred.
(TG 1, 3.3 and 3.4)
(TG 3, 1.4.1, 2 and 6)

FAA Response

FAA attempts, where possible, to design systems that bring benefits to the first users who buy the necessary avionics, rather than systems that require a large portion, or the total fleet, to be equipped before anyone derives benefits. This may not be possible in all cases. It is FAA's responsibility to consider the overall cost to the nation and the users of new air traffic control and aviation services, in which the total cost of providing the service, both ground and airborne, can be minimized by new systems.

FAA has reservations, with respect to the user consensus on criteria for equippage, "that the government should not expect users to purchase new avionics whose major function is only to reduce ground systems costs..."

There may be cases when the safety of the public may require mandatory carriage of certain systems. FAA's policy continues to be to encourage equippage through the provision of services recognized as desirable by the users, to stimulate implementation and to favor ATC concepts that provide additional capabilities and benefits for the equipped aircraft, regardless of the extent of equippage. Yet such a policy cannot be a cardinal ground rule if safety and the broader interests of the taxpayers are to be served.

6. Pace of Development

Ways must be found to decrease the length of time needed to complete and implement vital E&D programs. For example, M&S has been under development for a decade and still has many remaining uncertainties so that an eventual implementation date is not yet in sight. The rate of development of the vortex avoidance system is of equal concern.
(TG 2, 1.1, 4.3.1 and 5.2.2)

FAA Response

FAA agrees that the length of time needed to complete and implement the products of vital E&D programs needs to be shortened wherever practical. A number of actions have been undertaken by FAA to draw the operating services and the engineering and development activities closer together. The examples given in the recommendation illustrate the problem:

> The achievement of automated metering and spacing in an implementable form has proven elusive. The use of automatic metering and spacing requires a basic commitment to automated decision-making in air traffic control, but this has not yet been possible because the systems have not been demonstrated to be acceptably reliable, or sufficiently encompassing of the terminal problem. The problem is much more complex than it was originally thought to be. The increased importance of optimum paths for fuel conservation, fuel management, area navigation computers, the recognition of the need to tie en route metering, terminal metering and several other factors together complicates the problem of achieving an implementable metering and spacing system.
>
> Several activities are underway to deal with this problem. First, the development of an integrated flow management program is underway which encompasses the issues that have been raised, including that of an implementable metering and spacing system with appropriate integration of the various elements which impact efficient runway feeding. Second, FAA examining the basic problem of controller interaction with automated systems in order to achieve the best implementable capability at the earliest date.
>
> The wake vortex problem is equally difficult. When the wake vortex problem was first recognized, two efforts were undertaken. One, by NASA, concentrated on the characterization of wakes and research into the mechanics and causes of wake vortices, and the second, examined methods to alleviate wake vortices at the source. These efforts have had modest success, but have not yet reached the stage where either the airframe manufacturers or users feel implementable systems are achievable. FAA undertook the development of wake vortex detection and avoidance systems and has been moderately successful in characterizing wakes and developing meteorological means for predicting the probable location of wake vortices. The system under test at O'Hare has not yet proven to be operationally acceptable. There is a view that a real-time detection capability may be required before an acceptable wake vortex avoidance system can be introduced. To date there are no wake vortex detection sensors that can reach out to or beyond the Outer Marker.
>
> FAA's work on wake vortex detection and avoidance system is attempting to overcome these basic limitations, although FAA recognizes that

the current promise for wake vortex detection and alleviation systems is less than either NASA or FAA had hoped. A number of other approaches to this problem are being studied -- such as staggered runways, "dual-lane" operations and applications of MLS.

These two examples illustrate that, while it is easy to argue that more resources and more people would have sped up, or could now speed up this phase of the attack on the achievement of higher airport capacity, the technology may simply not yet be in hand to deal successfully with these particular problems in a short time. FAA will continue to press hard for resolutions to the airport capacity problem. The examples are not intended as an excuse, but simply an illustration of the challenge.

In a more general sense, the length of time required for E&D is heavily impacted by factors such as the following:

1. A technical breakthrough may be required, e.g., long-range vortex sensors and/or a practical system to alleviate the wakes at the source.

2. Solution of human factors problems may be needed, e.g., acceptance of automated metering and spacing for routine use may require commitment to automatic decision-making processes which do not readily permit reversion to a manual backup mode.

3. Level and extent of coordination required among pilots and other user groups.

4. Requirements for ground and user equipment.

Further comment on this general recommendation is contained in several of the following FAA responses, especially the response to Recommendation 17 and 33.

User General Comments on the March 1, 1979 Consensus Report

Aircraft Owners and Pilots Association (AOPA), in its letter of July 2, 1979, indicates that it does not wish to be committed in the future to any consensus that may have been achieved at one historical point in time. In support of this position, AOPA tends to view the degree of consensus achieved as less than that which the documents and subsequent comments indicate was in fact obtained.

(While FAA understands that all user organizations wish to reserve the right to deal with each issue or implementation proposal on its merits at the time it is proposed, this effort was valuable because it is believed appropriate to attempt to

achieve periodically a consensus of user viewpoints in an organized manner on a broad range of E&D issues.)

Air Transport Association (ATA) considered the final report in most instances to be a reasonable consensus of the users' viewpoints and thus fairly acceptable to the airlines. They felt the Introduction and Summary, however, did not in all instances accurately reflect the consensus of the users.

(Many of ATA suggestions for modifications in the Introduction and Summary, however, seem to FAA to be either minor or substantial changes from the body of the report that participating user representatives did not discuss or approve.)

Airline Pilots Association (ALPA) objected to the omission of its minority opinion on CAS from the Introduction and Summary although it was included in the relevant chapter of the report.

(The FAA contractor notes that ALPA's minority viewpoint was submitted thirty days after the close of the comment period and after nine months of CAS deliberations during which ALPA expressed no objection. It was not physically possible to include late minority viewpoints except in the chapter to which they pertained and still meet the publication deadline.)

(ALPA's objections to certain conclusions that appeared in both the Introduction and Summary and body of the report were not surfaced during the deliberations of the users and can not be assumed to represent consensus. ALPA interprets user conclusions on goals for closer lateral and longitudinal separations and the means to possibly achieve them, differently from what is believed to be the user consensus. It had raised no objections to the conclusions as stated, during nine months of deliberations to which they contributed.)

National Business Aircraft Association (NBAA) seemed generally to agree with the conclusions as summarized in the Introduction and Summary and with the body of the report.

General Aviation Manufacturers Association (GAMA) seemed generally to endorse the consensus views of the users as published in the March 1, 1979 consensus report with some recommendations for priority efforts among the many suggestions of the users.

The Experimental Aircraft Association (EAA) "complimented all those who contributed so ably to the excellence of this report." They had reservations with respect to the need for implementing DABS/ATARS as rapidly as FAA proposes since they do not believe aviation will grow as rapidly as FAA projects. They also believe BCAS unsuitable for general aviation.

Helicopter Association of America (HAA) found the references pertaining to helicopters satisfactory, but felt the words "compilation of views" would probably be more accurate than "consensus views of users/aviation industry representatives", in the title of the report.

The Dutch Civil Aviation Department found the users' report "most interesting" and many of the issues addressed were of concern to the Dutch and Europeans.

II. PRODUCTIVITY AND AUTOMATION

7. Organization of Airspace

The users believe that the en route air traffic control process - by means of new computational techniques - no longer needs to depend on increased sectorization of the airspace to handle increased traffic. The future system should manage adjoining airspaces so that boundaries are transparent, to permit more flexible routing and fewer altitude and route restrictions. The automated system should use flight intent, weather information and surveillance by means of DABS or ATCRBS for traffic separation and flow management. Through increases in the precision of meteorological knowledge, and through better understanding of the dynamic uncertainties of airport capacity, the future ATC system should plan more precisely and over a longer time horizon than it does now.
(TG 1, 5.1 (2) through 5.2 (1, 3 and 7))
(TG 3, 2.5.2.2)

FAA Response

The FAA concurs with the objective stated in the user recommendations that new computational techniques be employed in the future to: (1.) manage adjoining airspaces so boundaries are transparent, and (2.) permit more flexible routing, with fewer altitude and route restrictions. The implementation of these types of capabilities will be considered on an incremental basis by the development of validated software which permits the improvements, and by the deployment of a replacement for the en route computers to provide the required data processing capacity.

FAA is planning to conduct its future air traffic flow planning over a longer time horizon than it does now. Near-term steps are being taken to make some improvements in the present system and to investigate the terminal flow management problem. One project already in progress is the development of en route metering software which will enable the planning of airborne traffic flow into congested terminals to be conducted well ahead of actual arrival times, thus enabling more fuel-efficient traffic flow management. As more precise meteorological information is obtained and airport capacity estimation is improved, this process of managing flow into the terminal area will become even more effective. In addition, a long-range effort directed at defining the automated en route ATC system (AERA) is underway. This automation concept is being designed to increase the size of en route sectors, permit more flexible aircraft routing, minimize the effect of airspace restrictions, and provide improved aircraft flow management.

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FAA takes the last sentence of this recommendation to mean the system should have improved national and terminal flow control, but that this recommendation is not an endorsement of the feasibility of national strategic control as discussed in Appendix C, Chapter I of the March 1, 1979 users' report.

8. Computerized Clearance Generation

The computerized generation of conflict-free clearances by an Automated En Route ATC (AERA) type system and their transmission by DABS data link to aircraft will expedite traffic by reducing the controller work-load induced restraints with respect to direct routings and desirable altitudes. If successfully developed and when fully implemented, it might improve controller productivity by a factor of two.
(TG 4, 5.1 (2))

FAA Response

The intent of the AERA program is to design a highly automated control system that provides conflict-free en route clearances automatically to DABS-equipped aircraft and demonstrates higher levels of sector control team productivity than we have so far achieved. In the AERA concept an en route sector, manned by a single control team should be able to handle more aircraft through the increased use of automated decision-making techniques. This increase in sector size decreases the frequency of handoffs, and, therefore, increases the transparency of the control process. Severe weather information, flight plans, and airspace restrictions are used to plan conflict-free clearances up to twenty minutes in advance. Clearances and plans are periodically updated to keep the flow of traffic regulated and separated. The AERA concept has been demonstrated in closed loop simulation. A testbed is being designed and built to evaluate the AERA concept with operational data.

9. The Role of Voice Communication and DABS

The cockpit cues provided by voice "party line" communication, whether manual or automatic, must be maintained at least during the transition to DABS and perhaps thereafter. Together with DABS/ATARS the en route air traffic control process should be able to generate and transmit to cockpits weather and relevant traffic information so that the pilot can monitor separation and in certain airspaces participate in the separation process and movement of traffic, should this prove to be desirable.
(TG 1, 5.1 (2))

FAA Response

FAA agrees that the cues from the information flow provided to the cockpit by the voice "party line" communication system must be maintained at least through the transition period. Today's voice "party line" communication system provides the pilot with information about other traffic in his vicinity, as well as unrequested weather and NOTAM information. In an effort to retain the information provided by this "party line" in the cockpit, the data link system is being developed so that it can be implemented in an evolutionary manner. The initial data link service is planned to supplement the service presently provided via the voice channel. Weather/NOTAM data will be available in a digital form that will allow a hard copy printout in the cockpit. While it must be requested by the pilot, data link service will present the information in a better form for his use. CDTI and the ATARS service being developed will eventually provide proximate traffic information in the cockpit. Some level of air-ground voice communications will have to be maintained to handle the non-routine functions of ATC, such as aircraft emergencies, airborne equipment failures and ground failures. See FAA's response to Recommendation 1.

10. The Policy Controlling the Transition to a New Computer-Based System

The replacement of a real-time complex computer-based system on which lives may depend, such as the en route 9020s or the Automated Radar Terminal System (ARTS) II and III:

a. Should not include a large change over in a single step so as to avoid the potential for major software validation problems.

b. Should not stop additional functions from being added to the existing system while waiting for the replacement.

c. Should result in a system designed for continuing evolution.

The advent of distributed processing and the decreasing cost of computer hardware makes all this feasible with a high degree of reliability.
(TG 1, 5.1 (5))

FAA Response

FAA is acutely aware of the need for a nationwide computing complex that can support continued ATC evolution. FAA analyses have shown that the en route system (9020 computers, display channels and display systems) are candidates for replacement in the mid-to late 80s. To that end a major computer replacement program has begun.

In defining an ATC computer replacement program, FAA is analyzing different transition strategies. The primary goal is to assure that safety is maintained at current or higher levels of traffic. Other criteria must also be considered in formulating a transition strategy, including technical risk and impact, disruption of the controller's operational environment, software validation problems, and the costs associated with different transition strategies. FAA agrees in principle that the replacement program should not prevent additional functions from being added to the existing system. As a practical matter, however, these additions will be limited by the 9020 capacity. Many architectural options are possible for a new en route computer complex, and studies are underway to evaluate a number of them.

11. Human Factors and Automation

From the beginning human factor activities must be an integral part of automation program developments and design efforts. Within the context of the specific automation concepts which FAA pursues, meaningful human roles must be developed and shown to provide satisfactory performance. Research on methods for transitioning human roles is needed. Satisfactory methods of introducing automatic communications and computer decision making are crucial to achieving the desired goal of automation. Designs of any automated systems must be based upon careful and comprehensive studies of human behavior and error inducing phenomena. In addition, simulations should be used where practical to verify the tolerance of the aircraft separation concepts to human blunders.
(TG 1, 5.2 (10))
(TG 4, 3.7)

FAA Response

FAA fully agrees with the thrust of this recommendation. While the problem is understood, and its importance recognized, meaningful research into the basic problems of human factors in automation has been difficult to structure. FAA has recognized that the problem must be solved both generically, in terms of the motivational and technical factors involved in a transition to automated decision making, and in the context of specific efforts at automated decision making as characterized by the automated metering and spacing effort.

The transition to automated air traffic control has both human and technological content and is being attacked from both perspectives. At the most practical level, FAA Air Traffic Service has been working at its facilities to prevent system errors at their source and to use the best that engineering psychologists and system analysts have to offer to reduce the incidence of system error. This work augments FAA's efforts that deal with the introduction of automated decision making. Efforts are underway to optimize human interaction

with the Electronic Tabular Display System. Work has begun on the examination of the tolerance of aircraft separation concepts to human blunders. FAA and NASA are working jointly to define the roles of both the pilot and controller in a highly automated environment. An example of FAA's effort is the upgrading of the Air Traffic Control Simulation Facility at the National Aviation Facilities Experimental Center (NAFEC) to include conflict alert and certain other functions and to allow an investigation of controller performance in a representative control environment. FAA is developing a standardized measurement base, System Effectiveness Measures, that will allow examination, separately or in combination, of proposed improvements to the system. FAA believes it is essential that adequate analytical and experimental methods be applied to measure human performance and interaction processes in such a way that the success or failure of particular automation strategies can be predicted.

12. The Policy Concerning Avionics Complementary to the Automation System

The future automation system must be capable of providing benefits to users with additional airborne capabilities which promise either immediate or eventual system wide benefits, even if these users should be in the minority. While the ATC system and its associated automation should be designed so that such advanced airborne capabilities can be exploited, it should not require these advanced capabilities in order to function. Of all additional airborne capabilities considered by the users, DABS data link seems to be the most important element for increasing productivity. Therefore DABS acquisition should be encouraged by giving a wide range of additional benefits to users carrying this equipment. Such DABS data link services are essential for EFR, ATARS, CDTI, weather information, AERA, MSAW, VHF frequency changes (perhaps automatically), transmission of radar vectors or 3D or 4D instructions, and transmission of ATIS or NOTAMS.
(TG 1, 5.1 (7 and 9)
(TG 3, 1.4.1, 3 and 4 through 2.7.2.4)

FAA Response

FAA agrees with this recommendation within the limits of the response of Recommendation 5. In many cases, it is expected that users who choose to equip will get immediate benefits, while requirements for carriage of the capability by all users is not required. There may be other cases in which the value of a safety service may demand broad or perhaps, universal carriage of systems before benefits are achieved.

As a basic view, FAA believes that the DABS data link function should be initially directed to specific safety services, such as ATARS, that cannot be efficiently provided by other means. New services can then be developed and

added to the data link system, thus providing additional benefits that will motivate more people to equip their aircraft to obtain the services DABS data link can provide. Services such as CDTI, AERA, frequency changes, 3D or 4D navigation instructions, and possibly Electronic Flight Rules (EFR) as listed in Recommendation 12could, when developed and implemented, provide additional incentives for users to equip their aircraft. It is expected that as the data link system grows, users experience will cause an increase in the exchange of new ideas on other uses for data link along with the benefits obtainable. FAA is pursuing various efforts in low cost DABS avionics for general aviation use with DABS, in addition to work on ground equipment.

13. Hardware and Software Reliability

The hardware and software for terminal and en route centers should be an order of magnitude more reliable than today's system. Design standardization of terminal and en route systems should be considered. The use of standard system architectures, computer languages, software testing and validation procedures, and data bases may all be instrumental in upgrading FAA's ability to develop and maintain terminal and en route software. Furthermore, close coordination is needed between terminal and en route M&S development programs to assure the two-way effectiveness of the interface between these systems.
(TG 1, 5.2 (3))
(TG 2, 7.8)

FAA Response

FAA concurs with the users' comment about the desirability for further improvement of hardware and software reliability in the ATC systems. This is already a primary consideration in FAA's planning of the ATC computer replacement program. Design standardization will be considered to the extent practical for the en route and terminal systems. The potential for using common computer programming languages, software test and validation techniques, and data base definitions is also being studied in the context of the computer replacement program. Coordination between terminal and en route M&S development programs is taking place.

14. Consolidation of FAA Facilities Including Maintenance Functions

Possibilities for increasing productivity and reducing costs by consolidating ATC facilities (e.g., center with center, terminal with center, etc.) should be investigated. E&D programs should explore potential techniques to centralize and automate the maintenance functions of performance assurance and fault diagnosis for software and hardware in the system. These efforts should also assess the resulting potential for increased productivity of FAA's maintenance force.
(TG 1, 5.2 (9 & 11))

FAA Response

FAA is working on the consolidation of facilities in order to reduce costs, increase productivity, and to improve operations. FAA has an FSS modernization program underway that is expected to result in a consolidation of facilities. FAA has also established a Remote Maintenance Monitoring Program. Over the next decade most existing FAA systems will be replaced with more reliable solid state equipment having built-in remote monitor/control/diagnostic capability. Remote monitoring will enable FAA to consolidate maintenance staffs and substantially reduce the number of work centers, as well as to contain the growth in the maintenance work force.

FAA is interested in increasing productivity and reducing costs and will continue to investigate alternatives by either consolidating facilities or automating manually-performed functions wherever this can be accomplished without compromising safety. The consolidation issue must be approached cautiously. It has the potential for degrading system reliability, since the ability to transfer functions and responsibility to adjacent facilities is a key to achieving a high degree of protection against local facility failures. This point is recognized by the users in Recommendation 39.

User Comments on Productivity and Automation

Air Transport Association of America (ATA) objected to some of the discussion involving the use of 4 D navigation as a backup and some of the discussion involving a pilot-based ATC system. However, ATA accepted all the recommendations in this area including those concerning E&D on 4 D navigation and a pilot-based ATC system.

General Aviation Manufacturers Association (GAMA) felt ATC automation was one of the four high priority E&D programs, with an emphasis on reducing manpower intensity.

National Business Aircraft Association (NBAA) stressed the importance of improving pilot and controller confidence in automation, as well as the importance of data link in accordance with the users' consensus.

Aircraft Owners and Pilots Association (AOPA) seems to support the users consensus in this area, but feels that some of the backup provisions may be so expensive as to be impractical.

Air Line Pilots Association (ALPA) evidently supported the users' consensus in this area, but wished to ensure that E&D addressed the issue of cockpit workload in any examination of an ATC system that delegated more responsibility to the pilot. This was a consensus recommendation of the users.

Boeing, an aircraft manufacturer not a user, disagrees with the consensus achieved by users when discussing potential limitations of 4D RNAV "strategic control". Evidently Boeing agrees with user E&D recommendations that both terminal and en route automation should be developed compatible with the delivery of 4D RNAV clearances to aircraft by DABS, should this prove desirable.

III. TERMINAL CAPACITY

15. Terminal Automation

The users stated that terminal area automation objectives should be to provide aids to the controller's metering, sequencing and spacing capability. Automation could also permit pilots to perform the final spacing function in instrument weather conditions. The clearances provided must be conflict-free and accommodate wake vortex avoidance sensor inputs, as well as profile descents. This terminal control process should be capable of handling arrivals to independent parallels, staggered arrivals to dependent parallels and intersecting runways, as well as taking into account departures, missed approaches and holding. The terminal metering and spacing control process must be coordinated with en route metering and spacing and national flow control. The outputs of terminal automation should be capable of delivery to the cockpit in various formats: (1) radar vector clearances for transmission by the controller; (2) conflict-free clearances transmitted directly by data link; (3) merge sequences and spacing information for aircraft equipped with cockpit traffic displays; or (4) time schedules at waypoints for 4D RNAV equipped aircraft, assuming that the additional cockpit capabilities described prove advantageous.
(TG 1, 5.2 (2))
(TG 2, 4.3.1.1)

FAA Response

FAA agrees that a major objective of the Terminal Automation Program should be to provide aids to the controller in metering, spacing and sequencing of traffic. Present development planning addresses this, as well as providing accommodation of profile descents and wake vortex avoidance sensor inputs, if they become available. FAA agrees that the terminal control process must be capable of handling the interface with en route metering, arrivals to independent parallels, staggered arrivals, intersecting runways, departures, missed approaches and holding.

Methods to deliver automated outputs to the cockpit for pilots to use in conjunction with 4D RNAV and CDTI capabilities are now being investigated. The achievement of automated metering and spacing in an implementable form has proven elusive. The use of automated metering and spacing requires a basic commitment to automated decision-making in air traffic control. The problem is much more complex than it was originally thought to be. The increased importance of optimum paths for fuel conservation, fuel management, area navigation com-

puters, and the recognition of the need to tie en route metering, terminal metering and several other factors together complicates the problem of achieving an implementable metering and spacing system.

16. Metering and Spacing

The development of an integrated terminal flow management system, which encompasses M&S, might well be the basic component of the future terminal area air traffic control system, and should be pursued with high priority. The completion of the Basic Arrival M&S System simulation, live flight verification tests and field appraisal under various weather and runway conditions, should be expedited. It is essential that a plan for field appraisal be developed and approved as soon as possible. The development of an implementable M&S capability as an integral part of the more comprehensive integrated terminal flow management system discussed above should be initiated as soon as possible. Additional simulation work will be required and should include, for example, a determination of missed approach rates and efforts to integrate M&S with VAS and terminal area flow management. Before M&S is approved for national implementation, the field trials should be analyzed to determine its improvement in delivery precision as compared to the present manual system.
(TG 2, 7 (4, 5, 6 and 7))

FAA Response

Refer to FAA response to Recommendations 6 and 15.

17. Techniques for Increasing Airport Capacity

The E&D recipe to increase runway capacity is well known, but its implementation is too slow. For example, terminal area automated Metering and Spacing (M&S) is a long delayed but essential ingredient in the search for capacity increases at major airports. Both closer lateral spacing between runways and closer longitudinal separations on approach under IMC can be safely achieved, approximating those obtained under VMC. For example, the improved guidance capability of MLS and the improved communication and surveillance capability of DABS operating at approximately a one second data rate should permit a runway separation of 2,500 feet. As another example, the delivery accuracy of terminal M&S in conjunction with wake vortex alleviation or avoidance, and achievable shorter runway occupancy times, should have a 2-nautical mile longitudinal approach spacing as a reasonable goal. It may be necessary to have information on nearby traffic, runway occupancy, and the control process available to the cockpit to achieve this goal. Wake vortex alleviation seems sufficiently promising that FAA should examine the desirability of requiring wake vortex alleviation systems on newly certified aircraft, as well as on the current wide body jets. Capacity

limiting interference between airports can probably be minimized by MLS and RNAV; capacity limiting interference between runways on the same airport can probably be minimized by MLS-guided missed approaches. Dual glide slopes provided by MLS may be a useful technique to alleviate wake vortices during IMC. The curved approach capabilities of MLS and RNAV may assist in the development of independent terminal approach procedures. While there are E&D products that are generally useful to improve airport capacity, they may have to be tailored to site-specific airport needs.
(TG 2, 4.4.6; 4.6.2, 7)
(TG 4, 3.2.1; 3.2.2; 3.2.3; and 6.3)

FAA Response

The frustration implicit in Recommendation 17 is understood and is shared by FAA. While the efforts dealing with automated metering and spacing and wake vortex relief are highlighted in the user recommendation, a great deal of other FAA work is going on and producing valuable results, such as:

A series of airport task force studies undertaken by FAA in partnership with the operators and users at a group of major airports have been extremely valuable in identifying near-term improvements, as well as defining clearly the limitations of airport capacity under present and potential future conditions, including the delay impact of the manner in which the capacity is used, and the aircraft mixes encountered. The airport task force studies at eight major airports are nearing completion and further studies are scheduled, or underway, at an additional number of airports.

Efforts to develop an integrated flow management system and on improvements in the capability to avoid wake vortices continue, as described in response to Recommendations 6 and 15.

A series of other studies have yielded important insights. These studies, among others, have dealt with: the potential for reduced longitudinal spacings on final approach, examination of the benefit and cost impact of reduced of longitudinal spacings by effective wake vortex avoidance and alleviation systems; and examination of the potential beneficial impact of short runways to serve the growing commuter and general aviation operations segregated from larger aircraft using long runways.

Studies are underway to establish optimum ways to utilize staggered approaches, "dual-lane" runways, closer-spaced parallel runways, and precision missed approach paths.

While important airport capacity increases would be achieved if two-nautical mile aircraft interarrival spacings could be routinely achieved, such spacing remains a goal unlikely to be achieved without successful solution to problems inherent in wake vortex avoidance and alleviation, runway occupancy and successful development of a fully-integrated flow management system.

There are, however, opportunities to obtain capacity payoffs in terminal capacity and to reduce aircraft travel time by methods other than reduction of longitudinal separation between aircraft. These opportunities have been derived from site-specific situations and can yield significant benefits and fuel savings. Important gains, currently being explored in detail, appear to be achievable for specific airports.

18. Techniques for Decreasing Runway Occupancy Times

FAA should determine the capacity increases obtainable by reducing runway occupancy times at congested airports for present and proposed in-trail separations on runways used for arrivals only and for mixed operations. A design goal for runway occupancy times should be determined in part by analyzing and collecting data on touchdown locations and dispersion, deceleration rates, exits used and exit speeds. The technical and operational alternatives available to achieve this design goal should be determined. Various options should be analyzed, such as high speed exit taxiways, runway grooving, drift off areas, dual lane runways, high speed entrance ramps and staggered dependent dual lane runways for arrivals. Factors such as pilot motivation, data acquisition and display, landing, route and taxi guidance requirements, traffic control procedures, and separation between runways and parallel taxiways, should be considered.
(TG 2, 7 (19, 20, 21, 22 and 23))

FAA Response

FAA has conducted several studies to examine the factors that contribute to currently observed runway occupancy times. The studies utilized a variety of observed data collected at many different airports with varying configurations.

A proposed data collection concept has been developed from the previous studies and includes such elements as touchdown locations, dispersion, deceleration rates, exits used, and exit speeds. Based on these data, ground movement capacity for any given airport can be estimated, considering specific given elements (runway configuration, approach aids, ASDE, taxiway arrangements, turnoffs, high speed approaches, etc).

Recommendations for modifying or adding equipment in the cockpit are being evaluated under a joint FAA/NASA program. In conjunction with this program,

another study is underway to examine occupancy times of both conventional and advanced short-haul aircraft.

The areas of runway grooving, drift-off areas, taxiway guidance and separation between runways and taxiways are being addressed in current E&D activities. Further studies are underway on independent dual runways, and short independent runways for general aviation and commuter operations that may help alleviate the runway occupancy problems.

19. Vortex Avoidance Programs

The FAA should expedite the completion of the VAS test program to track vortices between the middle and outer markers at O'Hare. Once this is accomplished, a Technical Data Package should be prepared to assist FAA operating services to acquire, deploy and operate VAS at high density airports. FAA should immediately use VAS wind criteria algorithms to establish departure intervals that are operationally safe and that will, under appropriate conditions, decrease current departure standards. VAS capability beyond the outer marker should be investigated. Wake vortex effects on approaches to parallel runways spaced less than 2,500 feet apart should be determined. Vortex research activity should be continued in association with a strong NASA effort in an attempt to increase airport capacity. Some consideration should be given to providing an electronic alerting system in the cockpit to advise the pilot as to the VAS system status (RED or GREEN). Based on a goal of a longitudinal spacing of two nautical miles, a system design for a complete vortex avoidance system should be immediately developed, efforts toward the selection of an operationally reliable vortex sensor should be accelerated, and the vortex avoidance system prediction model should be refined, validated and adapted to an operational configuration. FAA should determine the benefits of a complete vortex avoidance system without an M&S interface.
(TG 2, 7 (37-44))

FAA Response

A partial response to this recommendation is given in the FAA response to Recommendation 6. As noted, a basic wake vortex advisory system, based on measurement of wind speed and wind direction, has been developed and tested, but is expected to provide benefits smaller than had been hoped.

Initial research into the behavior of vortices from departing aircraft has been completed at Toronto International Airport and further data collection on departures will be conducted at O'Hare International Airport in fiscal year 1980.

Investigations into vortex effects on parallel and intersecting runway operations are planned for fiscal year 1980-81.

The design of the VAS allows for digital outputs that could be transmitted to the cockpit to provide red and green status, or other indication, if the data link were available and an operational requirement existed. There are no current plans to incorporate cockpit alerting as a function of the current VAS.

While the recommendation proposes the immediate design and development of a VAS, it is important to recognize that VAS alone will not guarantee two-nautical mile interarrival separations. The design of an operationally viable VAS which could permit spacing below existing separation criteria is dependent not only on an operationally usable real-time sensor, but also on acceptable procedural strategies, and adequate maneuvering and warning lead times for the manual control system. Current vortex research sensors are not suitable for incorporation into an advanced vortex system. Anemometers are limited to tracking surface winds. Acoustic sensors are usable to approximately 400 feet and require vortex movement through the sensor's scan plane, so that real time data output is not readily achieved. Laser detectors are limited to distances probably inside the outer marker, as noted in an earlier recommendation.

FAA has worked closely with NASA, both in the characterization of wakes and in the consideration of wake vortex source alleviation systems. NASA is presently conducting tests at Edwards Air Force Base on airborne alleviation devices.

20. The Structure of Airport E&D

FAA should concentrate the total airport E&D program into a single organizational entity within the FAA E&D structure whose sole responsibility is this program. FAA should develop a plan for determining how the total advanced terminal system (both airborne and ground based) would be operationally utilized. This plan should include the capacity to test and evaluate the effectiveness of the system. Site specific aspects of airports should be identified and considered in the E&D plan. Airport layouts that utilize a minimum of land should be developed to facilitate construction of airports and to provide guidance for improving existing land constrained airports. FAA should perform periodic integrated airfield/airspace analyses, at major urban areas, on a site specific basis.
(TG 2, 7)

FAA Response

The FAA Associate Administrator for Airports is expanding the Airport Research Needs Plan to fully recognize the interdependence of airport systems

components as highlighted in the recommendation. Other FAA organizations will respond to that Airport Research Needs Plan, which will range widely over various disciplines. The E&D organization is responding with programs that cover the range of needs, from aircraft fire fighting improvements, airport security, weapons detection, etc., to the more operationally oriented elements of airport pavement design and construction runway design and improvements, and air and surface traffic control improvements. The heart of the E&D effort on airport capacity and delay is based on the understood need to make optimum use of existing runways, melding into the E&D program the output from the Airport Task Forces that have identified specific needs. E&D effort, which relates to the airport program, is concentrating on related programs, including the integrated flow management program, wake vortex detection and avoidance systems, utilization of an exploitation of precision navigation aids and surveillance aids at and near the airport, and others.

FAA agrees to the need to periodically examine terminal problems, along with airport capacity improvement proposals, to permit the local airport development planning processes to proceed with the best and latest information. Some of this has already been achieved through the Airport Task Forces, but this effort will be expanded, using periodic planning meetings held at the local level with participation of air traffic and airspace experts, airport planners, operators and users to formulate development recommendations to be included in the National Airspace System Plan (NASP).

21. Non E&D Approaches to Increase Airport Capacity

While E&D can increase terminal capacity, it cannot replace the need for more runways and airports and for fuller use of existing airports such as Midway and Dulles, and the need for less reliance on passenger transfers at key airports such as O'Hare and Atlanta, and for maintaining the current inventory of reliever and general aviation airports. Therefore technology and runway construction, as well as institutional approaches, are needed to provide the forecasted need for capacity. However all sectors of the user community rejected pricing mechanisms for allocating scarce runway capacity. One continuing problem may be the negative reaction to increased activity by communities bordering airports.
(TG 2, 1.1; 7 (48))
(TG 5, 1)

FAA Response

FAA recognizes the need for more effective utilization of existing underutilized airport capacity in saturated areas. To this end FAA has supported recent CAB route decisions by assuring that adequate facilities are installed at multiple airports within major metropolitan areas. FAA has undertaken a major program to

upgrade facilities at reliever airports and to encourage more joint-use of military facilities. The ultimate decision, however, as to which airport in an area will be used by the air carriers or general aviation must be made by the users themselves.

User Comments on Terminal Capacity

Aircraft Owners and Pilots Association (AOPA) point out that M&S increases the utilization of the capacity of the airport, not the capacity itself, but otherwise evidently agrees with the thrust of the users' consensus.

National Business Aircraft Association (NBAA) agrees with the users' consensus in this area and places highest priority on development and implementation of M&S, on reduction of longitudinal separations and on minimizing the effects of wake vortices.

General Aviation Manufacturers Association (GAMA) agrees with the consensus achieved by the users in this area and places special emphasis on increasing general aviation airport capacity in metropolitan areas.

Air Transport Association of America (ATA) agrees with the major thrust of the users' consensus in this area. However, ATA objects to increasing capacity by having "...less reliance on transfers at key airports, such as O'Hare and Atlanta". (The user consensus here is that substantial transfers at hub airports, rather than direct city-pair service, tends to tie up capacity at hub airports to the detriment of other users of hub airport capacity.) ATA objects to the strength of the user recommendation that FAA examine the feasibility of requiring wake vortex alleviation systems on newly certified aircraft, preferring that E&D be completed on an acceptable alleviation system before mandating adoption of a wake vortex alleviation system. (The phrase "feasibility of requiring wake vortex alleviation systems", would seem to cover ATA's concern adequately.)

Air Line Pilots Association (ALPA) does not correctly quote the user consensus on closer separations to which it objects. (Users pointed out that a high data rate DABS (one interrogation per second) has the ability to detect transgressions in a timely manner for smaller runway separations than currently permitted and has the ability to transmit this information to both aircraft automatically, and more rapidly and reliably, than present ground-air communication capabilities. Users did not say, as ALPA implies, that a conventional data rate DABS (one interrogation every four seconds) would be adequate. Further user consensus appeared to be that improved runway occupancy times and wake vortex alleviation and avoidance would be needed to achieve the goal of 2-NM longitudinal separation, not that M&S alone could be used to achieve this goal as ALPA states.)

Boeing states that independent parallel approaches must not depend upon a cockpit display of traffic (CDTI). (FAA's understanding, however, is that users did not assert that it should, they said CDTI might be helpful for "crosscheck, runway monitoring and pilot assurance".) Boeing also states that the decision to implement aerodynamic vortex alleviation should be made by the airlines, not by the FAA, as the users recommended.

IV. FREEDOM OF AIRSPACE

A number of E&D programs and initiatives were suggested by the users to improve the availability of airspace and the expedition of flight with safety for many users of the airspace. Some of these E&D initiatives -- in areas such as productivity and automation, terminal capacity and weather information -- will only be touched on here to the extent that they relate to freedom of airspace. This section summarizes FAA's understanding of user suggestions with respect to supplementary control concepts, the availability of airspace through better coordination of joint use airspace, through better altimetry and navigation and the improved expedition of flight that would result from better communications, and facilities to enhance low altitude IFR flight -- particularly as applied to helicopters.

22. Avionics Equippage and Airspace

An automated ATC system that improved FAA productivity but required extensive airborne equippage would not be appreciated. The automation system should be designed so that it provides benefits to IFR flights carrying only transponders and altitude encoders, VOR and two-way radio equipment. Automation concepts that provide additional capability and benefits for aircraft with more than this equipment should do so, regardless of their number. Automation concepts which provide no additional capability until almost all aircraft have more equipment should not be seriously pursued. Users will resist the installation of any additional equipment when procedures serve to exclude even equipped aircraft from certain airspaces or terminal areas. Users agree that ATCRBS or DABS are needed to permit freedom of operation with safety in mixed and positively controlled airspace, but uncontrolled airspace outside of terminal control areas and below some nominal altitude of 5,000 or 10,000 feet should be protected for the use of unequipped aircraft engaged in training, recreational flying, special industrial or agricultrual operations, soaring, ballooning, etc. Unequipped, low altitude, cross country transportation should be practical, if not always convenient, in this airspace.
(TG 1, 5.1 (6 and 9))
(TG 3, 1.4.1 (2 and 5))

FAA Response

As discussed in earlier responses, FAA believes that in cases where carriage of new equipment would serve a major safety need, such development should be pursued regardless of equippage factors. There is no intention of requiring more equipment than the minimum required to assure safety and to meet national goals

for successful and efficient operation of the NAS. The trade-off between full freedom of operation, economics and costs of the ATC system is a complex issue and is heavily impacted by safety concerns.

FAA agrees that airspace outside of Terminal Control Areas and below some altitude should remain accessible to unequipped aircraft. Should risks increase or should the accident rate increase in airspace of this kind, appropriate measures would have to be considered.

23. Need for General Aviation Airports

The lack of general aviation airports can be considered both as a constraint to freedom of use of airspace and as contributing to airport capacity problems in major metropolitan areas.

FAA airport data for the years 1969 through 1977 indicate that about thirty-six public-use airports have been lost per year. This means that airplanes based at public-use airports which are closed, must find a home base at some other airport. The problem is further increased by the manufacture and sale of some 14,000 general aviation aircraft per year. When a public-use airport closes, and especially in major metropolitan areas, often the only solution open to the based aircraft owners is to move to the central major airport or to other crowded reliever airports.

The recent report by the Department of Transportation entitled "Potential Closure of Airports" estimated that fully 40 percent of the privately owned airports available for public use are expected to close within ten years. The continued loss of general aviation airports already is having adverse effects on efficient utilization of the airspace and will impact the airports used by the air carriers in major metropolitan areas.

An action program to correct the growing inadequacy of general aviation airport facilities is required on a number of fronts involving the FAA, the users, state and local officials and the Congress. Courses of action to explore include:

1. An aggressive program for retention of privately owned, public-used airports. Tax relief for the public-use portions of such airports should be a part of this program. Provision also should be made for these airports to be eligible for Federal airport funds contingent on suitable assurances that the airport will continue to be available for public use.

2. Joint civil-military use of military airports where feasible.

3. Conversion of surplus military and government airports to civil use.

4. A major effort to improve existing and to build additional general aviation airports in major metropolitan areas and elsewhere as warranted, including facilities for servicing, instrument approach capability, weather observations, transportation, weather briefing and other ancillary services.

5. Increase the capacity of airports used jointly by the air carriers and general aviation wherever possible through the construction of short parallel runways to handle the average general aviation traffic and commuter traffic.

6. A comprehensive public information campaign under FAA leadership and encouragement to inform the public at large of the benefits that airports bring to the nation as a whole and to communities in particular. If this is understood by the general public, support of airports would materially increase and at least some of the existing feeling that airports are a nuisance would likely disappear.

7. The provision of instrument approach capability, remote radio outlets that permit direct contact with ATC from the airport surface, and other aids will do much to enhance the usability of many existing general aviation airports, thus increasing their attractiveness to users who otherwise have no alternative but to use the major airports. This increases utility and provides additional capacity in the system.

Insofar as the potential is not yet exploited, funding policies encouraging the construction of non-interfering, low-capital runways capable of supporting general aviation/air taxi traffic may significantly enhance the capacity of some busy metropolitan airports. In other instances additional capacity benefits may result from the simple expedient of designating presently existing taxiways for general aviation departures.

In many cases the most economically efficient (lowest cost) method for enhancing effective capacity in metropolitan areas may be to ensure that alternative landing sites are readily available for use, particularly in instrument meteorological conditions (IMC). It was observed that current funding policies do not take into consideration the full beneficial effects that would result from the development of reliever airports, because the qualification formulae for facilities and equipment funding effectively ignores the status of some airfields as being potential relievers. To correct this situation it is suggested that the FAA should confer special status on reliever airports, to encourage appropriate instrumentation, lighting and safety measures for such airports.
(TG 3, 2.8.1 through 2.8.2)
(TG 5, II, 1.2)

FAA Response

FAA recognizes the need to provide adequate airport facilities to accommodate general aviation and is particularly concerned about the situation in major metropolitan areas.

FAA commitment to upgrading general aviation facilities in metropolitan areas was demonstrated recently when FAA initiated a $100 million satellite airport program. This program, and the publicity that accompanied it, will serve to upgrade general aviation metropolitan airports and will inform the public of the importance of such efforts. A major component of the program is the establishment of instrument landing systems at general aviation airports in many metropolitan areas.

The continued operation of privately owned, public-use airports in metropolitan areas is a subject that has received considerable attention in recent years. The Secretary's report to Congress on the "Potential Closure of Airports" highlighted the problem and recommended appropriate measures, including state and local tax abatement and land use controls. The Administration's proposal for post-1980 airport aid legislation would permit participating states to provide development grants to privately owned general aviation airports that are available for public use. That legislation would also greatly increase the amount of money available for the development of reliever/satellite airport in metropolitan areas.

Programs are underway to encourage joint use of military airfields and convert surplus military airports to civil use. There are now broad joint-use agreements at thirteen military airports and limited joint-use agreements at another forty-two. Additional joint-use and surplus military property agreements are under consideration and these programs will continue to be emphasized in the future.

The proposal for utilization of taxiways for general aviation departures is considered to be inconsistent with need for operational safety, unless such taxiways can be incorporated as runways in the operational management of the airport.

24. Nondiscrimination in Obtaining IFR Departure Releases

It was also observed that many general aviation operators have the conviction that the air traffic control system effectively discriminates against IMC movements from some of the smaller airports, contrary to official FAA operations policies. The users asserted that if such discrimination (i.e., in obtaining IFR departure releases) exists, it is counterproductive to the ultimate goal of spreading aircraft movements to less congested airports.
(TG 5, II, 2)

FAA Response

FAA does not discriminate against general aviation IFR movements from satellite airports, but fully understands the conditions that contribute to this conviction. The primary problem, as FAA sees it, relates to satellite departures having to utilize the same airspace as aircraft operating in the primary airport area. Consequently, a lone IFR departure at a satellite airport must frequently be sequenced among the many IFR departures awaiting release from the primary airport. Other contributing factors may be poor communications, absence of radar coverage, or inefficient management of airspace. In addressing these problems, FAA is striving to improve communications at the satellite airports by establishing remote transmitter/receiver sites, increasing radar coverage through new or relocated airport surveillance and en route radars, reconfiguring terminal arrival/departure routes where it will result in improved airspace management and improving ATC flight plan processing and distribution.

25. Regional Airport Planning and Implementation

Apart from simple enhancement of the capabilities of relievers or potential relievers, the users expressed particular concern over the trend toward the conversion of many small airports in metropolitan areas to non-airport uses. The trend in the closing of small airports is dramatically illustrated in the Philadelphia metropolitan area. In 1950 that area supported thirty-five general aviation airports. Since that time twenty-four of those airports were closed and only nine were opened, for a net reduction of fifteen, or forty-three percent. Moreover, within the central portion of the area, the number of general aviation airports suffered an even more precipitous decline, dropping from twenty-five to five, or eighty percent.

The users found that the full advantages to the metropolitan area and/or region of retaining these airports were rarely given due consideration in the planning and political processes. It was observed that the construction of satellite and reliever airports may be the most cost-effective way to increase effective capacity for a congested metropolitan hub. Equally important, the preservation and enhancement of the capabilities of existing reliever airports could mitigate growing congestion at the busy principal airport in a metropolitan region, thereby benefitting all who use that busy airport and all who might otherwise be compelled to pay for its expansion or relocation. Although the benefits in either case are widespread, diffused and not directly apparent, often a great portion of the direct and indirect costs are concentrated on the host community within the broad metropolitan area. While ADAP and other federal financing assistance may largely absorb the out-of-pocket costs to a community for the construction and operation of the airport, real monetary costs in terms of property taxes foregone (as the land occupied by the airport is often prime industrial or commercial real estate) and

other perceived costs to the community, such as noise, safety hazards, and other environmental concerns received considerable attention in such a community whenever a policy option regarding the airport appeared. The users argued that total, overall benefits of retaining reliever or satellite airports and the construction of new satellite or reliever airports should be weighed against total costs; to do this effectively would require a stronger emphasis on regional airport system implementation of regional plans as a prerequisite for funding.

The patterns of use of existing airports are to some degree influenced by Department of Defense policies regarding civil use of military airports. Following an analysis of those policies the users reached the conclusion that civil requirements for airport capacity should be afforded greater consideration than presently given in determining the joint use of active military airfields in metropolitan areas. The users also expressed the desire to see that the conversion of deactivated military fields to civilian use is further encouraged, and that present military use of civil airports be reassessed, particularly at busy airports, in light of the projected trends in civil aircraft movements.
(TG 5, II, 3 and 4)

FAA Response

FAA agrees that a portion of Airport Grant Federal Funding should be linked to the implementation of system planning. This type of provision is included in the Administration's proposal for post-1980 airport aid. Under the proposal, federally-aided airport development in primary hubs would conform to a current system plan and a capital improvement plan mutually agreed upon by the eligible airport sponsors. This proposal should lead to an increasing awareness of the system implications of individual development decisions. The primary hub funding would be in addition to funds normally apportioned to air carrier airports.

FAA is concerned about obtaining the most effective use of existing airports and will continue to work closely with the Department of Defense to develop joint-use and surplus property agreements for the benefit of civil aviation. These programs have been very effective in the past and hold considerable promise for the future.

26. Availability of High Quality Weather Information

For weather to be observed at less than half of the 1,700 airports in the U.S. having published Instrument Approach Procedures is an obvious deficiency. Weather information available to pilots is frequently more than one hour old as a result of low frequency of observation, processing time and limited transmission circuit capacity. The timeliness of observations on severe weather phenomena are of particular importance because many of these phenomena associated with

thunderstorms are short-lived. And the persistent inability to collect and disseminate in-flight weather information is a handicap, both to the planning and execution of flights and to the improved forecasting of aviation and other weather.

According to NTSB reports, weather is a contributing factor or cause in about 40 percent of all fatal accidents. Typical among the factors are low ceiling, fog, rain, and continued VFR flight into adverse weather.

FAA has a number of programs for improving weather services. FSS modernization includes several improvements to mass weather dissemination and weather briefings. Further, FAA has under development an Automated Low Cost Weather Observation System (ALWOS) for use at general aviation airports with approved instrument approaches which currently do not have local observations. In addition, FAA has under development a semi-automated weather observation system for use at Air Traffic Control Towers designated to take weather observations.

Users believe FAA should accelerate the present activities which will lead to automation of aviation weather observation and dissemination and work toward a goal of instant availability of real-time weather at airports with instrument approach procedures via radio link to aircraft in flight and telephone link for flight planning.

FAA should continue present work towards the improvement of short-term forecasts, taking full advantage of the anticipated availability of an increased weather data base from automatic observation points.

FAA should develop a systematic means to sense or observe in-flight weather and incorporate the in-flight observations in the forecasting process, as well as distributing it for flight planning and execution.

Users feel FAA must improve the timeliness and forecasting of severe weather phenomena, such as thunderstorms, gust fronts and wind shear.

FAA should continue to improve weather data distribution, including the provision of direct accessibility to automatic weather sensors by telephone and radio to supplement higher capacity teletype circuits, modernization and automation of Flight Service Station functions, and any other appropriate improvements in information transfer.

E&D should be oriented toward developing the role of primary radar toward the detection and mapping of hazardous weather rather than aircraft tracking.

Finally, there should be formal review of and recommended improvements to the bifurcated federal bureaucracy responsible for weather research and development, weather sensing, weather information distribution, and perhaps, even weather modification. It is possible that this should constitute a legislative initiative.
(TG 3, 1.2.2; 1.3.2; 1.4.1 (9))

FAA Response

FAA has been working for some time on developing a capability for automated weather observations at airports not having trained weather observers. To date, FAA has evaluated two commercially developed systems capable of providing temperature, dew point, surface wind and altimeter setting. If these systems are located where remote altimeter setting is presently used, the MDA for instrument approaches can be lowered. One of these systems has been approved by FAA for use in making instrument approaches. The test of the other system has been completed and the evaluation is in process. A test of the Wind, Altimeter and Voice Equipment (WAVE) jointly developed by FAA and NWS has been successfully completed which will permit FAA to deploy seventeen systems in FY 1982, with a possible 85 systems by 1985. Finally, an Automated Low-Cost Weather Observation System (ALWOS) has been developed by the NWS under an FAA contract and will be tested at Dulles in early 1980.

If successful, one of the initial applications of the Data Link Program will provide a selected limited "menu" that will extend the accessibility of the FSS automation aviation weather data base to the cockpit. The pilot will request the desired weather information by a downlink request and the information will be automatically uplinked to him via the data link.

Another application being developed, Enhanced Terminal Information Service (ETIS), will provide real-time terminal-related data to aircraft via DABS data link. Such items as temperature, dewpoint, winds and other data needed by a pilot landing or taking off from an airport, will be available to the pilot in real time via the ETIS data link application. Initially, the pilot will be required to request the service at the appropriate point in his flight and to indicate if he desires automatic updates of the data. If he desires the updates, then these will be provided automatically by the data link.

A possible future expansion would automatically deliver ETIS to all aircraft in the terminal area with filed flight plans that indicate that airport as a point of landing. This service is being designed so that neither controller or pilot workload is increased. Also, capability is included to provide for downlink of in-flight weather sensed by airborne equipment. Future work will involve the automated en route delivery of real-time weather data based on flight plan and potentially hazardous conditions.

Several efforts are underway in the area of sensing in-flight weather. Some air carrier aircraft are participating in a joint NASA/DOC test of forwarding automated in-flight observations via satellite transmission. DOT's Transportation Systems Center (TSC) is conducting a study for FAA to determine what instrumentation is presently available aboard commercial aircraft, what additional sensors can be readily added, and the optimum means to transmit and collect the data. If this approach proves to be feasible, an airborne weather sensor unit will be designed and tested in an operational environment. NWS presently uses in-flight observations (PIREPS) in the forecasting process.

Aviation weather forecasting is a responsibility of the NWS. FAA is assisting NWS by funding a continuing effort to develop improved short-term forecasts of thunderstorms and associated hazards. The plan is to have short-term forecasts, now typically up to one hour, updated every ten minutes, for use by both pilots and air traffic controllers. This includes forecasts of gust fronts. NWS routinely forecasts low-level wind shear associated with fast moving frontal zones and low-level jet streams.

Low-level wind shear alerting systems are currently being installed at sixty major U.S. airports. The system uses anemometers near approach and departure ends of the runways to compare with center of airport winds and alerts the controllers whenever a significant difference indicates low-level wind shear is present. Controllers relay this information to pilots preparing for take-off or landing. This system will not detect all low-level wind shear. Testing of low-level wind shear detection by a pulsed Doppler radar will be conducted in the near future. These tests will determine the feasibility and limitations of modifying the existing terminal radars to provide for accurate real-time wind shear detection.

Extensive manned simulation experiments have shown that airborne solutions to the wind shear problem can be implemented. Flight testing of airborne low-level wind shear detection and warning systems are underway. An Advanced Notice of Proposed Rule Making (ANPRM) has been issued and comments received concerning the possible requirement for wind shear equipment in commercial large jet aircraft. A Notice of Proposed Rule Making (NPRM) is now being considered as a result of this work and the recent ANPRM.

FAA is proceeding with an FSS automation program. Details are delineated in the "Master Plan Flight Service Station Automation" January 1978.

Another facet of the weather program is the concept of direct user access. Users of aviation weather and aeronautical data will be able to obtain weather information directly from the FAA computers via telephone and/or computer terminals. They will also be able to file flight plans directly into the FAA computers. An ongoing demonstration of direct user access via telephone has received very favorable pilot acceptance.

Regarding interagency coordination, the Office of the Federal Coordinator for Meteorology has recently initiated, at Office of Management and Budget's (OMB) request, a number of "crosscut" analyses aimed at determining the common requirements of all of the various agencies involved with weather and determining the best government-wide approach to satisfying them. This will, hopefully, lead to more standardized systems, both hardware and software, throughout the government, thereby simplifying testing, design verification and implementation.

The Aviation Weather System (AWES) will evolve as an integral part of the ATC and FSS systems rather than as a parallel functional entity. It will use, wherever practicable, existing and planned ATC and FSS system components, elements, subsystems, facilities and resources in the collection, distribution, processing and dissemination of operationally significant weather information. This approach will tend to ensure the real-time availability of weather information to the various system users, e.g., pilots, controllers, FSS specialists and aviation meteorologists, with minimal implementation and operational costs. One of the critical design attributes of the AWES is the presentation of weather information to those users in a form, format and mode that is directly applicable in the operational decision making process. This should require a minimum of interpretation and/or analysis, and in no way interferes with the primary ATC mission relating to aircraft separation.

A systematic approach to enhancing aviation weather services was adopted to ensure the functional integrity and compatibility of each of the links in the weather information chain, from the basic sensor to the delivery of the operational product to the final user. There are four basic links in this chain, each of which is critical to total system effectiveness and efficiency. They are data acquisition, processing, communications and presentation/display.

Pilot presentation/display capabilities are limited due to the cost of avionics. With a functional AWES, significant weather services can be provided to a pilot in-flight. Continuous broadcast by computer (CWPC) driven voice generation systems will be implemented to supplement En Route Flight Advisory Service (EFAS). For DABS equipped aircraft the display potential is, of course, much higher. CRT (alpha/numeric or graphic) display is feasible, as is a printer.

27. Alternate Separation Procedures

Since airspace has a large range of traffic densities, it is reasonable to suppose that ATC concepts may differ in various portions of the airspace, and these different ATC concepts may expedite traffic without compromising safety. The users have named one such concept Electronic Flight Rules (EFR). EFR are procedures that should be an objective of an E&D program. In regions where DABS coverage is available, EFR would permit a DABS equipped aircraft to fly in IMC

where traffic densities are light without necessarily filing any, or a complete flight plan, since aircraft intent in this airspace may not be needed at all times to provide separation safety. There would be no limitation to the use of this same airspace in IMC by aircraft operating under IFR procedures with no additional equipment. EFR procedures in the DABS environment should be evaluated. Extensions of EFR to the current ATCRBS environment and to non-surveilled airspace using airborne collision avoidance systems or low-cost extensions to the DABS ground environment should also be investigated.
(TG 3, 1.5; and 2.4.2)
(TG 4, 3.8)

FAA Response

FAA has been conducting a program to investigate alternative separation concepts with the objective of achieving the equivalent of VFR operation in mixed airspace under IMC conditions. The basic purpose is to enhance freedom of flight and to permit those who choose not to participate in the ATC system to retain the highest possible amount of freedom to do so without jeopardizing safety.

Solutions to this problem are not easily achieved. For example, a ground-based system using DABS only would be applicable in areas of DABS surveillance. An airborne approach based on BCAS would in effect eliminate non-transponder-equipped aircraft from participating in procedural IFR in areas with no surveillance. Cockpit displays of nearby traffic of concern may have value if a feasible airborne or ground-based cost-effective information source can be found.

FAA is actively seeking suggestions to pursue this effort fruitfully and expects to advise the user community of progress as the work proceeds.

28. Increasing Airspace Availability

Users proposed E&D initiatives that could make airspace more readily available. For example:

a. Improve communications between and within Federal agencies and improve identification of responsibility to optimize the joint use of special use airspace. Make appropriate and timely information available at all centers.
(TG 3, 1.3.3)

b. The regulatory responsibility for the control of man-made obstacles should be reviewed. There should be a better balance between use of airspace for the transit of aircraft and the use of airspace for other purposes. For example, respresentatives of the aviation and broad-

casting industry might be called upon to propose mutually satisfactory guidelines for tall tower construction with respect to navigable airspace. Furthermore, reduced obstruction clearance limits might be authorized provided improved navigation accuracies can be demonstrated for those aircraft willing to install more expensive equipment. In any case there are opportunities for improving the visual or electronic marking of obstructions. Guy wires, for example, are inadequately marked and never lighted.
(TG 3, 1.3.1)

c. Users considered a number of alternative plans to relieve the coverage and accuracy constraints of the present navigation system and concluded that hasty replacement of the international standard short-range navigation system of VOR and DME would be a serious strategic error, as its replacement system or the need for it is not now evident, either as to type or timing. There are obvious advantages to a satellite based system if cost-effective, but this is yet to be demonstrated. While an optimum satellite based system is being evaluated, it is vitally important to pursue E&D initiatives to take full advantage of the capability of the existing VOR/DME.
(TG 3, 1.3.5)

d. Users suggest FAA should undertake technical and operational initiatives to utilize more efficiently flight levels above 29,000 feet. The required altimeter accuracies should be determined to provide equal or better safety with vertical separations of less than 2,000 feet. The capabilities of existing air data systems to provide the needed accuracies should be assessed. In particular, FAA should test sample and quantatively determine the current 2-sigma and 3-sigma deviations in altimetry error existing above FL 290 for aircraft with and without air data computers; FAA should develop, test and publish methods and techniques and Minimum Operational Performance Specifications (MOPS) which would permit 1,000 feet vertical separation above FL 290; FAA should designate airspace (routes) where equipment meeting MOPS standards would be authorized 1,000 feet vertical separation above FL 290.
(TG 3, 1.3.5, 1.5)

FAA Response

FAA agrees that there is a need to improve communications between agencies in the management of airspace to optimize joint use of special use airspace. Through FAA/DOD working groups, FAA ATREPs, military FAA liaison officers in each command and ARTCC/ATCT military representatives or working

groups, FAA is continually searching for ways to improve communications. For example, FAA has entered into a joint FAA/DOD project to optimize civil/military use of the eastern California R-2508 restricted area. This project involves the development and installation of an ATC automation system (MT DARC) at Edwards AFB, and the deployment of additional long-range (ARSR) and short-range (ASR) radars to improve radar coverage in this area.

On June 13, 1978, FAA announced a Regulatory Review Program of Federal Aviation Regulations, Part 77, Objects Affecting the Navigable Airspace. A conference was held in Washington, D.C., on December 4-8, 1978, to provide a forum for all interested persons. The results of this review will be reflected in Part 77 NPRM presently being written, and will be issued about March 1980. With reference to "limited authority", FAA has adequate existing authority. The intent of Part 77 is not to control structures but provide FAA the authority to assess their potential impact on navigable airspace and adjust aeronautical operations and procedures if necessary. This is enabled by requiring notice of proposed construction or alteration of a structure. The inherent large granularity in the identified geographical positions of unsurveyed obstacles in the system would probably not permit FAA to reduce current obstacle clearance criteria. However, improvements in airborne navigation could lead to less stringent obstacle clearance criteria along the final approach course in the airport traffic area. (Note: status accounting and determining the geographical positions and elevations of obstacles is a statutory responsibility of the National Ocean Survey (NOS).)

Additionally, FAA believes that pilots should use aeronautical charts and be aware that guy wires are an integral part of a tower. Furthermore, the AIM and charts caution pilots about guy wires associated with tall structures.

Lastly, FAA foresees no hasty replacement of VORs or VOR/DMEs resulting from any breakthrough in satellite navigation system technology.

FAA concurs with the recommendation that work should be initiated to evaluate the use of reduced vertical separation (less than 2,000 feet) above FL-290. Engineering studies are needed to determine:

1. Actual measurements of performance of aircraft in height-keeping in the current system.

2. Economic benefits to be realized as a result of a separation reduction.

FAA recognizes that the user community has, for many years, been working on the implementation of improved altimetery systems. As the study of this problem proceeds, full advantage will be taken of these improvements.

One major difficulty is that no recent data exists on absolute altitude performance, either in terms of altimetry system performance across the fleet or on height keeping performance. A test program has been developed to gather such data, but it is an expensive program and the work has not yet begun. FAA will be discussing this problem internally, and with users and other agencies (DOD and NASA) and it is hoped that work can commence soon.

29. Improving ATC Communications

Users felt that most of the constraining aspects of voice communication in the National Aviation System will respond only to a multiplicity of small procedural and publication reliefs. Eventual complete relief of the coverage constraint will await the economic feasibility and development of satellite based communications with the strategic planning and scheduling cautions similar to those recommended above applied to the development of satellite based navigation. Improvements in speed, accuracy and reliability of communications, from whatever terrestrial or extraterrestrial source, will be small until FAA begins the conversion process to digital communication techniques. The advent of DABS data link capacity provides the first significant opportunity to define the optimum format and functions which lend themselves to digital communication. Studies should be conducted to establish the importance of "party-line" peripheral communications and the impact on safety and capacity if digital "private-line" communications are substituted. Optimum mix between broadcast information and discretely addressed or accessed information, particularly in the dissemination of weather data, should be assessed.

More use should be made of published procedures, such as conventional and RNAV SIDS and STAR, rather than ad hoc, or radar vector navigation by controllers. It should be possible to use both systems to their optimum advantage, but not be rigidly cast in the use of published procedures where radar vectors make more efficient use of airspace or vice versa.

Communications are essential to the ATC system and users proposed the publication of a national aviation communications plan that would include the funding, equipment, manpower and timetable necessary to upgrade the entire aviation voice and data communications network, air-to-ground and point-to-point with particular attention to techniques for reducing mutual interfering VHF communications and for identifying VHF communication coverage deficiencies. This plan should include modifications to communication procedures that would reduce congestion and enhance safety, including simplified flight plan filing. The plan should also include the results of evaluations to determine the optimum mix between "party line" broadcast information and discretely addressed information. (TG 3, 1.3.7)

FAA Response

FAA agrees that there is a need to improve air/ground communications and increase the use of standard arrival and departure routes (SIDS and STARS). The former should be significantly improved by planned systems, such as DABS/Data Link, Automated Air Traffic Information Service (ATIS), ATARS, and the increased equippage of aircraft with communications equipment capable of 25 kHz frequency separation. The latter is being addressed through increased use of SIDS and STARS in our major terminal areas where beneficial.

30. Special Requirements of Helicopters

Operational requirements for helicopters frequently favor low cruising altitudes to avoid headwinds or icing conditions and optimum fuel conservation. This imposes a need for low altitude coverage of communication, navigation, and surveillance signals so that helicopter operators may enjoy the full benefits of participation in the ATC system. There may be areas where such coverage is justified hundred of miles out to sea, or down to the surface of certain areas of land or water.

Since many of the helicopter missions will be over low density routes to infrequently used destinations, ATC services by line of sight station referenced systems will not always be justified. Communications beyond VHF coverage will need to be supplemented, perhaps with HF or eventually satellite-based area coverage. Navigation service beyond the range of line of sight facilities can be supplied by VLF/Omega, LORAN C, or satellite-based systems as appropriate. In areas where surveillance coverage is not feasible, procedural separation should suffice for adequate ATC management.

Because of the shorter range of the helicopter mission and the need to land almost anywhere, RNAV offers even more dramatic benefits than it does to fixed wing aircraft. But the coverage limitations of VHF station referenced navigation signals make helicopter operators strong advocates of a high accuracy system with global coverage, providing RNAV without the need for point-reference navigation aids. The accuracy of en route navigation should be adequate for standard IFR operations and capable of supporting route widths of two nautical miles or less each side of centerline where necessary.

The navigation need for helicopter instrument approach and landing is uniquely different from that for conventional fixed wing aircraft. Efforts to adapt the helicopter flight characteristics to a conventional ILS approach procedure constrains both the helicopter and the conventional traffic flow. Alternate or supplementary precision approach guidance such as that offered by the high selectable glideslope angles of MLS will assist in relieving this constraint. At

remote sites unique to helicopter operations special portable or low-cost landing aids, such as airborne radar used with reflector arrays or heliport transponders, should be developed and standardized.

In brief, the users requested FAA to select and test technology and procedures to improve the communication, navigation and surveillance coverage for helicopter low altitude IFR operations.
(TG 3, 1.5; and 2.9)

FAA Response

FAA concurs with the users' statement of special requirements for helicopters. Our Helicopter Operations Development Plan (Report No. FAA RD 78-101), implemented in September 1978, is being pursued. The overall objective of this development plan is to improve the National Airspace System so as to enable helicopters to employ their unique capabilities to the maximum practical extent. Major issues addressed in the plan are:

1. Communications: The methods by which information is conveyed between air and surface elements of the system must be identified where the communications link extends beyond the line of sight. The data transferred will include not only clearances, position reports, etc., but will likely include unique weather information critical to safe flight also.

2. Navigation: Determination of the optimum means for accurate positioning when operating beyond the line of sight limitations of the VHF standard navigation system is most important. Data is being collected on various forms of RNAV for accuracy of current position and with respect to terminals, waypoints, landmarks, rigs, etc.

3. Surveillance: This is a concomitant requirement with navigation involving identification of the means of surveillance by which ATC will maintain knowledge of aircraft position within the system when operating outside of radar coverage.

4. ATC Procedures: New ATC procedures and special routes need to be investigated to encompass navigation and communication capabilities and unique helicopter characteristics. VTOL/CTOL mix problems must be studied and determination must be made of requirements for protected airspace.

5. Weather/Icing: It is necessary to determine the applicability of present weather data to all-weather helicopter operations and, where appropriate, to develop the means for satisfying new requirements.

6. Certification: Data packages developed in the program, will contribute to new certification criteria which may be developed for helicopter IFR certification and operation.

The Administrator has reestablished the FAA Helicopter Operations Task Force to provide a focal point to all agency helicopter programs and activities. The task force will monitor and coordinate E&D activities with users, offices and services, and the regions.

User Comments on Freedom of Airspace

National Business Aircraft Association (NBAA) generally agreed with the E&D initiatives in this area, placing special emphasis on problems associated with obstructions, on the need for improved weather information, on greater use of RNAV, SIDS and STARS, on E&D to permit 1,000 feet separation above FL 290, on the continued development of DABS, and on EFR.

Aircraft Owners and Pilots Association (AOPA) had a number of specific problems with certain recommendations in this area. While in favor of automated weather observations, they would object to any interpretation of this recommendation that would automate all weather observations. While in favor of E&D oriented toward developing the role of primary en route radar toward the detection and mapping of hazardous weather rather than aircraft tracking, they are not prepared to drop an aircraft tracking mode. While supportive of greater use of RNAV, they do not necessarily support the FAA RNAV policy. They feel designated direct routes destroys the flexibility of RNAV and would prefer that FAA develop a master matrix for RNAV based on latitude and longitude for filing and handling by FAA's computers. AOPA is generally fearful of recommendations that are phrased "develop, test and implement", presumably feeling that they wish to review the development and testing results before agreeing to the implementation.

Air Transport Association of America (ATA) generally accepts the users' consensus in this area with a few recommendations. They feel that when integrating an Electronic Flight Rule (EFR) program, it is necessary to ensure that EFR should not interfere with expansion of ATC, as necessary for safe conduct of future flight operations. ATA also suggests that references to the need for improved navigational accuracy everywhere in the March 1, 1979 consensus report should be deleted or limited to rotary wing aircraft operations. ATA also indicates that altimetry is not deficient in all aircraft and therefore some of the recommendations in the March 1, 1979 report having to do with Minimum Operational Performance Standards (MOPS) to permit 1,000 feet vertical separation above FL 290 could be strengthened.

Air Line Pilots Association (ALPA), referring to that part of the March 1, 1979 E&D Initiatives report that dealt with "Freedom of Airspace" -- when it was asked, "Are there additional programs that FAA should undertake?", has responded positively. They suggest FAA investigate the feasibility of Slant Visual Range (SVR) measurement. Previous R&D efforts were cancelled prior to completion to make the funds allocated available for the higher priority wind shear program. ALPA claims SVR is needed for Category II operations for safety and economic reasons since 8-10 percent of Category II approaches result in missed approaches and a significant number of these are caused by SVR being less than RVR.

The Helicopter Association of America (HAA) is satisfied with the recommendations of the users in this section.

General Aviation Manufacturers Association (GAMA) agrees fully with the users' recommendations in this section dealing with improving weather collection, forecasting and dissemination programs, and with increasing general aviation airport capacity in metropolitan areas.

The Airport Operators Council International (AOCI) objected to the users' recommendation that regional airport system implementation be a prerequisite for ADAP funding of hub airports. They say, "Such a recommendation ignores the jurisdicational and institutional realities of most airport hub areas, where reliever airports are not necessarily owned or operated by the governmental entity that operates the major air carrier airport. It is implicitly unfair, and certainly unproductive, to hold the use of trust fund monies at an air carrier hub airport hostage to the accomplishment of an extremely difficult task of interjurisdictional integration. While AOCI strongly supports the development of reliever airports, there are jurisdictional realities which preclude the course of action suggested in the report."

Boeing questioned the use of EFR under IMC, claiming that IFR and VFR traffic today in mixed airspace poses an undesirable collision risk. (FAA, however, understands the users' view is that the EFR concept would reduce risks under VMC and have safety under IMC comparable to present practice.)

V. SAFETY

Users evaluated safety issues with great care in the New E&D Initiatives process and made the following eight general recommendations:

31. Safety Impacts of Human Performance

Human performance is clearly the largest general category of safety concern in the operations of all segments of the aviation industry. Actions of the pilot are cited more than any other factor in accidents of all types of aircraft. The FAA E&D progress in this subject area has been inadequate historically. Present E&D planning appears to recognize the relative importance of this issue, however, it is not clear yet whether E&D has truly made the necessary commitment for this critical research. Priority treatment is urged.

FAA Response

As indicated in earlier responses, FAA is aware that "pilot errors" are cited more than other factors in accidents of all types of aircraft. FAA has undertaken human factors research over the years, usually associated with specific projects. Scientists at the Civil Aeromedical Institute (CAMI) and at NAFEC conduct research designed to improve the performance of pilots and air traffic control personnel and to maintain the safety and health of air crews and passengers.

FAA also recognizes that human factors considerations must enter in the early phase of equipment and system design, that relates to aircraft systems and the air traffic control system. Two E&D programs have been initiated for Air Crew Performance Enhancement and Error Reduction (APEER) in the operation of aircraft and Controller Performance Enhancement and Error Reduction (CPEER) for operation of the ATC system. Because human factors research in aviation is widely conducted by NASA, the military and universities, FAA coordinates its efforts with these organizations and cooperates in several of their specific projects. Work related to medical and physiological aspects of human safety is conducted by the Office of Aviation Medicine.

The recently established Office of Aviation Safety will serve as the focal point for all issues relating new technology to aviation safety. That office will work closely with all other FAA elements to assure that a fully coordinated and responsive agency program exists in any of these areas which may relate to aviation safety.

While FAA has mostly focused on the human engineering part of the problem, there still remain other tasks which have to do with behavioral and psychological factors, such as motivation and morale of the monitor of highly automated systems, cockpit discipline, flight crew compliments, and task allocation in present and future aircraft. Since they also affect flight safety, FAA has conducted surveys and research in these areas and will continue efforts which deal with this difficult part of the human factors problem.

Among the efforts underway in both the air carrier and general aviation category, the following examples deserve to be mentioned -- human engineering aspects of cockpit alerting devices, head-up displays and cockpit displays of traffic information, cockpit information requirements involving air traffic control information, collision avoidance systems, pilot workload assessment, and optimum approach and landing aids. Moreover, FAA is sponsoring experiments aimed at reducing human error in weather related accidents.

32. Safety Impacts of Availability of Accurate and Timely Weather Information

The most important safety issue relative to general aviation operations is the availability of accurate and timely weather information for the pilot. This same issue is a major concern for all other segments of the aviation user community as well.

FAA Response

FAA concurs. FAA and NWS are jointly undertaking efforts to improve the quality of aviation weather information. FAA has efforts underway designed to improve the availability of weather information, first, by collecting weather information at more airports, and then by improving weather dissemination to pilots, either through an FSS specialist or by direct access, if desired. Additional efforts are underway to improve the quality and availability of aviation weather information to air traffic controllers so they may better serve pilots. Details of these programs are discussed in the FAA response to Recommendation 26.

33. Safety Impacts of Allocation of E&D Resources

Allocation of E&D resources must be made in a manner which produces the largest incremental safety gain for the associated resource investment. This cost/benefit consideration must be tailored to each segment of the aviation community. The proper cost/benefit criteria are not constant among the various user groups, but depend upon the acceptable risks and burden of costs associated with each.

FAA Response

FAA agrees that cost/benefit analyses should be one of the bases for allocating R&D resources for safety related programs. New programs implemented as a result of R&D efforts generally will effect benefits in several areas. Increased capacity, improved system efficiency and improved productivity, as well as improved safety, can all flow from a specific R&D investment. Thus, the totality of benefits of all kinds are considered when making resource allocation decisions. FAA agrees with the suggestion that R&D resources should be allocated in a manner that gives heavy weight to incremental safety gain for the associated resource investment.

In keeping with the above philosphy, two key mechanisms within FAA explicitly consider cost/benefit analyses that can affect R&D investments. First, a System Acquistion Management (SAM) process for major FAA development, facility establishment and modernization programs. One of the first steps in the SAM process is the definition of mission needs. These mission needs are documented in a System Requirements Statement (SRS) which is an authorization by the Administrator to proceed with development. Cost/benefit, engineering economic analysis and assessment of technical risk are basic foundations for an SRS. The analysis covers all potential benefits of the program -- safety, capacity, efficiency and productivity. Each segment of the user community is considered in the overall analysis. The SAM process also provides for substantial consultation with industry, system users and the general public before key decisions are made.

Second, a continuing assessment of E&D activities, their prospects, and their benefits, is done in an internal project priority review within the E&D organization. This is a process intended to continually examine the priorities of the E&D program, again from the perspective of the basic goals of the E&D program that relate to the achievement of safety, capacity, efficiency and productivity.

34. Safety Impacts of Increased Automation

Increased automation, while offering many potential benefits in areas of efficiency and capacity, and perhaps safety, also introduces a high level of complex interfaces between human beings and computers in a real time and often critical environment. There are many safety issues which must be comprehensively addressed prior to implementation of major automation concepts.

FAA concurs. The human interface with automated systems has been discussed in Recommendation 11.

35. ATC Responsibility for Weather Avoidance

The development of the future ATC system must include the requirement that the ground element of the ATC system accept a portion of the responsibility for separation of aircraft from weather which may be hazardous to flight.

FAA Response

While FAA understands the users' wish that the ATC system accept a portion of the responsibility for separation of aircraft from weather which may be hazardous to flight, FAA cannot concur in full with this recommendation. While a number of efforts are underway to improve the level of knowledge, understanding, and dissemination of weather information, there are likely to be circumstances in which information available on the ground is of less value than information available in the aircraft itself, and therefore, acceptance of responsibility, at least in the legal sense, would not appear to be appropriate.

However, FAA has a series of programs to improve the detection and dissemination of weather. These are discussed in the response to Recommendation 44. In addition, efforts to detect and warn of wind shear and wake vortices provide a basis for providing information with respect to hazardous phenomena. Further, FAA has developments underway to provide automated weather information in a number of its programs, including the Flight Service Station Automation Program and other weather dissemination programs. FAA is planning for information to permit separation from severe weather to be included in the AERA and Integrated Flow Management efforts. Finally, the use of the DABS data link to make real-time severe weather information available is a part of the DABS data link development program.

36. Additional Simulation Needed - ATARS, BCAS, CDTI

There has been insufficient real-time operational simulation and evaluation of the BCAS and ATARS backup separation assurance concepts. Simulations are required to answer a variety of questions concerning the actual operation and interrelationship of ATARS, BCAS, CDTI and others, as well as detailed examination of various failure modes under realistic operational conditions.

FAA Response

Extensive real-time simulations of BCAS in operational environments, for Knoxville and Chicago, have been performed at NAFEC and the reports will be available within the next few months. In addition, a comprehensive flight test activity for active BCAS will be underway at NAFEC beginning in January 1980. ATARS testing will include extensive flight testing, as well as real-time simulation testing for purposes of evaluating ATC interactions beginning in 1980. Comprehensive analyses of ATARS and BCAS have been conducted, and software programs developed to assure compatability. Flight testing will be conducted.

A joint FAA/NASA effort is underway to investigate the advantages and disadvantages of CDTI through simulation and actual flight testing. Interactions between CDTI and other systems will be a prominent part of this examination.

37. Safety Impacts of Primary Radars

The role of primary radar and the plan for development and installation of DABS should be reviewed in light of the users recommendations that primary radar emphasize weather information rather than aircraft detection.

FAA Response

This issue is responded to under Recommendation 45.

38. Safety Impacts of E&D on Approach and Landing

Approximately 50 percent of fatalities are associated with the approach and landing phase of flight. More E&D effort should be expended in this general area. The problems associated with low visibility have been brought out and should receive more E&D since accident rates in Category I conditions are very high in relation to those associated with VMC.
(TG 4, 9.1)

FAA Response

FAA agrees and is spending considerable resources on reducing the incidence of approach and landing accidents. During the approach and landing phase of flight, an aircraft is in its most vulnerable position, in that it is configured for landing, flying at low altitude and speed and is in immediate confrontation with the weather, i.e., fog, wind shear, precipitation, storms, etc.

Previous regulatory action required that airborne ground proximity warning systems be installed on all large turbine powered aircraft. This system provides an aural and visual signal directly to the pilot when his aircraft is dangerously low or is rapidly approaching an unsafe altitude.

A minimum safe altitude warning system (MSAW) has been installed at the major terminals. This system provides automatic detection when it is too low within the terminal area. It alerts the pilot via the controller.

Analyses of weather-related accidents have clearly shown the value of precision approach and landing aids, visual and electronic, in enhancing landing safety. It is also widely agreed that increased use of automatic landing would increase safety.

Current efforts are aimed at development and standarization of ILS antennas for reducing the cost at difficult installation sites. Developments are underway to improve lighting systems that are less costly to install and maintain.

The MLS program, so far, is expected to reduce site installation costs, provide high availability and allow flexibility in the selection of flight paths, guidance to runway threshold, and may help reduce problems at airports that have not been equipped with a precision approach and landing system.

The area navigation system (RNAV) will help improve safety by providing better navigation reference during nonprecision approaches to non-ILS equipped runways. The degree to which RNAV might contribute to improved air safety is now being considered.

An evaluation to determine the benefits of a head-up display to be used as an approach and landing aid, as well as to provide improved vertical guidance in reduced visibility conditions is currently underway.

Guidelines for standardizing air transport cockpit alert/warning systems are being evaluated. Such systems may provide safety benefits in newly designed transport aircraft.

The development of ground-based air-derived, and forecasting system to detect wind shear is a major program for reducing approach and landing incidents. See FAA response to Recommendation 26.

39. Pilot and Controller Confidence in Automation

Pilot and controller confidence in automation is crucial for automation to benefit productivity. Therefore the primary air traffic control system must be designed with extraordinary reliability. The E&D program must deal with the identification and development of failure protection and backup capabilities which will provide substantial improvement in reliability as compared to today's system. This E&D program should include an effort which is independent of the automation design team and has the continuing mission of looking for and characterizing possible failure modes, i.e., trying to "break the system".

The backup reliability effort should include consideration of the following concepts:

a. The automation should be designed so that the air traffic controller who is supervising the traffic situation is able to provide backup ATC services to maintain safety even though these backup systems may not be as efficient as the first line of ATC. This backup system should

include monitoring and planning aids on displays driven by hardware and software which is independent from the main automation system.

b. Automation should have the capability of providing the pilot with traffic and runway occupancy information should this prove desirable to improve system reliability and to expedite traffic.

c. ATARS should be the collision prevention backup for DABS-equipped aircraft within DABS ground station coverage. Active Beacon Collision Avoidance System (BCAS) should provide collision prevention backup outside of DABS ground station coverage, or in the event of a DABS ground station breakdown. Further development of BCAS is warranted to provide backup aircraft separation assurance for a full range of traffic environments. The performance of ATARS and BCAS under Instrument Meteorological Conditions (IMC) and Visual Meteorological Conditions (VMC) in terminal environments should be more fully evaluated to determine their interaction with current procedures. The transition from ATARS to BCAS for backup protection when leaving DABS ground station coverage and possible mutual reinforcement of the two systems within DABS ground station coverage should be more fully investigated.

d. Adjoining facilities should be equipped to provide backup control for each other. The ground system should be required to continuously compute and update a set of backup clearances to be either stored in the aircraft or ready for transmission via data link.

e. Simulated failure training exercises for air traffic controllers and pilots should be part of the process for maintaining proficiency in dealing with failures.
(TG 1, 5.2 (3 and 4))

FAA Response

The future replacement systems will be designed to include backup provisions to assure availability of essential ATC information to the controllers. However, it is not yet certain that a backup system "which is independent from the main automation system" is the best approach. Work is underway to establish an overall system architecture which meets the spirit of the recommendation. However, the backup system for the conflict alert function is quite independent of the ARTCC, consisting of ATARS and BCAS.

If a firm operational requirement is established to provide pilots with traffic and runway occupancy information, it should be possible to do so using technologies

now under development. The future DABS system and ARTS III will both contain surveillance data on airborne traffic which could be sent via DABS data link to properly equipped aircraft. The future surface traffic control output could also be transmitted to the cockpit via data link. While the technology may be capable of providing airborne traffic and runway occupancy data to appropriately equipped aircraft, implementation of this capability would require economic justification and a firm statement of operational needs.

As described in response to Recommendation 36, extensive operational evaluations of BCAS and ATARS are planned. These tests will include the validation of the logic and algorithms for coordinating ATARS and BCAS at the boundaries of DABS ground station surveillance volumes.

FAA expects to provide proficiency training in failure modes, as well as normal operations for air traffic controllers in future systems. Federal Regulation, Part 61, on pilot certification, deals with pilot proficiency. In addition, Federal Aviation Regulation, Part 121, on air carriers, and Part 135, on Air Taxis, deal with pilot proficiency.

40. Human Performance and Interface with Avionics and Ground Equipment

Human performance and interface with evolving ground and airborne equipment requires E&D beyond current FAA efforts so as to maintain safety levels while improving productivity. E&D should define the needs of a controller to manage an automated control process and to maintain proficiency and alertness. Pilot actions are cited more than any other factor in accidents for all aviation sectors. Nevertheless, additional cockpit information may be valuable to achieve closer separations, expedite traffic, and monitor automated clearances. The following specific E&D activities were recommended by users:

a. Design of input/output devices in the cockpit which minimize pilot interpretation errors and input blunders should be examined. The fundamental human factors concepts associated with such designs should be explored by NASA and industry, as well as FAA, but all should have the support and the guidance of FAA to ensure applicability to the actual aviation environment.

b. The question of appropriate level of direct human involvement in the air traffic separation or navigation function, versus the level of human monitoring should be given more emphasis. The users were unable to reach specific conclusions or recommendations due to the limited amount of relevant information presently available. The optimum use of human capability and techniques for minimization of opportunities for human error must be better understood.

c. There should be additional real-time simulation and operational evaluation of ATARS and BCAS systems in an operational environment to assess their ability to provide backup against pilot or controller errors.

d. Work must establish the tolerance of the overall system design to human error, and the achievement of system safety under backup separation operations caused by human blunders.

e. The degree to which pilots can or should be involved in the air traffic separation process is an important issue in the development of the future ATC system. The display of traffic information in cockpits which might support increased pilot participation raises many fundamental questions which should receive priority E&D attention.

f. A specific E&D program to examine the possible safety impact of lost voice communications associated with certain uses of data link should be identified and given priority consideration.

g. A specific E&D initiative should be identified which will examine the potential safety benefits which can be realized through improved pilot training.

h. What is the importance of motion to the training of various flying maneuvers and for the various skill levels applicable to each segment of aviation? How can a minimum standard of simulator capability be established for the various levels of pilot training that achieves appropriate safety goals in the most cost-effective manner?

i. How can visual simulators be classified to relate the information content of the visual scene to the various training objectives? Included in this examination should be questions of simulated visual illusions, disorientations, distortion by precipitation and other real world visual problems. Guidelines should be developed which can form the basis for simulation certification and approval.
(TG 4, 9.2 (3, 4, 6, 7, 12, 13, 14))

FAA Response

a. FAA agrees with much of this recommendation. The minimization of pilot error in data interpretation and reaction continues to be a major concern for new design. FAA has initiated a study with industry to determine future cockpit information requirements in the evolving ATC system. This analysis will assess the impact of new technology on cockpit design. Safety aspects will be considered. This study will

assess the requirement for input/output devices in the cockpit and opportunities for design standardization guidelines. FAA will continue to provide direction and support to NASA and the industry so that collectively we can reduce aviation accidents attributable to pilot error. Additional discussion can be found in FAA's reponse to Recommendation 31

b. FAA agrees. Refer to FAA's reponse to Recommendations 2 and 11.

c. FAA agrees. Refer to FAA's response to Recommendation 36.

d. FAA agrees. FAA's responses to Recommendations 2 and 39 are applicable to this recommendation.

e. FAA agrees. The issue raised in this recommendation represents one of the areas to be considered in FAA's CDTI program.

f. During the next fiscal year FAA plans to initiate a study to examine the possible safety impact of lost voice communication ("party line") associated with data link. This study will include, but not be limited to (1.) pilot information about other traffic in his vicinity; and (2.) information of hazardous weather in both a full data link environment and during the transition phase. This will include simulation activities to verify the findings of the study. See FAA's response to Recommenation 9.

g. A project entitled "Civil Pilot Judgment Training and Evaluation Syllabus" is scheduled for completion in 1981. It will evaluate improvement of student pilot performance and predict the level of safety benefits that may be expected with introduction of the syllabus into the National Pilot Training System.

h.-i. FAA, in its study leading to NPRM 79-18, determined the value of motion assist as it pertains to each specific aircraft maneuver. A minimum standard of simulator capability was determined. FAA believes it is not necessary to repeat studies in this area.

41. Surveillance as it Relates to Safety

Users suggested that E&D resources on issues related to primary radar should be expended in accordance with the following:

a. Fulfilling future aviation weather information requirements should not depend upon present FAA primary en route radar.

b. E&D programs for ATC en route radar development should recognize the preminence of weather performance and coverage as their objective.

c. Procedural non-radar separation should be continued as an alternative to beacon-based traffic separation.

d. Development of en route traffic surveillance capability should emphasize coverage which provides optimum ATCRBS and DABS service.

e. Improvements to the en route beacon-interrogator surveillance system should concentrate on modifications which might provide a more cost-effective surveillance and aircraft separation service. For example, in certain regions higher update rates may be needed.

f. The long range plan to reorient en route primary radar service as set forth above should be reviewed by the aviation user organizations.

g. FAA E&D efforts to develop airport surface traffic surveillance should include both primary (ASDE) and secondary radar techniques. Interrogators at multiple sites may be needed to provide coverage and might not be colocated with primary radar (ASR) antennas and might be based on electronically rather than mechanically scanned antennas. (TG 4, 9.2 (1))

FAA Response

a. An FAA task force is considering the future potential of en route primary radar; one major area of concern is the availability of adequate weather data if en route primary radar for target detection were eliminated. FAA agrees with the need to provide improved weather information and is actively pursuing programs to improve it. A test is now underway at the Atlanta center using NWS radar information so that its value may be determined. If the additional information is sufficiently useful, steps will be taken to use the NWS facilities operationally for near-term application. See FAA's response to Recommendation 45.

b. An investigation that compared the performance of FAA's en route radars, when optimized for weather returns, to that of the NWS's WSR-57 radar has been completed. The results of this effort indicated that the en route radar systems could be modified with a new weather receiver and processor to provide calibrated weather data, except for height data. The better approach, however, is joint development of a

next generation weather radar by the USAF, NWS and FAA. Response to Recommendation 44 and 45 will discuss this matter further.

c. FAA agrees and intends to continue to provide non-radar separation as an alternative to radar and/or beacon-based traffic separation. The capability to provide non-radar separation in areas not having radar or beacon coverage, and as a backup during failure of such coverage, is necessary to ensure safety. With regard to provision of non-radar separation in areas having radar or beacon coverage, certain areas (above 12,500 feet and Group I and II TCAs) require a transponder. In these areas non-radar separation is used only as a backup in case of equipment failure. It is possible that, if traffic continues to increase, additional airspace will require transponder carriage. Any such change would go through the rulemaking procedure and adequate opportunity for comment would be provided.

d. FAA agrees. A substantial improvement in ATCRBS surveillance performance can be realized through proper siting of the ATCRBS or DABS antenna. With automation now relying primarily on beacon surveillance data, care is being taken to select sites for new installations that optimize coverage and ATCRBS and DABS performance within the constraints of available land.

e. FAA agrees and has developed a back-to-back antenna for en route surveillance and aircraft separation service application. The new antenna configuration is undergoing test and evaluation at NAFEC. The back-to-back antenna doubles the update rate of current operational en route ATCRBS or DABS radars.

f. FAA agrees. A decision to reorient en route radar service in accordance with these recommendations could result in a major system change and FAA would solicit user comments and views.

g. FAA concurs with this recommendation. E&D programs are in progress to develop the recommended capabilities, namely, ASDE-3 for primary radar surveillance of surface traffic and the secondary radar multilateration techniques.

42. <u>The Need for Data and Realistic Safety Standards</u>

Blind reliance on arbitrary goals or safety standards untutored by data or validated models is likely to be counterproductive. For example, the goal for automatic systems is ten million landings per accident. The reliability standard for autoland subsystems was derived from this goal to be one failure in a billion

landings. During the period 1964-1975, approximately 11,000 landings per accident were achieved under CAT-I conditions while making manual precision approaches. If all necessary requirements for use were satisfied, an automatic system capable of one million landings per accident would have provided a reduction by a factor of one hundred for CAT-I accident rates and a reduction by a factor of ten in accident rates for all IMC precision approaches. Autoland would probably have been more widely utilized with this apparently decreased but adequate reliability, since it would have been available at lower cost. Thus, paradoxically, excessively high numerical goals can derogate safety. Similarly, certification to numerical safety levels derived from unvalidated models is a futile exercise. E&D should be devoted to gathering the data necessary to validate models, so that safety and cost/benefit analysis is not a mathematically sterile excerise, but is illuminated by technical and operational experience.
(TG 4, 2.2.; and 9.1 (8))

FAA Response

FAA agrees, in part, with this comment. As a part of continuing evaluation and development of safety standards, FAA assesses risk criteria, costs and benefits to be derived as a result of proposed rules, regulations and standards. This is an iterative process, in that no single, inviolate criterion can be made to fit all circumstances. The FAA sponsored study on precision and non-precision landing accident rates, as a function of ceiling and visibility, is an example of one such study which FAA has conducted to assist in development of realistic safety standards.

With respect to certification to numerical safety levels, FAA is aware of the issues raised by the users, and will continue to review, clarify and validate the uses and limitations of numerical safety probability estimates.

43. Landing Aids

Users have recommended that FAA pursue an extensive program to implement landing aids when developed and to develop additional capability where needed. This program, aimed at reducing landing accidents, is described here:

a. Substantial E&D resources should be allocated toward development of truly low cost landing aids for general aviation airports.

b. There is general agreement that increased use of coupled approaches or autoland systems can enhance safety. Several operational factors characteristic of today's ATC system, as well as equipment limitations, particularly in older aircraft, preclude use of coupled approaches when they would otherwise be appropriate. An E&D initiative should

investigate ways to minimize these constraints to additional use of coupled approaches.

c. E&D should examine the issue of critical weather information availability in the cockpit during the approach. Methods for directly sensing critical weather parameters in the cockpit, as well as for expediting transmission of such data from ground sources should be developed.

d. The FAA should expedite the development of an improved airport surface surveillance system detecting aircraft on and near the surface of the airport with automated identity and tracking functions. The DABS sensor in some applications, where higher data rates or special coverages such as airport surface regions are needed, could be based on electronically rather than mechanically scanned antennas. The development of the DABS should consider this possibility in order to assure that the most cost-effective technique is provided. The design goals of the FAA DABS Surveillance and Data Link Development Program should be a surveillance azimuth accuracy of 1 mr, a data rate of one second and the capability of reducing the time delay in issuing a missed approach command to three seconds where required to reduce lateral spacing standard for parallel runways.

e. There is a need to demonstrate the suitability of MLS for use in a wide range of applications and to develop proposed safety standards for its use.

f. A VASI system should be installed on every runway authorized for use by turbine-powered aircraft whenever that runway is not equipped with an electronic glide slope.
(TG 2, 7 (18 and 26)
(TG 4, 9.2 (5, 6, 7, 15 and 16)

FAA Response

a. Substantial FAA E&D effort has been expended in the area of low cost visual landing aids. NAFEC recently completed an extensive test program of several low-cost systems. In-service field appraisals of two such visual aids, the CUMMING-LANE and the Poor Man's Optical Landing Aid (POMOLA) systems, based on the principle of alignment of lights or panels, are currently being planned for several small general aviation airports. Improvements in pilot training and improvements in ground sensing and automatic transmission of weather information, which can be provided to the pilot via voice radio, also impacts the problem of improved safe operations at general aviation airports.

b. FAA agrees that increased use of coupled approaches or autoland systems enhances safety and has encouraged implementation and use of such systems. There is a problem here because the desirability of using routine autoland must be tempered by the equally important requirement for pilots to retain manual proficiency in any situation where autoland cannot be used every time. FAA has discussed this matter internally and will consider further activities, if appropriate.

c. One of the initial data link services being developed will provide real-time terminal weather and other data to the cockpit as the aircraft is making its approach. The airborne processor associated with the data link display device can be designed so that it could be programmed to flag critical parameters for the pilot.

FAA programs to improve the availability of ground sensing of weather parameters, that can be provided to the pilot via voice radio, are also discussed in response to Recommendation 26.

d. FAA is currently pursuing the ASDE-3 radar program in conjunction with the evolution of miltilateration beacon-based techniques to provide an improved airport surface surveillance system.

The primary DABS functions are aircraft surveillance, ATARS, and providing additional information to pilots via DABS data link. The user representatives' recommendation is to utilize DABS to perform the additional functions of surveillance, identification and tracking, on or near the surface of an airport. To accommodate these additional functions, the user representatives have recommended the system design goals of surveillance azimuth accuracy of 1 milliradian, a data update rate of one second and a time delay in issuing a missed approach command of three seconds where required at the 24 airports with a reduced lateral spacing standard for parallel runways.

The current DABS design meets the surveillance accuracy requirements of 1 milliradian at a 4 second scan rate. The antenna to perform a faster scan rate would have to be a uniquely designed. Several design alternatives are available (back-to-back antennas, and electronic scanning) if operational studies verify a need for higher data rates.

In the future, FAA does plan to initiate a study assessing the unique system needs in performance of surveillance and communications function on and near the airport surface. It is not foreseen that this development will impact the DABS implementation schedule.

e. FAA has embarked on a Service Test and Evaluation Program (STEP) for MLS to extend the scope of experience to operational field facilities and provide a transition from the R&D phase to the operational phase. This program provides for the procurement of a number of MLS ground and avionics hardware systems and deployment of this system to obtain real world operational experience in a wide range of difficult applications. The operational use of these systems will focus on the development, validation and refinement of operational, technical and support concepts that use the unique attributes of MLS to optimize user benefits, including safety. STEP will include participation by users and all segments of FAA. The program will serve as a firm base for the subsequent preparation of policy, procedures and standards appropriate to the optimum implementation and operational use of MLS.

f. FAA believes that transport category turbojet-powered aircraft which use a stabilized approach have a need for visual approach slope information on non-instrumented runways and an increasingly high degree of emphasis is being given to the installation of VASI at runways in that category. Use of "turbine powered aircraft" alone, however, is not considered to be a valid qualifying criterion since many light non-transport category aircraft occasionally operate from runways that would not otherwise qualify for VASI.

User Comments on Safety

The Experimental Aircraft Association (EAA) believes BCAS is unsuitable for general aviation because it is too expensive, since only aircraft equipped with BCAS obtain protection (two non-equipped aircraft have no protection), since the collision problem is most serious among small general aviation aircraft, and since it will not work in heavy traffic where most needed.

General Aviation Manufacturers Association (GAMA) is concerned that FAA will proceed with the implementation of BCAS before it is proven, and feels that faster E&D answers are needed.

Air Transport Association of America (ATA) and National Business Aircraft Association (NBAA) support the users' recommendations with respect to backup Collision Avoidance Systems (CAS).

Air Line Pilots Association (ALPA) has taken exception to the users' consensus with respect to backup CAS, evidently preferring a system based on ATCRBS only and not dependent on DABS, requiring all aircraft to have a Mode C transponder and an appropriate antenna system, providing pilots with vertical and horizontal maneuvers for collision avoidance based on air-derived data, and

providing pilots with a traffic display to permit assessment of the detected threat and the appropriateness of the resolution maneuver presumably based on air-derived data. (Other users rejected this approach.)

Air Transport Association of America (ATA) has taken exception to the extent of the suggested E&D in the section entitled "Pilot Decision Making" concerning the data pilots need during the landing phase of flight in the report of March 1, 1979 on E&D Initiatives. ATA evidently feels that the suggestions limit investigation to certain areas, some of which have already been, or are currently being thoroughly investigated, and other areas which are the responsibility of FAA Flight Standards rather than R&D.

Aircraft Owners and Pilots Association (AOPA) objects to singling out general aviation pilots for improved training in the introduction to this area in the report of March 1, 1979 when the body of the report talked to the need of improved training for all pilots. (AOPA is correct; this was a mistake in an early draft of the report that escaped correction.)

Mr. Robert N. Buck, a well-known retired TWA captain from Moretown, Vermont, has pointed out that VASI should be installed on runways whether or not they have electronic glide slopes -- in distinction to the users' recommendation "That VASI should be installed on every runway authorized for use by turbine-powered aircraft whenever that runway is not equipped with an electronic glide slope." He says, "The electronic glide slope is an aid as long as the pilot is looking inside the aircraft. However, when he becomes contact, his eyes are outside and he still needs glide slope guidance...I strongly recommend VASI on all glide slope runways, and ILS, as they have in Europe. Again, as a pilot who has seen it both ways, extensively, I can assure you VASI is necessary."

ALPA took exception to the discussion of the "troubled" introduction of autoland as an illustration that the excessive cost of "overly" complex systems can derogate safety. ALPA disagrees that general installation of low-cost autoland would be an adequate solution to the low visibility landing accident problem. (But this was not the thrust of the recommendation -- there are many aspects to the "troubled" introduction of autoland, described by ALPA members, to which the users apparently reacted when they recommended a broad E&D, procedural and Flight Standards review to accelerate the introduction of autoland. ALPA's suggestion that Head Up Displays might help was covered in a more general E&D initiative covering Pilot Decision Making on page 239 of the March 1, 1979 report.)

With the exceptions noted, all user groups generally approved the safety recommendations.

VI. WEATHER

44. Needed Weather E&D and Implementation

All sectors of the user community are concerned about the accuracy, availability, timeliness and cost of weather information. This concern persists in spite of FAA's Aviation Weather System Program Plan. Users raised the following issues:

a. Will the National Weather Service (NWS) weather radar network provide the coverage and the turbulance detection needed by aviation? The aviation community has recommended that FAA's en route primary radars be replaced with a network of radars oriented toward weather detection rather than target tracking. How can FAA's weather radar network supplement the NWS network and what will be the performance of the combined NWS/FAA radar network?

b. The intensity of turbulance and the level of precipitation are not well correlated and the improvement to be obtained with Doppler and precipitation gradients is uncertain. Priority E&D efforts are needed to resolve this issue.

c. FAA plans to handle Pilot Reports (PIREPS) in a more systematic manner than at present for transmission to controllers and through them to pilots. The aviation community recommends that PIREPS also be used in conjunction with the ground network to improve weather forecasts. E&D is needed to determine how best to integrate PIREPS with ground radar for forecasting, as well as for assisting pilots to avoid potentially dangerous weather. Further E&D is needed to develop an improved automatic airborne weather sensing system both for general aviation and air carrier aircraft to measure weather phenomena and for transmission via DABS to the ground. This program should include analysis of how to select the aircraft sample and process the transmitted data.

d. FAA should develop an improved en route weather information service that would provide the timely dissemination of weather data obtained from PIREPS and the ground network in a manner that doesn't depend primarily on communications with an FSS or ATC facility which tend to be overloaded, but is available on regional broadcasts or by discrete access.

e. FAA should implement in the Automated Low-Cost Weather Observation System (ALWOS) program the automatic sensing of cloud height below 5,000 feet, visibility or visual range, wind direction and speed, temperature and altimeter setting. E&D should be directed toward obtaining additional capabilities, such as measurement of dew point, precipitation, wind gusts, prevailing cloud height and obstructions to vision - if these can be accomplished cost-effectively. To the general aviation community this development, along with a communications capability to disseminate the data in a timely fashion, is the most important E&D safety program. Weather is observed at less than half of the 1,700 airports having published Instrument Approach Procedures, and is frequently more than one hour old. This situation is a significant restraint on the safe and efficient use of the airspace.

f. The air crew should be provided with time-critical hazardous weather information, such as wind shear on approach, with the same priority as conflict alert or minimum safe altitude warning. This requires the development of sensors and techniques to present hazardous weather to the control process, means for prompt delivery of weather data to cockpits so as to minimize workload and to provide assurance of the compatibility of ground-derived and air-derived warnings.
(TG 3, 1.3.2; 1.5; and 2.2)
(TG 4, 4.5; 5.; and 9.2 (1, 8, 9, 10, 11))

FAA Response

a. The Departments of Commerce, Defense and Transportation are involved in developing and implementing the next generation weather radar using Doppler technology. The major thrust of the joint program is to field a network of weather radars to meet the requirements of each of the three departments. Thus, the network would provide area coverage for turbulence detection needed by aviation. In addition, FAA is continuing with its terminal Doppler radar development program to determine if its terminal radars can provide turbulence and possibly wind shear information along the airport arrival and departure flight paths. FAA agrees with the need for an effective radar weather detection system.

b. FAA agrees that the ongoing program, jointly pursued by FAA and NWS, be continued to determine the correlation between the level of precipitation and the intensity of turbulence using Doppler radar technology as it relates to aviation weather requirements.

c. There are two programs in this area of pilot reports which FAA plans to initiate. The first is to follow-up on a user proposed program having procedures for actively managing the integration of pilot reports into a weather data system for use in advising other pilots, and for forecasting. The second is to initiate an E&D effort to develop an "automated pilot reporting" system for general aviation and air carrier aircraft. This effort would result in a system over the U.S. similar to the test system now used by NWS. That agency now receives, via satellite communications, weather information from automated equipment aboard participating air carrier aircraft beyond the East, West and South coasts. These programs, if successful, should be implemented prior to implementation of the DABS data link program. However, the data link program should include automated pilot weather reporting and receiving, and should benefit from the experience gained with the other programs.

d. There are individual programs being initiated that may satisfy the in-flight weather information recommendation of the users. FAA plans to evaluate the transcribed weather broadcast system to determine the best means of improving its output. FAA is testing the use of two frequencies in our Western Region's En Route Flight Advisory Service (flight watch) to determine if interference-free service can be provided. The third action in this area of interest is a development and engineering effort to improve the local weather broadcast on the Automated Terminal Information System (ATIS). The fourth action is a development of automated surface weather observation and reporting systems. These will initially be for general aviation airports and will include continuous broadcast of weather information over the local air navigation aid. These E&D efforts should improve the in-flight weather information service to pilots without complete reliance on contact with an FSS or ATC facility.

e. There is a joint program to develop and implement automated surface weather observing and reporting systems, as mentioned earlier. The Departments involved are Commerce, Defense, and Transportation. The systems being developed will include all the elements listed in the recommendation. The reason for a joint program is not only similarity of requirements within the three departments, but also the cost and potential time savings obtained through the joint effort.

f. There is, as mentioned earlier, a development program within FAA to evaluate the use of Doppler technology in terminal radars so as to detect turbulence and possibly wind shear in departure, as well as approach flight paths. If this program proves successful, the infor-

mation would be provided to the cockpit similar to the way low level wind shear alerting system information is now provided to the cockpit.

45. The Role of En Route Primary Radar and Needed E&D

The role of primary radar in the en route system should be directed toward the detection and mapping of hazardous weather rather than aircraft tracking. Weather detection requires a pencil beam, high frequency, linear polarization, a low rotational rate and perhaps Doppler processing. Those characteristics are not optimum for aircraft tracking. The user perception is that at the current level of transponder equippage -- especially during IFR -- and considering the present modest capability of en route primary radar, particularly at low altitudes, there is in fact only occasional and then somewhat erratic radar tracking of low altitude targets in the en route system. However there is a need for better weather inputs to both the controller and the pilot. FAA should not purchase new or upgrade present en route radars for tracking aircraft, but should invest in radars designed for weather detection. This policy must not compromise the availability of non-transponder procedural separation in those portions of the airspace where it is currently permitted, nor should the present radar system be discontinued until the new weather radar is commissioned.

The overall aircraft surveillance requirements of en route air traffic control can be better met, given fixed resources, by an all-Beacon system augmented by a network of weather radars, than by maintaining the present network of long-range aircraft surveillance radars. If this change is to be implemented, specific provisions must be made for handling IFR aircraft with transponder failure. It will also be necessary, at least for some transition period, to adapt the En Route Air Traffic Control system to occasional routine handling of non-transponder-equipped aircraft and to aircraft whose transponders lack Mode C altitude reporting. (FAA understands this to mean that should a qualified pilot fly IFR in airspace that does not require a transponder, FAA will have to provide procedural separation from other unequipped, as well as from transponder-equipped aircraft, rather than radar separation. FAA further understands this to mean that a few users would be inconvenienced by procedural separation since most IFR-qualified users are transponder equipped.)
(TG 1, 5.1 (10))
(TG 3, 1.3.6; and 2.6)
(TG 4, 5.2.1)

FAA Response

FAA is aware of the attractions and potential system cost saving by eliminating primary radar service for air traffic control target detection in favor of DABS and altitude-reporting DABS/ATCRBS transponders. As noted in other

responses, FAA/NWS/DOD are examining the use of new radars intended primarily for weather information in which a national network would provide high quality weather information to many, although probably not all, en route air traffic control facilities.

The rationale for continued use of primary radar as part of the ATC en route surveillance system, in addition to Secondary Surveillance Radar, which has assumed the dominant role, deserves and is receiving careful consideration. The classic reasons for continued use of primary radar service are being reexamined. They are the military need for surveillance information from a joint-use primary radar network, the problem of coping with transponder failure, aircraft not equipped with transponders and intruders in restricted airspace. To a degree the question of the continued need for primary radar hinges on the prospect for universal carriage of transponders. These views are the subject of some controversy. There is no unanimity of view that primary radar is essentially useless in low altitude airspace, and objective scientific data is lacking.

FAA still provides many needed services to VFR aircraft, many of which are not transponder equipped. The following is a summary of the latter types of services which are enabled by primary radar:

1. Traffic information based on primary radar observation of non-beacon and beacon equipped aircraft.

2. Radar assistance and navigation services to non-beacon aircraft when lost or experiencing emergencies.

3. Radar advisory service and flight following for non-beacon equipped aircraft.

4. Holding pattern surveillance for non-beacon equipped aircraft.

5. Radar separation between beacon and non-beacon equipped aircraft.

6. Bird activity advisories.

7. Balloon/chaff advisories.

8. Radar advisory service to air carrier/air taxi aircraft operating to and from VFR tower airports where the likelihood of non-beacon equipped small aircraft operating is very real.

During FY 1978, primary radar service was provided to 80,000 aircraft operating IFR without transponders. This does not include aircraft that "pop-up" in

controlled airspace and request radar service. Additionally, (Reference: Item 8) there are approximately 400 non-tower/non-radar airports where approach control service is provided by ARTCC.

The users commented negatively on procurement of additional long-range radars, but have not agreed on universal carriage of transponders in controlled airspace. Thus, the matter of actual utility of the primary radar in low altitude en route areas, as well as future military needs must be considered. Since this issue involves many interests, the decision making process must, of necessity, be deliberate. Yet, a number of FAA's primary long-range radars are rapidly reaching obsolescence and must be replaced. In order to deal with these questions, FAA has established a task force.

The task force will obtain facts on current uses and performance of long-range radars in order to establish a factual data base on which to perform analysis of future role of primary en route radar. They will also determine what additional weather information could be provided if the en route primary radars were reoriented to this task.

This information will allow the agency to identify and describe available long-range alternatives or combination of alternatives, as well as the cost-effectiveness of these alternatives. Recommendations to FAA management on the future role of long-range primary radar will be included in a report due at the beginning of FY 1981. The user community will be kept informed of the results of this work.

User Comments on the Role of En Route Primary Radar

The Department of Defense (DOD) has expressed reservations with respect to a change in the role of en route primary radar based on both air traffic control and air defense considerations. DOD is concerned about the availability of radar advisories for traffic below 12,500 feet, the procedures to be invoked when transponders fail in the absence of primary radar, and the loss of those terminal radar approach control services that are supplied by en route radar. With respect to Air Defense, DOD states that the Joint Surveillance System (JSS) is essential to preclude a breach of sovereign U.S. airspace. If FAA withdraws from JSS, DOD would then have to install, fund and operate a dedicated, independent primary radar system. (The FAA understands that users were skeptical of the ability of present en route radar to detect low altitude targets. This skepticism contributed to their recommendations concerning a reorientation of en route radar toward weather detection. The major threat to a breach of U.S. airspace is low altitude penetration. DOD is also skeptical of the long-range low-altitude target detection capability of any surface radar. It is for that reason that AWACS and other systems are under development. FAA understands that DOD is reviewing JSS in view of these developments and the primary threat.)

Aircraft Owners and Pilots Association (AOPA) agrees that en route primary radar should be oriented toward weather detection, but recommends maintaining an aircraft tracking capability, a "multi mode radar".

VII. FAA RESPONSE & IMPLEMENTATION

46. Selected E&D Programs Need Broad FAA and User Support

The user community is concerned about the need for improved integration of E&D programs within the E&D structure of FAA, with other relevant organizations in FAA and with users and manufacturers. The troubled introduction of autoland is an example of the problem. Pilots first attempt automatic landings under better visibility conditions than the minimum certification of their equipment. This provides early familiarity with the equipment in a forgiving environment. However, the ILS signal quality is less satisfactory in this environment than under poor visibility conditions, such as CAT II, when aircraft must avoid areas that adversely affect the ILS signal quality. The autoland system follows the ILS vagaries faithfully, but the pilot is sure he can accomplish a better landing manually, so the pilot decouples, his familiarity suffers and his reluctance to use autoland increases. Unfortunately there are other inconsistencies between some ATC procedures and autoland capabilities. Furthermore, the reliability specification is unrealistically high. Therefore its complexity is great and maintenance expensive. When aircraft operators realize autoland is not used frequently by pilots, they are less fastidious about its maintenance. This discourages pilots even more. Obviously, coordination between pilots, manufacturers, operators, FAA flight standards and MLS advocates is needed if broad use of autoland is to become a reality, as NTSB proposes. Could an organization or process within FAA coordinate all the participants in an effort to achieve utilization of autoland?
(TG 4, 4.3)

Another example has to do with airport capacity. Exquisite integration is needed between runway, exit and taxiway design, terminal automation, M&S, wake vortex avoidance, MLS and surveillance of the surface and the terminal airspace, in order to squeeze capacity into airports safely. Could an organization or process within FAA, - perhaps as an extension of the present Airport Task Forces - integrate the various E&D, construction, operational and institutional components needed to improve airport capacity on a site specific basis?
(TG 2, 7, (1 and 2))

One last example deals with upgrading the air traffic control process in centers and terminals. This is a huge and necessary undertaking. The development of the desired ATC capabilities requires significant effort in two areas: first, the establishment of new automation concepts, the related operational procedures and the corresponding computer algorithms; second, the procurement and implementation of the necessary hardware and software to support the automation requirements. The first of these two tasks may well be the most time consuming

and difficult since it involves exploration of some fundamental changes to the ATC process itself. A somewhat comparable upgrading of a real time computer complex in the Bell System, the Electronic Switching System #4, took a "team of fanatics" two years in preliminary design, then five years for the delivery of the first article and 400 million dollars. The FAA must obtain whatever manpower and money is required to accomplish this vital program.
(TG 1, 5.2 (5 and 6); and 1.2.1)

FAA Response

FAA too, is concerned about the need for improved integration of E&D programs with other relevant organizations within FAA and with users and manufacturers. Anumber of specific actions have been taken.

FAA's response to Recommendation 33 mentions the agency-wide System Acquisition Management Process (SAM) and the fact that the first step in SAM is the definition of system requirements. Hopefully, the discipline of this definition process will lead to improved integration of the E&D programs with other relevant organizations in FAA.

Within the E&D organization, as part of its recent reorganization, a System Design and Integration Division has been established in the Office of Systems Engineering Management, and is being strengthened to better deal with some of the integration issues discussed by the users, especially at the conceptual level. Responsibility for leading the effort to assure integration of the various elements of the Integrated Flow Management system has been assigned to this division, as has the leadership of the task force on the future of primary radar. As part of these efforts, experts from the various disciplines within FAA are working together to assure that integration and reasonable transition times can be achieved. In the Systems Research and Development Service, a System Integration Management function has been established with a specific charge of assuring technical and program integration between the variety of development activities.

An earlier response dealt with the question of the introduction of autoland and described some of the difficulties beyond those identified in the consensus document. It is feasible that an organization or process in FAA could coordinate all the participants to achieve utilization of autoland. However, this should probably be pursued by the parties of immediate interest. FAA has, and will continue, to work on the elements that can make autoland simpler and better -- the improvement of precision approach and landing guidance, examination of head-up displays and other elements that enter into the autoland process. FAA has responded positively to requests for simplification of the airborne hardware requirements based on proposals from the industry.

A number of expert disciplines and interests must work together on the airport capacity problem, but a formal single-focus FAA organization is not likely to be the most productive. The approach FAA is taking counts on close cooperation between the Airports organization, the operating services and the E&D organization, with system analysis and integration activities conducted by the Office of System Engineering Management. Close cooperation is also required between FAA, the users, and state and local authorities at airport sites. The joint FAA/industry airport task forces have been valuable.

With respect to upgrading the ATC process, this effort is a good example of the closest possible cooperation between the FAA operating services, the implementing services, and the E&D organization. FAA understands the difficulties discussed in the final part of the Recommendation and understands the importance of adequate resources, both technical and financial, to proceed with this work.

47. The Need for User Inputs to FAA Management of Implementation Programs

The removal of rotating beacons from airport terminals and compass locators from outer markers has caused pilots unnecessary difficulties measured against the trivial cost of maintaining these facilities. In some cases, pilots will not accept a visual clearance to an airport on a clear night because they cannot identify the terminal against a background of urban lighting in the absence of a rotating beacon. This decreases airport capacity and increases controller work load. While this issue is not as significant as most implementation policies, users felt it important to include to illustrate the value of formal user consultation.
(TG 2, 4.4.2; and 7.16)

FAA Response

FAA is firmly committed to public consultation on all matters requiring regulatory action, and is also firmly committed to public consultation on key aviaiton issues, plans, programs, standards and facility criteria. User concerns over the consultative process for determining changes in services, or loss of service, as highlighted by limited decommissioning of airport rotating beacons is under FAA review.

48. FAA Response to User Recommendations

Users have recommended that FAA present their response to their suggestions not more than six months after they have been formally submitted.
(TG 1, 5.2 (12))

Users agreed without exception to these concerns and recommendations.

FAA Response

FAA concurs with the intent of the recommendation. However, due to the wide ranging implications of certain recommendations, FAA has not been able to establish policy or programs within the suggested response time frame. The Administrator has indicated his strong endorsement of an early interchange with the user community to ensure a meaningful response to their recommendations. To this end, a conference has been scheduled for January 29-30, 1980, for FAA to provide an initial public response. We envision additional conferences will be held for the purpose of keeping the users appraised of future actions resulting from the recommendations and for soliciting comments.

VIII. ENVIRONMENT

49. The Impact of Noise Reduction on Allowable Airport Operations

One question considered by the users throughout their deliberations - Is any program for increasing airport capacity viable in light of the growing environmental pressure to stabilize or even reduce the number of operations at many major airports? Before this question can be answered affirmatively, a methodology for trading off future environmental improvements for increased operations at existing airports will have to be developed.

Changes in operational techniques and noise abatement procedures have been incorporated into the system to reduce the adverse effects of aircraft noise. The introduction of high by-pass ratio engines has made a significant contribution to reducing aircraft noise. FAR 36 has made its contribution to the environment - but still public opinion has not changed. Technology offers promises of further noise reductions. In order to encourage aviation to continue its efforts to reduce the adverse effects of aircraft noise, a reward system should be established which would relate aircraft noise reductions made over a period of time with permissible increases in airport capacity. This would permit air transportation growth while at the same time reducing or stabilizing aircraft noise impacts on the community. (TG 2, 1.1)

FAA Response

Pressures to reduce noise impacts around our airports continue. Regulation of aircraft noise at the source (the airplane itself by FAR, Part 36) and through operational controls are reducing those impacts but will never "solve" the noise problem.

The airport proprietor has the authority to restrict the use of an airport for noise control purposes, so long as such restriction is nondiscriminatory, does not impose an undue burden on interstate or foreign commerce, and, of course, does not impair aviation safety. FAA has issued Advisory Circular 36-3, which tabulates the noise levels of approximately 290 models of aircraft under the standardized measurement conditions and procedures of FAR, Part 36. This tabulation of noise levels provides airport proprietors with a practical means for restricting use of an airport on the basis of noise, where such restrictions are warranted. Such restrictions will encourage aircraft operators to utilize quieter aircraft, since these will have access to more airports and reduce noise impacts generally.

50. Need for a National Standard Noise Measurement

Users found that airport planning was handicapped by the lack of adequate means of determining noise levels that would be considered as "tolerable" or "acceptable". Current measurement techniques - NEF - do not measure aviation's contributions to the total (ambient and aviation) noise. A national standard noise measurement technique would provide airport and urban planners with a common understanding of the noise problem.

FAA Response

Cumulative noise impact from aviation sources has been calculated and depicted in several metrics or system of noise units, such as the Noise Exposure Forecast (NEF), Average Day-Night Sound Level (Ldn), Community Noise Equivalent Level (CNEL), and others. For national uniformity, FAA has adopted the use of Ldn for airport noise impact analyses. This unit is compatible with analyses of other types of environmental noise, and will facilitate comparisons of noise impacts from a variety of sources.

51. FAA Actions to Improve Community Response to Airports

Although it is recognized that FAA has sponsored and funded numerous compatible land-use programs, the users felt that additional emphasis should be placed on programs to encourage local jurisdictions to zone areas around the airport for compatible land use, thus minimizing the impact of aircraft noise.

Whenever the public, for whatever reason (altered flight procedures, development adjacent to an arrival/departure course, etc.), is placed in closer proximity to sources of aircraft noise, an increasingly adverse reaction by the public is assured. Any change in FAR Part 77.25, Civil Airport Imaginary Surfaces, which would effectively raise these surfaces, by revision to the existing rule, would reduce the present buffer between aircraft and man-made structures - homes, apartment buildings, office buildings - and further aggravate an already critical airport/community noise situation.

Technological advances have been made toward the development of quieter aircraft, and noise abatement procedures have been adopted. To gain the benefits that are inherent in these advances, FAA should inaugurate a concentrated public information program, calling attention to the giant strides that have been taken in reducing aircraft noise, assuring the public that positive actions are being taken to protect the environment, emphasizing the many benefits the public derives from the airport and stressing that airports are vital to our national economy and national welfare.
(TG 2, 5.3)

FAA Response

FAA recognizes the need for an informed public and its improved understanding of the benefits and necessity for an effective and efficient air transportation system. One step toward this objective has been the development and implementation of a Community Involvement Training Program. Through a series of seminars, this program provides instruction for FAA personnel and industry representatives in working with local communities to ensure that aviation is seen as an asset at the local level. A part of this development was the issuance of the FAA Community Involvement Manual, providing practical guidance in informing the public about FAA programs.

52. Environmental Cost/Benefit Studies and Incentives

In weighing costs and benefits of environmental policies, users recommended certain economic analyses and economic incentives, adopting the following arguments:

Currently the feasible capacity of many airports is constrained by environmental, particularly noise, restrictions. It is the conclusion of the users that in many instances the scale is unduly biased toward accommodation of these legitimate concerns. Hence, the users have expressed a desire to see that the relevant environmental policies be reevaluated, affording proper consideration to their direct and indirect costs, as well as to their benefits. The general public good of "quietness" cannot be viewed as an absolute. Just as we are learning that "clean" air, water and other environmental elements may be desiderata, the benefits of policies designed to attain environmental purity must be weighed against their real, measurable, and often conflicting public costs, such as increases in traffic delays, energy use, and diminished air travel and commerce. In particular the users have found that the application of arbitrary restrictions on the number of movements, time of movements, aircraft types, and so forth, may be particularly ineffective and inefficient in addressing environmental problems, as they assume a static technology (i.e., advances in aircraft noise reduction are ignored). Hence, where environmental standards are appropriate, it is suggested that recourse to "performance-oriented" standards be fully explored. Further, when airport capacity (as constrained by environmental standards) is saturated, the method of adding capacity with the lowest total social cost may involve relaxing these restraints. Practical techniques for equitably adding to capacity in this fashion (such as the purchase of "noise rights", or providing tax abatements to affected property owners and residents) should be developed and tested.
(TG 5, and its comments)

FAA Response

All environmental regulations and decisions issued by FAA are analyzed regarding their cost/benefit relationships and potential impacts on the public and

industry. For noise regulations, as an example, such analyses are essential in meeting the FAA's statutory requirement to consider technological practicability and economic reasonableness of any noise control regulations. The role of economic incentives in environmental controls is under substantial review at this time and the role presently is unclear.

User Comments on Environment

The Airport Operators Council International (AOCI) considers itself a provider of airport facilities, not a user. AOCI did participate in the New Initiatives Process and disagrees with the users that noise-related restrictions have a significant effect on airport capacity. They say "It should be recognized that the airport proprietor is legally liable for claims by noise impacted citizens."

Aviation Consumer Action Project (ACAP) disagrees with the recommendations on weighing the costs and benefits of environmental policies. While the users conclude that in many instances the scale is unduly biased toward accommodating environmental, particularly noise, concerns, in ACAP's view, these are important concerns and the development in aviation must be compatible with a quieter and cleaner environment. ACAP believes that aviation can expand without trampling the rights of people on the ground.

IX. ECONOMIC INCENTIVES

53. Quotas and Pricing Mechanisms

The users who dealt with Non- and Low-Capital Policies to Improve Efficiency rejected the use of pricing-mechanisms to achieve efficient allocation of runway capacity. Some non-users disagreed with the users -notably the topic group chairman who concluded his minority statement as follows:

> "...a legitimate economic case can be made for augmenting reliever capability and capacity in metropolitan areas, a task which could be most efficiently addressed through regional planning and implementation of airport budgeting. It should be noted that the financing needs may extend beyond operating budgets, concrete and hardware: transfer payment to host communities to balance out externalities may be required. The concurrent implementation of an efficient demand allocation program (via pricing) might conceivably succeed if coupled with an appropriate supply augmentation program."

(TG 5, and its comments)

FAA Response

FAA implemented quotas at five designated high density traffic airports in 1969. They are now in force at four airports. FAA believes that these quotas have produced substantial savings in delay costs over the years with a relatively small impact on the users. Thus, the quotas have been a qualified success. The imposition of quotas does not have to freeze the airport at historic levels. FAA is conducting a review of these quota levels to determine if they should be revised.

The quotas need not restrict new entrants. This is a function of the allocation process and not the quotas themselves. The current process for certificated carriers has recently admitted a considerable number of new entrants at the quota airports. Both the Administration and the General Accounting Office (GAO) have called for legislation giving the Secretary of Transportation authority to impose quotas and/or pricing means as a mechanism for reducing congestion. Currently, the allocation of runway access to specific users is performed by user groups. FAA is considering a number of alternate methods, including pricing and administrative means for doing this. Affected users will be provided ample opportunity to comment on any such proposals before a final decision is made with respect to implementation of any of them.

User Comments on Economics Incentives

Aircraft Owners and Pilots Association (AOPA) feels aviation is a growing and dynamic industry that needs flexibility to properly provide all the advantages that aviation can bring to the public. Imposition of quotas destroys that flexibility and freezes airport use at a level that depends on historic use of the past rather than meeting the needs of the future.

AOPA believes that quotas have no provision for expansion and in effect freeze out any but those who have their "foot in the door" by having a place in existing quotas. Quotas nullify plans for additional air carriers to serve a location under the new deregulation concept or even when approved by the CAB under the old concept. If the existing carriers at a location refused to give up any of their slots under the quota, there could be no additional service. The same applies to the demand for expanding air taxi or commuter service, which would have no way of meeting the demand.

AOPA is opposed to quotas.

Aviation Consumer Action Project (ACAP) disagrees with the consensus that all qualified users should have free access to all airports on a "first come, first served" basis. ACAP believes that the FAA should encourage experimentation with quota and off peak pricing systems for congested airports which recognize that one air carrier flight may serve more than 100 times as many persons as one general aviation flight. The consensus in the report is an agreement among various segments of the industry, and ACAP believes it should be evaluated accordingly.