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Identification of Exit Taxiways (Retroreflective Markers Only)

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April 1983

Final Report

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16. Abstract

The purpose of the exit taxiway lighting is to enable the pilot to expeditiously exit from the runway to a taxiway. There is evidence that this has not been satisfactorily accomplished by the present lighting for short-radius exit taxiways.

This report evaluated the use of surface retroreflective markers for identifying short-radius exit taxiways at night. The markers are intended for locations where the cost of inset centerline lighting cannot be justified.

The results indicate that there was an improvement in the pilots ability to identify the exit taxiway associated with the exit-taxiway retroreflectors. The results also show that the retroreflectors should be placed on an arc from near the runway centerline to the taxiway centerline using a cord spacing of 12.5 feet (4 meters).

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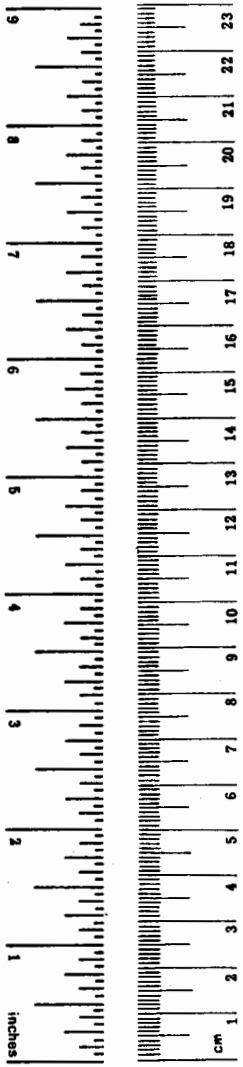
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

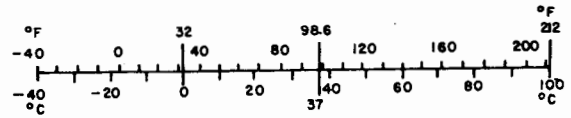
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

Exit taxiway lighting and marking should enable the pilot to expeditiously exit from the runway to a taxiway. The present lighting for short-radius exit taxiways does not provide this guidance at night. Systems Research and Development Service requested the Technical Center to evaluate a system of surface retroreflective markers to provide this guidance for identifying short-radius exit taxiways at night.

Project personnel evaluated the system at the Federal Aviation Administration (FAA) Technical Center's Atlantic City Airport (ACY) by obtaining FAA, general aviation, commuter, and air carrier pilot opinions. Project personnel then revised the system, using these opinions, and installed the revised system for an inservice test at Bader Field in Atlantic City, NJ (AIY).

The inservice test used questionnaires and interviews to determine the usefulness of the system. The questionnaire results indicated that 91 percent of the pilots responding were helped by the exit taxiway retroreflectors. The interview results indicated a statistically significant increase in the pilot's ability to identify the exit taxiways. Also, the evaluation team observed a more orderly flow of traffic after the installation of the retroreflective markers.

The inservice test indicated that the system of surface retroreflective markers should:

1. Be placed in an arc from the runway centerline to the taxiway centerline.

2. Have the retroreflectors spaced 12.5 feet (4 meters) apart.

3. Have the retroreflectors oriented with the reflective face toward the approach to the exit.

4. Have a color pattern of green-green-yellow.

In conclusion, retroreflective markers improve the pilots ability to locate, identify, and use the short-radius exit taxiways.

INTRODUCTION

PURPOSE.

The work described in this report was performed in response to a request by the Office of Flight Operations (AFO-1), "AFS 9550-1, Request No. 200-79-10 as amended on October 13, 1980." It was accomplished under Technical Program Document No. 08-493, Subprogram 081-502, Project 540, "Identification of Exit Taxiways (Retro-reflective Markers Only)."

The purpose of this project was to perform an evaluation of surface retroreflective markers for identifying short-radius exit taxiways ("low-speed" exits). The markers are for use at night at airports where the cost of centerline taxiway lighting cannot be justified. A preliminary evaluation of this concept was previously completed at the Federal Aviation Administration (FAA) Technical Center and described in a February 1980 Letter Report (appendix A). Described in this report are the results of further investigations; an extensive evaluation conducted at the FAA Technical Center's Atlantic City Airport (ACY) Atlantic City, N.J.; and a 3-month inservice test conducted at Atlantic City Municipal/Bader Field (AIY); Atlantic City, N.J.

BACKGROUND.

The primary purpose of taxiway lighting and marking is to provide guidance between the runway and the apron. An earlier study (reference 1) states that a critical part of this function is to enable the pilot to expeditiously exit from the runway to a taxiway. There is much evidence that this has not been satisfactorily accomplished by the present lighting for short-radius exit taxiways.

Exit taxiways have always been difficult to identify at night and under low visibility conditions. This was confirmed by a review of reports contained in the Aviation Safety Reporting System (ASRS) from May 1, 1978 through March 31, 1981 (reference 2). The reports show that pilots have exited runways onto closed taxiways, closed runways, or even unpaved areas. Near collisions have been reported because of difficulty pilots have had in finding an exit taxiway. When heavy traffic, weather or ambient light conditions make operations difficult, confusion in identifying the exit can result in major problems for controllers and pilots. A National Aeronautics and Space Administration (NASA) ASRS report (reference 3) on the causes and problems of air carrier go-arounds stated that 12 of 194 go-arounds reported were caused by aircraft being slow to exit or overshooting the exit taxiway. The report also stated that "Perhaps more significant than the conflict-generated go-around statistics was the finding that 32 percent of the reported climbouts transitioned immediately into subsequent conflicts. Furthermore, these follow-on conflicts involved more serious near midair collision incidents than the initial, often precautionary, avoidance maneuvers."

Methods now used to help the pilot find the exit taxiway include double blue taxiway edge lights, large taxiway guidance signs, and green taxiway centerline lights for long radius exit taxiways (references 4, 5, and 6). Often these aids are expensive or ineffective. For a history of the lighting and marking of exit taxiways, see C. A. Douglas' report noted in reference 7.

In 1966, the International Civil Aviation Organization's Visual Aids Panel recommended extending the green taxiway centerline lights onto the runways. The United States has adopted this recommendation for long radius exit taxiways but not for short radius exit taxiways because of concern over possible confusion. In the Technical Center report (appendix A) it has been recommended that a green-green-yellow color pattern be used for short radius exit taxiwys to differentiate between short and long radius exit taxiways. This recommended color pattern is used to provide a method that is both effective and inexpensive compared to other methods. Retroreflective markers, similar to those used on highways, are placed on an arc leading from the runway centerline to the taxiway centerline. The pilot should be able to identify the retroreflectors approximately 500 feet before reaching the exit. When the exit is reached and the pilot begins the turn, visual cues from the regular taxiway lighting and marking will serve to provide the necessary guidance. The retroreflectors are not a replacement for centerline lights, but are intended for airports where such lights cannot be justified.

EVALUATION

TECHNICAL CENTER TEST.

Retroreflective markers were installed on runway 4/22 at the FAA Technical Center's Atlantic City Airport (ACY). Runway 22 exits identified were Delta and Bravo (22/D and 22/B). Runway 4 had only Bravo exit identified (4/B). For taxiway 4/B 12.5 foot (4 meter) spacing of the retroreflectors was applied along the arc while 25 foot (8 meter) spacing was used for the other exits (figure 1).

Comments on the retroreflective markers were obtained from FAA Technical Center test pilots after they had made several approaches or high-speed taxi maneuvers to the marked exits. Questionnaires were completed by general aviation, commuter, and air carrier pilots using the airport. These pilot comments and opinions were used to refine the system before installing the system at Bader Field for inservice testing. Appendix B is a copy of the exit taxiway marker questionnaire which also includes questions on another related project.

BADER FIELD TEST.

The retroreflective markers were installed with 12.5 foot (4 meter) spacing on runway 11/29 at Bader Field in Atlantic City, N.J. Six exit taxiways were marked with the retroreflectors. Two were marked on runway 11 (11/A and 11/C) and four were marked on runway 29 (29/A, 29/B, 29/A2, and 29/A1) (figure 2). Interviews and questionnaires were used to collect data from the Bader Field test.

INTERVIEWS. The interviews obtained reponses from pilots to determine a rating of the ease or difficulity of finding the exit taxiway. Pilots landing at Bader Field were interviewed before, during and after the three-month inservice test. The first interview was conducted before the installation of the retroreflective markers. The ratings were used to determine if there was an improvement caused by the retroreflective markers. See appendix C for a copy of the questions asked during the interview.

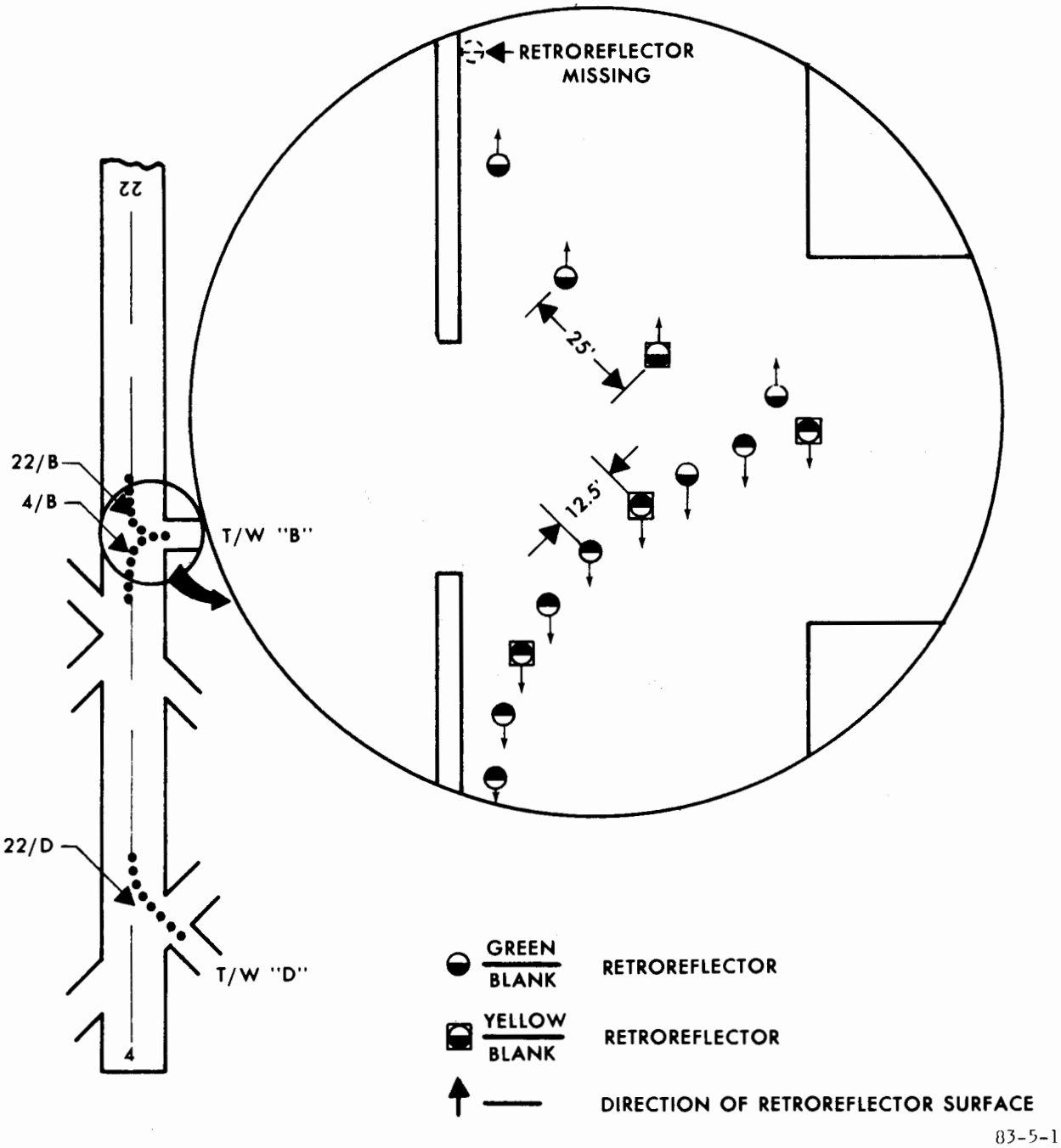

FIGURE 1. RETROREFLECTOR CONFIGURATION AT ATLANTIC CITY AIRPORT (ACY) ATLANTIC CITY, NEW JERSEY

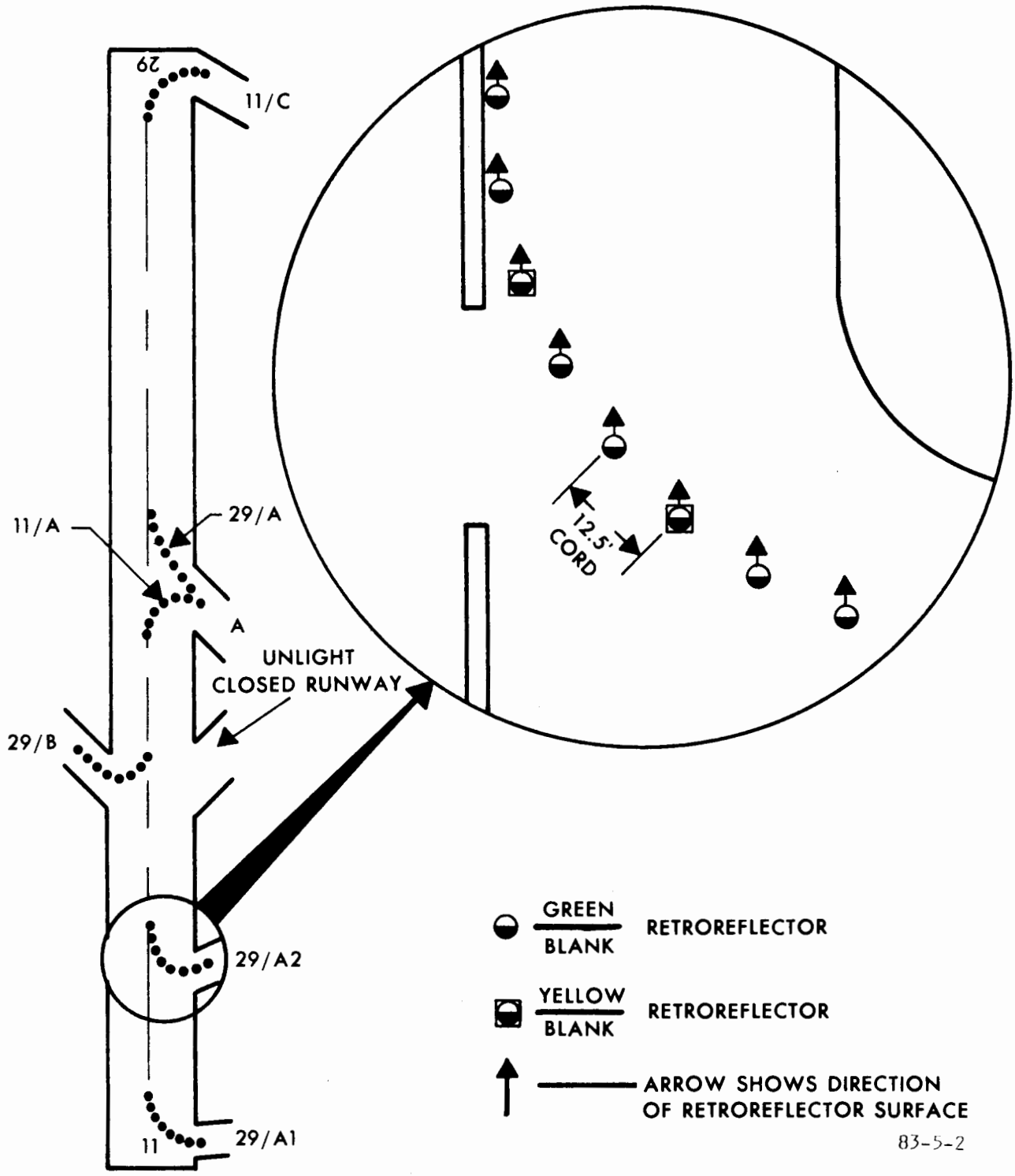

FIGURE 2. RETROREFLECTOR CONFIGURATION AT ATLANTIC CITY/MUNICIPAL/ BADER FIELD (AIY), ATLANTIC CITY, NEW JERSEY

QUESTIONNAIRES. During the inservice test a questionnaire was made available for pilots to complete at the Fixed Base Operator (FBO) counter (appendix D) to provide a comparison with the testing at ACY and record pilot opinion of the retroreflective system.

RESULTS

TECHNICAL CENTER TEST.

The test proved that during reduced visibility it was necessary to place the retroreflective markers closer to the centerline to enable the pilot to identify the exit taxiway. This also improved the usefulness of the system during higher visibility conditions.

The effectiveness of the retroreflector spacing was better at 12.5 feet (4 meters) than at 25 feet (8 meters). Table 1 includes a summary of the 27 pilot responses at ACY. Some of the pilots did not answer the question on exit taxiway and some answered questions applicable to more than one exit. Under the "ALL" EXIT USED category, each questionnaire is counted only once even though the answers were applicable to more than one exit.

TABLE 1. PILOT RESPONSES TO QUESTIONNAIRES (TECHNICAL CENTER)

Exit Used	No Help	Some Help	Great Help	Spacing (ft)	First Retroreflector	Number of Responses
Technical Center						
All	4%	29%	67%	--	--	24
22/B	0%	20%	80%	25	Missing	10
22/D	0%	33%	58%	25	Missing	12
4/B	0%	0%	100%	12.5	Present	11

BADER FIELD TEST.

INTERVIEWS. A summary of the responses to the interviews conducted at Bader Field is presented in table 2. This data was analyzed to determine if there was any significant difference between the three groups of responses.

TABLE 2. RESULTS FROM INTERVIEWS

On a scale of 1 to 5 (1=very easy, 5=very difficult) how easily were you able to find the exit from the runway?

	1 Very Easy	2 Easy	3 Ok	4 Difficult	5 Very Difficult	Average Response
All Responses Before Installation	1	3	6	3	6	3.5
All Responses Immediately After Installation	8	1	3	4	2	2.5
All Responses After 3-Month Inservice Test	9	8	2	1	1	1.9

The change in the average interview response, in terms of the ease with which pilots identified the exit taxiways, from before the installation to immediately after the installation (3.5 to 2.5, respectively (table 2)), indicated that there was an improvement. The statistical analysis (table 3) confirmed this improvement.

TABLE 3. STATISTICAL RESULTS FROM COMPARISON OF INTERVIEWS

Interview Responses Compared	Statistically Significant Improvement ?
Before Installation and Immediately After Installation	Yes
Before Installation and After 3-Month Inservice Test	Yes
Immediately After Installation and After 3-Month Inservice Test	Inconclusive

The change in the average interview response from before the installation to after the 3-month inservice test (3.5 to 1.9, respectively) also indicated that there was an improvement. Again, the statistical analysis confirmed that this improvement in identification of the exit taxiway was significant.

The change in the average response from immediately after the installation to after the inservice test (2.5 to 1.9, respectively), indicated that there may have been an improvement associated with pilot experience with the retroreflective markers. However, the statistical analysis was inconclusive in confirming or denying this conclusion. The general observations (discussed later), however, did indicate that the benefits of the system were immediately available and required little pilot experience with the system. A more detailed explanation of the statistical method used can be found in appendix E.

QUESTIONNAIRES. The results from the questionnaires are shown in table 4. The results indicate that 91 percent of the pilots answering the questionnaire felt that the retroreflectors provided help in identifying the exit taxiways. Some of the comments are included as follows:

"--Great help finding poorly lit taxiways--"

"--They provide a sense of distance and depth from the approaching turn. Not as good as lighted centerline lights but a vast improvement over no lighting at all."

"Very Excellent!"

"The concept is good. I feel that the reflectors are not angled for high wing aircraft. (Light in wing.)"

"In poor visibility during rain showers it enables you to find the runway exits without much of a delay."

"Alerted myself of the actual taxiway well in advance so that the turn to the taxiway was easily made."

"Very effective-looked like electric lighting."

"Especially helpful when runway is wet during night operations."

TABLE 4. PILOT RESPONSES TO QUESTIONNAIRES (BADER FIELD)

Exit Used	No Help	Some Help	Great Help	Spacing (ft)	First Retroreflector	Number of Responses
Bader Field						
All	9%	28%	63%	12.5	Present	65

GENERAL OBSERVATIONS. The questionnaire responses agree with the observations of the evaluation team made while conducting the interviews. Prior to the installation of retroreflector markers, some aircraft were observed to slowly taxi to the end of the runway and exit at the last exit taxiway. There were even a few cases of aircraft turning off the runway where there was no exit taxiway; the aircraft would then taxi through the grass toward the operations building. This occurred at night when the pilots could not see the surface over which they were taxiing.

After the installation of the exit taxiway retroreflectors there was a definite improvement in performance of pilots exiting from the runway. Approximately 2 weeks after the exit taxiway retroreflectors were installed, construction on another runway began. This construction made it necessary to close exit 11/C (figure 2). This did not appear to cause a significant problem for aircraft landing on runway 11. The pilots seemed to naturally exit at 11/A or, if they passed exit 11/A, they would stop, turn around and use exit 29/A.

The overall impression was of a more expeditious and orderly flow of traffic.

CONCLUSIONS

TECHNICAL CENTER TEST.

The unidirectional retroreflectors should be placed so that they have a cord of 12.5 feet (4 meters) (table 1). The first retroreflector should be located on the arc where it is tangent to the runway centerline. The first exit taxiway retroreflector should be located as close as possible to the centerline of the runway. If runway centerline retroreflectors are used, then the runway centerline retroreflectors should be placed on the side having the most frequently used exits. See figures 3 and 4.

BADER FIELD TEST.

The analysis of the questionnaires indicates that pilots perceive the retroreflectors as a help (table 4). This agrees with the results that were obtained at ACY. The use of retroreflectors to mark short-radius exit taxiways is effective in improving the pilots ability to locate and identify the exit taxiway. Also, use of the green/green/yellow color pattern resulted in no comments about possible confusion with a high speed turnoff.

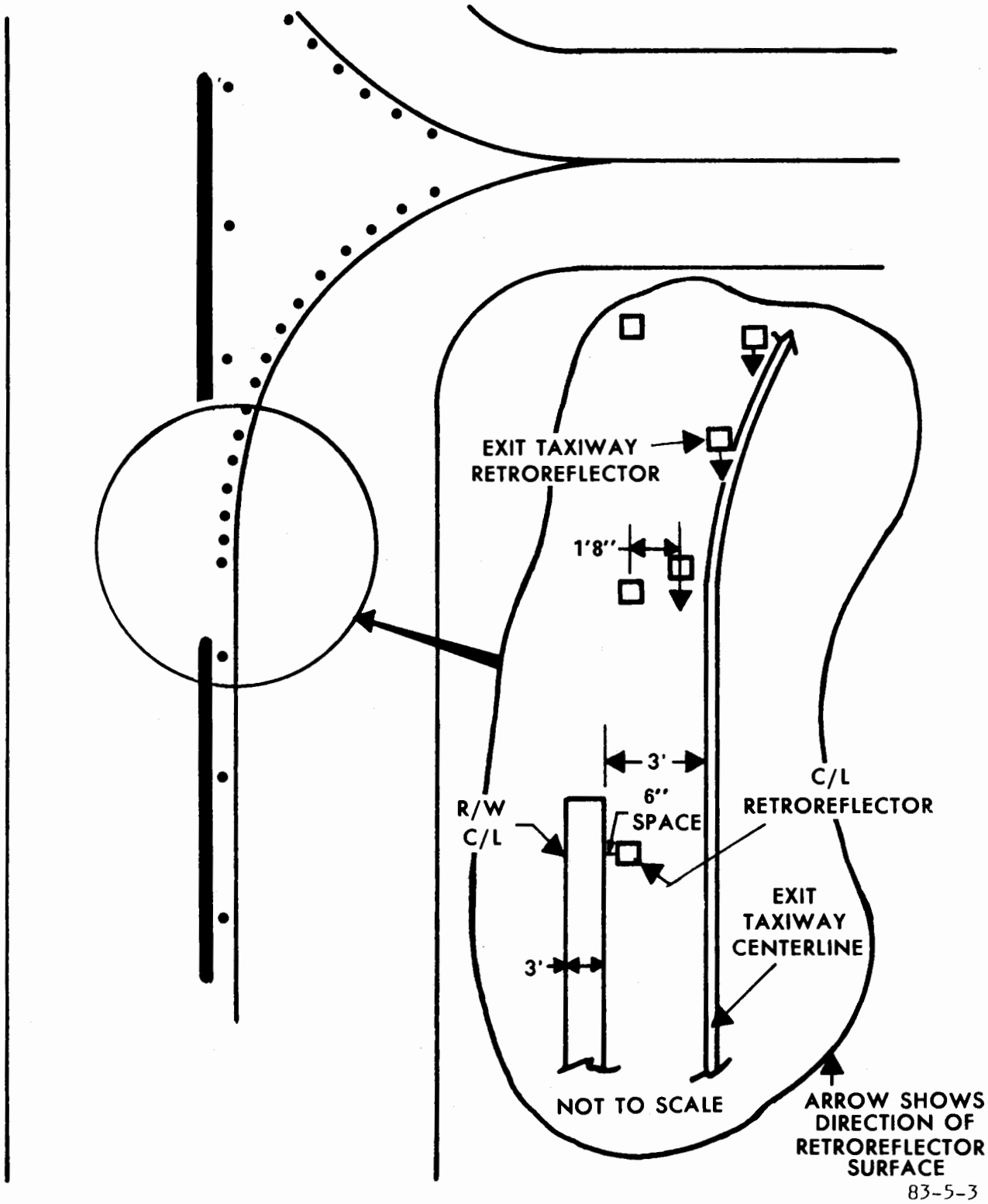

FIGURE 3. LAYOUT OF EXIT TAXIWAY RETROREFLECTORS WITH CENTERLINE RETROREFLECTORS ON SAME SIDE AS EXIT TAXIWAY

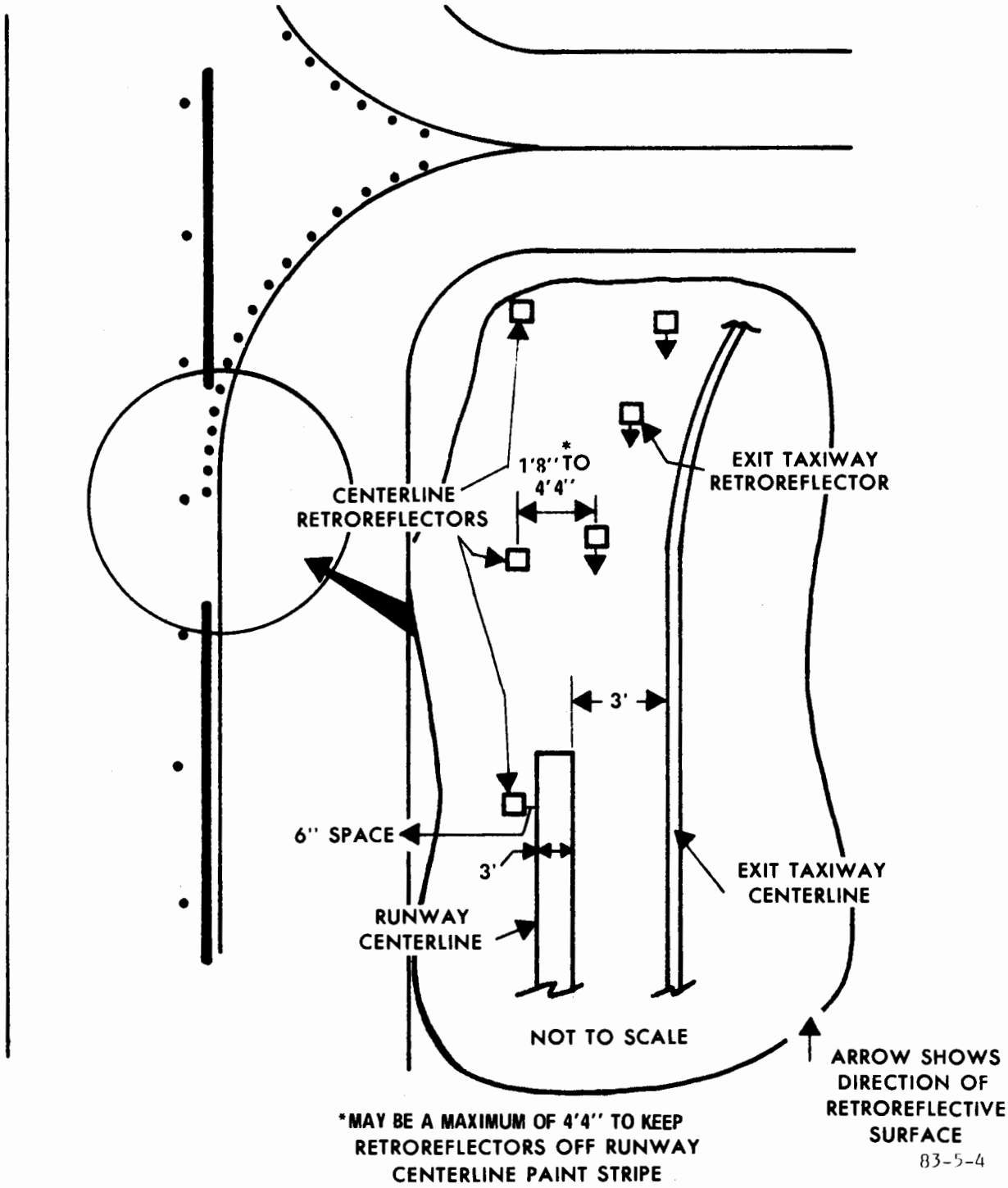

FIGURE 4. LAYOUT OF EXIT TAXIWAY RETROREFLECTORS WITH CENTERLINE RETROREFLECTORS ON OPPOSITE SIDE FROM EXIT TAXIWAY

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APPENDIX A

NAFEC TECHNICAL LETTER REPORT

NA-80-24-LR

TAXIWAY TURNOFF LIGHTS

By

Larry W. Hackler

February 1980

ABSTRACT

This project was performed in response to a Flight Standards Service request to investigate methods of visually identifying short radius exit taxiway turnoffs. The report describes several taxiway centerline lighting and marking configurations that were tested and makes recommendations as to the most effective method for providing the necessary visual guidance.

TAXIWAY TURNOFF LIGHTS

INTRODUCTION

The work described in this report has been performed in response to Flight Standards Service (now Office of Flight Operations) 9550-1 Request Number AFS-200-79-10. It was completed under NAFEC Program Document Number 07-493, Subprogram 071-412, Project 810, "Quick Response to Solve Field Encountered Problems." The author of this report is Larry Hackler, ANA-410, and the Program Manager is Thomas H. Paprocki, ANA-410.

PURPOSE

The purpose of this project was to investigate methods for identifying short radius exit taxiways. Testing included both centerline lights and retroreflective markers extended to the runway centerline. Further, it should be determined that the system would alert the pilot that the turn could not be negotiated at high speed.

BACKGROUND

User organizations have indicated that pilots have problems identifying short radius exit taxiways at night and in reduced visibilities. Poorly identified short radius exit taxiways also increase the time required to find the exit and clear the runway. Presently, short radius exit taxiways are identified by blue taxiway edge lights, or by blue taxiway edge and green taxiway centerline lights ending at the runway edge. The long radius exit taxiway "high speed turnoff" identification is not a problem since the green taxiway centerline lights are extended to and along the runway centerline.

The United States has not adopted ICAO Annex 14 recommended practice 5.17.11 for short radius exit taxiway lights, due to the possibility of mistaking the green lights of the ICAO short radius exit taxiway system for either a runway threshold or a long radius exit taxiway.

TESTING

The original intent of this project was to provide a quick evaluation when the Port Authority of New York and New Jerseyrequested an approval of short radius exit taxiway lights installed at John F. Kennedy International Airport (JFK). A configuration suggested by Systems Research and Development Service was to extend the taxiway centerline lights onto the runway with the lights aimed either parallel to the runway centerline or tangent to exit centerline marking. Alternating green and yellow colors were proposed.

An exit taxiway at NAFEC was surveyed and marked to identify light positions and provide proper aiming of the light fixtures. Approximately 1 hour before the test, temporary electrical cables were placed along the exit taxiway centerline and the fixtures were placed in the predetermined locations. The aimed and leveled fixtures were then connected in series to the cables and a portable generator. A Variac © and an ammeter were connected to provide control of the light intensities. FAA Gulfstream G-159 or Convair 580 aircraft were used to taxi toward the lights at a speed approximating an aircraft approaching an exit taxiway. A minimum of three pilot observers were on board during each run. Comments and opinions of the observers were recorded and used to make an evaluation of the exit taxiway lights.

After evaluating the proposed configuration, the extent of the problem was found to be greater than anticipated. The proposed exit taxiway light configuration was found to be confusing. In addition, it gave no appearance of a curve.

Additional tests were conducted in an attempt to provide a satisfactory solution. A brief discussion of the different combinations of fixtures, aiming and color patterns tested follows. The color pattern determined to be best during testing of the short radius exit taxiway lights should also be suitable for retroreflective marker systems.

FIXTURES

The L-852N (narrow light beam) and L-852W (wide light beam) taxiway centerline lights were tested. The results indicate that the L-852W taxiway centerline lights provide better guidance in the turn, and a more uniform appearance from a distance.

AIMING

The light beam axes were aimed during testing as follows:

1. Parallel to the runway centerline (Figure 1A).

2. Tangent to the exit taxiway centerline curve (Figure 1B).

3. Toed-in to intersect the exit taxiway centerline at a point equal to four times the spacing of the lights (cord) (Figure 1C).

4. Miscellaneous aimings determined by trial and error.

All aiming methods proved to have objectionable characteristics when used with the L-852N fixtures. The tangent and toed-in aiming methodswere found to be acceptable when used with the L-852W fixture.

COLORS

The use of green and yellow filters in the light fixtures was an acceptable method to distinguish between the short and long radius exit taxiway. The green indicated that the lights were an exit taxiway and the yellow cautioned that the lights were defining a short radius exit taxiway. Alternating green and yellow filters presented too much yellow to identify the lights as an exit taxiway. The use of a repeating pattern of two green and one yellow presented an acceptable balance of both green and yellow in the short radius exit taxiway lights. The testing also indicated that green filters should be installed in the first two fixtures of the exit taxiway lights.

BALANCE OF INTENSITIES

The testing showed that unbalanced intensities of the green and yellow lights with absorption filters could be confusing to the pilot. The use of yellow absorption and green dicroic filters in the fixtures provided an acceptable balance of intensities.

RETROREFLECTIVE MARKERS

The color pattern of green/green/yellow was used with retroreflective markers. The markers used this way proved adequate to indicate the location of an exit taxiway from distances of approximately 700 feet. All reflector faces were orientated perpendicular to the runway centerline.

CONCLUSIONS

1. The green/green/yellow color pattern is an effective method of differentiating a short radius exit taxiway from a long radius exit taxiway.

2. The dicroic green filter should be used with the yellow absorption filter to balance the intensities of the short radius exit taxiway lights.

3. The L-852W taxiway centerline fixture with the standard 65-watt lamp should be used.

4. At airports where traffic and/or cost does not justify the installation of centerline lighting, the use of reflectors in a similar color pattern will provide the required visual guidance.

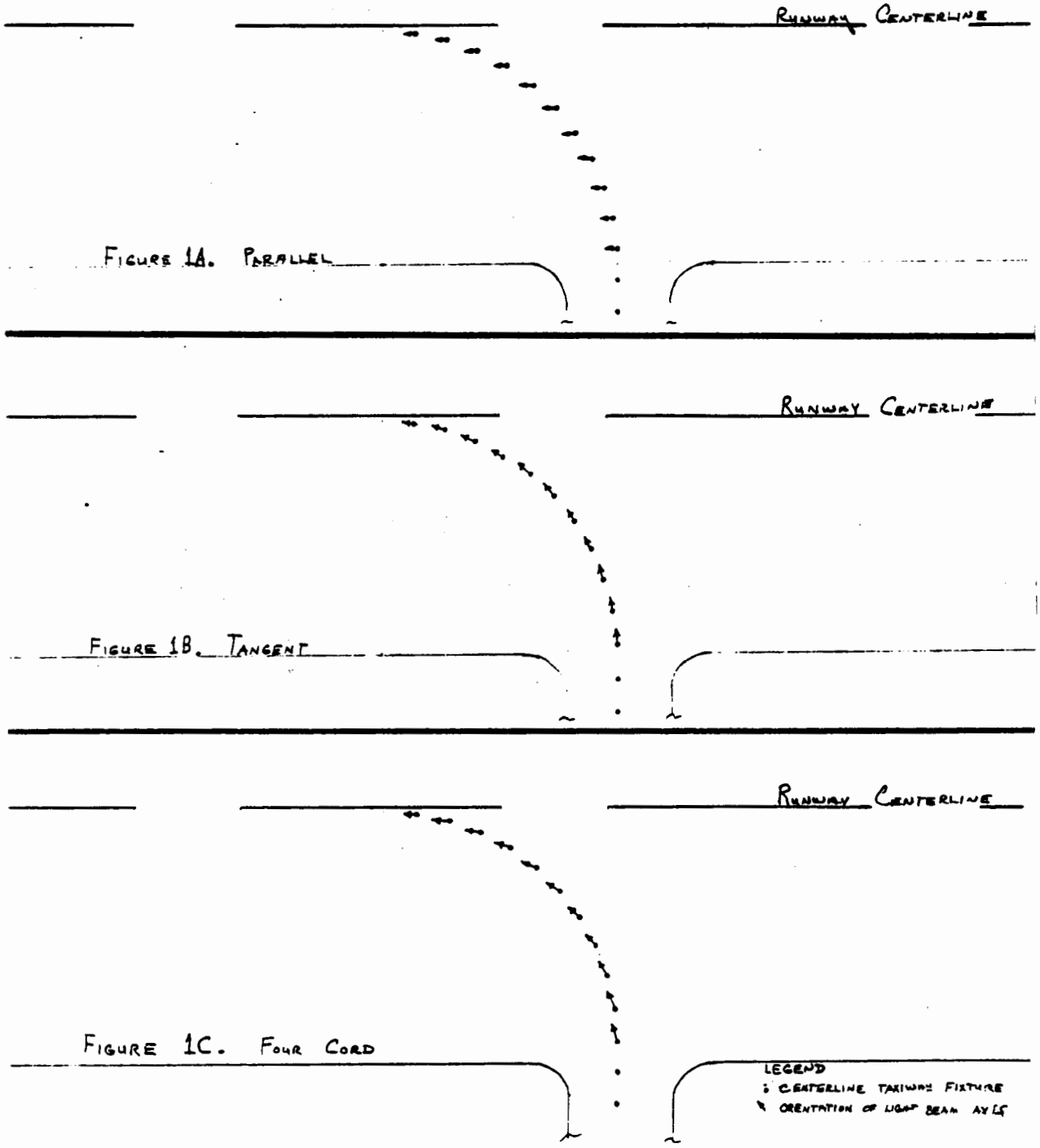

FIGURE 1. EXIT TAXIWAY LIGHT AIMING

5. The aiming of the L-852W lights four cord ahead for unidirectional lights and tangent to the exit taxiway centerline for bidirectional lights was acceptable.

RECOMMENDATIONS

An in-service test or a test program using a visual simulator should be conducted to confirm that pilots will not mistake the system for a long radius exit taxiway.

Mr. Larry W. Hackler is the NAFEC Project Manager and may be contacted at (609) 641-8200, extension 3316, or FTS 346-3316, for further information regarding the work involved.

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APPENDIX B

QUESTIONNAIRE FOR THE

EVALUATION OF RETROREFLECTIVE RUNWAY PAVEMENT MARKERS

AT THE TECHNICAL CENTER

EVALUATION OF RETROREFLECTIVE RUNWAY PAVEMENT MARKERS

Runway 4/22, Atlantic City Airport (ACY)

Type and Model Aircraft_____ Date_____

Location of Taxi/Landing Lights Used: Wind_____

Nose____ Wing ____ Both _____ Other_____ Pavement: Wet____ Dry____

Visibility:

<1 Mile ____ 1 to 2 Miles____ 2 to 3 Miles _____ >3 Miles _____

Precipitation/Visibility Restrictions:

Rain____ Snow____ Fog____ Haze or Smoke____ None_____

Exit Taxiway Retroreflectors

Runway Used: Taxiway Used to Exit Runway:

Rwy. 4____ Rwy. 22____ T/W Bravo____ T/W Delta_____

How much help were the reflective markers in finding the exit taxiway?

No Help____ Some Help____ Great Help_____

Centerline and Touchdown Zone Retroreflectors

For the type aircraft and weather conditions experienced, please answer the following questions.

1. Please rate the effectiveness of the markers during the:

a. Approaches	Excellent ____	Good ____	Fair ____	Poor ____
b. Flare & Touchdown	Excellent ____	Good ____	Fair ____	Poor ____
c. Landing Rollout	Excellent ____	Good ____	Fair ____	Poor ____
d. Takeoff	Excellent ____	Good ____	Fair ____	Poor ____

Comments:

2. During crosswind conditions, were you able to decrab sufficiently early during the approach to illuminate the pavement markers?

a. Yes____ No_____

Comments:

Continued on next page.

3. Did you find the red/white and all red coded centerline markers useful in determining distance remaining on the runway?

Comments:

4. How would you rate the landing lights on your aircraft as to:

a.	Illumination/ Brightness	Excellent ____	Good ____	Fair ____	Poor ____
b.	Aiming	Excellent ____	Good ____	Fair ____	Poor ____

5. Considering the weather conditions encountered, do you feel that the additional guidance provided by the retroreflective markers improved the safety of operations during:

a.	Takeoff?	Yes ____	No ____
b.	Approach?	Yes ____	No ____
c.	Flare & Touchdown	Yes ____	No ____
d.	Landing Rollout?	Yes ____	No ____

Comments:

Please include any additional comments or remarks:

Name _____
(Optional)*
Organization* _____

*Name and Organization will not be used when test results and comments are reported.

APPENDIX C

INTERVIEW QUESTIONNAIRE FOR THE EVALUATION OF EXIT TAXIWAY IDENTIFICATION AT BADER FIELD

EVALUATION OF EXIT TAXIWAY IDENTIFICATION

Runway 11/29, Atlantic City Muni-Bader Field (AIY)

Type and Model Aircraft_____Date_____

Location of Taxi/Landing Light Used:

Nose_____ Wing_____ Both_____ Other_____

Visibility:

<1 mile_____ 1 to 2 miles_____ 2 to 3 miles_____ >3 miles_____

Precipitation/Visibility Restriction:

Rain_____ Snow_____ Fog_____ Haze or Smoke_____ None_____

Runway Used:

Runway 11_____ Runway 29_____

Taxiway Used to Exit Runway:

T/W A1_____ T/W A2_____ T/WA_____ T/WB_____ T/WC_____

On a scale of 1 to 5 (1=very easy, 5=very difficult)

How easily were you able to find the exit from the runway?

_____	_____	_____	_____	_____
1	2	3	4	5
Very Easy	Easy	OK	Difficult	Very Difficult

How did you find the exit?

Local Yes /_/

No /_/

Familiar Yes /_/

No /_/

APPENDIX D

QUESTIONNARIE FOR THE EVALUATION OF RETROREFLECTIVE EXIT TAXIWAY MARKERS AT BADER FIELD

BADER FIELD AIRPORT

ATLANTIC CITY, NEW JERSEY

EVALUATION OF RETROREFLECTIVE EXIT TAXIWAY MARKERS

An evaluation of retroreflective exit taxiway markers is being conducted at Bader Field in cooperation with the FAA Technical Center. The markers are placed on an arc leading from near the runway centerline to near the taxiway centerline. The markers use a green-green-yellow color pattern to indicate a short raidus "low-speed" exit. The pilot should be able to identify the retroreflectors approximately 500 feet before reaching the exit taxiway. Near to or at the exit, visual cues from the regular taxiway lighting will serve to provide the necessary maneuvering guidance.

Please take a moment of your time and answer a few questions based on your experience with the retroreflective markers.

DATE_____ TIME_____ AIRCRAFT TYPE_____

VFR_____ IFR_____ RAIN (Yes or No)_____

LOCATION OF TAXI/LANDING LIGHT(S) USED:

NOSE_____ WING_____ BOTH____ OTHER_____

HOW MUCH HELP WERE THE RETROREFLECTIVE MARKERS IN FINDING THE EXIT TAXIWAY?

NO HELP_____ SOME HELP_____ GREAT HELP_____

ADDITIONAL COMMENTS:

PLEASE RETURN COMPLETED QUESTIONNAIRE TO THE OPERATIONS DESK.

THANK YOU.

APPENDIX E

STATISTICAL METHOD

APPENDIX E

STATISTICAL METHOD

A Ranked Sum Test for two independent samples was used to analyze the data. See reference 8. This test is a one tail test which assumes that the two samples are independent, but no assumptions are made about the distributional form from which the two samples are drawn (test is distribution free). The results for the Ranked Sum Test are shown below. The table shows a Z-statistic which is calculated from the data and then compared to the appropriate Z for a 10 percent, 5 percent, and 1 percent confidence level (e.g., 10 percent confidence level means a 90 percent chance of being correct). If the Z-statistic is greater than or equal to the Z for a desired confidence level, then the test determines that there is a statistically significant difference between the two sample populations at that level of confidence. If the Z-statistic is less than the reference Z, then the test determines that it is inconclusive as to whether there is a difference between the two samples, at the desired level of confidence.

		CONFIDENCE LEVEL		
		10%	5%	1%
	Z FOR CONFIDENCE LEVEL →	1.28	1.64	2.33
INTERVIEWS COMPARED	CALCULATED Z-STATISTIC ↓	RESULTS		
BEFORE INSTALLATION AND AFTER INSTALLATION	Z = 1.87	DIFFERENCE	DIFFERENCE	INCONCLUSIVE
BEFORE INSTALLATION AND AFTER INSERVICE TEST	Z = 3.56	DIFFERENCE	DIFFERENCE	DIFFERENCE
AFTER INSTALLATION AND AFTER INSERVICE TEST	Z = 0.92	INCONCLUSIVE	INCONCLUSIVE	INCONCLUSIVE

DIFFERENCE - There is a statistically significant difference between the two samples.

INCONCLUSIVE - It cannot be determined if there is a statistically significant difference between the two samples.