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Design and Installation of Flasher Baffles at the Arcata/Eureka Airport

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Final Report

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16. Abstract

The medium intensity approach lighting system with runway alignment indicator lights operating on runway 32 at the Arcata/Eureka Airport in McKinleyville, California, was causing a severe glare hazard to motorist driving on a nearby highway that crossed through the system, approximately 1400 feet from the end of the runway. Specifically, the glare was caused by high-intensity light output from the strobe portion of the Approach Lighting System. The Western-Pacific Region, Airway Facilities Division requested the Airport Technology Research and Development Branch to investigate and provide possible solutions to eliminate the hazard.

Based on the geometry of the roadway and the Approach Lighting System, it was determined that a series of baffles installed on three of the five strobe lights would be the most effective way to block the light from being projected directly into the motorists' eyes. Engineers designed, developed, and constructed three different aluminum baffles specifically for the situation at the Arcata/Eureka Airport. Each of the three baffles differed slightly in design, as they were optimized for each of their respective locations within the Approach Lighting System.

Ground and flight evaluations, which included the use of motor vehicles and aircraft, were conducted during both day- and nighttime conditions to determine if the glare hazard had been eliminated without affecting the usability of the lights for approaching aircraft. The results of the evaluations showed that the baffles had eliminated the glare hazard to motorist on the highway without reducing the essential approach guidance needed by pilots.

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LIST OF ACRONYMS

ACV	Arcata/Eureka Airport
ALS	Approach Lighting System
FAA	Federal Aviation Administration
ILS	Instrument Landing System
MALSR	Medium Intensity Approach System with Runway Alignment Lights

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) Office of Aviation Research, Airport Technology Research and Development Branch, ATO-P, conducted this project at the request of the Western-Pacific Region, Airway Facilities Division, AWP-400. The task was to obtain and install light baffles for the runway alignment indicator lights (RAIL) portion of the Medium Intensity Approach Lighting System (MALS) at the approach end of runway 32 at the Arcata/Eureka Airport in Arcata, California. Assistance was requested to remedy a situation in which local residents had filed several complaints stating that the system crosses a public road and that the glare from the sequenced flasher was distracting and hazardous.

Airport Technology Research and Development Branch personnel were sent to the site to survey the installation, and as a result, developed preliminary plans to fabricate baffles to prevent the light from the RAIL units from striking the roadway. After the baffles were fabricated at the FAA William J. Hughes Technical Center, the team returned to the site for installation and testing. This installation is unique in that the roadway climbs up to the MALS system, making it very difficult to mask the light for the roadway at both short and long distances without impacting the usable light required in the approach zone. This report describes the steps taken to assess the situation, fabricate the baffles, and install and test them at the Arcata/Eureka Airport.

Ground and flight evaluations conducted by the Airport Technology Research and Development Branch verified that the installed baffles had eliminated the hazard without reducing the essential approach guidance needed by pilots.

INTRODUCTION

PURPOSE.

The purpose of this effort was to provide a solution to a road hazard situation existing at the Arcata/Eureka Airport (ACV). The project was initiated and sponsored by the Federal Aviation Administration (FAA) Western-Pacific Region Airway Facilities Division, AWP-400, and undertaken by the FAA Office of Aviation Research, Airport Safety Technology Research and Development Branch.

OBJECTIVE.

The objective of this research effort was to determine if a baffle device could be designed that would block nuisance light from distracting drivers operating their vehicles on a public road that crossed the final approach of runway 32 at ACV. In addition, the objective was to fabricate, install, and flight test the baffles, and once installed, to ensure that the usable signal was in no way affected for approaching aircraft.

BACKGROUND.

A well-traveled public road, Central Avenue in McKinleyville, California, passes to the east of the Arcata/Eureka Airport immediately adjacent to the airport boundary fence. The road also passes directly through the runway 32 approach area of the airport at a very acute angle of approximately 30 degrees to the Approach Lighting System (ALS), and passes beneath the lights at a point only 1700 feet from the runway threshold (figures 1 and 2).

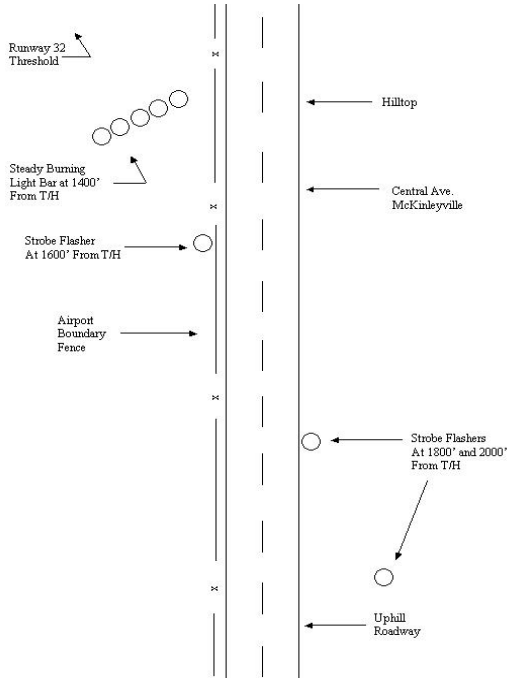


FIGURE 1. PLOT PLAN OF THE RUNWAY 32 APPROACH AREA

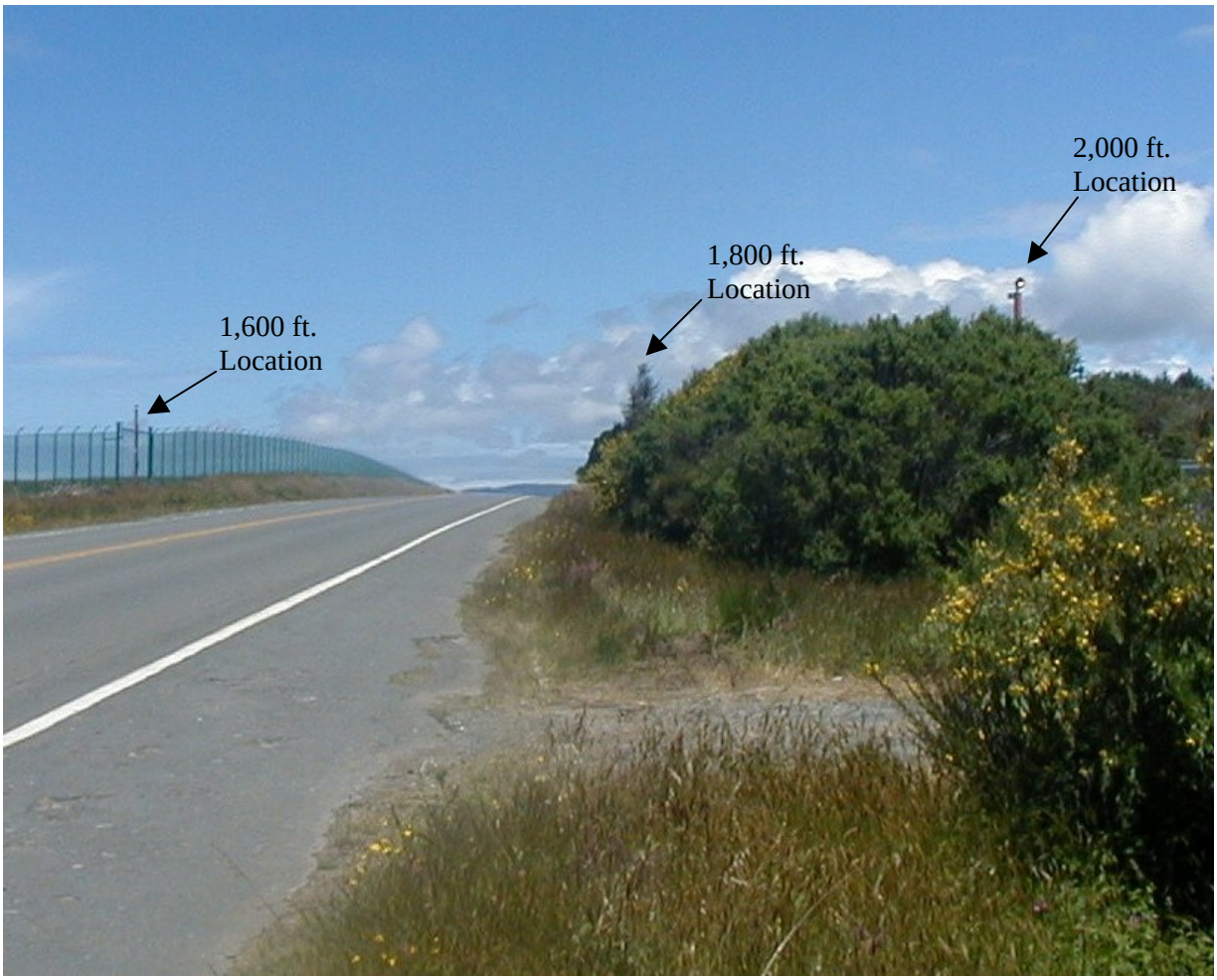


FIGURE 2. ROADWAY TRAVERSING THE ALS SYSTEM

While the steady-burning lights of the medium intensity approach lighting system with runway alignment indicator lights (MALSR) are far enough from the road, they pose no visual hazard to passing motorists, but the high-intensity condenser discharge (strobe) lights located immediately adjacent to the road on either side have occasioned numerous complaints. They are especially irritating when set to the highest intensity setting for pilots executing instrument approaches during inclement weather. The Arcata/Eureka Airport is noted as having extremely frequent occurrences of heavy fog during early morning, high-vehicle traffic along this road.

The requesting office felt that the strobe lights might be baffled or shielded to cut off light from the motorists' eyes, while still maintaining the essential visual guidance for pilots.

RELATED ACTIVITIES AND DOCUMENTATION.

While the Airport Safety Technology Research and Development Branch has executed several quick response projects for baffling strobe lights, either in the Runway End Identifier Light or ALS configurations, each effort was to solve a unique, site-specific situation. No standard

configuration for strobe baffles has been developed, and virtually no specific documentation can be identified herein. The following reports do, however, describe several approaches to the problem used in the past.

- Letter Report No. NA-76-62-LR, "Evaluation of MALS/RAILS Baffles," December 1976.

- Technical Note DOT/FAA/AR-TN01/61, "Installation of Runway End Identifier Light Baffles at the Medina, Ohio Municipal Airport," June 2001.

PROCEDURES

THE INITIAL SITE INSPECTION VISIT.

A project team from the FAA Airport Safety Technology Research and Development Branch traveled to the Arcata/Eureka Airport, July 6 through July 8, 2004, to investigate the problem and to collect data for later use in designing baffles at the William J. Hughes Technical Center.

The team had several different rough prototype trapezoidal-shaped baffles that were prepared for previous projects and mounted them temporarily on the three most critical strobe towers (figure 2) in an attempt to establish the degree of baffling required. Ground observations were made along the affected road segment, both with and without temporary baffles mounted. Vertical and horizontal measurements were obtained from all critical observation points.

Precise theodolite measurements were taken at the site to establish acquisition angles from different points on the roadway and to determine the optimal orientation, size, and design of the baffle devices that would be needed to correct the problem. Actual measurements taken with a theodolite resulted in the following angular measurements:

- Angle A H: 27º 44′ 00″
  Horizontal angle of the right side of the road with respect to the centerline of the runway

- Angle B H: 26º 11′ 40″
  Horizontal angle of the left side of the road with respect to the centerline of the runway

- Angle C V: 5º 35′ 00″
  Vertical angle from the roadway to the ALS unit, directly in alignment with the runway centerline (approximately 100 ft away from fixture)

- Angle D V: 2º 47′ 20″
  Vertical angle from the roadway to the ALS unit at the lowest point on the road where the ALS unit is first visible (0.35 miles)

After completing the theodolite measurements, it was decided that the strobe fixtures on each side of the road, at 1600, 1800, and 2000 feet from the runway threshold, would be temporarily fitted with the prototype baffles. Addressing the problem with the strobe unit at 1600 feet from

the runway threshold, the first baffle (figure 3) was relatively long in design, which is optimal for situations where the targeted area is somewhat distant from the light fixture. The problem in this situation, however, was that the road is to the side of the fixture, and a great amount of light was still visible over the side of the baffle directly from the flasher light unit. When the baffle was turned towards the road, approximately 26 degrees to the right of the extended runway centerline, the baffle blocked most of the light. In this position, however, the baffle did not block the light from immediately in front of the fixture. It was determined that a fan-shaped baffle design might be more effective, as it would likely block light from both in front of the fixture and from the road 26 degrees to the right.



FIGURE 3. PROTOTYPE A BAFFLE

The second smaller baffle design was then tried at the same location (figure 4). Based on pictures that were provided by the local Airway Facilities group, it was thought that a shorter, wider baffle would be better suited in close proximity to the roadway. Once mounted to the light unit, however, it was quickly determined that the longer unit that was first tried would be more appropriate for blocking the light from the affected area.

The smaller baffle was then tried on the light unit at 1800 feet from the runway threshold, which is on the opposite side of the roadway from the airport, and yielded much better results. As can be seen in figure 4, the baffle was mounted to the side of the light fixture, which was very effective at masking the light from the immediate side of the fixture, precisely where the roadway was in relation to the fixture.

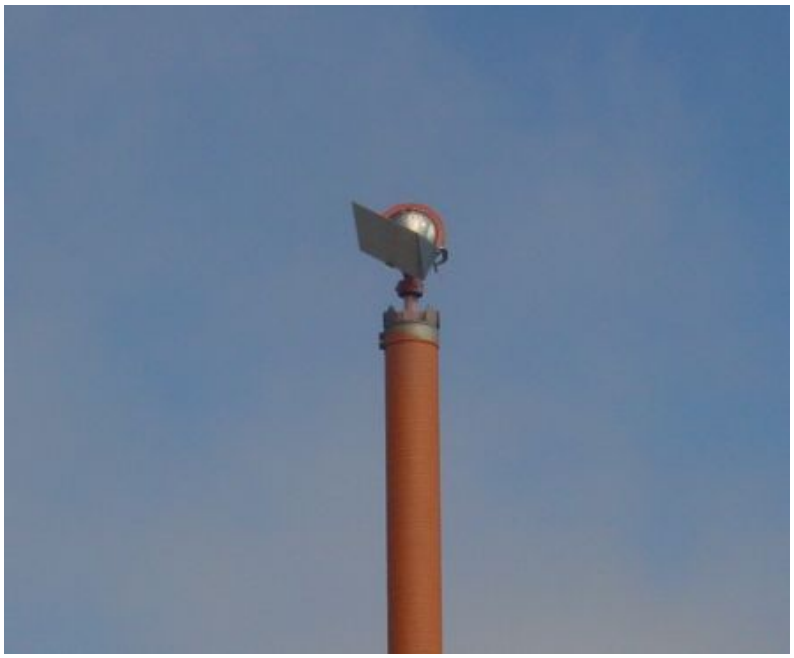


FIGURE 4. PROTOTYPE B BAFFLE

The prototypes were tested in various configurations until an optimal orientation with respect to the oncoming traffic on the road was obtained. In addition, large cardboard panels were taped to the baffle to simulate a larger baffle design. Black tar paper was also added to the baffle to reduce the amount of reflection from the baffle itself.

Under full darkness, the team returned to the site to observe how much of the light was blocked from the roadway with the prototype baffle installed. All present agreed that the baffles greatly reduced the amount of light visible, but that additional work would be necessary to properly construct a baffle specifically for this installation that would feature a wide angle to cover the +26 degrees of coverage area, have higher sides to block light to the sides of the fixture, and be constructed of black-painted aluminum to endure the harsh salt air environment prevalent in the Arcata area.

The team also sketched and photographed the manner in which the strobes, and associated tower hardware, were mounted so as to be able to later design and fabricate suitable mounting hardware at the William J. Hughes Technical Center. A spare PAR56 strobe lamp retaining ring was also brought back to the William J. Hughes Technical Center with the thought that it might serve as a mounting surface for smaller baffles that could attach directly to the light unit.

PREPARATION.

As a result of the data obtained and observations made at the Arcata/Eureka Airport, the strobe unit (1600 feet from the runway 32 threshold) facing almost directly into the motorists' eyes, would have to be fitted with a relatively large (2- to 3-foot long) dust-pan-shaped baffle. The baffle would need to be supported independently from the strobe light head by attachment to the tower tube and top cap portion of the tower structure itself.

The other two strobe units, 1800 and 2000 feet from the runway threshold and on the far side of the road, actually faced away from the eyes of the motorists. It was only necessary to block the light directed sideways and rearward from the strobes. It was determined that smaller (approximately 1-foot long) baffles, again of the dust-pan shape, could be provided and attached directly to the strobe light retaining ring (i.e., directly to the strobe head).

The smaller baffles were designed so that they could be rotated in a circular fashion on site before being permanently attached to the light head. In addition, they could also be adjusted vertically to vary the amount of light being directed to the ground.

A larger baffle, of considerably greater weight and surface area, was designed to be attached to the top of the tower, directly below the strobe light fixture, and supported by aluminum channels bolted from a lower position on the tower to the front sides of the baffle. The vertical angle of the baffle could, thus, be adjusted on site to cut off any direct observation of the strobe by passing motorists by simply sliding the tower end of the supporting channels up or down.

The three baffles were then fabricated from lightweight aluminum, primed, and painted flat black. All necessary mounting supports, attachment devices, and related hardware were either fabricated at the William J. Hughes Technical Center or purchased at a local hardware store.

INSTALLATION SITE VISIT.

Once fabrication and shipment of the baffles had been accomplished, the team traveled to the Arcata/Eureka Airport on January 10, 2005.

Installation of the large baffle at the location inside the boundary fence was accomplished first, and necessitated some adjustment so that it could be oriented almost parallel to the road, facing south, while keeping the strobe light itself facing directly toward the path of approaching aircraft. An additional small bracket was fabricated and attached on site to stabilize the baffle in the desired direction. The baffle shown in figure 5 resembles the previously used larger prototype baffle, with the exception that it was made somewhat longer and with a wider lip (i.e., more fan-shaped). When comparing figures 3 and 5, the larger overall shape and wider lip is evident.

The two smaller baffles were then attached to the strobe light units on the other side of the road to the east. This was a relatively easy task, since the baffles had been designed to attach directly to the lamp retaining ring with the existing wing nut fasteners. The baffle was rotated approximately 30 degrees clockwise prior to mounting to further shield the light from motorists approaching from the south. The vertical elevation was left at the maximum setting to cut off light from below the center of the lamp, but was changed after flight tests, as will be explained in the Results section. The smaller baffles used in the final installation are so similar in design to the prototype version that the prototype installation shown in figure 4 serves to depict both units as mounted.

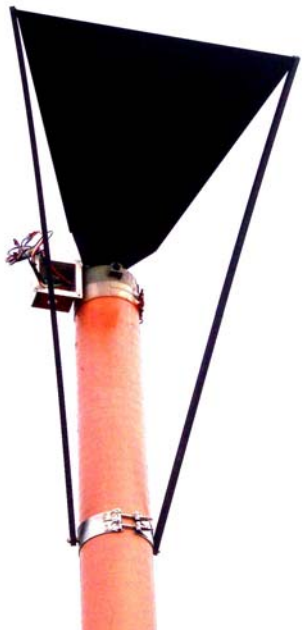


FIGURE 5. UPWARD VIEW OF LARGER BAFFLE AS INSTALLED

RESULTS

A ground test, using a vehicle, was conducted during the afternoon of January 11th to determine whether the installed baffles were blocking off the direct strobe light emissions that proved to be distracting to passing motorists. Under partial sunlight conditions, virtually no evidence of the strobe flashes was perceived when driving in either direction along the road.

A daytime flight test using a Cessna 172 general aviation single-engine aircraft was accomplished during the same afternoon. This aircraft was selected because observations can be made at very slow speeds while safely deviating considerably from the on-course glide path and localizer of the runway 32 Instrument Landing System (ILS). ILS localizer deviations up to and exceeding full-scale needle deflections were flown well beyond the point at which a pilot would have to abandon the approach and perform a go-around or missed approach. In addition, these left-right course deviations were accomplished while maintaining a two-dot fly-up ILS glide path signal, as verified by a three-red/one-pink precision approach path indicator (PAPI) visual signal. During the initial approaches, a slight decrease in the intensity of the strobe unit at the 1800-foot location was noted while flying the widest off-course deviations. Slight adjustments to the vertical positioning of the baffles on both strobes to the east of the road were requested via radio and resulted in restoring full intensity to the entire sequenced flashing display, commonly nicknamed the rabbit.

Both the ground and flight tests were conducted again that evening in full darkness and relatively clear sky conditions.

A test vehicle passing through the lighting system along the road revealed that only reflections off particles in the air above the strobe units could be detected, and that all direct light from the

strobes were successfully masked from motorists traveling past the units. This was a significant reduction in perceived light, and one individual in the test vehicle remarked that "the lights from on-coming cars are much more of a distraction than the small amount of light from the strobes."

The flight test conducted during the same evening and under the same darkness and weather conditions produced results identical to those obtained during the daytime test flights. The entire sequenced flashing light display was fully visible at the extreme ILS glide path and localizer deviations (full localizer and two-dot fly-up glide path needle deflections).

Various members of the Arcata/Eureka Systems Service Center also participated in the day- and nighttime evaluations from both the vehicle and aircraft. All participants were given the opportunity to provide comments on the performance of the baffles. At the conclusion of the evaluation activity, a final meeting was held at the Systems Service Center to discuss the results of the prior day's evaluation. All participants felt that the effort had been successful and that the results were satisfactory.

Within 1 month of the installation, follow-up telephone conversations with the manager of the Systems Service Center provided positive feedback on the results of the baffle installation. Both the FAA and local airport administration have indicated that they are very pleased with the results of the research effort.

SUMMARY

Site surveys of the Arcata/Eureka Airport showed that baffles could be used in this situation, where a roadway crosses the final approach zone of the runway at distances as close as 100 feet from the inboard strobe fixture of the medium intensity lighting system with runway alignment indicator lights installation.

The baffles can be fabricated from generally available metal/aluminum stock, requiring minimal bending and workmanship. Data collected from site visits was essential in designing the baffle to ensure that it blocked light from the proper areas.

The installation procedure was very basic and required only a few minutes per fixture.

Flight test efforts, from 8 miles out, on a simulated full-needle deflection approach, 2 degrees below the proper glide path, proved that the installed baffles performed as desired, only masking light from the ground, and not from the air.

Evaluation efforts on the ground proved successful, as the strobe lights that, at one time, flashed on the roadway were deflected such that no direct light was visible from the roadway, approaching from either the north or south direction.

CONCLUSIONS

Having completed the research, the following conclusions were made:

- It was determined that the geometry of the runway and the approach lighting system in relation to the roadway was such that a baffle could effectively be used to mask the light from the roadway.

- It was determined that the baffle devices that were fabricated and installed at the Arcata/Eureka Airport sufficiently masked the light from the roadway, but in no way affected any of the usable signal intended for use by approaching aircraft.