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Temporary Installation Methods for PAPI/A-PAPI Systems

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16. Abstract Airports have a need to temporarily install a precision approach path indicator (PAPI) or an abbreviated PAPI (A-PAPI) to provide accurate approach slope guidance when a runway threshold is temporarily displaced due to construction or maintenance projects. Airports have been reluctant to pour concrete foundations for temporary installations because of the cost and impact on operations. However, since the vertical alignment of the PAPI system is critical, a temporary installation method must take into consideration the need for enough rigidity and stability to maintain the proper aiming angles without excessive field monitoring. This report describes three temporary installation methods that were effective in maintaining proper aiming angles within the Federal Aviation Administration Advisory Circular 150/5345-28 limitations.					
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EXECUTIVE SUMMARY

Airports frequently have a need to displace their runway threshold to conduct construction and maintenance operations without disturbing the traffic flow to that particular runway. When a runway's threshold is displaced, it becomes important to temporarily install a precision approach path indicator (PAPI) or an abbreviated PAPI (A-PAPI) systems to provide accurate approach slope guidance to the touchdown zone of that particular runway.

Airports have been reluctant to pour concrete foundations for temporary installations of these systems because of the cost of installation, removal, and impact on operations. However, since the vertical alignment of the PAPI system is critical, a temporary installation method must take into consideration the need for enough rigidity and stability to maintain the proper aiming angles without excessive field monitoring.

The Federal Aviation Administration (FAA) William J. Hughes Technical Center's Airport Technology Research and Development Branch conducted a study on temporary installation techniques at the request of the Office of Airport Safety and Standards, AAS-200. This study consisted of an airport survey of current installation practices followed by a field study subjecting the proposed techniques to a year of exposure to the airport environment and seasonal conditions.

Data from the field study indicates that an acceptable installation technique would be to mount the PAPI/A-PAPI light housing assemblies (LHAs) to a metal frame then secure the framework to the ground, using 8-foot grounding rods. Modifications to this technique proved effective in reducing the effects of ground swell and frost heave.

INTRODUCTION

BACKGROUND.

Airports frequently have a need to displace their runway threshold to conduct construction and maintenance operations without disturbing the traffic flow to that particular runway. When a runway's threshold is displaced it becomes important to temporarily install a precision approach path indicator (PAPI) or an abbreviated PAPI (A-PAPI) system to provide accurate approach slope guidance to the touchdown zone of that particular runway.

Airports have been reluctant to pour concrete foundations for temporary installations of these systems because of the cost of installation and removal and the impact on operations. However, the vertical alignment of the PAPI system is critical. A temporary installation method must take into consideration the need for enough rigidity and stability to maintain the proper aiming angles without excessive field monitoring.

The Federal Aviation Administration (FAA) William J. Hughes Technical Center's Airport Technology Research and Development Branch conducted a study on temporary installation techniques at the request of the Office of Airport Safety and Standards, AAS-200. This study consisted of an airport survey of current installation practices followed by a field study subjecting the proposed techniques to a year of exposure to the airport environment and seasonal conditions.

OBJECTIVE.

- Determine the typical temporary installation methods presently being used and when and what length of time the temporary PAPI or A-PAPI units are being used.
- Develop an inexpensive, easily installed, and sufficiently rigid base upon which airports can temporarily install PAPI or A-PAPI systems.
- Determine which installations are appropriate to prevent frost heave.
- Determine light unit reaiming schedules for temporary units if reaiming is found to be required more often than for permanent installations.

TESTING METHOD

The testing method for this evaluation was separated into two areas. The first area was an airport survey to study current practices of airport maintenance personnel. The second area was to develop a temporary installation procedure and field test it over a 1-year period in an airport environment.

AIRPORT SURVEY.

Surveys were conducted at several airports regarding temporary installations of PAPI, A-PAPI, or visual approach slope indicator (VASI) systems. The survey was used to determine what installation methods are currently being used, the length of the time required for the installation, and the time periods that they were used. Data was collected from a range of airports of different sizes and geographical regions. Regional data was used to determine the extent of the freeze/thaw or ground swell concerns for maintaining the proper projection angle. Certain climatic/environmental concerns may only apply to specific regions of the country. The size of the airport (measured by number of operations and complexity of design) could indicate to what extent the airport can go to in installing a temporary system.

FIELD TESTING.

Based on the data gathered from the airport survey, temporary light housing assembly (LHA) installation methods, warranting further testing, were fielded at the FAA William J. Hughes Technical Center. Data was collected over the course of 1 year to incorporate the effects of changes in seasons. Horizontal and vertical aiming angle data were the primary data collected. Also collected was subjective data regarding the rigidity and stability of the installation over time.

For this test, electrical power was not necessary for illuminating the optical portion of the system. The PAPI units were installed inside the airport operations area (AOA) where they were subjected to the same wind, weather, and jet blast conditions as a fully operational system.

INSTALLATION TECHNIQUES.

Three different installation techniques were used in this evaluation. Each PAPI LHA was mounted onto either a galvanized steel or a square tubular aluminum framework. The framework was then secured to the ground using 5/8" electrical grounding rods. Each metal frame was secured to the grounding rod by U-bolts around the grounding rod and through the metal framework.

LHA no. 1 was mounted to the aluminum framework using 5/8" stainless steel all-thread rods as the legs of the LHA. The unit was then secured to the ground by three 5/8" grounding rods, each 2 feet long. The LHA was set flush on the ground and then adjustments were made to level the unit. Once leveled horizontally, the LHA was set to an elevation of 3 degrees. Figure 1 shows the initial installation of LHA no. 1.

LHA no. 2 was mounted to the galvanized steel framework using a standard 2" aluminum conduit, frangible couplings, and flanges. It was then secured to the ground with four 8' by 5/8" grounding rods. LHA no. 2 was also set flush on the ground and then adjustments were made to level the unit. Once leveled horizontally, the LHA was set to an elevation of 3 degrees. Figure 2 shows the initial installation on LHA no. 2.



FIGURE 1. INSTALLATION OF LHA NO. 1



FIGURE 2. INSTALLATION OF LHA NO. 2

LHA no. 3 was also mounted to the galvanized steel framework using a standard 2" aluminum conduit, frangible couplings, and flanges. It was then secured to the ground with four 8' by 5/8" grounding rods. LHA no. 3 was secured to the grounding rods 6" above ground level. Small adjustments were then made from that point to level the unit and set the elevation to 3 degrees. This modification to the mounting procedure was done to determine whether the 5/8" grounding rods were secure enough to mount the LHA and framework on without affecting its ability to maintain its alignment settings. By mounting the LHA and framework 6" off the ground, the ground was able to shift during seasonal changes without effecting the alignment. Figure 3 shows the initial installation of LHA no. 3. Figure 4 shows the complete installation of all three LHAs.



FIGURE 3. INSTALLATION OF LHA NO. 3



FIGURE 4. THREE LHAs INSTALLED AT AIRPORT OPERATIONS AREA

RESULTS

The survey from several airports regarding temporary installations of PAPI, A-PAPI, or VASI systems produced significant variations in the methods used by each airport. The survey determined that airport installation methods were mostly determined by the length of time the threshold would be displaced. Some airports use a stake-mounted installation for displacements of 90 days or less. Other airports felt that due to the importance of the approach slope indicator signal and the difficulty of making frequent inspections on a busy airfield, that concrete foundations were the only feasible method.

Data collected from airports different geographical regions indicated much of the same concerns of which ground movement was a primary concern. Some of the airports would have issues with winter freeze/thaw cycles while others would have ground swell concerns from excessive moisture. These shifts in the ground surface make it difficult for maintaining the proper projection angle.

The U.S. Air Force was also surveyed to determine what installation methods were used in constructing their emergency airfield lighting systems (EALS). The EALS are complete airfield lighting installations for rapid deployment in remote, unimproved airfields. The suggestions of the Air Force are what led to the installation procedure for LHA no. 1.

With this information in hand, the three installation methods were established and the LHAs were installed adjacent to runway 31 at the Atlantic City International Airport. This installation location subjected the test LHAs to the same wind, weather, and jet blast conditions as a fully operational system.

The installation of the LHAs took approximately 3 hours. The majority of that time was from driving the eight 8-foot grounding rods into the ground for LHA nos. 2 and 3. Once the units were installed, no further adjustments were made to the units for the remainder of the 1-year evaluation.

FAA Advisory Circular 150/5345-28D, Precision Approach Path Indicator (PAPI) Systems, sets the vertical and horizontal alignment deviation limits at $+0.5^{\circ}$ (30 min.) and -0.25° (-15 min.). Biweekly inspections were made of the units for 1 year. Data was collected on the vertical and horizontal angles as well as general observations of the conditions of the units. Figures 5 and 6 show the vertical and horizontal deviations of the three LHAs over the 1-year, in-field evaluation.

At the completion of the 1-year evaluation, the LHAs were removed from the airfield. The level of effort to remove the units was also an important factor. If an airport is required to install concrete foundations, a significant amount of equipment would be needed to breakup and remove the concrete once the threshold relocation is complete. In this evaluation, a forklift was used to lift the 8-foot grounding rods from the ground. Any airport maintenance vehicle with a lifting hoist would have been capable of removing the grounding rods as well. Complete removal of the three LHAs and mounting equipment was accomplished within 1 hour.

PAPI Vertical Deviation

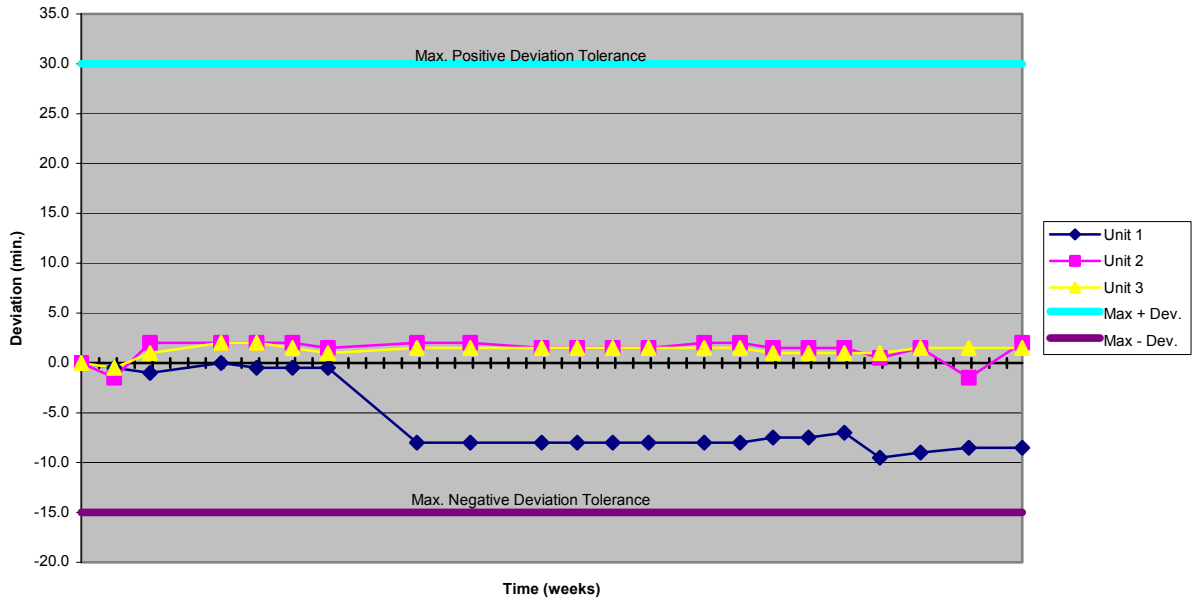


FIGURE 5. VERTICAL DEVIATION DATA

PAPI Horizontal Deviation

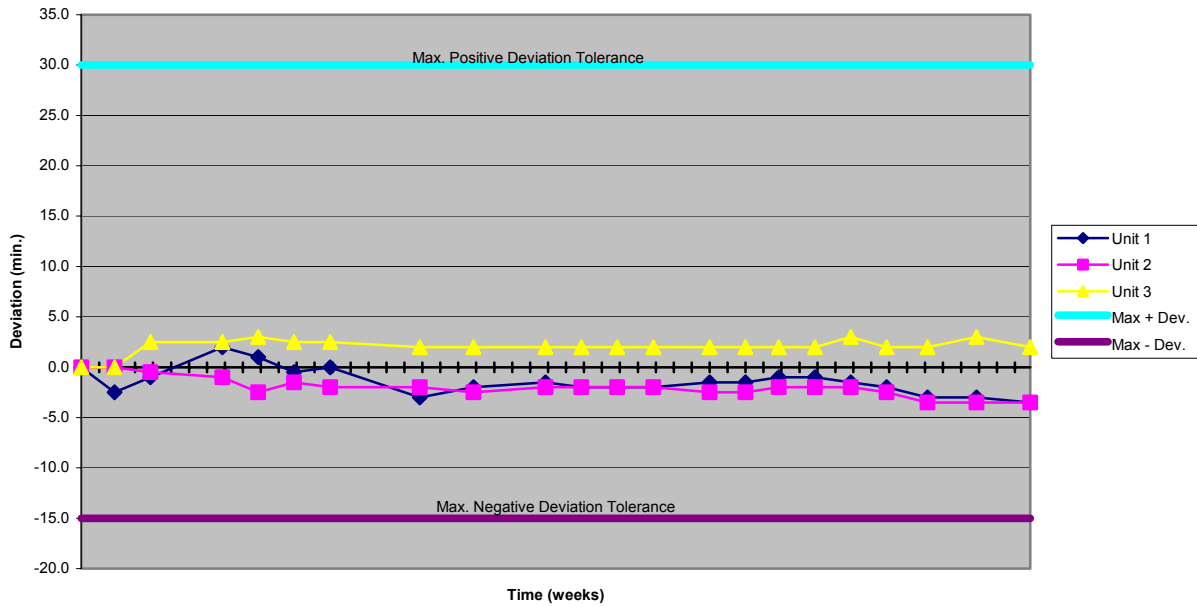


FIGURE 6. HORIZONTAL DEVIATION DATA

CONCLUSIONS

- All three installation methods proved adequate for temporary installations of approach path indicators for a full year of seasonal changes. All units remained within the tolerance required by Federal Aviation Administration (FAA) Advisory Circular 150/5345-28D, Precision Approach Path Indicator (PAPI) Systems.
- While all three installation methods remained within the FAA tolerance, the units anchored with the 8-foot grounding rods held their aiming angles better than the installation with the shorter rods. The military may have better results from the shorter anchoring system due to the lower number of flight operations on their emergency airfield lighting system (EALS) runways. The shorter, 2-foot grounding rods did not require any mechanical assistance in removal, making it quicker to remove and relocate a system if necessary. The military also has shorter installation periods and greater ability to inspect more frequently than many major U.S. airports.
- Data indicated that installing the metal framework 6" off the ground on the 5/8" electrical grounding rods allows for the ground surface to shift without affecting the aiming angle. It also proved to be a secure and stable method of installation and would be helpful in areas subjected to frost heave and other ground swells.
- Data from this evaluation indicate that the three installation methods tested were capable of maintaining their alignment within the specified tolerances. However, when thresholds are displaced and approach path indicators relocated, there is typically more construction vehicle traffic in the area of the light housing assembly (LHAs). FAA Order 6850.5C, Maintenance of Lighted Navigational Aids, requires quarterly vertical and horizontal alignment inspections. Based on this increase in construction vehicle traffic, it is recommended that the frequency of alignment inspections be increased to a monthly basis.