30-DEGREE MODIFIED SLOPE-LINE APPROACH-LIGHT SYSTEM

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SUMMARY

This report presents the results of an investigation to determine the feasibility of widening the spacing between pairs of slope-line lights. This spacing is increased by decreasing the angle between the individual light bars and the horizontal. An installation was made in which the bars at the inner end of the approach path were set at 30° instead of 45°, while the bars of the outer portion were left at 45°. This resulted in a definite break in the lines, which proved undesirable. In general, the sensitivity of the guidance furnished by the 30° bars is not as sharp as that furnished by the 45° pattern.

INTRODUCTION

The location of the units of slope-line lights is determined by passing two planes through a theoretically correct approach path to intersect the ground plane at a fixed angle (usually 45°) with the horizontal, on either side of the extended center line of the runway.[1] The light units are mounted in the sloping planes at the intersection of the sloping planes and the ground plane. Under these circumstances the spacing between pairs of slope-line lights varies directly with the height of the glide path, which in turn varies directly with the glide angle and the distance from the touchdown point.

The actual spacing between rows of slope-line lights at the end near the runway is of the order of 100 feet. There has been some objection to this because of the added danger to any aircraft which might overrun the end of the runway while approaching or taking off from the opposite direction.

The height of the light units above ground is about 12 feet. While these fixtures are no hazard to a normal conservative landing, there may be some danger to an aircraft making a low approach which will result in a touchdown very near the runway end. The previously mentioned height has been reduced in some cases by mounting half-length units near the runway end.

ANALYSIS OF THE PROBLEM

The spacing between the rows of slope-line lights varies with the cotangent of the mounting angle. It is then possible to increase the spacing by reducing the angle of setting.

The setting at 45° was chosen because it gives a balanced indication of deviation both vertically and horizontally. Any variation from 45° will be at the expense of sensitivity of indication in one or the other direction. As the only change which would result in increasing the space between pairs is reducing the horizontal angle of setting, the reduction in guidance sensitivity is in the horizontal plane.

While it is desirable to increase the spacing between the pairs of approach lights at the inner end of the approach path, it is undesirable to increase this spacing at the outer end, as this would locate the units so far from the axis that the visibility of the lights would be seriously affected. Several expediencies to meet this condition were considered, such as warping the planes in which the lighting units are mounted and selecting planes defining a different line at the inner end. An analysis of the guidance effect produced by warping the planes was made by a perspective study, and it was found that this warping produced conflicting and misleading guidance. This is primarily due to the impossibility of predetermining the point in the approach from which the pilot will first see the warped portion, and from which he will use it for guidance. This conflicting guidance was evident also when an attempt was made to use planes defining a horizontal path for the inner end of the approach.

The only solution which showed any real promise was to break the planes serving the outer end, and select two other planes intersecting on the same line in space. As the shortest section of the path which would show practical guidance appeared to be about 1,000 feet, it was decided to install the inner end

[1] H. J. Cory Pearson, "The Slope Line Approach Light System," Page 6, Technical Development Report No. 104, March 1950.

of the approach system out to a point 1,000 feet from the threshold in 30° planes instead of 45° planes. Arrangements were made to de-energize the corresponding section of the 45° units when the 30° units are in operation.

RESULTS OF EXPERIENCE

Mounting the lighting fixtures at 30° instead of 45° results in increasing the spacing between the lines by the relationship between the cotangents of the angles with the horizontal; which produces a spacing on level ground 1.732 times the spacing provided by the 45° angle. Similarly, the projection of the linear units above the horizontal is decreased by the proportion of the tangents of the angles, or 0.577.

The indication of deviation from the correct path is affected in both vertical and horizontal planes. This is shown in Fig. 1, where the relative displacement of P_1 from the 30° and 45° planes is indicated by the relationship b-P_1 and a-P_1 and the displacement of P_2 from these planes is indicated by c-P_2 and d-P_2. It will be noted that the decrease in sensitivity horizontally is materially greater than the increase in sensitivity vertically.

A material break in the lines of the approach lights occurs at the point where the angles change. This is shown in Fig. 2.

Fig. 3 shows the relative spacing of the 30° and the 45° rows, as well as a comparison between the position indication given by the two patterns to a pilot who is above his proper glide path. Fig. 4 gives a comparison of the indications available to a pilot who is to the left of the proper glide slope. Figs. 5, 6 and 7 are perspective studies showing the pilot's view from 1,000 feet out. Fig. 5 shows the appearance when the pilot is on course, Fig. 6 when he is 27 feet too high and Fig. 7 when he is 27 feet to the left.

With the split pattern, having two-thirds of the approach-light pattern set at 45° and the inner one-third at 30°, there are several advantages and some disadvantages which must be given careful consideration. The added clear space between the lines adjacent to the runway end and the actual lowering in height of the light units are definite advantages. The increase in width is enough to clear a runway 150 feet wide, but it can not be effectively spread any farther and retain good guidance. The split in the pattern at 1,000 feet can be disturbing to a pilot. The tests at the Landing Aids Experiment Station, Arcata, Calif., where various patterns of overrun approach lights were flown, indicated that pilots are seriously disturbed by a change in the method of guidance part way along the approach. There is a material loss in sensitivity of horizontal guidance without a compensating increase in sensitivity of vertical guidance. A number of flight checks have been made on this pattern, which confirm the results of this study.

CONCLUSIONS

The split approach-light pattern, using 45° light mountings at the outer 2,000 feet and 30° mountings for the inner 1,000 feet, provides added clearance at the approach end of the runway. It is considered, however, that the disadvantages inherent in the split system outweigh this advantage for normal installations.

Where it is imperative to keep the overrun area free of any obstruction, this split pattern is a possible solution for a cleared area width of 150 feet.

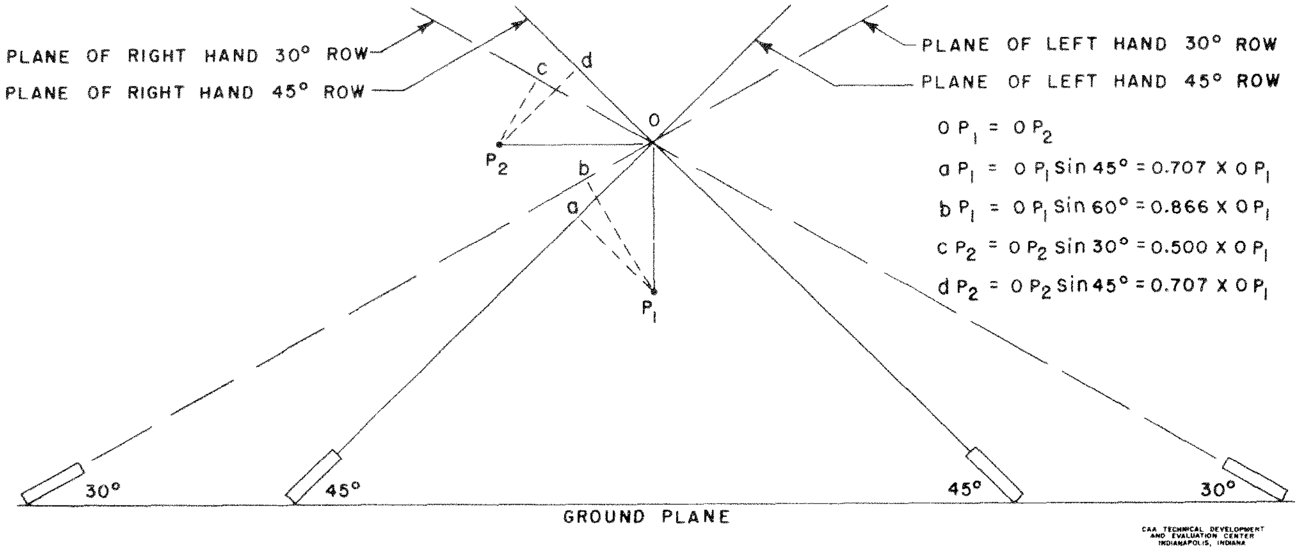

Fig. 1 Comparison of the Effectiveness of Horizontal and Vertical Guidance Available from 45° and 30° Slope-Line Lights

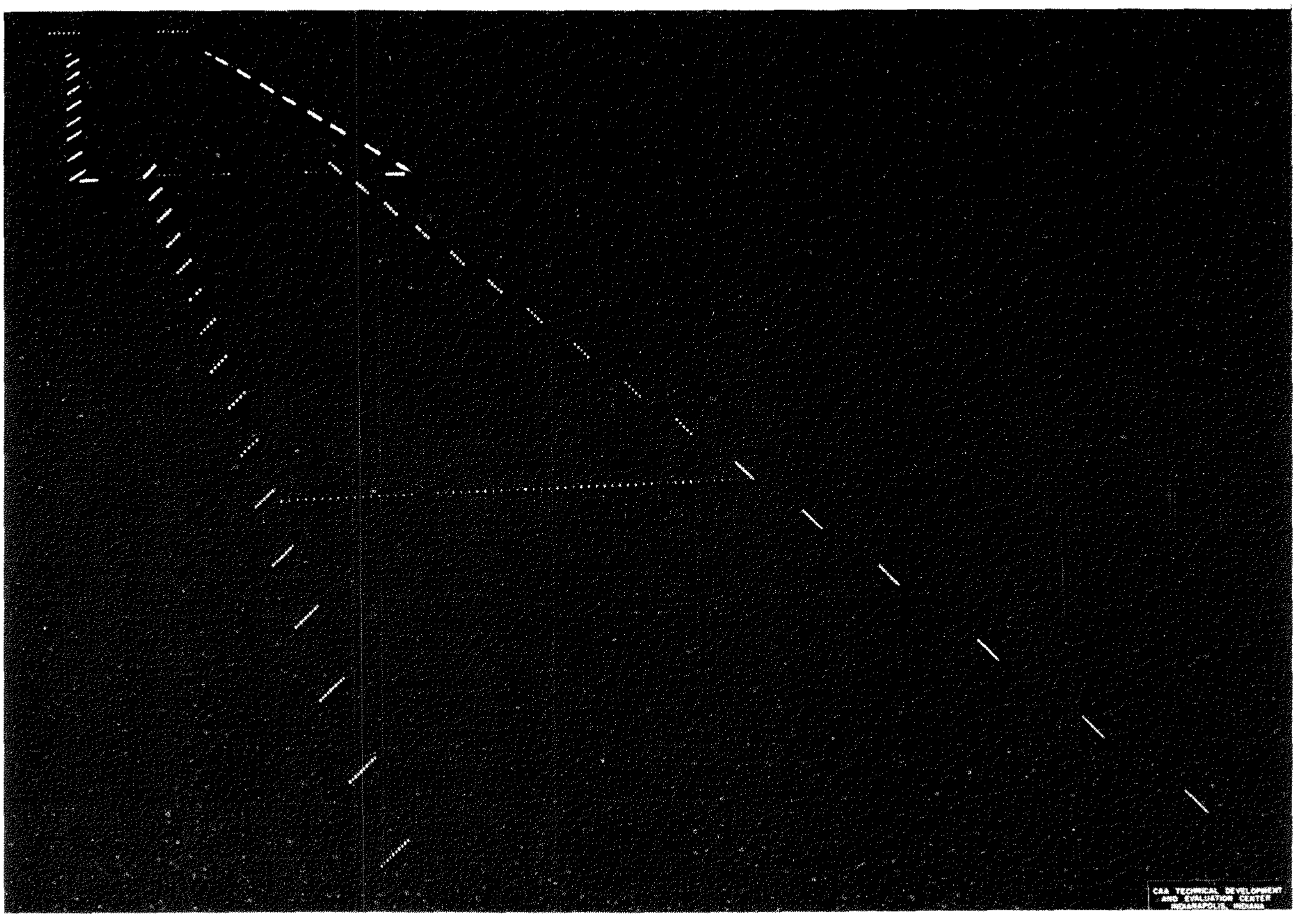

Fig. 2 Night View of Pattern

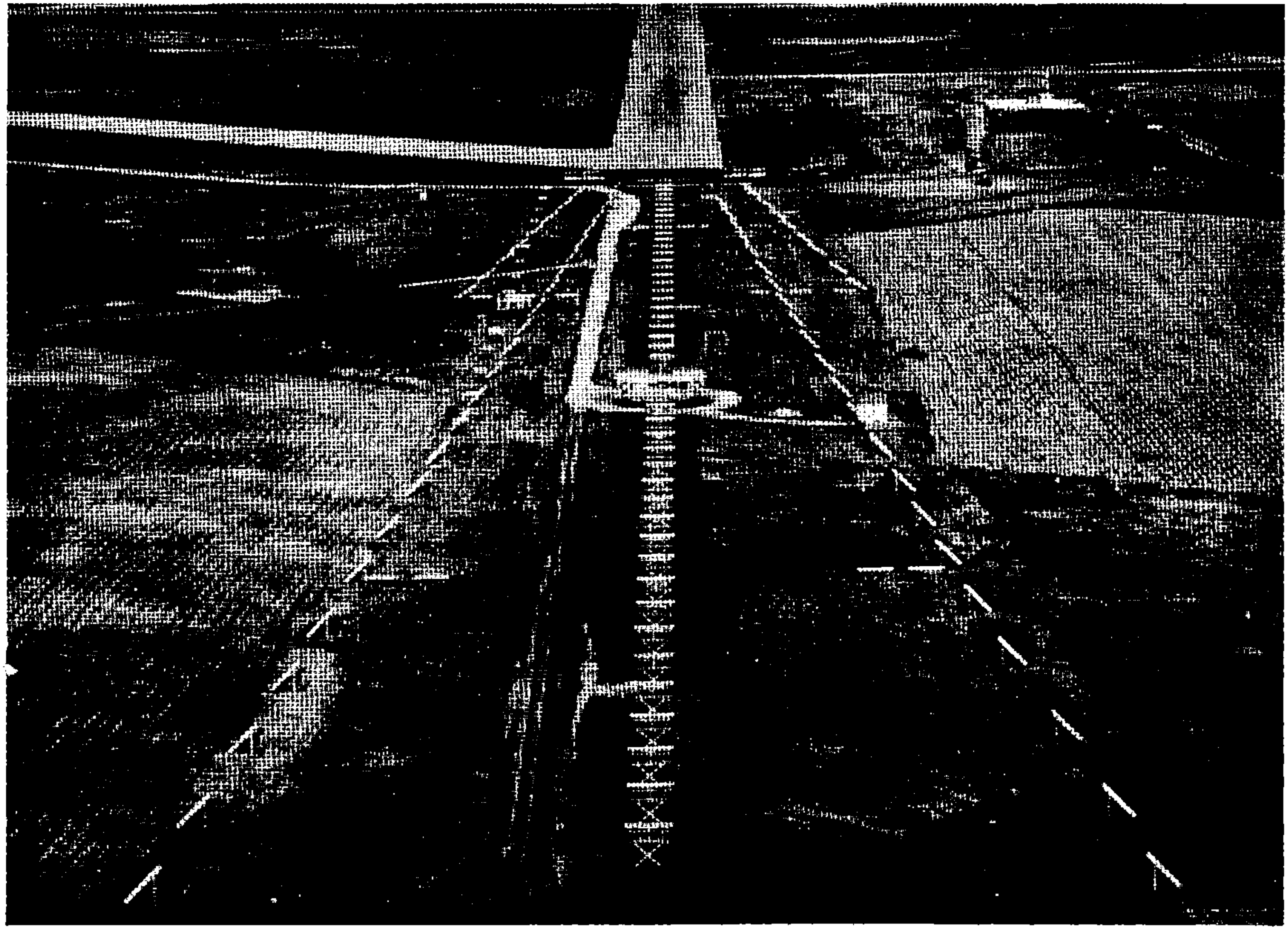

Fig. 3 Photograph Showing Both 30° and 45° Slope-Line Lights from a Position Slightly Above the Correct Approach Path

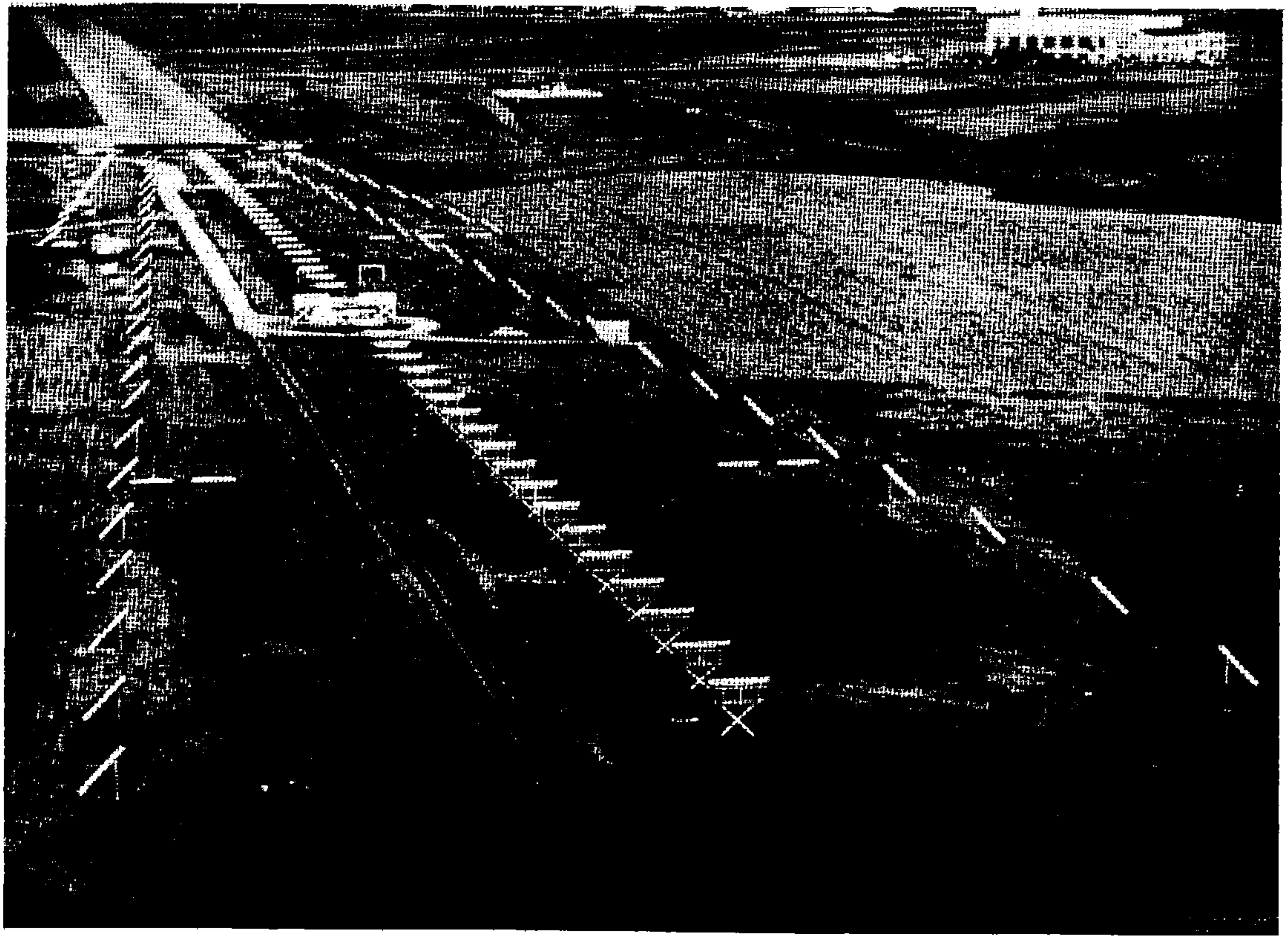

Fig. 4 Photograph Showing Both 30° and 45° Slope-Line Lights from a Position Left of the Correct Approach Path

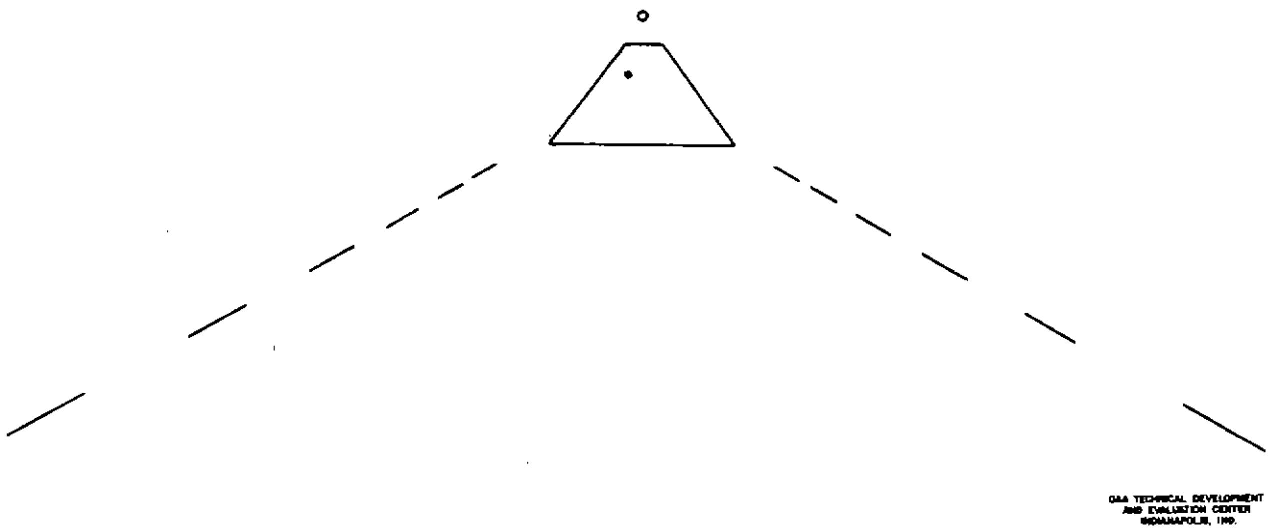

Fig. 5 Pilot's View of 30° Slope-Line Lights as Seen 1,000 Feet from Threshold on Course. Altitude is Correct.

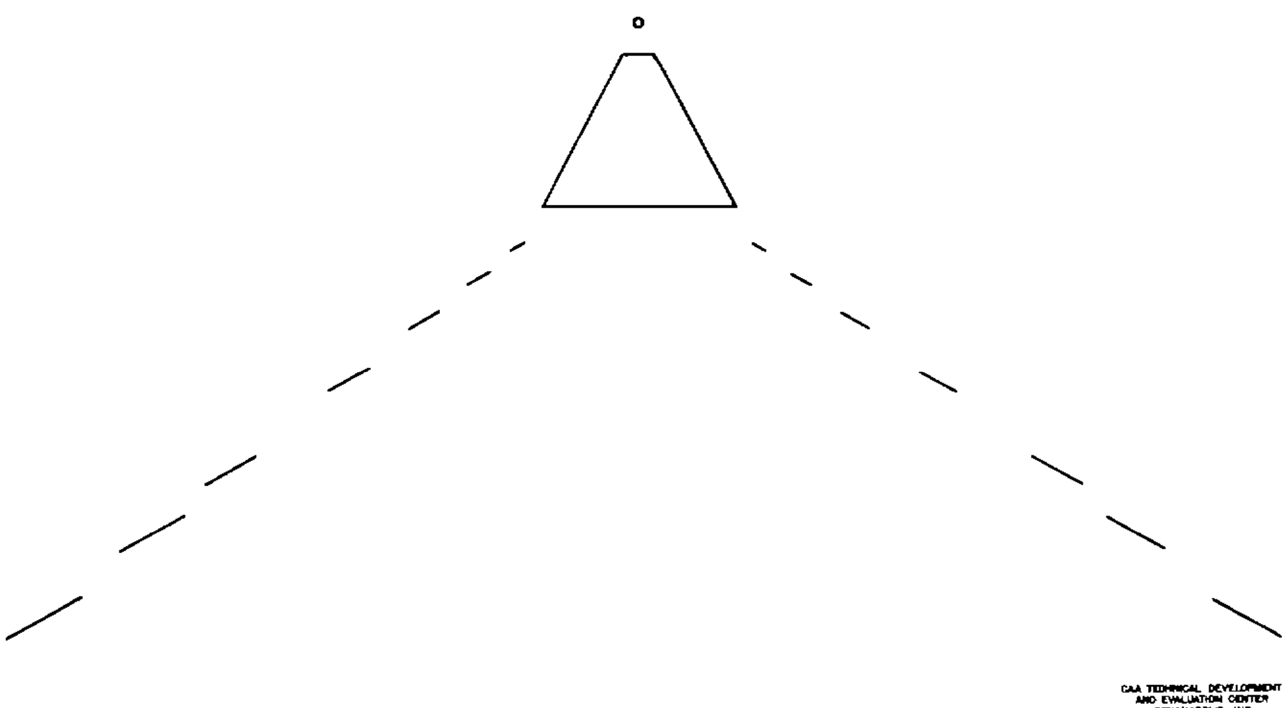

Fig. 6 Pilot's View of 30° Slope-Line Lights as Seen 1,000 Feet from Threshold on Course. Altitude is 27 Feet Too High.

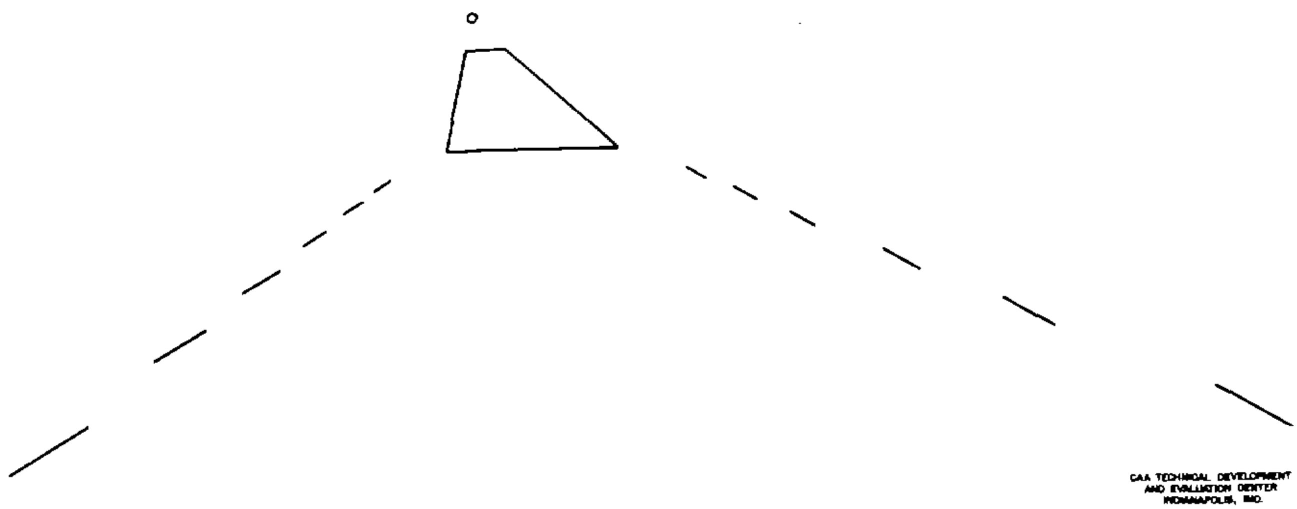

Fig. 7 Pilot's View of 30° Slope-Line Lights as Seen 1,000 Feet from Threshold and 27 Feet Left of the Runway Center Line. Altitude is Correct.

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