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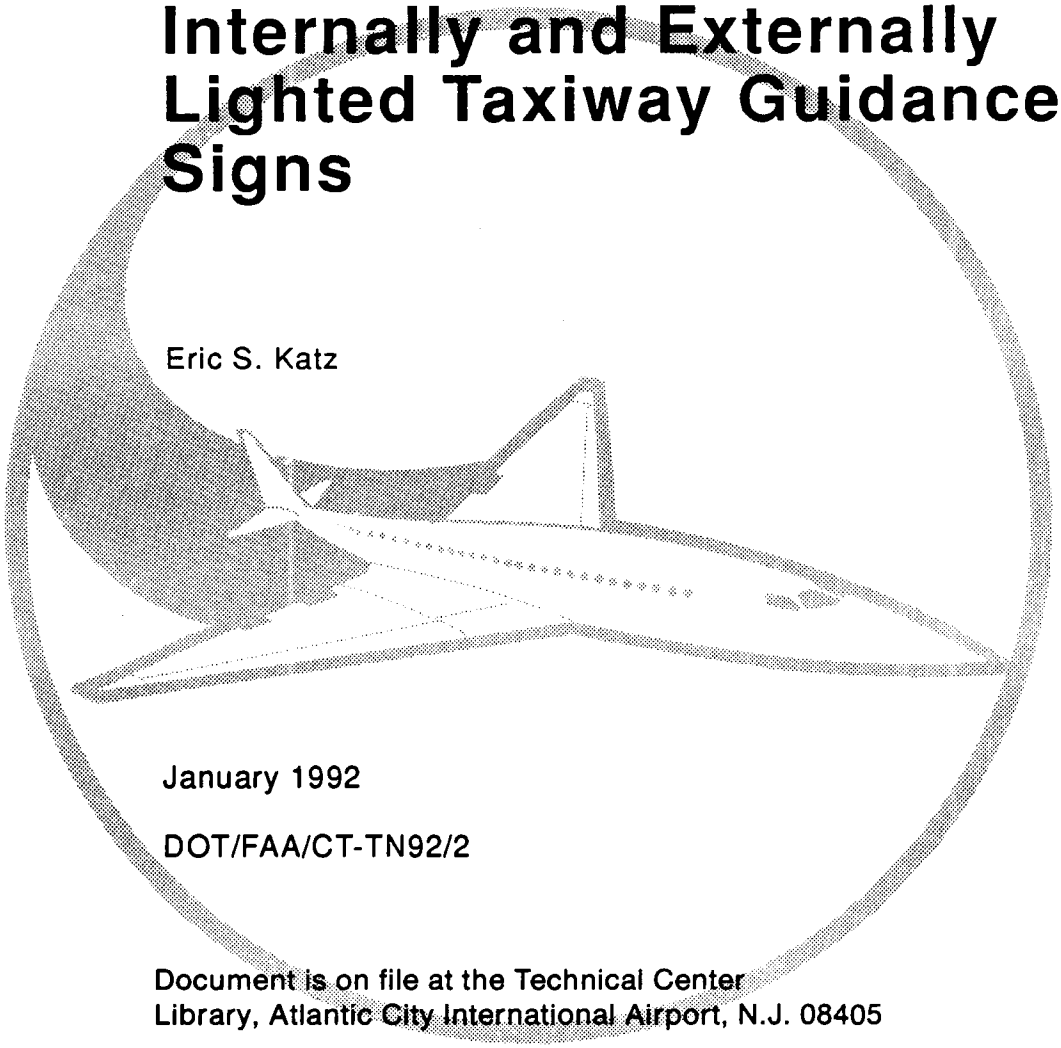
Comparative Evaluation of Internally and Externally Lighted Taxiway Guidance Signs

Eric S. Katz



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16. Abstract

Airport installations of both internally and externally lighted taxiway guidance signs are presently eligible for Federal Airport Improvement Program (AIP) funding. However, there is some basis for believing that the internal form of sign illumination is superior because of the more uniform light distribution attainable and the reduced maintenance required. In view of this, the Federal Aviation Administration (FAA) is considering a change to advisory circulars making the internally lighted sign the sole standard for AIP funded installations.

A comparative evaluation of the two types of illuminated airport signs was conducted at The Federal Aviation Administration (FAA) Technical Center. The purpose of the evaluation was to determine if one sign illumination technique exhibited significantly better performance than the other technique. To obtain performance data applicable to signs presently in service, samples of both internally and externally illuminated signs were obtained and evaluated. Results of the evaluation indicate that the performance of the internally illuminated taxiway guidance signs can be expected to be significantly better than that of externally lighted signs, especially at greater viewing distances and under conditions of reduced visibility.

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INTRODUCTION

PURPOSE.

At the present time airport installations of both internally and externally lighted taxiway guidance signs are eligible for Federal Airport Improvement Program (AIP) funding. However, there is some basis for believing that the internal form of sign illumination is superior because of the more uniform light distribution attainable and the reduced maintenance required. In view of this, the Federal Aviation Administration (FAA) is considering a change to advisory circulars making the internally lighted sign the sole standard for AIP funded installations.

In particular, the purpose of this effort was to comparatively evaluate the effectiveness of the two types of illuminated taxiway signs. To obtain performance data applicable to signs presently in service, used, but serviceable, samples of both types of signs were obtained on loan from user organizations.

OBJECTIVE.

The project effort was directed specifically toward determining the following:

1. Comparative performance (effectiveness) of the two techniques (external and internal) presently used for sign illumination.

2. Reasons for superior performance of one type of illumination, if some superiority is evident.

3. Maintenance considerations unique to one or both schemes for sign illumination.

BACKGROUND.

There is little doubt that, historically, the first generation of lighted taxiway signs used at airports utilized externally mounted lights. This is only reasonable since airport owners and operators could easily construct such signs in their own maintenance facilities using "off-the-shelf" lighting fixtures mounted on simple painted wooden boards. This form of sign illumination served well during operation in relatively good nighttime weather conditions, but it was gradually supplanted by internal illumination techniques as improved transparent and translucent faceplate materials became available. At present most new taxiway guidance sign installations utilize internally lighted fixtures. However, some airports, both large and small, still procure and/or construct the older externally lighted signs in the interest of maintaining uniformity of type within the airport movement area. As a result, we now find a combination of both types of signs used throughout the country.

SIGN EVALUATION

EQUIPMENT DESCRIPTION.

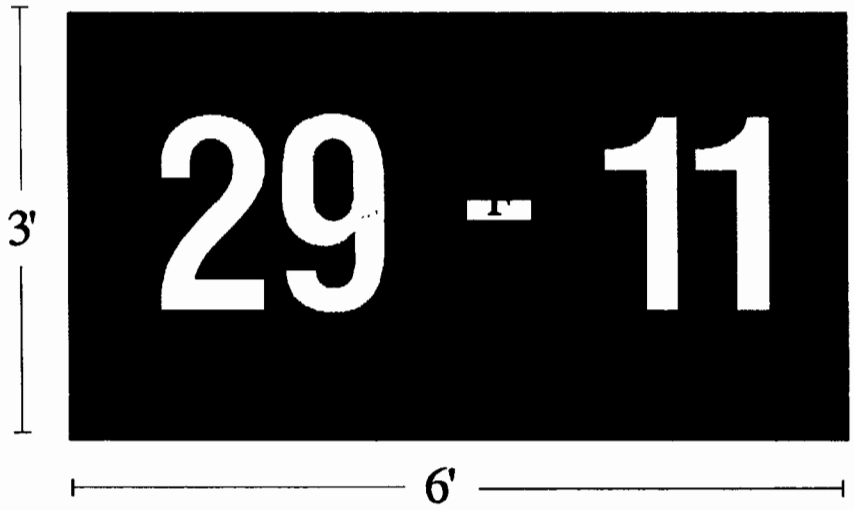
Externally lighted white-on-red "Mandatory Runway Entrance" and black-on-yellow "Taxiway Guidance" signs were provided for the test by the Port Authority of New York and New Jersey. Internally lighted signs, of the same format with regard to usage, were obtained from surplus stocks removed from service at the FAA Technical Center. Both types were of virtually identical size (mandatory -- 6 by 3 feet with 18-inch legend; taxiway direction -- 4 by 3 feet with 18-inch legend) and differed only with regard to the type of illumination used. Both externally lighted signs were illuminated by a single lamp, weatherproof 48-inch fluorescent light fixture, mounted along the top edge of the unit. The two internally lighted signs were illuminated using a single internally mounted 72-inch fluorescent lamp. The faces of the externally lighted signs consisted of painted backgrounds and legends on a plywood board, and were in well-weathered condition (faded, chipped paint, etc.). The faceplates of the internally lighted signs were in somewhat better surface condition, having a clear plastic covering, but exhibited considerable delaminating of the retroreflective material originally attached to the faceplate. In general, the appearance of all four signs was that of units which had been in continuous use at a major airport for a period of approximately 10 to 15 years.

PROCEDURE.

The comparative evaluation was conducted during the evening of October 1 under full darkness, clear-weather conditions, on the FAA ramp at the Technical Center. The signs were installed as pairs (externally and internally lighted) for comparison and energized from a standard taxiway edge lighting circuit. The pair of white-on-red "Mandatory Runway Entrance" signs were observed and evaluated first, and then replaced by the black-on-yellow "Taxiway Guidance" sign pair for evaluation. The procedure followed was that of observing appearance and legibility of sign pairs from varying distances of 150, 300, and 450 feet. In addition, and subsequent to the visual determination of comparative effectiveness, intensity measurements for each sign were obtained from a distance of 20 feet using a Minolta LS-100 Luminance Meter. Measurements of intensity at various locations on the sign faces were obtained to document relative intensity variations across the surface of the sign face. Results of these intensity measurements are illustrated in figures 1 and 2 of this report.

Observers making the subjective performance evaluation were Messrs. Eric Katz, Larry VanHoy, and Keith Bagot, ACD-110, and Mr. Tom Paprocki, Mitech, Inc. Messrs. Katz, VanHoy, and Paprocki are certificated pilots having extensive experience in the arena of airport visual guidance testing and evaluation. Mr. Bagot, while not a pilot, has also had considerable experience with airport visual guidance systems.

EXTERNALLY ILLUMINATED



Position	cd/m² at 20'
A	4.9
B	2.8
C	3.9
D	2.9
E	40.0
F	60.1
G	7.5

Entire sign at 300' = 10.9

INTERNALLY ILLUMINATED

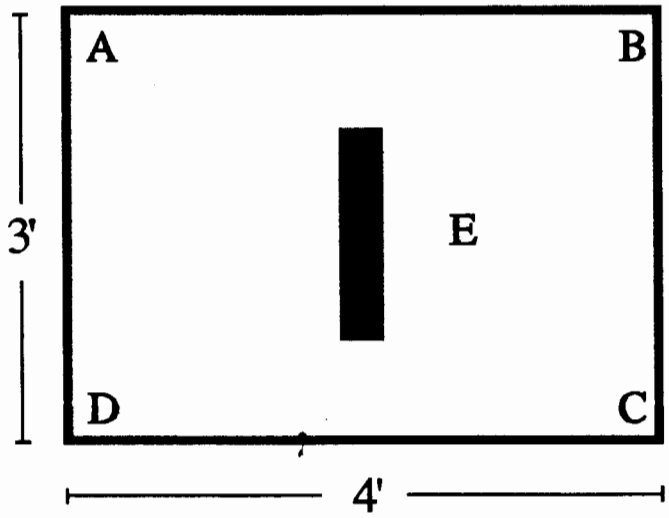
Legend Height = 18"

Position	cd/m² at 20'
a	14.1
b	12.1
c	11.4
d	11.6
e	36.2
f	225.7
g	16.1

Entire sign at 300' = 29.1

FIGURE 1. RUNWAY SIGN CANDELA READINGS

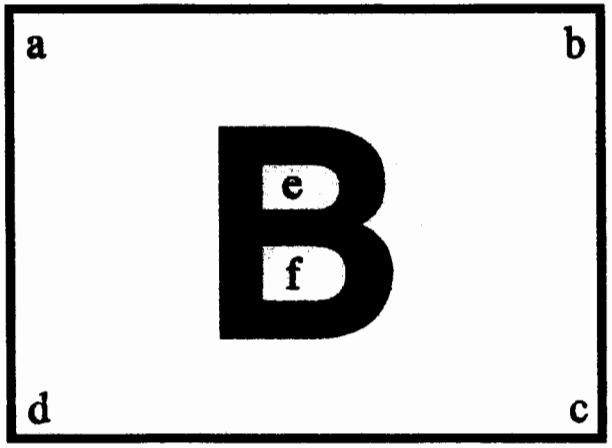
EXTERNALLY ILLUMINATED



Position	cd/m² at 20'
A	98.4
B	86.8
C	15.3
D	16.0
E	56.6
Legend	29.6

Entire sign at 300' = 13.4

INTERNALLY ILLUMINATED



Legend Height = 18"

Position	cd/m² at 20'
a	141.8
b	126.1
c	82.3
d	72.8
e	187.7
f	160.4
Legend	90.8

Entire sign at 300' = 35.2

FIGURE 2. TAXIWAY SIGN CANDELA READINGS

RESULTS

The consensus of the evaluators was that, under the clear weather conditions prevailing, the internally lighted signs exhibited significantly better performance than did the externally lighted signs. The difference in effectiveness was less obvious, but still evident, at the shorter observation range of 150 feet, and became much more distinctive as the viewing distance was increased to 300 feet and, subsequently, to 450 feet. Both types of illumination, regardless of faceplate color combinations displayed, provided easily interpreted information (legend message) at the 150- and 300-foot ranges. At the 450-foot range, the legend on the externally lighted sign was perceived as somewhat indistinct, while the legend on the internally lighted sign remained virtually as distinct as at the lesser ranges. While at the 450-foot distance, the observers displaced themselves to the side at an angle of approximately 45 degrees to the face of the signs. From this location, the legend on the externally lighted sign became even more indistinct, while that of the internally lighted sign retained its superior legibility. This gradual but perceptible reduction in legibility was considered to be of little concern under the excellent visibility conditions that prevailed, but all observers agreed that it could become a significant problem under operating conditions of greatly reduced visibility (i.e., Category II or III operations).

The light intensity measurements taken at the time of evaluation revealed a considerable variation in value over the face of the externally illuminated sign, with a most apparent reduction in illumination reaching the lower half of the sign face. This irregularity in surface illumination, while of relatively lesser importance at the shorter viewing distances, appeared to be the reason for the perceived less adequate performance at longer ranges. Similar measurements of intensity, taken under the same conditions, showed a uniform distribution of illumination across the surface of the internally lighted sign. This would seem to account for the more effective guidance provided by this sign at the greater viewing distances.

During the course of the evaluation, the intensity setting (circuit current) of the taxiway edge lighting circuit providing power to the test sign installation was varied from high (step 5) to low (step 2) to observe the effect on sign illumination. In no instance was there any perceptible change in sign illumination level.

Aside from concerns about legibility and variations in surface illumination, use of external light sources requires the mounting of lamp fixtures either above or below the sign face and projecting in front of the faceplate. If mounted above the sign face, the lamp fixture will certainly obscure portions of the legend when the sign is viewed from a high-cockpit (wide-body) aircraft at close ranges. Conversely, lamp fixtures mounted at the lower edge of the sign face, to project the light upward, will certainly be subjected to contamination (snow and ice deposits, bird droppings, etc.) which could adversely affect light output and, consequently, performance.

In summary, the evaluators were unanimous in judging the internally lighted signs to be more effective than the externally lighted signs, especially at greater viewing distances. At the present time, when changes to the Advisory Circular for taxiway guidance sign usage will be mandating extensive replacement of existing sign installations at many airports, it would seem appropriate to encourage use of the most effectively illuminated sign type.

CONCLUSIONS

From the results of this comparative evaluation, it is concluded that:

1. Performance (effectiveness) of internally illuminated taxiway guidance signs can be expected to be significantly better than that of externally lighted signs, especially at greater viewing distances and under conditions of reduced visibility.

2. The superior performance exhibited by the internally lighted signs can be attributed, primarily, to the more even distribution of light across the entire surface of the sign, resulting in increased conspicuity and contrast of legend with background. Additionally, the protrusion of illumination components (i.e., lamps, holders, shields, etc.) can be expected to mask portions of the externally illuminated sign legends when viewed from the side or above.

3. Required maintenance of externally lighted signs can be expected to be significantly greater than that required for internally lighted units.