Civil Aviation Research and Development
An Assessment of Federal Government Involvement

AIRPORT AND SUPPORT FACILITIES

A report by the ASEB Ad Hoc Committee on Airport and Support Facilities
CIVIL AVIATION RESEARCH AND DEVELOPMENT

An Assessment of Federal Government Involvement

AIRPORT AND SUPPORT FACILITIES

AERONAUTICS AND SPACE ENGINEERING BOARD
NATIONAL ACADEMY OF ENGINEERING
Washington, D.C.
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Foreword

The National Academy of Engineering established the Aeronautics and Space Engineering Board (ASEB) in May 1967 to advise the National Aeronautics and Space Administration (NASA) and other government agencies. In consultation with officials of NASA, the Department of Transportation, the Federal Aviation Administration, the President's Science Adviser, certain interested committees of Congress, and the National Aeronautics and Space Council, as well as other government and private groups, the Board selected as its first topic of study, "Civil Aviation Research and Development: An Assessment of Federal Government Involvement." The Board's report under that title was published on August 13, 1968. It summarizes reports of six ad hoc committees, including this report by the Committee on Airport and Support Facilities.

As background information for the reader of the committee reports, the most important conclusions and recommendations of the Board are stated below (summary report, pages v-vi).

The Board has concluded that in a favorable economic climate civil aviation can continue to flourish; in fact it can accelerate its beneficial growth if a carefully conceived program of planning and research and development aimed specifically at the civil air transport system is carried out.

After considering the multiplicity of factors affecting the growth of civil aviation, the Board concluded that the three most critical factors are (1) airport and support facilities, (2) noise, and (3) air traffic control.

The most important recommendation of the Board pertains to knitting together more tightly the civil aviation research and development activities of the Department of Transportation,
its major operating unit, the Federal Aviation Administration, and the National Aeronautics and Space Administration, and especially to dividing their responsibilities according to capability. The DOT should provide the leadership in conducting systems studies to identify, analyze, and rank civil aviation goals as well as the research and development needed to attain these goals; NASA should be responsible for research and development in all the areas of importance to civil aeronautics; the FAA should, in addition to operating the airways network, be responsible for the systems testing of the resulting operational concepts and hardware.

The Board's report also contained many detailed technical recommendations concerning research and development needed to ensure the continued growth of civil aviation. These pertain to most of the important areas of civil aviation, including systems and the specific areas of flight vehicles, aircraft operations, air traffic control, airport and support facilities, economics, and noise.

The Board assigned detailed work to six ad hoc committees covering the above specific areas. Each committee was composed of knowledgeable men from different parts of the aviation community; their valuable contributions are sincerely appreciated by the Board.

Board membership is listed in Appendix I. The Board wishes to express its appreciation and indebtedness to a large number of individuals beyond its membership with whom it conferred. These are also listed in Appendix I. The Board is indebted to the American Institute of Aeronautics and Astronautics, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Institute of Electrical and Electronic Engineers, and the Society of Automotive Engineers for conducting special studies, making available special reports, and identifying members for participation in an advisory capacity. The cooperation of these societies served to broaden the advisory base.

The Board is particularly grateful for the valuable assistance provided by the members of the Ad Hoc Committee on Airport and Support Facilities, who are listed on the following page.
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Contents

INTRODUCTION ........................................... 1

DISCUSSION OF PROBLEMS AND RECOMMENDATIONS

General Considerations ................................ 4

Technical Considerations ............................... 6

APPENDIXES

I. CONTRIBUTORS ....................................... 13

II. BIBLIOGRAPHY ...................................... 23
Introduction

Organization for Conduct of the Airport and Support Facilities Study

The members of the Committee on Airport and Support Facilities are actively engaged in major phases of aviation activities, and the judgments expressed in this report are based on their background and experience in engineering problems of modern airports. Advisers to the committee included experts in the fields of air transportation, airport operations, and development of airport facilities and equipment. In addition, the committee benefited from contributions of authorities in several fields serving the air transportation industry.

Method of Conducting the Study

The committee held two meetings to discuss the problems of airports and support facilities and to draft its report. The committee reviewed current studies by other groups, including a special report on airports prepared by the American Institute of Aeronautics and Astronautics at the request of the ASEB. Further assistance was provided by the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Institute of Electrical and Electronic Engineers, and the Society of Automotive Engineers.

The committee also took note of other reports on the problem of airport congestion, including a 1961 study of national aviation goals (Project Horizon) conducted under the sponsorship of the Federal Aviation Agency, and a recent study of civil aviation by the Transportation Workshop, entitled "Air Transportation 1975 and Beyond."

In its deliberations the committee identified some major issues and recommended a series of actions that should be accomplished by government agencies, with the assistance of industry in some instances, to eliminate or
minimize the airport problems that threaten to stifle the
growth of civil aviation in this country.

Background

During the early phases of the ASEB study, the dis-
cussions by experts in the various fields of civil aviation
and the review of Senate Document No. 90, "Policy Planning
for Aeronautical Research and Development," prepared by
the staff of the Library of Congress, identified major prob-
lems that are either already restricting the growth of
civil aviation or that are expected to limit growth of avia-
tion in the future. Among the problems cited were con-
gestion of the airways and airports with related traffic
control difficulties, safety, aircraft noise, and sonic boom
associated with supersonic flights. Although attention has
been given to these problems, they still remain a potential
retarding influence on the growth of civil aviation.

The 1961 Project Horizon study referred to above
cited the need for planning and implementing a long-range
nationwide system of airport and terminal development
capable of keeping pace with the projected growth of civil
aviation. In the opinion of the committee, the require-
ment for such a long-range plan for national airport de-
development remains a key factor in solving the problems
facing the nation's airports.

Scope of the Study

This survey of airport and support facilities should
be read with the recognition that other ASEB ad hoc com-
mittees were active in the following areas:

Flight vehicles and airbreathing propulsion
Aircraft operations
Air traffic control
Economics of civil aviation
Noise

The study of airport and support facilities was
limited to those problems not directly encompassed by
other ad hoc committees. For example, two areas that
may be considered part of the airport problem — air
traffic control and noise — were the subject of study by
other ASEB ad hoc committees as noted above and thus were not considered by this committee.

The area of study of the Committee on Airport and Support Facilities was defined at the outset to include the portion of the airport complex starting with the landing strip and extending through the main gate of the terminal. The airport access problem was only touched on in this study because it is of such magnitude and complexity that it would require a comprehensive in-depth study beyond the intended scope of the present ASEB effort.

In many cases, the committee has suggested agencies that it considered appropriate to carry out the recommended actions or to participate in such actions. In its summary report the Board generally chose to omit any such references, thus giving the agencies concerned the option of determining appropriate implementing activities.

As a general method of operation, the committee limited its recommendations to those specific areas in which it considered that more progress was both possible and necessary to solve the problems. These topics are discussed in the following sections of this report.
Discussion of Problems and Recommendations

GENERAL CONSIDERATIONS

Since the establishment of the federal airport program in 1946, aviation has grown steadily and rapidly to the point where its progress has outgrown the facilities that support it. Even the most moderate projections of civil aviation growth over the next decade indicate that today's airport problems will be greatly multiplied unless coordinated action is initiated soon and maintained in the years ahead.

As another indication of the magnitude of the problem, recent testimony before the Aviation Subcommittee of the Senate Committee on Commerce indicated that by the end of 1973 an additional $3 billion must be invested in the national airport system. Another $3 billion will be required by 1975. This total of $6 billion needed over the next seven years will equal the total amount of money spent during this century for development of the national airport system. The figure includes funds for terminal area and airport access needs as well as for runway development.

Overall Planning for Airports

An expanded national plan for airport development emerges as a major factor in solving the airport problem. Such a plan would take into account the interests and responsibilities of the federal and state government and the local communities in developing new or expanded airports throughout the country. The proposed national airport plan could be based on the existing Federal Aid to Airports Program, which would be broadened in scope to include an inventory of various categories of airports. Under this concept, local airports would provide data on the projected need for a modernized or expanded airport
capability matched against the existing capacity in each case. This planning document would provide factual data for projecting the technical and financial requirements of a national airport development program geared to the future needs of civil aviation. At the same time, the plan would be an important step in formulating the national transportation system plan, which has been advocated by other sources as a means of integrating all elements of an air transportation system to include ground transportation interfaces, local and national economic trends, and applicable new technology. The Department of Transportation (DOT) would appear to be the logical agency within the federal government to develop such a plan.

As a step in the planning process, a study should be made of new aircraft developments to determine the maximum size, weight, flotation characteristics, and servicing requirements of future aircraft. This study should involve the Airport Operators Council International (AOCI) with the active participation of airline, aircraft, and engine companies. With such information in hand, guidelines can be established to allow for future airport expansion to achieve required capabilities. The Federal Aviation Administration (FAA) should translate this information into airport advisory circulars for continuing guidance of airport operators.

Government-Industry Airport Steering Group

For a national airport plan to be most effective, it must provide for participation by representatives of the government and industry groups concerned with the problems of airports. Among these are the DOT and its FAA, the Air Transport Association, the AOCI, the Aerospace Industries Association, the American Institute of Architects, the American Association of Airport Executives, and the American Society of Civil Engineers.

One possibility for achieving joint government-industry participation would be a steering group with representation from the above organizations and possibly others having an interest in air transportation planning. Such a group would be responsible for reviewing the air transportation plans described above and would provide a mechanism for the exchange of information on the
adequacy of the air transportation system and the development of coordinated recommendations for improvements. The method of operation would be similar to that employed by competent advisory groups in other commercial areas using a systems approach.

The committee felt that one of the main obstacles to developing optimum solutions for the airport and support facilities problem is the lack of staff attention to the field of civil engineering in the government and industrial organizations that are responsible for design and construction of airports. Participation of top-level civil engineers with these organizations might make it possible to shorten dramatically the time from identification of needed airport facilities to completion of the required construction. To date, no interest has been shown in tackling this problem on a nationwide basis; rather each problem is solved (or unsolved) by the individual airport operator using data that are sometimes fragmentary and contradictory.

Educational Programs

Another recommended action to ensure the effectiveness of a national airport development plan is the creation of university programs in local communities to acquaint local officials, industry representatives, and airport managers and developers with the social, economic, and political factors involved in airport design and location. Such educational courses would provide a forum for the discussion and resolution of issues involving federal, state, and local government responsibilities in the establishment of new airports or the expansion of existing facilities.

TECHNICAL CONSIDERATIONS

Moving from broad issues, the committee considered several specific items that could contribute to the betterment of present and future airport operations. Committee recommendations were categorized as follows: airport capacity, runway and taxiway capacity, airport standards, baggage handling, loading bridges, freight, terminal-ground transportation interface, ground transportation,
Discussion of Problems and Recommendations

and general aviation. These categories are discussed in the following paragraphs, and actions are recommended for appropriate agencies within the government or industry.

A growing number of airports in high-density traffic areas either will soon reach capacity, have attained capacity, or have already exceeded their original limits for aircraft acceptance and departure rates. Recognizing the long lead time necessary to design and construct new airports, the committee suggests that it would be profitable to examine critically several major operational airports to determine if increased use of existing facilities could be achieved. New technology and techniques as well as improved traffic criteria and procedures may permit a significant increase in the capabilities of these airports.

Airport Capacity

The committee recommends the following:

1. Realistically reappraise spacing of parallel runways, now set at 5,000 ft, to determine if this distance can be decreased. The original research that established this criterion was performed before modern radar controls were being used to establish acceptance rate. It is possible that newer electronic equipment might make it possible to recast the dimensional requirements and establish a new acceptance rate. As far as is known, no studies are being made in this area. It is probable that the FAA is best qualified to perform this work.

2. Determine optimum operational acceptance and departure rates as a basis for possible revision of the present standards. The following procedure appears feasible:

   a. Study airports that are exceeding their theoretical capacity to see how this is being accomplished.
   b. Study airports that are not achieving their theoretical capacity to determine the reasons for the deficiency.

   These studies could probably be undertaken by a qualified transportation research group with direction and support provided by airport operators through the AOCI.
3. Examine taxiway high-speed turnoffs. It is apparent that they are not being used as designed, possibly because the angle is too great or because the 60-knot design speed is unrealistic. A study should be made by a research group or educational institution familiar with the problem, with participation by the FAA, the airlines, pilot organizations, and the AOCI.

4. Study the ratio of gates to total aircraft capacity for both large and small airports. The most logical way to carry out this investigation would be to update earlier reports on this subject. The study could be carried out by a private transportation research organization, with participation by the AOCI and the airlines.

5. Study the orientation and location of the air terminal as it relates to runway configurations for both instrument flight rules (IFR) and visual flight rules (VFR) and for aircraft with vertical or short takeoff and landing (V/STOL) capabilities. Possible sources of information would be academic institutions having transportation departments that could initiate aircraft-ground traffic studies using the techniques developed in ground vehicular traffic studies.

Runway and Taxiway Capacity

Within this framework particular consideration should be given to the following recommendations:

1. For airport runway and taxiway lighting, the FAA should be urged to accelerate its research and development program to avoid delays such as those that occurred in the approval of the centerline lighting fixtures.

2. The FAA should speed the program for transfer from visual aids to electronic aids for landing and taxiing.

3. The FAA should pursue development of an automatic taxiway system. It is possible that existing hardware could be used for an interim solution, thus reducing the time and cost necessary to place the system in operation.

Airport Standards

To maintain the currency of airport standards and to provide proper guidance for airport operators and
users, airport standards should be available that reflect the latest information on all types of current and future aircraft. The standards promulgated by government agencies need to be studied and updated on a cooperative basis with participation by the airlines and the airport operators.

**Baggage Handling**

This area appears to be satisfactory with the research being done by commercial organizations supported by the airlines. Interested government agencies should keep abreast of developments in this area.

**Loading Bridges**

Development of bridges for conveying passengers between aircraft and air terminals is being supported by industry. Work should continue with attention being paid to necessary capacity and to fire safety measures. The committee suggests that the National Bureau of Standards of the Department of Commerce or possibly other governmental laboratories might be helpful in providing advice on the fire resistivity of construction materials for this purpose.

**Freight**

Recent forecasts of the growth in the air cargo market indicate that over the next fifteen years the demand for air cargo service may greatly increase. For the next decade, while passenger aircraft are handling a major portion of air freight, it will be necessary to provide large airports with segregated cargo areas with direct truck access independent of the airport automobile roads. This facility should have ready accessibility to passenger loading areas.

For the future, attention should be given to the possibility of providing special freight airports, particularly in hub areas, as it appears that the time is rapidly approaching when more freight will be carried in special planes. In the foreseeable future, it is probable that a considerable amount of freight will still be carried on
passenger planes but large air freight shipments, probably in containers, will use all-cargo planes. This parallels marine and rail procedures in which small freight shipments are handled in one manner and large containerized shipments in a completely different manner. Studies in this area should involve both airport operators and airlines, as well as government agencies experienced in air cargo operations.

*Interface Between Terminal and Ground Transportation*

Ground transportation systems represent a major constraint to an effective air transportation system. The airport access problem should be studied using a systems approach, recognizing it as a part of the total urban problem of moving people and goods. More research on various ground transportation systems is necessary to determine the best possible approaches to the urban transit and airport access problems. The results of these studies would serve to guide local community planners.

Effort should be made to encourage participation of appropriate elements in the DOT, such as the Bureau of Public Roads, in studying this facet of the airport problem. Areas of particular interest would be:

1. The capacity of interchanges adjacent to airports requiring specialized design.
2. The types of vehicles and characteristics of travel mode used for airport access. An updating of earlier studies would be one way of accomplishing this.
3. The airport parking problem, with particular attention to parking times, long-time parking facilities, and facilities for air travelers and airport visitors. This work could be undertaken by transportation research organizations or university transportation departments.
4. Airport directional signs. Signing at most airports is unsatisfactory and sometimes confusing. It is suggested that the DOT Bureau of Public Roads could provide advisory assistance in this area.
Ground Transportation

It appears that some facets of this problem are being overemphasized, while insufficient effort is being applied to the overall problem. Although it is agreed that development of advanced ground transportation vehicles should proceed, the committee feels that more effort should be concentrated on analytical studies of all modes of local transportation systems serving the airport. Transportation research organizations or educational institutions having transportation departments should be able to conduct such studies.

General Aviation

The impact of general aviation on airport facilities is now considerable and will become an even greater factor if the present forecasts for the expansion of general aviation are correct. At the same time, general aviation aircraft are expected to become not only more numerous, but also larger and faster. This increasingly significant segment of civil aviation must be provided with adequate facilities if it is to contribute to and not impede the growth of civil aviation.

As the first step in serving this segment of the air traffic, consideration should be given to providing general aviation strips that have a traffic pattern different from that used by commercial aviation.

As traffic increases, specialized airports for general aviation must be provided. These airports should have all-weather operational capabilities and include such items as weather reporting facilities, passenger lounges, and a suitable interface with ground transportation systems. It is also essential that these airports operate on a financially self-sustaining basis, which may necessitate an evaluation of the airport charges in line with the facilities provided. A cost-benefit frame of reference might be employed to evaluate solutions to this problem, which is fundamentally one that might be considered by the DOT as a part of its responsibility for all transportation in the United States.
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