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IN-SERVICE TESTING OF THE PRECISION APPROACH PATH INDICATOR (PAPI) AT NEWARK INTERNATIONAL AIRPORT, NEW JERSEY

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16. Abstract

This report covers that portion of the Precision Approach Path Indicator (PAPI) tests involving 4 months of in-service testing at Newark International Airport, New Jersey. Basically, the PAPI was compared against the standard red/white Visual Approach Slope Indicator (VASI) system at a large airport and on a runway with an Instrument Landing System (ILS).

The PAPI system was installed in a manner to take care of aircraft of all sizes; that is, different wheel-to-eye distances. The information was obtained from pilots of large commercial aircraft. Questionnaires from general aviation aircraft pilots were not used for this particular report.

Results showed that under these conditions about 60 percent of the pilots (a total of 117 questionnaires) preferred the PAPI over the VASI system.

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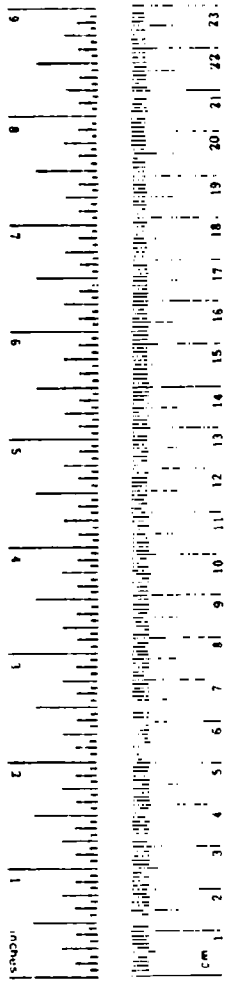
METRIC CONVERSION FACTORS

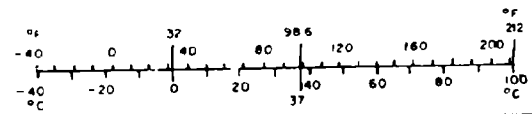
Approximate Conversions to Metric Measures

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



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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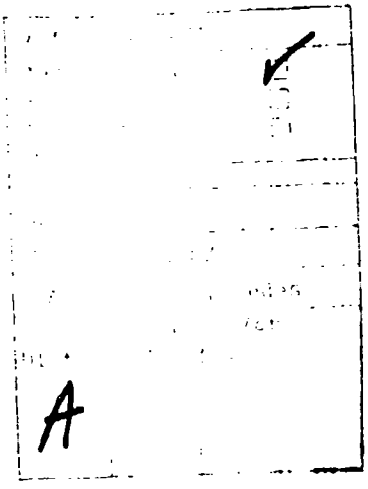

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INTRODUCTION

PURPOSE.

The Precision Approach Path Indicator (PAPI) system is a visual glidepath indicator similar to the standard Visual Approach Slope Indicator (VASI) system. Previous testing of PAPI at the Technical Center has shown that the differences in PAPI over the standard VASI may be advantageous to the pilots who use the PAPI system. The purpose of this Interim Report is to document the in-service testing of the system at Newark International Airport (EWR).

DISCUSSION

GENERAL.

Four months (December 8, 1980 to April 8, 1981) of in-service testing was accomplished at EWR on runway 4R. Questionnaires (appendix) were provided to the pilots by the Air Line Pilots Association and collected by it and the Air Transport Association. The results are shown in this report.

In order to allow for the large difference in wheel-to-eye height between some small aircraft and some large aircraft, the scheme used at EWR was to move the PAPI units down the runway 300 feet beyond the Instrument Landing System (ILS) glide slope intercept point (a total of 1350 feet down from the displaced threshold at EWR), and open up the on-course signal to 30 minutes of a degree instead of the regular 20-minute segment. This allows the wheels of the small aircraft to cross the threshold at 62 feet and the wheels of the largest aircraft (B-747) to cross the threshold at 21 feet when folowing the bottom of the visual on-course signal.

Newark International Airport was selected to obtain data from large commercial aircraft and no general aviation testing was performed. Testing at a general aviation airport utilizing small aircraft and general aviation pilots is scheduled for a later date.

EQUIPMENT.

The PAPI equipment used during the EWR tests was the standard four-box model Mk 6 PAPI system manufactured by the Barrel Lighting Company Limited, of Stansted, England. It was installed on the right-hand side of runway 4R with the intensity controlled by a photo cell (bright during the daylight hours and dim during the hours of darkness). The system was left in the ON condition except when requested to be turned off by pilots and during low visibility conditions.

RESULTS

TEST.

During the 4 months of flight testing, a total of 117 questionnaires were returned. Basically, they compared the PAPI system to the standard red/white VASI system generally used throughout the United States. Table 1 shows the mix of aircraft used to obtain information for the tests.

Questionnaires were received from pilots of seven different aircraft types, all of which are considered transport aircraft, giving a good sampling of today's commercial aircraft. No questionnaires were received from general aviation pilots.

More than 90 percent of the flights were made with the visibility greater than 3 miles, the ceiling higher than 2000 feet, and with no precipitation. A few flights reported rain, snow, fog, cloudiness, and smog. Some 63 percent of the approaches were made during the hours of 1600 to 2400, 34 percent during the hours of 0800 to 1600, and 3 percent during the hours of 0000 to 0800.

Table 2 shows the results of the comparison of the PAPI system with the standard red/white VASI system, in percentage form.

TABLE 1. PERCENTAGE OF TYPES OF AIRCRAFT

Aircraft Type	% of Total
B-727	42
DC-10	22
B-737	13
DC-8	9
B-747	8
L-1011	5
B-707	1

TABLE 2. A PERCENTAGE COMPARISON OF PAPI WITH VASI

	BETTER	SAME	WORSE
Rate Information	57	37	6
Ease of Maintaining Approach Angle	50	43	7
Correcting Vertical Excursions	57	33	10
Usefulness of Touchdown Aiming Point	40	53	7
Coincidence with ILS	40	57	3
Initial Contact Range	60	29	11
Overall Value Compared with VASI's	61	28	11

SUMMARY.

Analysis of these data show that the United States pilots were not quite as enthusiastic about PAPI as testing results have shown in England, Canada, or France. PAPI, however, was rated better than VASI in all rating factors at Newark except in the "Usefulness of Touchdown Aiming Point" and the "Coincidence with ILS." In these two cases, most pilots thought that both PAPI and VASI rated about the same.

No overall test ratings by the pilots indicated that the VASI was better than PAPI. In the "Overall Value Compared with VASI's," 61 percent favored PAPI, 27 percent thought they were about the same and 11 percent thought the VASI was better than the PAPI. This clearly indicates that, overall, the pilots who evaluated the PAPI at Newark considered the PAPI to be an improvevent over the VASI. It must be remembered that these in-service tests include only information derived from commercial pilots of large aircraft and do not include the general aviation segment of the flying public. Further testing of this type is presently in process.

APPENDIX

QUESTIONNAIRE AND SAMPLE COMMENTS

Figure A-1 is a summation of the results of the questionnaires received from the 117 pilots who flew the system at Newark. It also contains samples of the majority of comments received from the pilots.

(After completion of the approach,
please check the appropriate boxes)

EWR TEST RESULTS

Date: 12-8-80 to 4-8-81	Time: 0000-0800=3% 0800-1600=34% 1600-2400=63%	Aircraft Type:

RVR or Visibility on Approach	1200 to 1800	1800 to 2400	2400 to 4000	1-3 miles	≥ 3 miles X

Lowest Clouds	100 to 200 ft.	200 to 300 ft.	300 to 500 ft.	500 to 2000 ft.	> 2000 ft. X

Precipitation/Visibility Restriction	Type:	None: X

Comparison with VASIS. Please assess PAPI on the following points:

(NUMBER OF PILOT RESPONSES)

	Better	Same	Worse
1. Rate Information	64	42	7
2. Ease of Maintaining Approach Angle	56	48	8
3. Correcting Vertical Excursions	64	38	11
4. Usefulness on Touchdown Aiming Point	44	59	8
5. Coincidence with ILS	42	61	3
6. Initial Contact Range	67	33	12
7. Overall value compared with VASIS	70	31	13

FIGURE A-1. QUESTIONNAIRE WITH NEWARK TEST RESULTS (Sheet 1 of 2)

SAMPLE COMMENTS TAKEN FROM THE QUESTIONNAIRES

1. By far the vast majority of comments (at least 20) concerned the control of the brilliance of the lights. Most indicated that the white lights were too bright compared to the red lights; or the red ones were not bright enough compared to the white. Some thought both colors (red and white) were overpowering and should be dimmed.

2. At least eight comments stated that overall, the Precision Approach Path Indicator (PAPI) system is better than the Visual Approach Slope Indicator (VASI) system. Samples - "PAPI gives more precise information," and "An excellent system."

3. At least six comments concerned the rapid change in colors. Most thought this was beneficial but two preferred the subtle pink transitional area of the VASI.

QUOTED COMMENTS

1. "Since interpretation is not based on pink/red shading, the positive change of one light from white to red shows very positive trend allowing faster recognition and thus correction. I purposely went to 3 red/1 white, then 3 white/1 red, then to 2 red/2 white. I feel the system is a vast improvement from VASI."

2. "The visibility, intensity of PAPI is much greater than VASI. I particularly like knowing its location, touchdown aiming point, extremely useful. PAPI is a highly acceptable, flyable, visual landing aid. However, I would rather have a VASI on all non-ILS runways than PAPI on the runways that now have a VASI."

3. "One light low and high corresponded to exactly one dot low and high on ILS glide slope."

4. "Appears to be more definitive in close; i.e., inside the outer marker. Cannot be seen as far out as VASI."

5. "Biggest factors were ease of acquisition even at 10 nmi and rapid transition from red to white and back. I like it much better than conventional VASI."

6. "Easier to determine small excursions early in approach."

7. "Information is not as obvious as VASI."

8. "Requires horizontal plane scanning which is not normal during approach."

FIGURE A-1. QUESTIONNAIRE WITH NEWARK TEST RESULTS (Sheet 2 of 2)