Airports:

DESIGN, CONSTRUCTION AND MANAGEMENT

AIRPORTS:
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INTRODUCTION

In preparing this text it has been the intention of the authors to acquaint the reader with the important factors which enter into airport problems and to provide procedures and guides for solving the problems which will be encountered in the design, construction, and management of nearly every airport. Since an airport is such a complex facility, a common fault of the airport engineer has been that he does an especially good job on the portion of the work with which he is familiar, but neglects phases which will later assume equal, or possibly greater, importance in the operation of the airport. The authors collectively are fortunate in having been directly connected with all the stages of the development of an airport. They recognize that it is impossible to supply the answer to each problem, particularly in view of the rapid changes which are taking place in the field of airport development. Following the principle that to be forewarned is to be forearmed, they have endeavored to point out the existence of each element so that the reader will be in a position to carry out such investigation as the particular situation with which he is confronted calls for.

At the expense of being repetitious the authors have stressed the need for making provisions for future expansion of the airport and insuring space for operational aids such as radio facilities, clear approaches, adequate buildings, and plane parking.

Regarding the design and construction of the grading, drainage, paving, lighting, and turfing, the text is intended to be sufficiently complete so that the engineer can carry out this work aided only by standard handbooks. The authors have used the guide specifications given in the appendices with a high degree of success. It has been necessary in preparing bid proposals for each airport to make minor revisions to suit local conditions. The drawings used to illustrate each element of runway construction were chosen because experience has shown them to be completely satisfactory when used on construction projects. One of the major difficulties which had to be overcome in actual practice was the development of drawings which clearly indicated the intent of the specifications and the scope of the work to be performed. The illustrations used have been evolved and improved during four years, as deficiencies in the original drawings appeared.

The authors realize that the splendid progress which has been made in airport design and construction practices is the result of the experience of a great many engineers, both civil and military. The only claim they can make to originality in the preparation of this text is their choice of the material presented and the incorporation therein of as much of their experience as possible.

The trend toward improving engineering practices and standards is going forward rapidly under the impetus of the demands of both the aviation industry and the public for airports which will provide satisfactory year-round operation without being a burden on the taxpayers. Economical construction is expected to become increasingly important as the aviation industry is placed more nearly on a pay-as-you-go basis. Accompanying the trend toward economical construction is an increased consciousness of the importance of revenue-producing features which, although not having a direct connection with air transportation, can be located on or near the airport. The airport engineer should be imaginative in this respect and should profit to the fullest possible extent by the practices which have already been proved sound in the operation of other airports.

Advance planning, which is almost impossible without a master plan, is probably as important in airport work as in any other field of endeavor. The results of surveys by fact-finding groups are now available and many more such surveys will be made. Present conditions and the predictions in the reports of such surveys warrant close study at the time plans are being formulated. Some conflict between building project and airport development interests has already arisen. With the boom which can be expected in housing projects and the expansion in private flying coming about simultaneously, careful planning is required or many communities will find themselves without suitable sites for small airports. The desired increase in personal flying cannot be brought about unless adequate facilities for storing, servicing, and operating privately owned aircraft are provided. Urban planning which considers the needs of the private flyer is paramount at this time, particularly in the large metropolitan areas, if communities are to enjoy the benefits private flying can provide in the years to come.

The time has passed when the airport engineer can pose as an authority on the entire subject of airports. Specialized knowledge is becoming increasingly important; hence the best an individual can do is to choose and become a specialist in the phase of the work in which he is most interested. The specialist will need to have a working knowledge

of the problem as a whole in order that his particular tree will not obscure the forest. The airport field offers opportunities to men in all branches of engineering and should provide an interesting and lucrative career to those with highway, mechanical, and electrical backgrounds. Agencies employing the services of engineers for the development, maintenance, and operation of airports can avoid costly mistakes by recognizing the specialized nature of the services they are paying for.

The authors sincerely hope that this text, in addition to providing the answers for many problems, points the way to an intelligent study of the subject of airport engineering.

Acknowledgments

This book was undertaken after the authors found from their experience in the design, construction, and management of airports that a great deal of difficulty is involved in the research necessary to acquire a working knowledge of the many factors involved. The amount of time and effort they have spent in acquiring data on tests, procedures, and standards is being used to save the reader as much of this kind of work as possible.

The authors have had the assistance of a great many experts both in their work with airports and in the writing of this text. They desire to acknowledge and give credit to these sources of information and to express their appreciation of the splendid cooperation which they have received.

Throughout the book the authors have used illustrative material taken from the published works of the Civil Aeronautics Administration, Bureau of Public Roads, United States Engineer Department, Bureau of Yards and Docks of the United States Navy, Highway Research Board, Association of State Highway Officials, American Society of Testing Materials, Portland Cement Association, Asphalt Institute, and the Crushed Stone Association. Each of these agencies has contributed its full share to the advancement of airport engineering, and an airport engineer can hardly attain a high degree of proficiency without studying and using the data which the efforts of their experts have made available. They have been generous in extending their permission to reproduce material and in offering the services of their personnel in producing the manuscript. This assistance has been invaluable.

The authors are indebted to the following personnel of the First

Region of the Civil Aeronautics Administration for the assistance they have given in reviewing portions of the manuscript during its preparation: Richard P. Battle, Radio Engineer and Chief of the Signals Branch; Stewart A. Mendell, Airport Service Lighting Engineer; James E. Burgett and Joseph M. Hill of the Airways Engineering Branch Airport Lighting Unit; and William Minuse, B.S., and Harry Schwartz, P.E., of the Airways Engineering Branch Airport Design Unit.

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GOVERNMENT PARTICIPATION

No text on the subject of airports and related problems would be complete without some discussion of the close association existing between our government and the public agencies having airport problems.

Except in rare instances the United States government will, in one way or another, play some part in the size, location, design, construction, and maintenance of an airport. Its role is usually quite important. The nature of the part played by the government in both air transportation and airports makes it necessary that anyone expecting to take an active part in either of these fields should understand the function, duties, and powers of the Civil Aeronautics Administration (C.A.A.).

The C.A.A., because of its multitudinous responsibilities, is quite a complex organization. Although many of the agency's functions are regulatory, it offers assistance and advice on every airport problem. It has been in the past, and no doubt will continue to be, the agency allocating funds appropriated by Congress for airport-development purposes.

A thorough knowledge of the functions and duties of each division of the C.A.A. will prove advantageous. It is advisable to ascertain the names and addresses of its local and regional representatives. Much information and assistance can be gained through personal contact with C.A.A. officials.

History

In order to assist the reader in becoming familiar with the C.A.A. the following résumé of its history and organization is given.

Recognizing the national as well as the international scope of air commerce, the 69th Congress enacted legislation known as the "Air Commerce Act." This act was approved May 20, 1926. The purpose of the act was to encourage and regulate the use of aircraft in commerce

and for other purposes. The Secretary of Commerce was charged with carrying out the provisions of the act.

Among other things, the act made it the duty of the Secretary of Commerce to encourage the establishment of airports, civil airways, and other navigational facilities. The act was amended several times, but its intent remained unchanged.

With the increase of air commerce the number of airports and navigational facilities increased. The problems of regulating the use of aircraft changed and expanded to large proportions. Air commerce assumed such significance by 1938 that the provisions of the Air Commerce Act of 1926 proved to be incapable of fulfilling their original purpose. The 75th Congress passed an act cited as the "Civil Aeronautics Act of 1938." This act was approved June 23, 1938.

The Civil Aeronautics Act of 1938 amended the Air Commerce Act, as well as other pertinent acts, in such a manner that the Civil Aeronautics Authority would be in a position to carry out fully the intent of both acts. The Civil Aeronautics Act was enacted to create a Civil Aeronautics Authority to promote development and safety, and to provide for the regulation of civil aeronautics.

Section 201 of the Civil Aeronautics Act of 1938 reads in part as follows:

> (a) An agency is created and established to be known as the "Civil Aeronautics Authority" which shall be composed of five members who shall be appointed by the President, by and with the advice and consent of the Senate. . . . The President shall designate annually one of the members of the Authority as chairman and one of the members as vice chairman who shall act as chairman in the absence or incapacity of the chairman. . . .
>
> (b) There shall be in the Authority an Administrator who shall be appointed by the President and with the advice and consent of the Senate. . . .

Section 701 of the Act reads in part as follows:

> (a) There is created and established within the Authority an Air Safety Board. Such Board shall consist of three members to be appointed by the President by and with the advice and consent of the Senate. . . . The Board shall annually elect one of its members as chairman of the Board. . . .

The Civil Aeronautics Act defines all aeronautical terms used in the act, makes a declaration of the policy the Authority will follow in the exercise and performance of its powers and duties, and recognizes a public right of freedom of transit through the navigable airspace of the United States. The act outlines the organization of the Authority; sets forth the powers and duties of the various offices; establishes rules and

regulations applying to such things as air-carrier operations, nationality and ownership of aircraft, and safety; and provides procedures and penalties.

Section 7 of the Reorganization Plan Number IV, approved April 3, 1940, reads in part as follows:

(a) The Civil Aeronautics Authority and its functions, the Office of the Administrator of Civil Aeronautics and its functions, and the functions of the Air Safety Board are transferred to the Department of Commerce.

(b) The functions of the Air Safety Board are consolidated with the functions of the Civil Aeronautics Authority, which shall hereafter be known as the Civil Aeronautics Board and which shall, in addition to its other functions, discharge the duties heretofore vested in the Air Safety Board so as to provide for the independent investigation of aircraft accidents. The offices of the members of the Air Safety Board are abolished.

(c) The Administrator of Civil Aeronautics, whose functions shall be administered under the direction and supervision of the Secretary of Commerce, and the Civil Aeronautics Board, which shall report to Congress and the President through the Secretary of Commerce, shall constitute the Civil Aeronautics Authority within the Department of Commerce; Provided, That the Civil Aeronautics Board shall exercise its functions of rule-making (including the prescription of rules, regulations, and standards), adjudication, and investigation independently of the Secretary of Commerce; Provided further, That the budgeting, accounting, personnel, procurement, and related routine management functions of the Civil Aeronautics Board shall be performed under the direction and supervision of the Secretary of Commerce through such facilities as he shall designate or establish.

The net result of the President's Reorganization Plan Number IV is that the Administrator of Civil Aeronautics and the Civil Aeronautics Board now constitute the agencies representing the government in air transportation.

Civil Aeronautics Administration

Matters of sufficient importance regarding the airport problems of any given community may warrant the personal attention of the Administrator of Civil Aeronautics or an Assistant Administrator. Ordinarily, however, contacts are made with an official of lesser importance, but one who has more specialized knowledge of the subject under consideration.

C.A.A. Regions

The C.A.A. is a decentralized organization. The offices in Washington act in an administrative capacity, formulating policy, setting up

technical procedures, and passing judgment on the activities of the regional offices. In most instances regional office personnel should be contacted as they are more readily accessible and are directly involved with all matters within their own territory. The functions of the Washington office personnel in this connection can be likened to a court of review should there be any reason to question the decision of regional office personnel.

DIRECTORY OF REGIONAL OFFICES OF THE CIVIL AERONAUTICS ADMINISTRATION

Region I	385 Madison Ave., New York City, New York.
For States of:	Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, West Virginia, Maryland, Virginia, District of Columbia.
Region II	84 Marietta St., N.W., Atlanta 3, Georgia.
For States of:	North Carolina, South Carolina, Tennessee, Georgia, Florida, Alabama, Mississippi.
Region III	22nd Fl., Transportation Bldg., 608 So. Dearborn St., Chicago 5, Illinois.
For States of:	Ohio, Indiana, Michigan, Kentucky, Illinois, Wisconsin, Minnesota, North Dakota.
Region IV	P.O. Box 1689, Forth Worth 1, Texas.
For States of:	New Mexico, Texas, Arkansas, Louisiana, Oklahoma.
Region V	9th Fl., City Hall Bldg., Kansas City 6, Missouri.
For States of:	South Dakota, Nebraska, Kansas, Colorado, Wyoming, Missouri, Iowa.
Region VI	1500 4th St., Santa Monica, California.
For States of:	California, Nevada, Utah, Arizona.
Region VII	Smith Tower Annex Bldg., P.O. Box 3224, Seattle, Washington.
For States of:	Montana, Oregon, Washington, Idaho.
Region VIII	Anchorage, Alaska.
For the territory of Alaska.	
Region IX	Honolulu.
For the territory of Hawaii and Pacific Ocean.	

The regional administrator supervises and coordinates the activities of all regional office personnel. All communications should be addressed to his office where they will be routed to the appropriate branch for action or reply.

Safety Regulations

The Office of Safety Regulation enters the airport picture wherever air-carrier operations are to be provided for. One of the functions of

the Air Carrier Division of the Office of Safety Regulations, with respect to scheduled air carriers, is set forth as follows:

> Arranges for inspection of landing and navigation facilities for adequacy for air carrier operation, and recommends limitations as to usage; recommends changes in aids to air navigation for improvement of air carrier operations on specific air routes.

Operation limitations, among other things, govern the minimum ceiling and visibility under which contact or instrument operations are allowed and the type and permissible gross weight of transport-category aircraft which can operate from runways of a given airport. If there is any question as to the effect of either natural or man-made obstructions on air-carrier operations it is advisable to secure the opinion of a representative of this division. This same advice is applicable to questions regarding runway length to accommodate any specific aircraft.

Federal Airways

The Federal Airways Service provides aids to air navigation along civil airways, operates airway radio and other communication facilities, provides traffic control, and carries on technical development projects.

Airports

The great majority of contacts will be with personnel of the airport branch. The trend of all federal legislation makes it safe to assume that there will be no change in the policy which requires this service to approve the plans and specifications for any nonmilitary airport on which federal funds are to be expended. Future federal airport legislation may well change the scope of this division's activities but it is very likely that it can be relied on for engineering, planning, survey, and advisory assistance. Information on standards for every component part of an airport is available from them in the form of bulletins, drawings, and specifications.

TERMINOLOGY

The words employed to designate the component parts of an airport as well as those describing aircraft and their performance have come into such common usage that the various terms have some meaning to almost everyone. In view of the technical aspect of this text, however, the reader is advised to review the glossary of terms given in Appendix 1.

BASIC PRINCIPLES

An aircraft can take off or land in a shorter distance and with less skill required in handling when the take-off or landing is made directly into the wind. The heavier the aircraft, however, the less effect wind direction has on the direction in which it must land or take off. These facts are pointed out at this time as they play a tremendously important part in airport layout.

CLASSIFICATION OF AIRPORTS

In order to simplify and standardize reference to size and degree of development of airports the C.A.A. has established airport size-planning standards for five classes of airports. Table 2–2 is a reproduction of the Airport Size-Planning Standards as they are given in Table 3 of C.A.A.'s publication entitled "Airport Design."

LANDING STRIPS AND APPROACH ZONES

A modern airport is a very complex facility. It is comprised of a varying number of component parts, depending on its degree of development. The landing strip and its approach zones are the basic parts of an airport. All other parts exist for the purpose of increasing the degree of safety or convenience with which each landing strip can be used.

An airport can have any desired number of landing strips and each landing strip can be of such length and width as the limiting factors such as terrain or cost will permit. As is brought out in Table 2–2 the true direction of the percentage of winds having a velocity of 4 mph and over governs the number of landing strips required as well as their direction. The volume of traffic is also a factor entering into the number required. The length of the landing strips will be governed by the distance required to take off or land the aircraft which are normally expected to use the airport.

CIVIL AIR REGULATIONS

The Civil Air Regulations are the regulations issued by the Civil Aeronautics Board governing aircraft certification and the conditions under which they may be operated. Part 04 deals with certification of all aircraft for operation, whereas Part 61 deals only with transport-category aircraft. These two parts affect the runway length of any airport from which transport-category aircraft are operated. Figure 1–3 is a portrayal of the basic requirements of Parts 04 and 61 of the Civil

Air Regulations and is given in order to afford the reader a better understanding of the effective length of a landing area and the effect of obstructions. A study of Figure 1–3 should result in an understanding of the factor of safety the government requires in the operation of transport-category aircraft. It is easily seen that this factor of safety results in landing strips that are considerably longer than normal aircraft performance requires.

LONG-RANGE PLANNING

Before any intelligent approach can be made to the problem of selecting an airport site, several decisions have to be made. These decisions can be correct only if they come as a result of a careful study of the community's transportation requirements and possibilities. The study must be made from a long-range point of view. It must determine the ultimate need for air-transportation facilities and if possible result in the acceptance of an over-all airport plan for the community.

Commission and Consultant

In order that the over-all interests of the community can be best served it is necessary that all interests be represented at the time an airport plan is adopted. A great deal of information must be gathered first. It is recommended that a qualified consultant be employed to secure and compile this information. The best arrangement is for the community to appoint an airport commission to work with the consultant. In the event a consultant is not employed, the city, county, or state engineer, or some other qualified public agency must be designated to secure the information.

The airport commission must be given certain powers, such as the authority to expend funds for a consultant's services, and any other necessary activities. Members of the airport commission should be chosen so that they represent the local business interests, property owners, agriculture, and aviation. Members of the commission should be chosen for their ability to make fair decisions rather than because of any special interest in aviation. The commission should be considered as a review body rather than an agency to secure information.

INFORMATION NEEDED

Before the consultant or local public agencies securing and compiling information can function properly, the commission must establish the boundary of the area which is to be served by the airport plan. A