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THE DEVELOPMENT OF AN AIRPORT TAXI GUIDANCE SYSTEM

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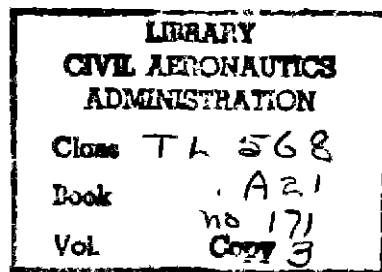
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THE DEVELOPMENT OF AN AIRPORT TAXI GUIDANCE SYSTEM

SUMMARY

This report discusses the need for and development of a system of signs to furnish guidance by day and night to pilots who are taxiing on an airport. Basically, the system consists of a number of conspicuous signs properly placed to identify intersections and turnoff points to specified destinations. The system described has been recommended for adoption as a Civil Aeronautics Administration standard.

INTRODUCTION

The ever-increasing public acceptance and resultant expansion of air transportation introduce many problems related to the movement and control of aircraft ground traffic. These problems have been brought about by the attendant increases in airport size and complexity, in airplane ground operations, and in the number of landings under lower visibility minimums.

At many airports, even though traffic control facilities are provided, considerable difficulty is experienced in exercising control of ground traffic, and the consequent delay in movement of such traffic is a serious problem. This delay and difficulty of control can constitute a hindrance to safety of operations. There are certain inherent conditions which emphasize the problem, and the most important of these, during both day and night, is the lack of landmarks available on the wide flat surface of a large airport. It is not unusual for a pilot to need special assistance when taxiing to his destination during daylight hours even though he may have an intimate knowledge of the airport layout. At night, the few available landmarks are almost entirely obscured by darkness, thus increasing the difficulties.

The increasing number of operations being conducted under reduced weather minimums result in more frequent occasions when it is necessary to give taxiing instructions to pilots of aircraft which cannot be seen by the tower operators. During both restricted and unrestricted visibility conditions there are also many other times when a number of pilots will require assistance from the tower simultaneously. On such occasions the necessary information concerning position and turnoff points has customarily been furnished them by means of radio. It can be readily

appreciated that as the traffic becomes more congested the work load of the tower personnel will be increased to a point, possibly, where it would be very difficult to handle the traffic. At many airports, traffic conditions are rapidly approaching this point, while at others the need for supplementary aids has been recognized for some time.

The most widely used method for supplementing the guidance furnished from the tower is by visual aids. Systems of taxiway marker lights to furnish visual guidance have long been in common use and serve to delineate the taxiways. These lights, however, do not identify a particular intersection or the destination to which the taxiway leads. While they can aid a pilot and help prevent him from running off the taxiways, such lights do not furnish complete guidance.

Since the problems involved in ground travel about an airport are similar in many respects to those involved in highway travel, it was only natural that engineers in studying solutions would consider a system of signs such as are used in highway traffic guidance as a possibility for application to airport taxiway guidance. The use of strategically located signs would appear to be a logical supplement to taxi lights for giving the pilot the information he may need concerning his location and to tell him how to reach his destination.

The desirability of using some type of sign for destination marking was emphasized at San Francisco, California. At that terminal, although domestic and international operations are based on separate sides of the airport, pilots frequently found themselves on the wrong side of the field with much attendant confusion. At New York, engineers of the Port of New York Authority believed that there was need for traffic-directing signs on the airports and were among the first to experiment with signs to designate runways or taxiways. The Illuminating Engineering Society Taxiway Lighting Subcommittee made a study of the problem and recommended the use of a system of signs for taxiway guidance.

As the early experiments showed that a system of signs could be made effective, it was decided that CAA should undertake the development of such a system. Accordingly, personnel from the Office of Airports and from the Technical Development and Evaluation Center initiated preliminary

studies. Since it was apparent that several types of systems were possible, a committee was appointed by the CAA Administrator early in 1951 to evaluate proposed systems of taxiway signs for the purpose of determining whether they satisfied the requirements for controlling ground traffic operations on an airport. The Committee was also authorized to make pertinent suggestions and recommendations. It was known as the CAA Taxiway Sign Evaluation Committee and was composed of representatives from the TDEC and representatives from the Offices of Aviation Safety, Federal Airways, and Airports. The Committee combined the backgrounds necessary for judging and evaluating any proposed system from the viewpoints of the pilot, traffic controller, and engineer. The CAA Taxiway Sign Evaluation Committee tested, modified, re-examined different systems at Indianapolis, and made visits to a number of other airports where various types of taxiway signs were installed. Finally, the Committee made recommendations and established design criteria covering what was judged to be the best taxiway guidance sign system.

This report describes the development of the system of taxiway guidance signs recommended by the CAA Taxiway Sign Evaluation Committee for adoption as a standard by CAA.

METHODS OF GUIDANCE

It is important that the guidance furnished by signs should be of such clarity and simplicity as to be readily comprehended by a taxiing pilot. Usually this pilot has either landed on a certain runway in accordance with instructions, or else he has left the ramp at a certain turnoff or taxiway. In both of these cases he will normally be aware of his general position, but before he can change his course or leave his position on the known runway or taxiway he will need guidance in the form of turnoff or destination signs.

En route to his destination he may need other guidance in the form of intersection or route markers which will enable him to identify his position. At controlled airports such signs will serve under any visibility condition to furnish confirmation of the guidance he receives from the controller and will make it possible for him to inform the control tower as to his position at any time.

Two possible methods or systems of guidance were studied. One is based on marking destinations and the other on identifying the taxi pathways. Both would include

turnoff marking and intersection marking, although the second system would necessarily provide more detailed intersection identification.

The method of destination marking is based on the assumption that his destination on the airport is of most interest to the taxiing pilot. This method would furnish the guidance by which a pilot could find his own path around the airport and would require only overriding and emergency direction from the control tower. It would provide only such incidental path identification as he would need to identify his position if necessary.

The method of pathway identification is based on the principle of assigning a continuous identification to a taxiway path, of keeping the pilot constantly advised of the identity of this path, and of making instructions from the control tower simple and easy to follow. This system would provide destination marking only when near the ramp or where it would be a positive necessity. It is primarily designed to serve as a supplement to control tower directions.

EXPERIMENTAL INSTALLATIONS AND TESTS

In order to experiment with proposed taxi guidance systems, it was also necessary to develop adequate signs. This development is described in another report.¹ Concurrently with the work on sign development and after an adequate size of letter had been determined, a number of simple painted signs were prepared with various legends in accordance with the principles of two systems evolved by CAA. These were installed at Weir Cook Airport, Indianapolis, Indiana. One system made use of the destination and runway segment marking principle and the other made use of destination signs with arrows and intersection, runway, and taxiway identification signs. It was planned to have the Committee evaluate the two systems and make a decision which could then be incorporated into a system of signs for day and night use.

The two systems were installed together, using temporary cloth envelopes to conceal one system while the other was being observed. Using the signs for guidance the

¹Marcus S. Gilbert and Robert E. Faucett, "The Development of Airport Taxi Guidance Signs," Technical Development Report No. 170, June 1952.

Committee made observations in daylight by simulating taxiing in a station wagon equipped with radio. After a number of observations, the Committee decided that the system should be based on certain elements of both systems tested

As a result of the tests it was found necessary to establish new criteria, and the Committee tentatively proposed the following requirements for a new experimental system

- a Runway or taxiway identification signs located at intersections
- b. A limited number of destination or turnoff signs with arrows, located only at intersections and indicating only preferred routes
- c Identification signs to be placed 20 feet ahead of the respective intersection, and destination signs 50 feet ahead of the identification sign, all signs to be placed 20 feet from the pavement

A new system of painted signs conforming to the above criteria was installed on the airport. Since by that time development of the lighted signs was near completion, plans were made to install lighted signs along one runway

Daytime inspection of the system embodying the Committee's recommendations indicated that the pattern appeared to be workable and effective. When the lighted sign system was tried by night, however, with the observers riding in a C-47 airplane, the results were not so satisfactory. In this

case the pilot tried to turn off prematurely, immediately after passing the destination turnoff marker. This indicated two deficiencies: that the turnoff markers should not be placed anywhere except at the actual turnoffs, and that the turnoff should be more adequately marked. Consequently, it was decided to revise the placement of the destination signs and locate them on the far side of the intersecting runway or taxiway so that the identification sign on the near side and the destination sign on the far side would bracket the intersecting runway into which the pilot could safely turn, if a turn were indicated.

After completing these tests the Committee prepared final detailed recommendations for nomenclature, location, placement, and height of signs for use in a taxi guidance system. These are incorporated in Appendix I

CONCLUSIONS

As a result of the test program, an effective system of taxi guidance marking was developed under the guidance of the CAA Taxiway Sign Evaluation Committee, which incorporates elements of both destination marking and pathway identification. The system recommended provides for and stresses effective turnoff marking and is designed to facilitate understanding of taxiing instructions and to provide guidance where no instructions are received.

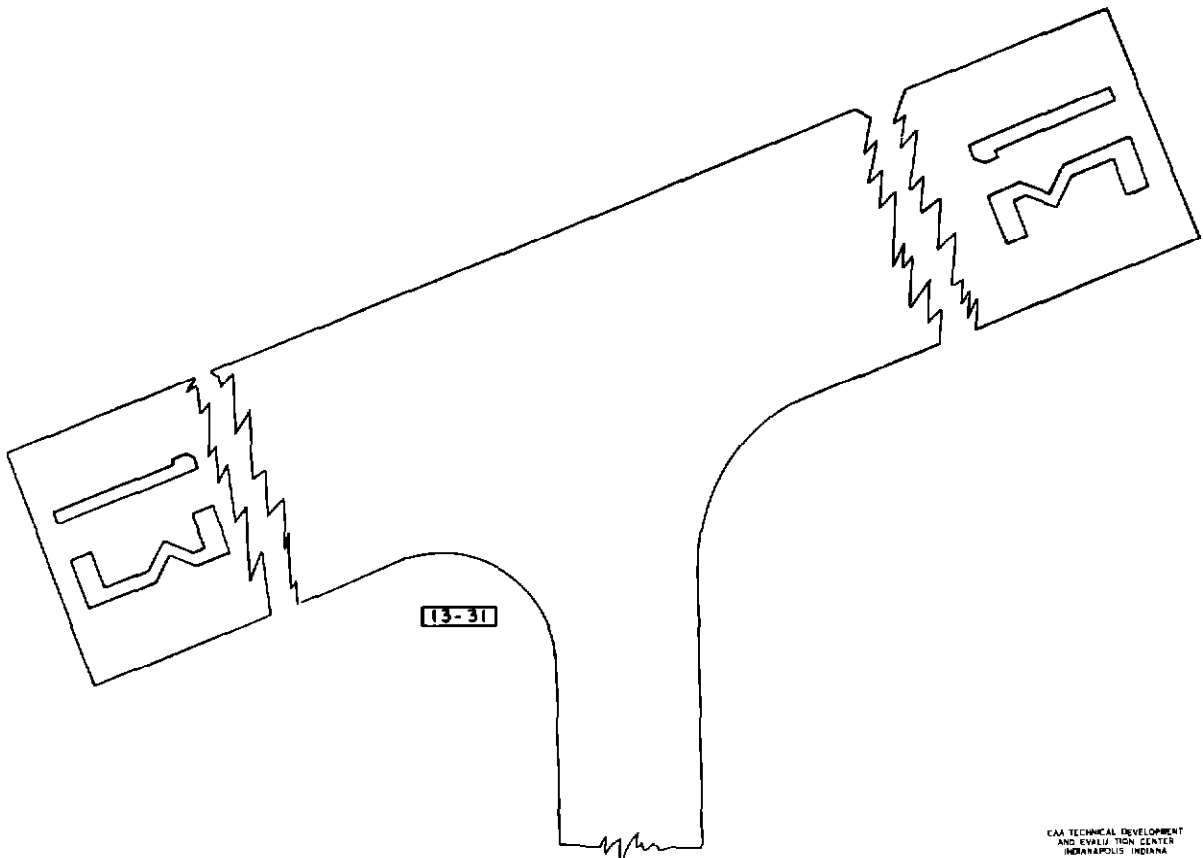


Fig 1 Runway Identification Sign

APPENDIX I

RECOMMENDATIONS FOR TAXI GUIDANCE SIGN SYSTEM*

The following recommended principles for the establishment of taxiway guidance signs are based on the premise that a taxiway marking system will serve two major functions, the relative importance of which will depend upon the particular airport involved. Where airport traffic control service is provided, the system should furnish information to enable the pilot of radio-equipped aircraft to follow tower instructions more readily. This information should also result in reduction in the amount of taxi instructions required to be issued by the airport traffic controller. However, at controlled airports, the signs do not replace or eliminate the controller's instruction. At locations not served by airport traffic control towers and for aircraft not radio

equipped, the system will provide guidance to major destination areas on the airport.

The taxiway marking system should be installed in accordance with the following basic principles:

A Identification Signs

Intersections formed by runways and/or taxiways shall be clearly marked and identified by appropriate signs as required. The purpose of these signs is to inform a pilot that he is approaching an intersection and to identify the intersecting route.

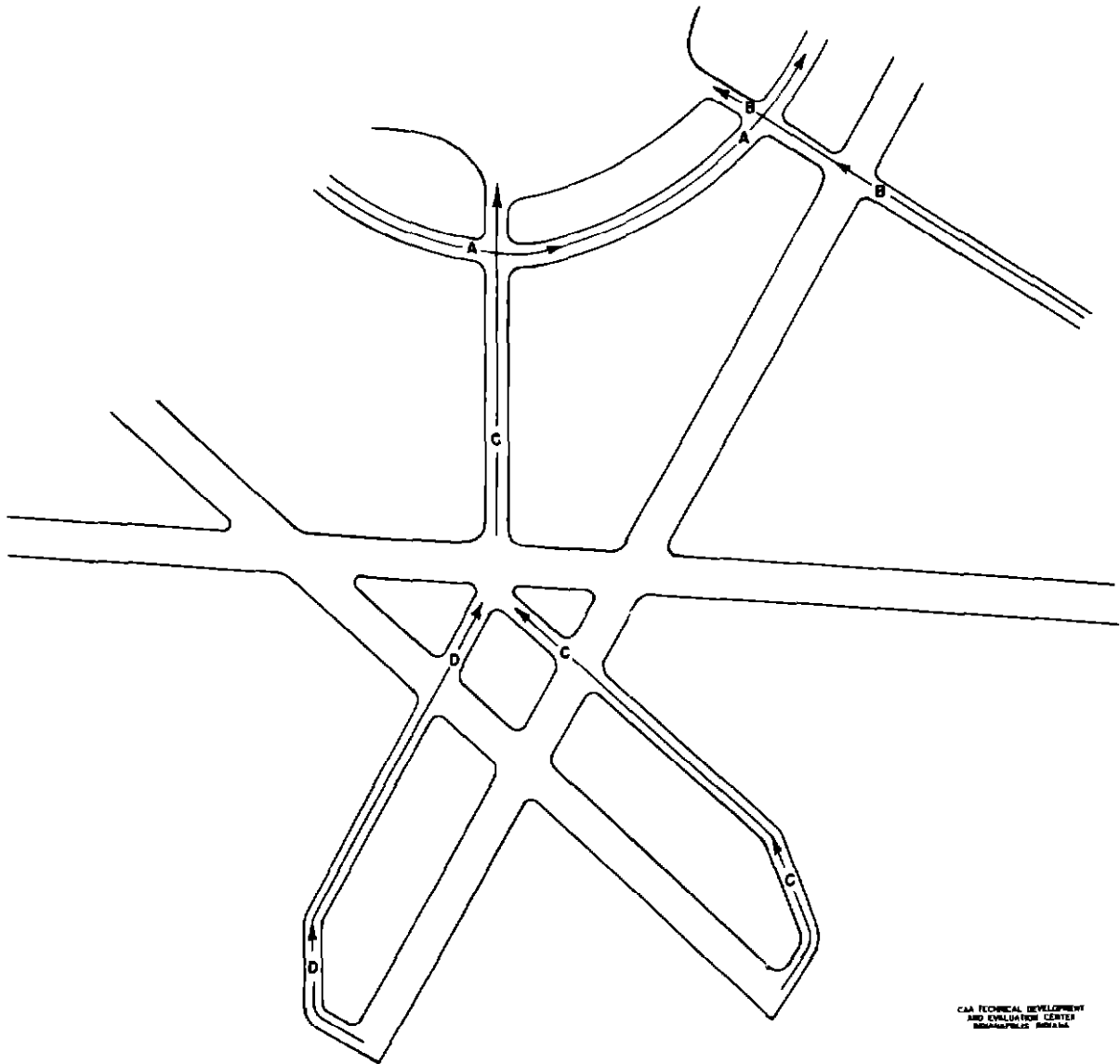
1 Runway Identification Signs

Runways should be identified in accordance with the following requirements:

a Numbers and Letters – Each runway end shall be designated by the assigned runway number, including letters where required, as established by TSO-N10.

b Runway Identification – The runway identification should consist of the numbers and letters assigned to both ends of a runway,

* Unpublished Recommendations by CAA Taxiway Sign Evaluation Committee, March 1957



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Fig. 2 Identification of Taxiways By Letters

in accordance with paragraph a and separated by a dash, such as "13-31." The order of placement of the runway numbers and letters on the sign should correspond to the direction of the take-off ends of the runway. For example, "13-31" indicates to a pilot that the take-off end of runway "13" is to the left and that of runway "31" is to the right. See Fig 1.

2. Taxiway Identification Signs.

Taxiways should be identified by letters of the alphabet insofar as possible. Only one letter should be used to identify an entire taxiway, which may consist of several continuous taxiway sections. For example,

a taxiway from a ramp to the end of a runway should be considered as one taxiway even though the route consists of a number of taxiway sections due to intersections with other runways and taxiways, except that another taxiway making a junction with a taxiway so identified should be assigned a different letter. A taxiway section should not be assigned more than one identification letter, even though it may be common to several possible taxing routes. It may be necessary, however, to assign double letters such as "AA," etc., where an airport has a larger number of taxiways than there are single letters available. See Fig 2.

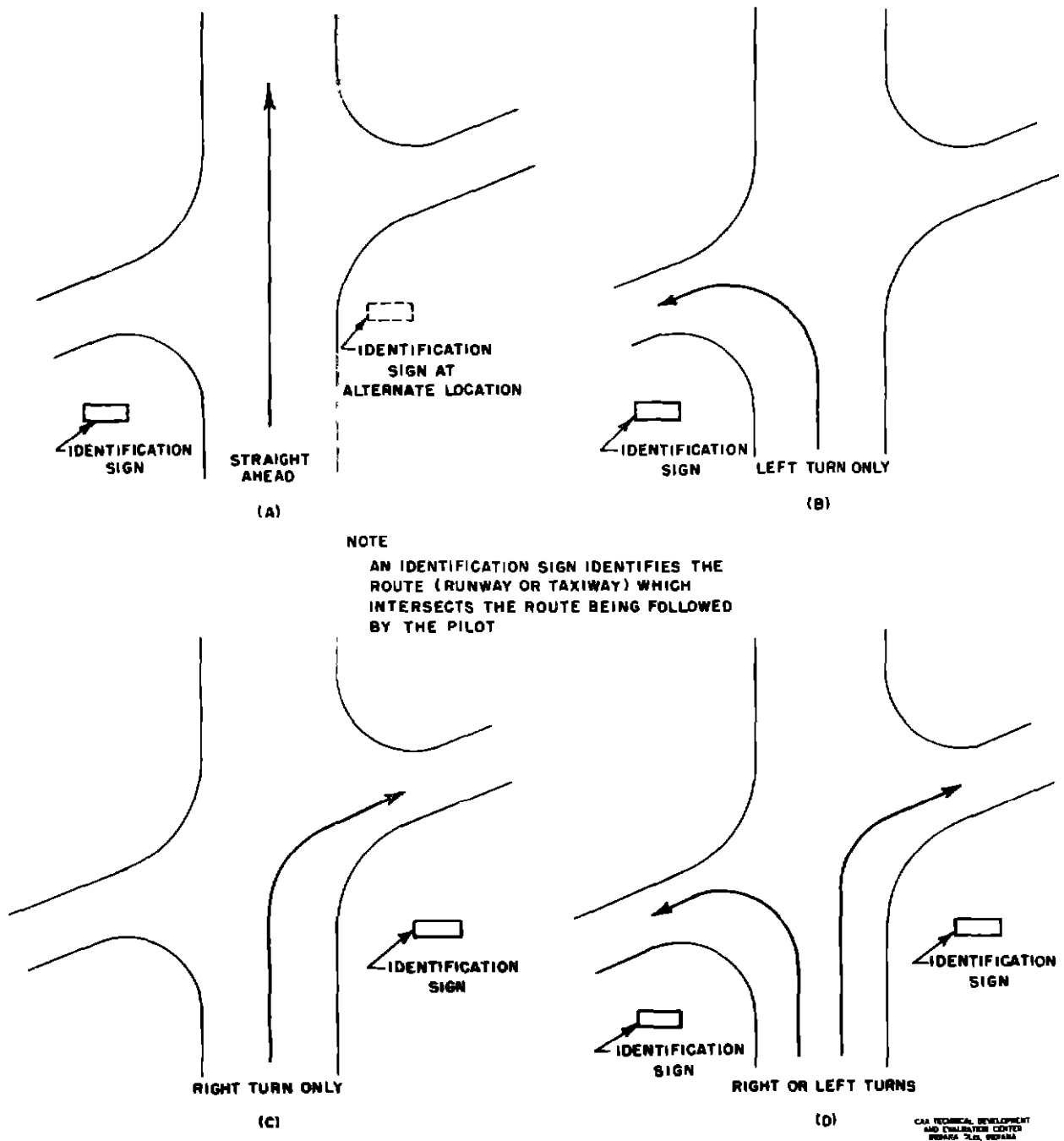


Fig. 3 Configuration For Identification Signs

3 Runway and Taxiway Identification Signs Configuration.

Signs identifying intersecting runways or taxiways for aircraft approaching the intersection should be placed on the near side of the intersection and as follows

a. At an intersection where taxiing aircraft from a given direction will normally proceed across the intersection (i. e., will not turn onto the intersecting taxiway or run-

way) a single sign identifying the intersecting route should be placed on either the right or left side of the aircraft's route, whichever is considered the more advantageous for safety of operations (preferably the pilot's side) See Fig. 3A

b. At an intersection where taxiing aircraft from a given direction will normally turn onto an intersecting taxiway or runway, the sign identifying the intersecting route

← RAMP

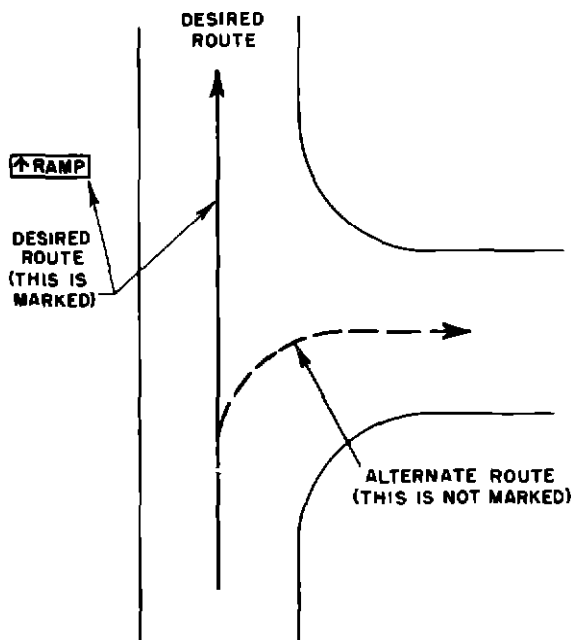
↑ RAMP

RAMP ↗

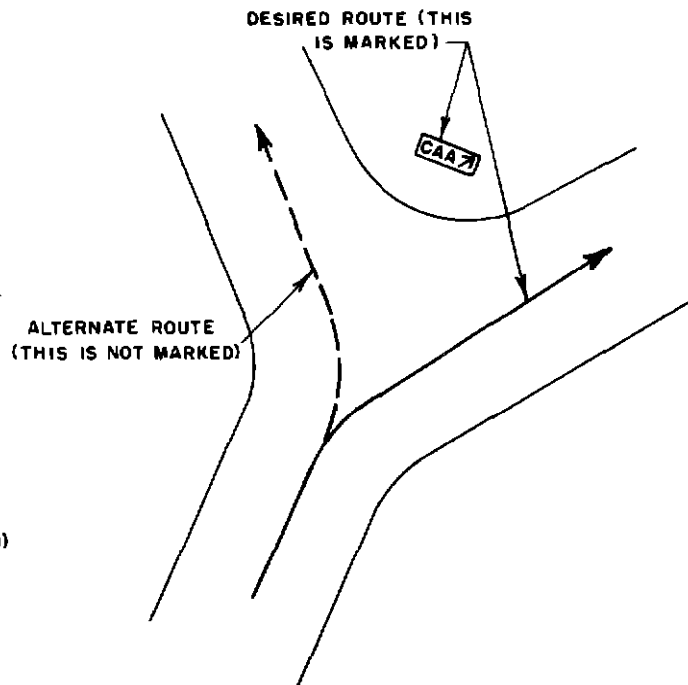
(A)

18 • 13 ↗

(B)



(C)



(D)

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Fig. 4 Destination Signs, Symbols and Number of Routes

should be placed on that side of the aircraft's route toward which the turn is to be made. Thus, if turns may be made in both directions, signs should be placed on both sides of the aircraft's route. See Figs. 3B, 3C, and 3D.

B Destination Direction Signs

Destination signs for both inbound and outbound routes should be provided as required.

1 Legend

Destination signs should show the destination and an arrow indicating the direction to taxi to that destination. When the direction to taxi is straight ahead or involves a turn to the left, the arrow should be located

to the left of the destination symbol. When the direction to taxi involves a turn to the right, the arrow should be located to the right of the destination symbol. The destination should consist of runway numbers for outbound routes and short words or abbreviations for inbound routes. See Figs. 4A and 4B. In general, inbound destination names should consist of not more than four-letter words or abbreviations. A list of standard destination terms follows.

RAMP — To identify all parking, servicing, and loading areas in general.

Note: This may be modified by a letter indicating direction (N, S, E, W) where required to distinguish

- between major ramp areas
- PARK — To identify areas specifically set aside for parking aircraft
 - FUEL — To identify areas where aircraft are fueled or serviced
 - GATE — To identify gates at which aircraft are loaded or unloaded
 - STN — To identify positions at which aircraft may be loaded or unloaded but which may not be located at a specific gate
 - ITIN — To identify areas set aside specifically for itinerant aircraft.
 - OPNS — To identify the airport operations office
 - MIL — To identify areas set aside for military aircraft.
 - CIVIL — To identify areas set aside for civil aircraft
 - RON — To identify areas or locations set aside for overnight parking
 - PASS — To identify areas set aside for passenger handling
 - CARGO — To identify areas set aside for freight or cargo handling.

2. Alternate Routes.

At any intersection or junction of runways and/or taxiways where the possibility of alternate routes to a particular destination exists from a given direction of travel, the destination signs should indicate only one route to be followed. See Figs 4C and 4D.

3 Outbound Signs.

Outbound destination signs may indicate more than one runway destination where the direction of travel to the take-off ends of several runways is common. In such cases, any pair of runway designation numbers should be separated by a circular dot. See Fig. 4B.

4. Destination Direction Signs Configuration.

Signs indicating the direction of travel to a destination should be placed on the far side of an intersection from the aircraft approaching and as follows

a. At an intersection where taxiing aircraft from a given direction will normally proceed across the intersection (will not turn onto the intersecting taxiway or runway), the destination sign should be placed on the same side of the aircraft's route as the identification sign preceding it. See Fig 5A.

b. At an intersection where taxiing aircraft from a given direction will normally turn onto an intersecting taxiway or runway, the destination sign should be placed on that side of the aircraft's route to which the turn is to be made. See Figs 5B, 5C, and 5D

5 Selection of Destination Signs

Only major destination areas should be shown on destination signs located on the

landing area proper. For example, at many airports, signs indicating the way to the ramp may be adequate, whereas at some airports it may be necessary to make a distinction between passenger ramp, freight ramp, military ramp, or between ramps in different locations on the airport, such as north ramp, east ramp, etc. At appropriate points closer to the major destination areas, more detailed destination signs may be provided to indicate specific areas which are designated for parking service, passenger handling, military aircraft, etc

C. Placement and Location Criteria for All Signs.

All signs should be placed so they are approximately 90 degrees to the direction of travel from which the sign is to be viewed from the aircraft. The signs should be located with respect to the runway and/or taxiway edge (of the aircraft's route) as follows

1. Lateral Distance

a. The signs should be located in the line of a row of runway or taxiway lights and in such a manner that no portion of the sign is closer to the pavement edge (not paved shoulder) than the row of lights, see Fig 6A, or

b. The signs should be located no farther than 20 feet from the pavement edge. See Fig 6A

c. Where there are no rows of lights, the signs should be located no closer than 10 feet from the pavement edge. See Fig 6B

2 Longitudinal Distance.

a. Where taxiway lights are installed or are proposed, the sign should replace the taxiway light or pair of lights closest to the point of tangency of the paving fillet. See Fig 7

b. At the intersection of runways, the signs should be located in accordance with one of the following methods

(1) If in line with the row of runway lights, it should be approximately 15 feet ahead of the runway light nearest the point of tangency of the paving fillet. See Fig 6A

(2) If NOT in line with the row of runway lights, it should be approximately opposite the point of tangency of the paving fillet. See Fig 6A.

D Design Criteria for Signs.

The most important requirements for a taxiway guidance sign are that the sign have attention-attracting qualities and adequate legibility for operating distances and visibility conditions involved. The size of the sign should be such as not to constitute a hazard to the operation of aircraft. The experimental

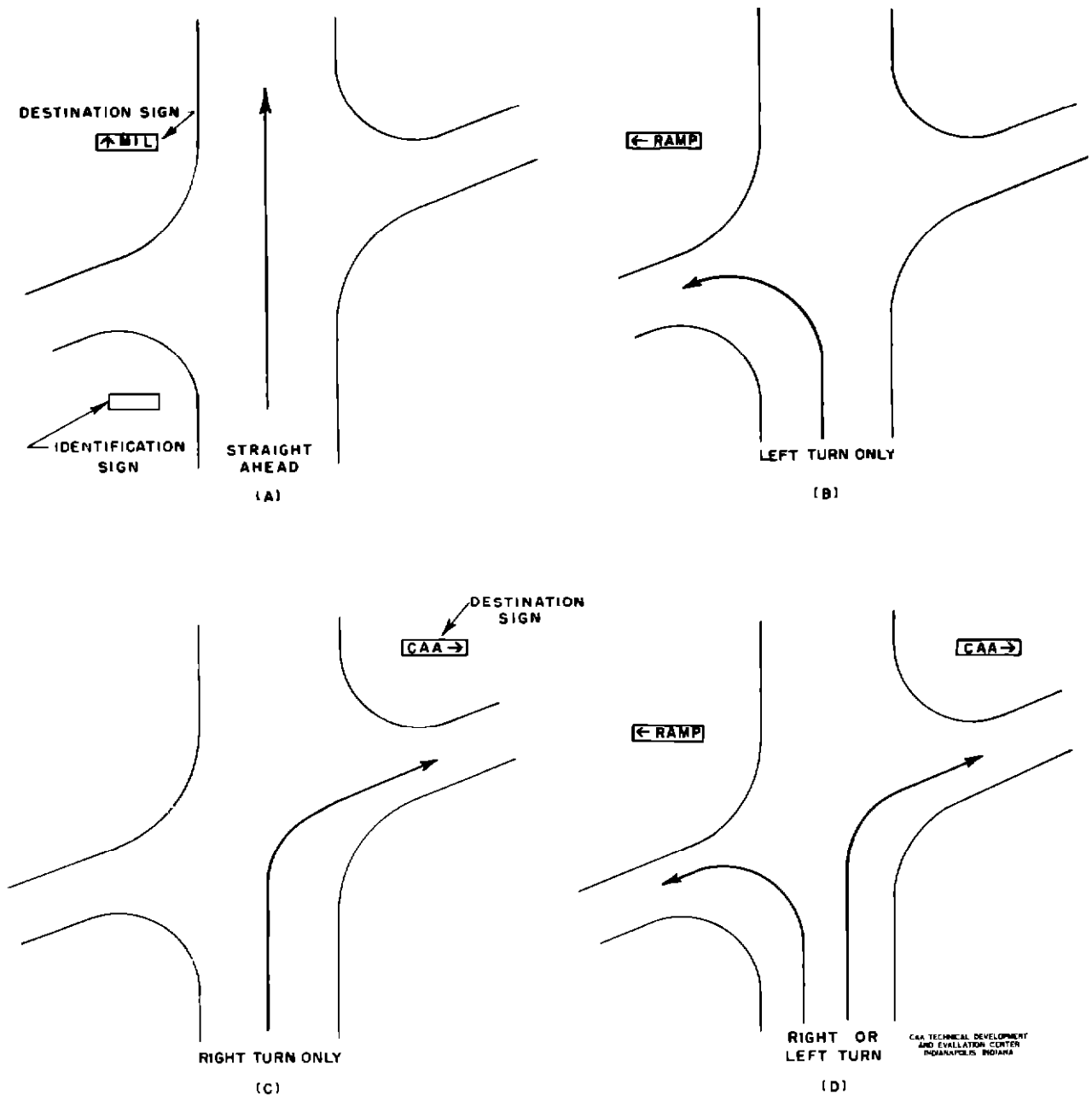


Fig 5 Configuration For Destination Signs

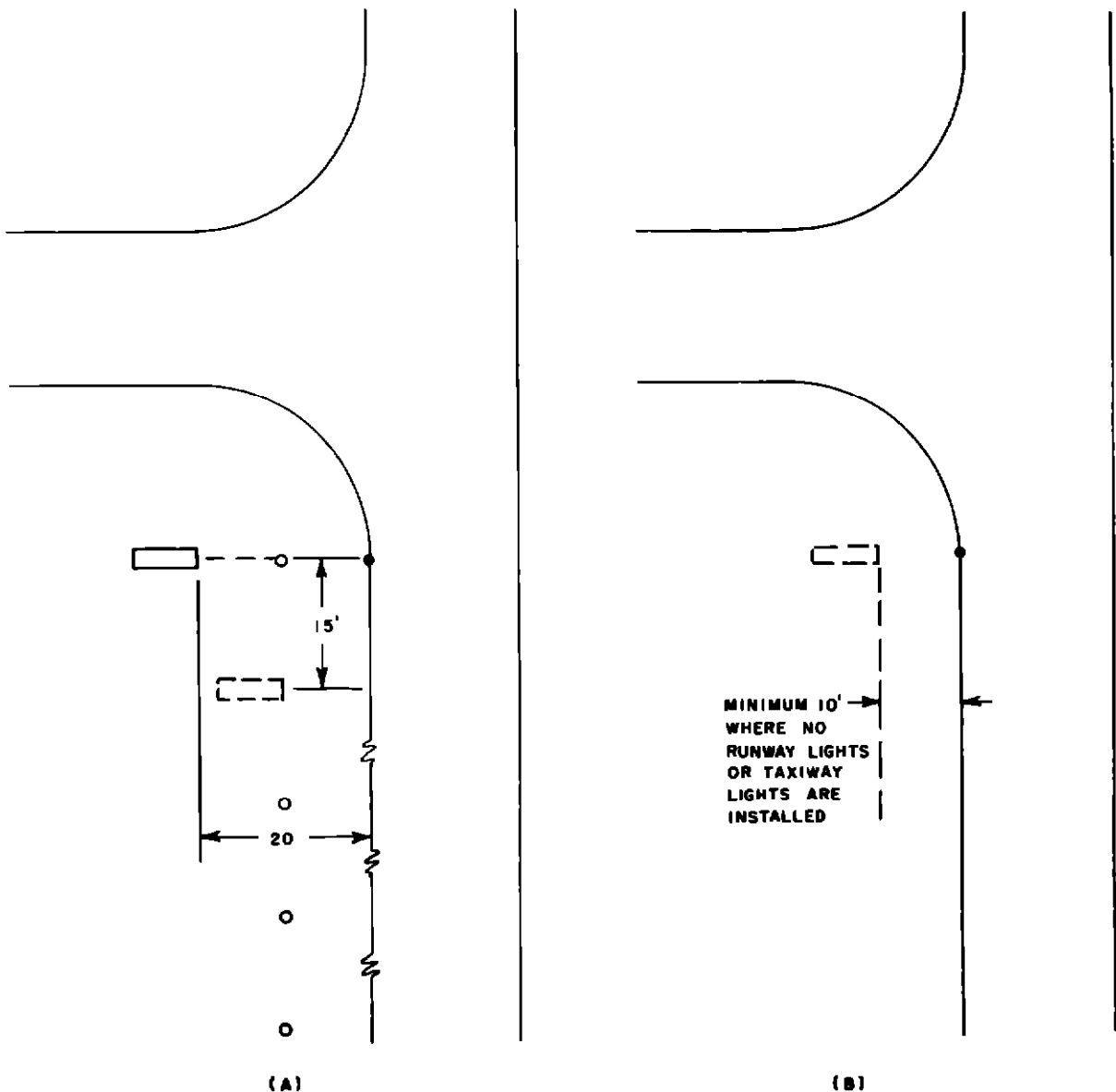
lighted signs installed by TDEC on the Weir Cook Airport, Indianapolis, Indiana, satisfy the above requirements. The development of these signs is described in TDEC'S forthcoming report on the development of taxiway signs, which sets forth the technical and experimental data upon which the design is based. Laboratory tests and theoretical calculations indicate that a sign designed in accordance with the criteria set forth in the above referenced report can be seen and read

at a distance of 500 feet under one-half mile visibility conditions.

The pertinent features of the design criteria of these signs are as follows:

1 Letters and numerals should be 12 inches high and proportioned in accordance with those attached to this report. See Fig. 8.

2 The over-all height of the mounted sign should not exceed 30 inches as permitted for elevated runway and taxiway lights (per TSO-N1a). However, it is considered by the



LEGEND

- RUNWAY OR TAXIWAY LIGHT
- POINT OF TANGENCY

Can be used for runway or taxiway lights

Fig 6 Location of Signs, Lateral Spacing

Committee that a 20-inch over-all height for a mounted sign is entirely adequate for most conditions and should also be the minimum height.

3. The color of lighted letters and numerals should be yellow.

4. The brightness of lighted letters and numerals should be of the order of 50 foot-lamberts.

5. For daylight conditions, all signs (lighted and painted) should have a chrome yellow background with black letters. This can be accomplished in lighted signs by outlining the lighted portions of letters with a black border.

6. The signs should be constructed for outdoor service and the weight held to a minimum.

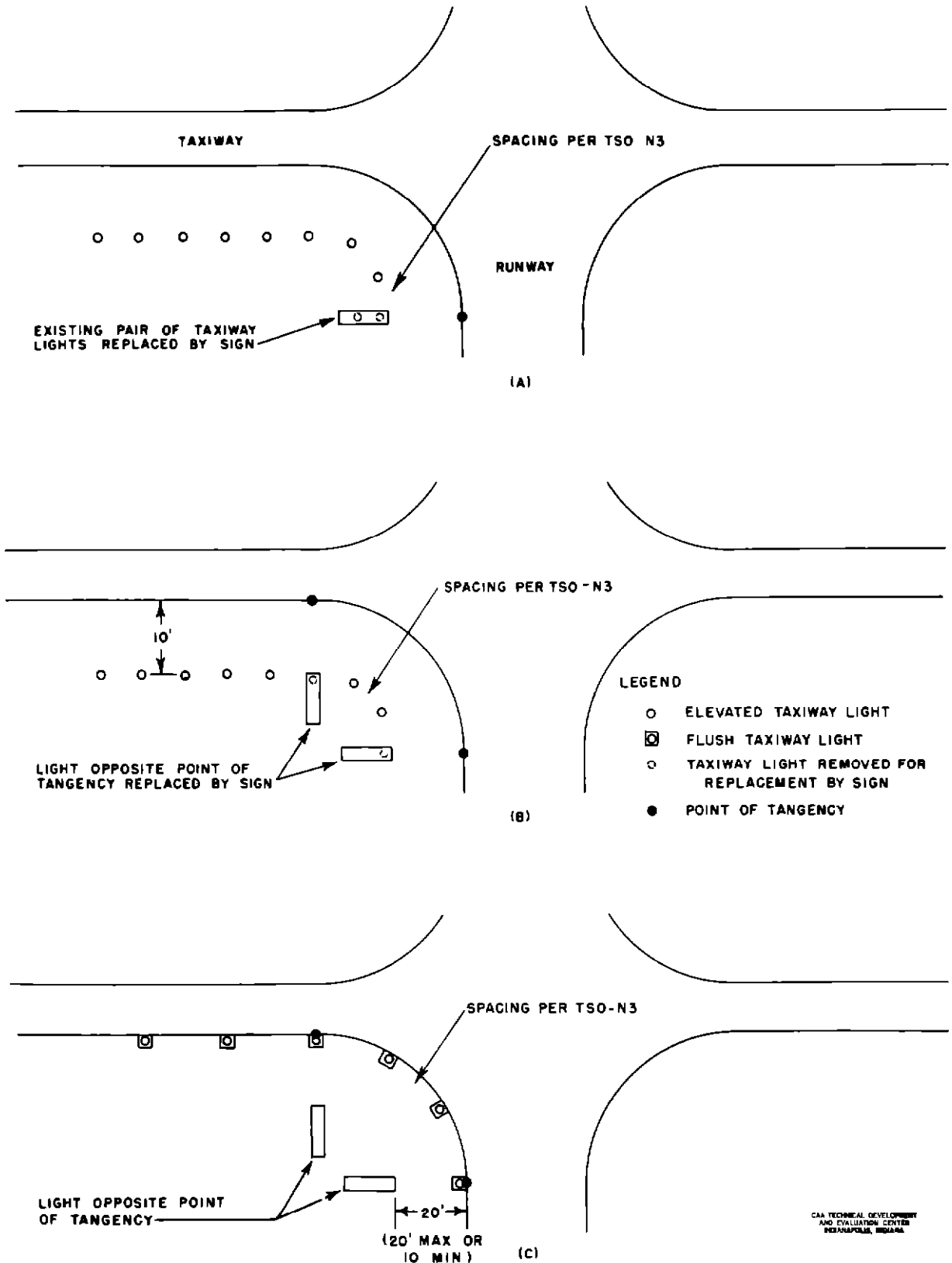
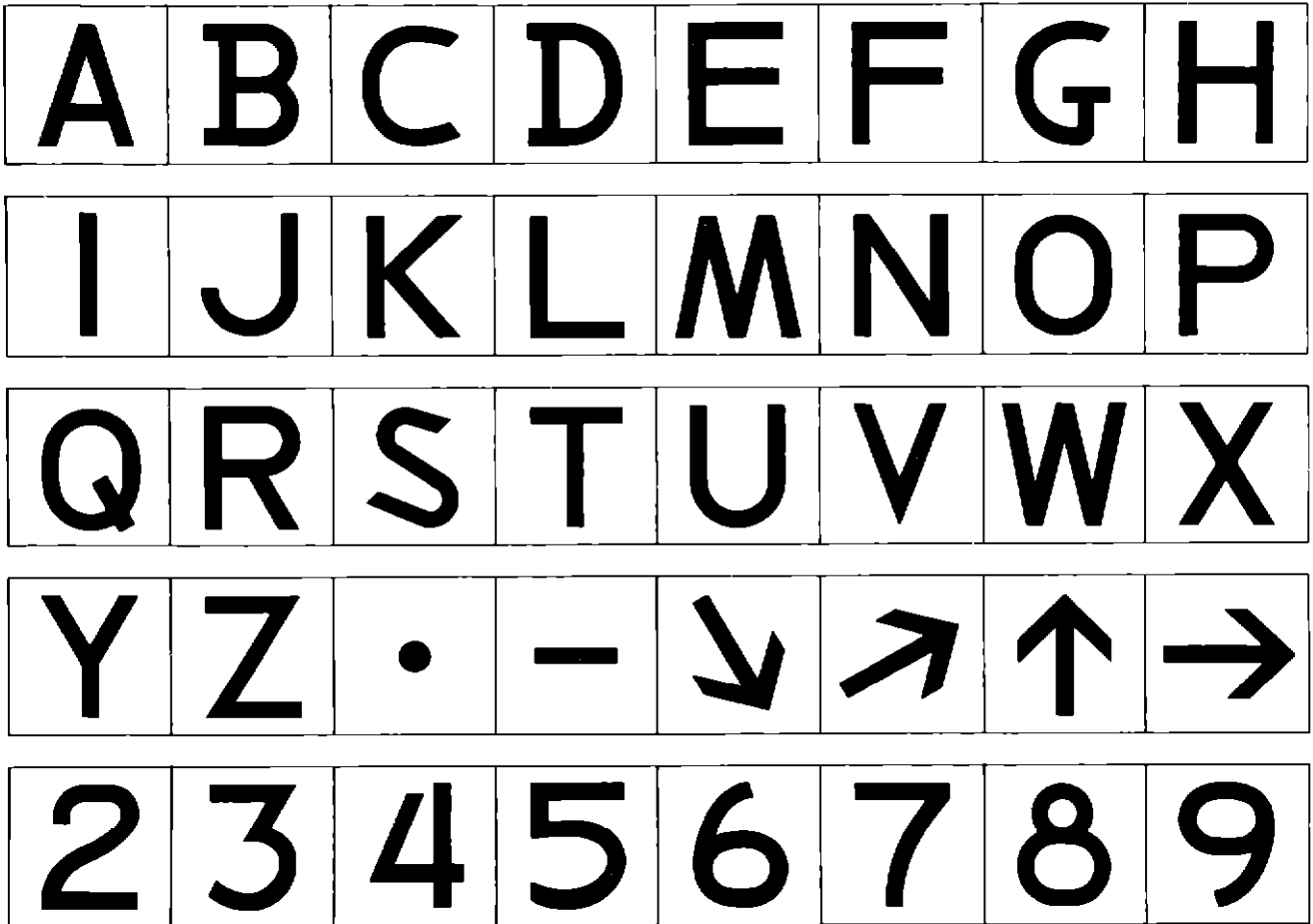


Fig 7 Location of Signs, Longitudinal Spacing



LETTER I AND FIGURE ONE ARE IDENTICAL
 LETTER O AND FIGURE ZERO ARE IDENTICAL
 BARBS OF ARROWS SHOULD NEVER BE PLACED IN A HORIZONTAL OR VERTICAL POSITION

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Fig. 8 Lettering System For CAA Taxiway Guidance Signs

E. Number of Signs Required.

At each individual airport, the use of signs should be subject to the individual needs of the airport as determined by a study of the local situation. See Figs. 9 and 10. Signs should be used as required to solve particular problems, and on any airport the number of signs should be kept to a bare

minimum needed to do the job. If special problems exist at an airport, however, due to complicated intersections, additional signs should be installed on the landing area as required. In the interests of uniformity, any signs installed should conform to the recommendations established above.

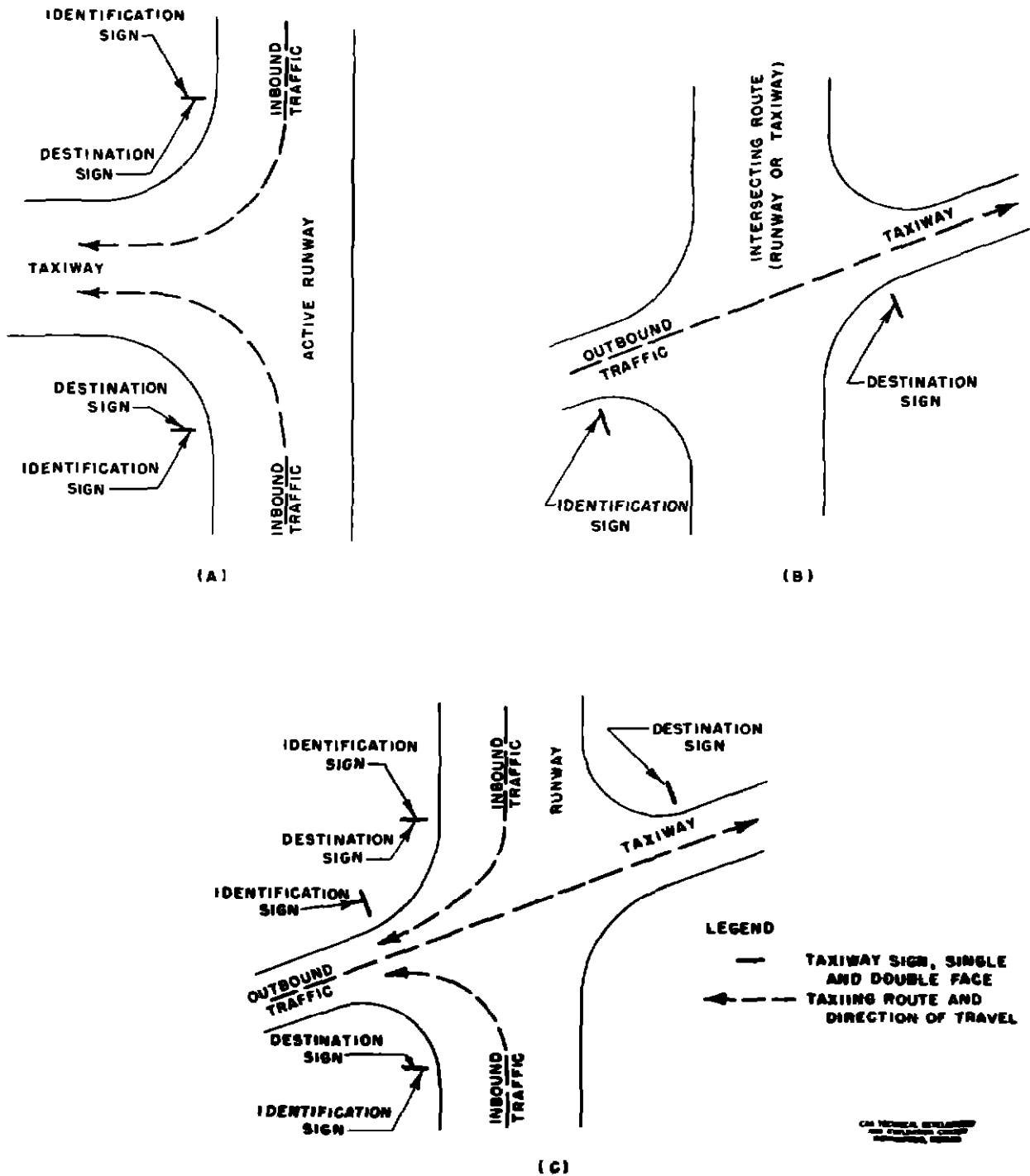


Fig. 9 Typical Signs at Intersections For Various Routes

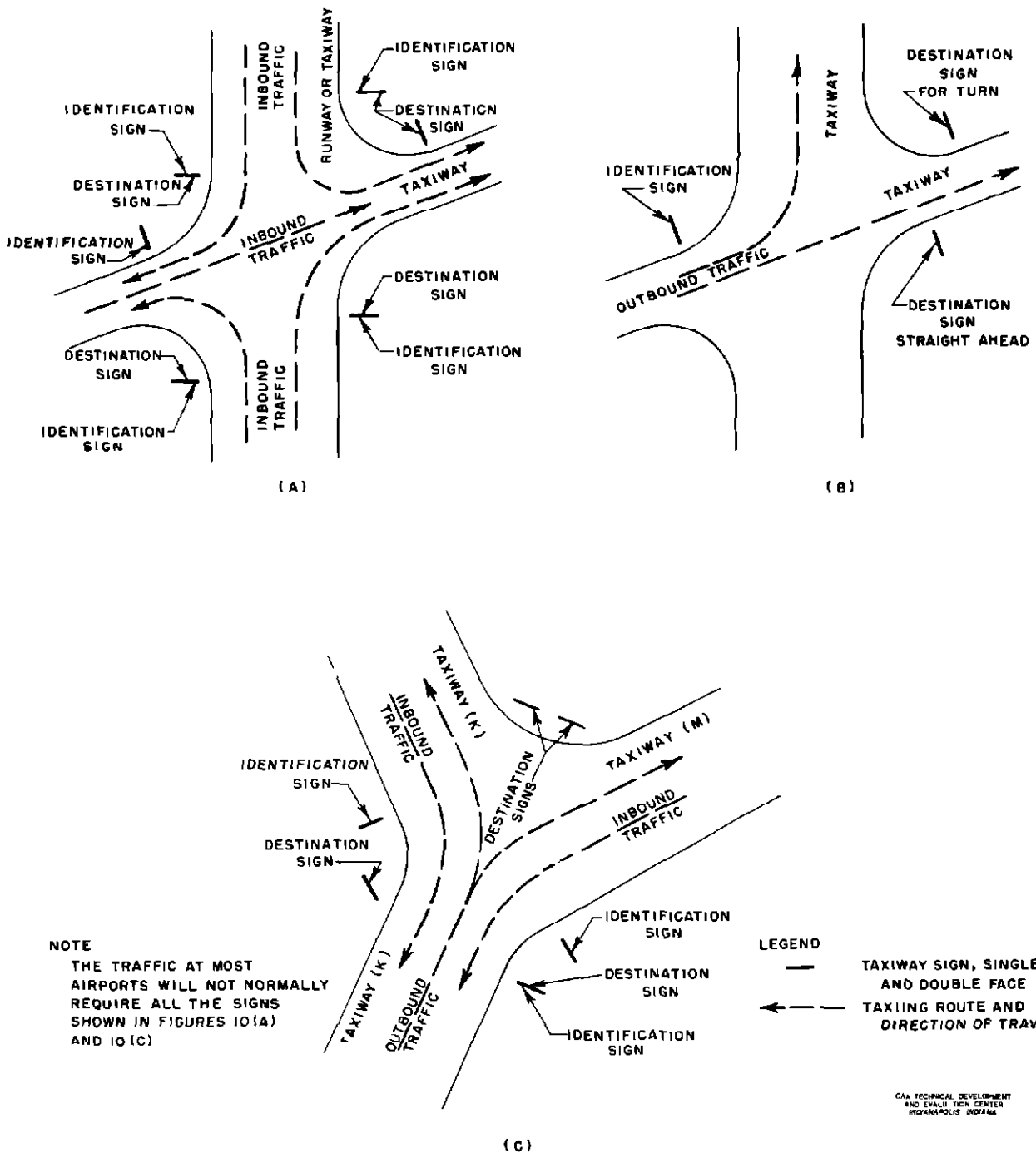


Fig 10 Typical Signs at Intersections For Various Routes