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Airports: Development and Problems

A. B. McMullen

AIRPORTS: DEVELOPMENT AND PROBLEMS*

A. B. McMULLEN†

As I look over the audience, I see many friends with whom I formerly worked when I was a member and officer in this Association, and with whom I have continued to work since I became identified with the Airport Section of the Bureau of Air Commerce, now the Civil Aeronautics Authority.

Since we have a mutual understanding of aviation, there is no need for me to dwell at length on generalities, and instead, I propose to discuss certain problems and recent developments which should be of interest and value to you in connection with your respective state programs.

First, I should like to say that after having worked several weeks with members of the new Civil Aeronautics Authority and the Air Safety Board, I am much impressed with the personal and technical qualifications of the men that constitute these organizations. They have, and are giving, every indication that they will approach all problems in connection with aviation with an open mind, and in my opinion we can not help but go forward if you place the confidence in them that I believe they both merit and deserve.

Several members of the new Authority have already indicated that they intend to rely to a large extent upon the advice and cooperation of state aviation officials in all matters pertaining to the regulation and development of aviation.

THE NATIONAL AIRPORT SURVEY

Perhaps the most pressing problem at the present time, insofar as airports are concerned, is the task of completing the national airport field survey, and the preparation of the report which Congress has directed shall be submitted by February 1, 1939, as to whether the Federal Government should participate in the construction, improvement, development, operation or maintenance of a national system of airports, and if federal participation is recom-

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† Chief, Airport Section, Private Flying and Planning Division, Civil Aeronautics Authority.

mended, the extent to which, and the manner in which, the federal government shall so participate.

The Private Flying and Planning Division of the Civil Aeronautics Authority has been directly charged with the responsibility of completing the survey and preparing the report. The Airport Section is specifically charged with the completion of the field survey, and to expedite the work, approximately forty engineers, draftsmen, stenographers, and statistical workers have recently been added temporarily to the regular force of the Airport Section. Even with this additional force, however, it will be impossible to complete this tremendous task by February 1, without the whole-hearted cooperation of state, municipal, and civic officials. A temporary Analysis and Report Staff headed by Mr. Douglas L. Cullison, has been created in the Private Flying and Planning Division, to conduct an economic study of the various regions and communities and to determine just what part Air Transport now plays, and may reasonably be expected to play, in the national economy. It will also be the duty of this staff to prepare the final report, together with the recommendations as to whether or not federal aid should be made available for airport construction, maintenance, and operation. This survey and report, we believe, is but the first step in accomplishing the program which we have long sought to achieve; namely, that of a coordinated national system of airports and airways, accomplished through the combined efforts of national, state, and local authorities.

A little over a year ago the Airport Section began making a special and thorough survey of airports, by using a combination of questionnaires and aerial photographs. As a result the Authority now possesses fairly complete information about airports throughout the country, municipal and otherwise, and it is hoped this survey embracing every airport in the United States will be completed by February 1, 1939. Up to August, 1938, 1137 airports had been surveyed by the Airport Section, compared with 361 on November 18, 1937, when I reported to this Association at your last annual convention.

Although I have no wish to become statistical, I can not refrain from citing just a few figures obtained from these questionnaires. During the calendar year of 1936, the total gross income of these 1137 airports amounted to approximately $2,300,000. Included in this group were 167 of the 209 scheduled air terminals, the gross income of which was approximately $999,500. Of this amount,

$402,000, or approximately 40%, was received from air transport companies. Another interesting fact brought out is that 83% of the $102,300,000 expended for improvements on airports, excluding cost of land, is accounted for by the *municipal* airports, the remaining 17% represents improvements made to private and commercial airports. The total capital invested in these 1,137 airports amounts to roughly $152,000,000, of which $44,800,000, or 29.5 per cent represents Federal funds; $49,230,000, or 32.4 per cent represents land costs, and $57,500,000, or 37.8 per cent represents other municipal, county, state and private funds. The average cost of land for all airports included in this tabulation is $286.00 per acre. The average cost per acre in cities over 500,000 population is $1,970, the cost decreasing in the smaller populated cities or communities to $66 in towns of less than 5000 population.

May I again call attention to the fact that the survey is to be made of the "existing" system of airports and that "definite recommendations" are to be made to Congress as to whether the federal government shall participate in the construction, improvement, development, operation, or maintenance of a national airport system, and if so, to what extent, and in what manner. I would also like to call attention at this time to the fact that the selection of approximately 800 airports for detailed survey purposes in no way determines the importance of any particular airport in the United States. I say this to allay any concern that airports were selected for survey purposes on their estimated or proposed importance in relation to a national system of airports. A veritable deluge of letters has descended upon our office as a result of this misapprehension, asking that this airport, and that airport, be included in the survey. You would be doing a great service if you would explain to the city officials and the airport people with whom you come in contact that the particular airports included in the present survey were selected impartially, and for cross-sectional purposes only, and that the territory selected for a regional study adapted itself more readily for survey purposes during the ensuing winter months.

It is hardly necessary to emphasize that the Civil Aeronautics Authority must, and shall call upon every organization and agency possessing pertinent facts, or means with which facts can be obtained relating to this survey, for immediate assistance and cooperation. Educating the officials and people in your states as to the purpose and intent of the survey and the necessity for a coordinated airport and airway plan is a task which we must call upon you to

PRELIMINARY REPORT ON AIRPORT CAPITAL INVESTMENT AND OPERATING FINANCES AS OF JAN. 1, 1937
(Based on National Airport Survey)

		Airports Grouped According to Population of the Cities in Which Located					
	All Airports	*Over* 500,000	100,000 *to* 500,000	50,000 *to* 100,000	25,000 *to* 50,000	5,000 *to* 25,000	*Under* 5,000
I. *Total Capital Investment* (1,137 airports)	$151,530,605	$35,511,470	$51,812,599	$12,041,568	$17,593,101	$21,875,405	$12,296,462
A. Total Cost of Land	49,231,640	13,247,528	14,304,982	2,801,437	7,499,128	7,185,284	4,193,281
B. Total Cost of Improvements:	102,298,965	22,263,942	37,507,617	9,640,131	10,093,973	14,690,121	8,103,181
1. By types of improvements:							
a) Landing area	62,755,383	13,702,394	20,000,878	6,897,396	7,052,467	9,368,171	5,734,077
b) Buildings & Equipment	39,543,582	8,561,548	17,506,739	2,742,735	3,041,506	5,321,950	2,369,104
2. By types of airports:							
a) Municipal (570)	85,021,547	19,040,254	36,108,869	8,865,684	7,020,631	9,577,496	4,408,613
b) Commercial and private (567)	17,277,418	3,223,688	1,398,748	774,447	3,073,342	5,112,625	3,694,568
3. By source of funds:							
a) Federal Government	44,797,914	7,502,594	13,126,720	6,246,365	5,958,267	7,089,461	4,874,507
b) State	3,775,139	.....	2,885,735	164,151	147,541	251,077	326,635
c) Other	53,725,912	14,761,348	21,495,162	3,229,615	3,988,165	7,349,583	2,902,039
II. *Average Capital Investment per Acre* (1,137 airports)	880	5,281	2,364	918	959	457	193
A. Average Cost of Land Per Acre	286	1,970	653	207	409	150	66
B. Average Cost of Improvements Per Acre	594	3,311	1,711	711	550	307	127
III. *Total Gross Income*—(1,137 airports)*	2,281,387	329,309	641,284	166,642	257,017	572,650	314,485
A. Total Gross Income—(970 misc. airports)	1,281,859	102,715	115,642	58,674	169,215	523,182	312,431
B. Total Gross Income—(167 Scheduled Air Terminals):	999,528	226,594	525,642	107,968	87,802	49,468	2,054
1. Gross Income from Air Transport Operations	402,207	138,075	166,791	39,260	40,163	16,240	1,678
2. Gross Income from Miscellaneous Operations	597,321	88,519	358,851	68,708	47,639	33,228	376
IV. *Total Operating Expenditures* (1,137 airports)*	3,062,938	768,549	935,385	206,381	264,945	569,432	317,796
V. *Progress of Airport Survey:*							
A. Total Number of Civil Airports	2,005	67	121	106	136	502	1,100
B. Total Number of Questionnaires Returned	1,137	21	79	51	100	343	543
1. For municipal airports	570	8	51	35	50	186	240
2. For commercial and private airports	567	13	28	16	50	157	303

* For calendar year 1936.

assist in, and in this connection, we have prepared for field use an "Outline-guide to a proposed national airport plan" to explain, (a) the necessity and purpose of the plan; (b) the theory upon which it is to be based; (c) the proposed methods to be used in its formulation; (d) and the standards proposed for the classification of landing areas and seaplane bases and the factors which enter into the assignment of such classifications.

Time will not permit me to go into detail as regards this outline-guide so, perforce, I shall merely attempt to touch on a few of the more important factors covered therein.

Classification of Airports; Landing Areas

We have assumed that it is possible to establish minimum landing area requirements, and these minimum requirements have been designated as Class 1 to 4 landing areas beginning with Class 1 as the smallest rather than the largest, making it possible to add additional classifications of landing areas when needed, in regular numerical order, thus eliminating the necessity for reclassifying all landing areas, if it becomes necessary in the future to establish landing areas of higher classifications than are now provided for. The adoption of this method will, we believe, also eliminate a great deal of confusion relative to landing area classifications, for it will only be necessary for aircraft operators to familiarize themselves with a single plan, inasmuch as each succeeding classification can be added in numerical order.

In order to determine whether or not a given airplane may be safely operated into or out of a given airport, it is necessary to compare the distances required for the airplane to take off or land at that airport with the distances available. The available distances obviously remain fixed for a given airport. The various factors which influence the distances required for an airplane to take off and reach a certain height above the ground or the space required in landing may be classified as follows:

A. *Characteristics of the site:*
   1. Actual altitude.
   2. Nature of runway surface.

B. *Weather conditions:*
   1. Barometric pressure.
   2. Temperature.
   3. Wind direction and velocity.

C. *Characteristics of the airplane:*

1. Wind loading.
2. Power loading.
3. Minimum parasite drag.
4. Maximum lift.
5. Engine characteristics.
6. Propeller characteristics.

D. *Operating technique:*

1. This is largely a matter of the selection of an approach glide speed and a throttle setting in landing or a steady climb speed and throttle setting in take-off.

In the classification of airports on the basis of the comparison of the distances required by the airplane with those distances available, it is obviously desirable to provide some margin of available distance over necessary distance. This margin must be sufficiently great to accommodate the effect of the worst possible combination of all of the above factors, which are not otherwise accounted for, and in addition should contain some provision for the effect of traffic density upon the required distances.

A study of airport locations disclosed that approximately 79% of the existing landing areas are located at elevations ranging between sea level and 2000 feet. We have therefore established minimum effective runway length requirements for each classification sufficient, we believe, to take care of all of the variable factors previously mentioned, for all airports located at elevations between sea level and 2000 feet. For landing areas located at higher elevations, the minimum effective runway lengths must be increased approximately 15% for each additional 1000 feet increase in elevation.

Briefly, for your information, I will outline the minimum requirements for each of the four landing area classifications into which it is proposed to group all airports or landing areas.

Class I. Landing area should provide a sufficient number of landing strips at least 300 feet wide, having a minimum effective length of 1500 feet, or permit the possibility of laying out such strips if an all-way landing area, making possible, landings and take-offs to be made within 22½° of the prevailing wind directions for at least 75% of the total winds over 5 miles per hour in velocity.

Class II. Landing area should provide the same general requirements save that the landing strips shall be at least 500 feet in width and have a minimum effective length of 2500 feet, with the landing strips so laid out as to allow landings and take-offs to be

made within 22½° of the prevailing wind direction for at least 80% of the total winds over 5 miles per hour velocity.

Class III. Landing area—same general requirements, save that the minimum effective runway length shall be 3500 feet—landing strips so laid out as to account for 90% of prevailing winds over 5 miles per hour velocity.

Class IV. Landing—same requirements save that minimum effective runway length shall be 4500 feet. By effective length is meant the actual length of a runway, landing strip or other portion of the landing field corrected for approach deficiencies, so approaches can be made at a glide angle of 20 to 1. This standard, however, may have to be changed at an early date to 25, or even 30 to 1.

Instrument Approach System

In this connection it may be of interest to you to note that the Civil Aeronautics Authority is carrying on a general development program, under W. E. Jackson, Chief Radio Development Section, Planning and Development Division, directed toward producing an improved instrument landing system. On June 27th, the Civil Aeronautics Authority let a contract with the International Telephone Development Company in the amount of approximately $65,000, for an instrument landing system to be installed at the CAA experimental station on the Indianapolis, Indiana, Municipal Airport. This landing system will give guidance to aircraft landing in any of four directions. Time does not permit me to outline this system, but it may interest you to know that for this system it is recommended that all buildings and obstacles should be at least 750 feet from the center line of any runway to be used for instrument landings. Paved runways should be at least 200 feet wide and 300 feet is desirable and if not 300 feet should at least have surfacing or sod on either side sufficient to permit off-runway landings. Runways should be at least 5000 feet long for instrument landings and obstructions at the end of these runways must be held to a minimum height. It is recommended that obstructions from a point at the approach end of the runway to 2500 feet from this point should be kept below a glide angle of 50 to 1. Objects from a point 2500 feet from the end of the runway to a point one mile from the end should be withheld to permit a glide angle of 40 to 1 and objects between one mile from the end of the runway to a point two miles from the end should permit a glide angle of 30 to 1.

This development designed to increase the operation of aircraft during periods of low or zero zero visibility by bringing aircraft into airports on instruments at flat angles of approach forcibly brings to attention the necessity of adequate zoning of airport approaches.

Photographic Analysis of Landing and Take-off Characteristics of Airplanes

The Airport Section first sounded a warning years ago as to the necessity for developing a coordinated airport plan which would allow for suitable expansion in the proper directions providing safe distances for take-offs and landings. The warning was again sounded when the rapid development of air transport aircraft threatened to doom large numbers of our airports. It became apparent then, that there was a desperate need for a criterion based on actual service performance characteristics by which safe runway lengths could be determined, rather than by theoretical calculation and personal opinions.

In developing equipment to obtain this information, every known make of photographic recording device was studied with respect to ability to produce the data needed. It would take too long to mention the disappointments and the hard work experienced by Airport Section personnel in the early experiments, as this is characteristic of all research work.

Through the cooperation of the Eastman Kodak Co., and particularly Mr. Ford Tuttle of that company, a multiple camera system was developed. This was based on the well known principle of triangulation, and functioned basically as a fixed base range finding device.

The essential equipment consists of four 16 millimeter spring-driven motion picture cameras, operated in pairs, equipped with two and one-half inch lenses and electrically operated solenoid single frame releases.

In order to simplify readings and calculations we are using a projector on which the images produced by either pair of cameras are projected side by side. These images are registered accurately on the projector screen by means of reference markers, which are placed in the fields of the cameras when the pictures are taken.

Up to July 1, 1938, some 850 take-offs and landings were recorded at various locations. The records obtained to date have provided a most valuable accumulation of data, speeds, accelerations,

and determined flight path angles. These data will have an important future bearing on determining airplane airworthiness regulations for landing. They may also be used for the recording of flight paths during instrument approaches on so-called blind landing systems. They would provide an excellent check of actual flight paths against theoretical radio beams and would be of valuable assistance to future developments of blind landing systems. This method of determining aircraft performance will play an important part in determining future landing area requirements for all aircraft.

Airport Lighting

One of the most important developments in airport lighting during the past twelve months has been the widespread installation of contact lights, which are flush lights installed along the edges of the runways. The Airport Section in cooperation with manufacturers of airport lighting equipment also developed a new type of flush contact light, which is designed to produce maximum light at low angles where it can be most readily picked up by a pilot approaching an airport in a normal glide.

Considerable study has been given to the best type of approach lane lighting designed to mark the approach to instrument landing runways, and experiments are now being carried on at Indianapolis and elsewhere to determine the best solution of this problem.

The Establishment of Seaplane Bases and Allied Facilities Throughout the United States

As a result of increasing seaplane activity and the extension of transoceanic operations, the Bureau of Air Commerce was often called upon to make recommendations as to the size of the water areas that would be required, and the type and scope of the land facilities that should be constructed for handling operations. Since the information then at hand as to the performance characteristics of large transoceanic water aircraft was limited to the extent that time elements for various maneuvers were calculated in seconds and minutes, rather than distance, a survey was conducted during the past year to determine the water maneuvering characteristics of this type of aircraft in relation to the length of run on the water, rate of climb, and altitude attained by large seaplanes in certain distances immediately following take-off. From this survey it was determined that the following minimum length landing areas were desirable for safe operations:

5000 feet usable water area or channel for seaplanes up to and including 20,000 lbs. gross weight.

12,000 feet for seaplanes from 20,000 to 40,000 lbs. gross weight, and

20,000 feet for seaplanes from 40,000 to 125,000 lbs. gross weight.

Under the direction of our Seaplane Terminal Adviser, Mr. Robert L. Campbell, extensive studies have been initiated to determine the ultimate utility that might be expected from various typs of marine railways, ramps, mechanical beaching gear and loading platforms. While such studies have not been completed, they have been carried out to a point that satisfactorily demonstrates the main features of design that must be incorporated in land facilities, if the greatest degree of diversified utility is to be accomplished.

Considerable work, research and study has been given to *operating areas,* i. e., restricted areas or areas in which seaplanes have the right of way over surface craft,—possible overland routes for seaplanes, and the lighting of water operating areas.

One of the principal responsibilities of the Airport Section of the Civil Aeronautics Authority is the review of all project applications, and plans and specifications pertaining thereto, for the development and improvement of airports where the expenditure of Federal funds is involved. Under the new Civil Aeronautics Act, the Authority is required to certify that any Federal funds expended by any Federal agency upon airports is reasonably necessary in the interest of National defense or air commerce. This part of the Act is interpreted to mean that these Federal funds shall be expended for facilities which are to be both adequate and safe. In order to carry out this responsibility, our engineers closely check all plans and specifications to determine that the finished work will be acceptable from an aeronautical standpoint, prior to the issuance of the Certificate of Air Navigation Facility Necessity.

When you consider that approximately 350 WPA and PWA project applications involving the expenditure of $93,930,000.00 have been submitted to the Civil Aeronautics Authority for processing during the past twelve months, it can readily be seen that our engineers must necessarily handle and review a vast amount of material in connection with the present airport development program. Unfortunately, this material is not always sufficiently complete, with reference to plans and specifications, to determine that the development proposed under the project is going to result in

good usable facilities. This results quite often in delay in processing the projects through regular channels in Washington, pending the preparation and receipt of additional material for review. Considerable time is lost which could be advantageously used in the actual operation of the project. Plans are very often received which are very sketchy and vague and do not indicate the most essential information, such as location of runways, buildings, surrounding obstructions, finished grades and topography of the field, etc. State aviation officials are in a position to give sponsors considerable help in securing the expeditious review and processing of project applications, by impressing upon them the necessity for—and assisting them in—preparing plans which are complete in the essential details and which will furnish the Civil Aeronautics Authority with sufficient information to take intelligent action when the application is first received.

Conclusion

I have endeavored to present to you a brief resume of some of the things that have been done during the past twelve months, what the CAA is trying to do to improve the "Airport Dilemma," as the American Municipal Association so aptly calls it, and a brief outline of the problems confronting us in the immediate future; but, due to the vastness of the program, it has been impossible to give you more than the sketchiest of outlines, and if I have rambled in so doing, I hope you will overlook it. Before I close, however, I would like to again express my appreciation for the work your Association has done during the past year. The activities of your officers, I believe, had a significant bearing on the final draft and passage of the Civil Aeronautics Authority Act of 1938.

May I again impress upon you at this time the importance of all working together as a unit, for only by so doing can you hope to continue the reputation of your Association as an unselfish, hard-hitting, clear-thinking organization interested solely in the advancement of aviation.