

# **Modification of Visual Approach Slope Indicator Baffles at Pearson Field Airpark, Vancouver, WA**

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## TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	vii
INTRODUCTION	1
Purpose	1
Background	1
Scope	2
Objectives	2
Related Documents	3
DISCUSSION	3
EVALUATION APPROACH	6
Required Equipment	6
Method	6
Evaluation Process	8
RESULTS	8
CONCLUSIONS	9
APPENDICES	
A—Figures Indicating VASI Unit Measurements	
B—Photographs of the Site and Final Modification	

## LIST OF FIGURES

Figure		Page
1	Diagram of VASI Unit Closer to Runway 8 Threshold	5
2	Diagram of VASI Unit Further From Runway 8 Threshold	5

## LIST OF TABLES

Table		Page
1	Angles Measured From VASI Centerline to Indicated Line	6

## LIST OF ACRONYMS

FAA	Federal Aviation Administration
mi	Mile
OR	Oregon
SCC	System support center
VASI	Visual approach slope indicator
VUO	Pearson Field Airpark
WA	Washington

## EXECUTIVE SUMMARY

This technical note describes a research effort that was accomplished to correct a safety deficiency with a Visual Approach Slope Indicator (VASI) system at the Pearson Field Airpark in Vancouver, Washington. During a recent inspection flight, the VASI units were found to be emitting a usable signal that could potentially draw an approaching aircraft dangerously close to an obstruction near the final approach path. As a result, the VASI system was shutdown. The VASI system had baffles previously installed on the inside and on the front opening of the unit that were intended to limit the emission of light in the direction of the obstruction. The baffles but were found to have very comparable opening widths in all units of the system, which allowed the signal from some units to be visible within a very close proximity to an obstruction. Typically, each opening requires a different width to provide proper signal blocking at the specific location of the obstruction. The Northwest-Mountain Region, Navigational Surveillance Weather Systems Team, AJW-W23, requested the Airport Technology Research and Development Branch's assistance in correcting the misaligned baffles so that the VASI system could be restored to operation.

Engineers from the Airport Technology Research and Development Branch visited the site to analyze the problem; collect data on the geometry of the obstruction, the baffles, and the general layout of the airport; and finally install and test the new baffles to make sure they operate properly. Engineers designed, constructed, and installed aluminum baffles that blocked the signal from the obstruction area, and provided a 2 degree margin of safety between the obstruction and the visible signal of the VASI.

Ground and flight evaluations conducted by the Airport Technology Research and Development Branch verified that the installed baffles had eliminated the hazard by preventing usable VASI signals from being visible near the obstruction.

## INTRODUCTION

### PURPOSE.

The effort described in this technical note was accomplished in response to a request for assistance received from the Federal Aviation Administration (FAA) Northwest Mountain Region Navigational Surveillance Weather Systems Team, AJW-W23, to assist the Portland, Oregon (OR) FAA System Support Center (SSC). The request specifically involved modifying the Visual Approach Slope Indicator (VASI) system located at Pearson Field Airpark (VUO) in Vancouver, Washington (WA), herein referred to as Pearson.

### BACKGROUND.

The VASI is a visual guidance device that is installed at an airport to provide vertical visual approach slope guidance to aircraft during approach and landing on a runway. A VASI system consists of light units that are specifically aimed at precise angles to produce a desired signal for the approaching pilot. The device radiates a directional pattern of high-intensity red and white focused light beams along the final approach path to the runway that the pilots use to determine their vertical position in relation to the desired glide slope. If the pilot sees red and white, he is “on glide path.” If the pilot sees white and white, he is “above glide path,” and if he sees red and red, he is “below glide path.”

VASI units are constructed in metal box-like structures and have a bulkhead at the rear of the box that has three high-intensity lights mounted to it. Just in front of the lights, there are red filters positioned such that they cover one-half of the light’s surface. Depending on the height of the aircraft, the pilot will either see the red-filtered light or the white-unfiltered light through the narrow slot on the front of the VASI unit. These lights are typically visible from 3 to 5 miles (mi) during the day and up to 20 mi or more at night. The visual glide path of the VASI should provide safe obstruction clearance within plus or minus 10 degrees of the extended runway centerline.

VASI installations may consist of a 2-, 4-, 6-, 12-, or 16-light unit arranged in bars, referred to as near, middle, and far bars. Most VASI installations consist of two bars, near and far, and may consist of a 2-, 4-, or 12-light unit. Some VASI systems consist of three bars, near, middle, and far, which provide an additional visual glide path to accommodate high-cockpit aircraft. This installation may consist of either a 6- or 16-light unit. VASI installations consisting of two-, four- or six-light units are usually located on just the left side of the runway. Where the installation consists of 12- or 16-light units, the units are located on both sides of the runway. At Pearson, the VASI was a four-light unit system, located on the right side of runway 8.

In certain instances, it may be necessary to restrict the lateral coverage of light being emitted by the VASI units due to safety concerns raised by the presence of physical obstructions that are in close proximity to the runway approach. The danger lies in the fact that if the pilot sees an “on glide path” indication by the VASI system and is not exactly aligned with the runway centerline, the pilot may fixate on the VASI or the runway and not notice the obstruction. To avoid this

potential problem, a process known as baffling can restrict the light that is visible to pilots at certain desired angles.

In the situation at Pearson's runway 8 VASI system, portions of the on glide path signal intersected with the northern-most vertical supports of the Interstate I-5 bridge connecting OR and WA over the Columbia River (see figure B-1 in appendix B). The FAA Flight Inspection Operations Group failed the VASI system on July 12, 2005, citing the potentially dangerous situation that the VASI signal created by overlapping the bridge obstruction. At that point, the VASI units were placed out of service. It is interesting to note that the VASI at VUO had been baffled many years ago, but over the last 25 years since the units were installed, the units became misaligned.

The Visual Guidance Team, consisting of airfield lighting engineers from the Airport Technology Research Development Branch and Hi-Tec Systems Incorporated, were assigned the task of conducting an investigation of the situation at Pearson, as well as construction, installation, and evaluation of new baffles so that the VASI system could be flight checked again and restored to operation.

This document describes the research, calculations, and baffling processes used at Pearson.

### SCOPE.

The scope of this project did not extend outside the VASI system at Pearson, and no other visual aids were considered. The project was accomplished in two days. The first day included initial assessments, temporary modifications, and day and night flight evaluations. On the second day, temporary modifications were made permanent, and a final afternoon flight evaluation was conducted.

There was a successful conclusion to this project, and no follow-on maintenance or action applied to Pearson. However, the techniques covered can be abstracted and applied at other airfields when applicable.

### OBJECTIVES.

The objectives of this project were to:

1. Assess and evaluate the safety of the existing VASI system configuration and presentation.
2. Perform any necessary modifications to the VASI, if obstruction clearances are not being met.
3. Flight test the VASI system in day and night conditions to the criteria that each unit:
  - a. Provides signal only in obstruction-free area while providing effective visual glide slope characteristics.

- b. Light emitted with adequate intensity.
- c. Light emitted with uniform fading and returning light characteristics.

### RELATED DOCUMENTS.

Related documents dealing with this evaluation project are:

- AC 150/5340-30B, “Design and Installation Details for Airport Visual Aids,” August 1, 2005.
- AC 150/5345-52, “Generic Visual Glideslope Indicators,” June 21, 1988.
- DOT/FAA/AR-05/41, “Design and Installation of Flasher Baffles at Arcata/Eureka Airport,” James W. Patterson, August 2005.
- DOT/FAA/AR-TN01/61, “Installation of Runway End Identifier Light Baffles at the Medina, Ohio, Municipal Airport,” James W. Patterson, June 2001.
- DOT/FAA-PROJECT 071-312-11X, “Data Report Reducing Lateral Coverage of Standard VASI Unit,” Paul Jones, November 1971.

### DISCUSSION

VASI units are not constructed with any type of lens or interior baffles that focus, divert, or block the light being emitted out of the fixture. As a result, an observer will notice that the light emitted from the lamps inside the fixture is the brightest along the centerline of the fixture, and that it slowly diminishes in intensity as the distance from the centerline of the fixture increases. Essentially, this creates a ramping down effect, where the intensity of light slowly declines as the angle from the center of the unit increases.

In the situation at Pearson, it was desired to have the light being emitted from the VASI units to rapidly decrease in intensity, and eventually be blocked entirely, at a location near the bridge obstruction. To do this, the VASI units are fitted with both outer and inner baffles that are designed to restrict the light emitted from the lamps at the rear of the bulkhead from extending through the VASI box, out through the narrow opening in the front of the unit, out towards the bridge obstruction. The baffles also have to be positioned such that they block each of the three lamps inside the VASI unit, since there are no natural channels or blocking mechanisms to keep the light from each lamp from passing through its neighboring lamp’s path. Baffling efforts must block light from each lamp from crossing paths, and also must block each light from the bridge obstruction.

Ideally, inner baffles should be of uniform length and symmetry with respect to a line cut through the center of the unit. The measurements from the previously installed baffles in the VASI units at Pearson indicated that there were slight deviations from symmetry. The inner baffles were trapezoidal in shape, with longer upper widths than lower widths. In addition, the

offset distances between the baffles varied with each unit. Furthermore, the inner baffles were attached using rivets to the sectional supports of the ceiling of the boxes, and were left in a hanging position without any support on the bottom. The inner baffles were constructed of 1/16-in.-thick aluminum. Over time, this type of material does have a tendency to warp and twist, and can contribute to the problem with the light being visible beyond the obstruction. It was determined, however, that the twisting and nonsymmetrical positioning of the baffles was not the cause of the problem at Pearson.

The outer baffles of a VASI unit are designed to restrict the angle of light laterally across the final approach area, and can be adjusted by increasing or decreasing the overall horizontal width of each outer baffle (see figure B-6 in appendix B). These outer baffles are also made of aluminum, and are approximately 6 in. high (enough to cover the 4-in. opening in the front of the VASI unit), and vary in width depending on their purpose. In the situation at Pearson, it was determined that the horizontal lengths of the outer baffles were the only elements of the system that needed modification to restrict the lateral coverage of the VASI signal.

In a preliminary meeting with the FAA Portland SSC, the Visual Guidance Team discussed the September 2005 effort to baffle the VASI system. The survey conducted during this effort showed that the obstruction was  $8^{\circ} 19' 57''$  left of the extended runway centerline of the approach end of runway 8. This measurement is shown as the angle between the runway centerline and the toward obstruction line, as shown in figure 1.

New measurements were needed prior to developing a plan for installing the baffles in the VASI units. These measurements were essential to give the Visual Guidance Team an accurate sense of the angles between the VASI unit on the outboard side of the runway and the bridge obstruction. The angles formed between the VASI centerline, the desired transition start line, the baffled line, and the toward obstruction line, are illustrated in figures 1 and 2. The values for these angles are given in table 1.

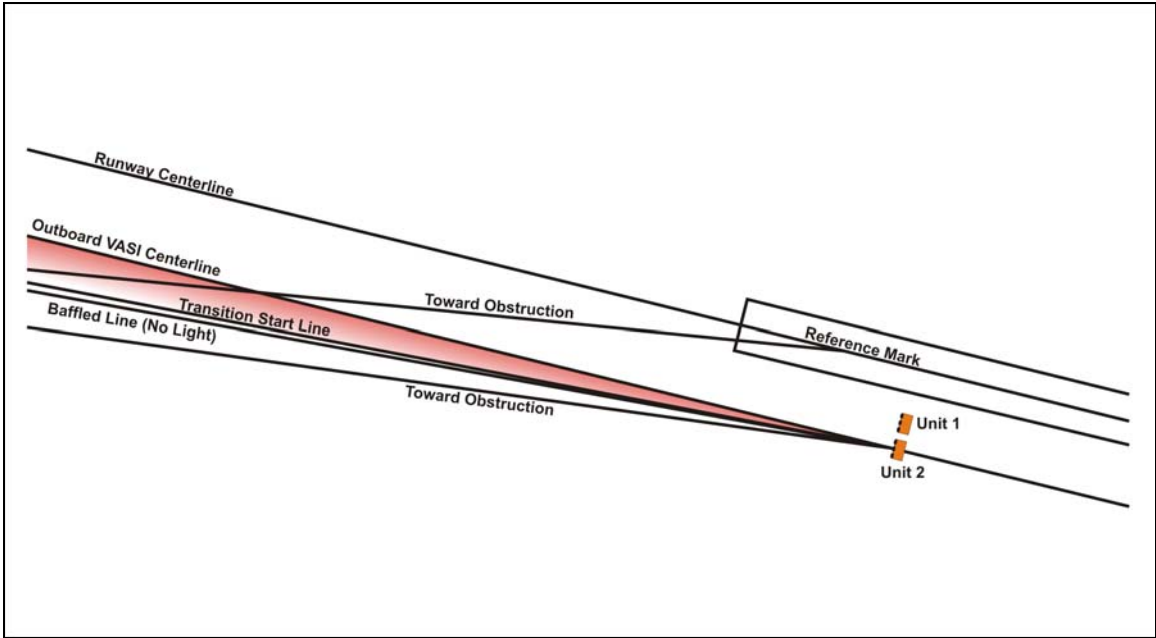


Figure 1. Diagram of VASI Unit Closer to Runway 8 Threshold

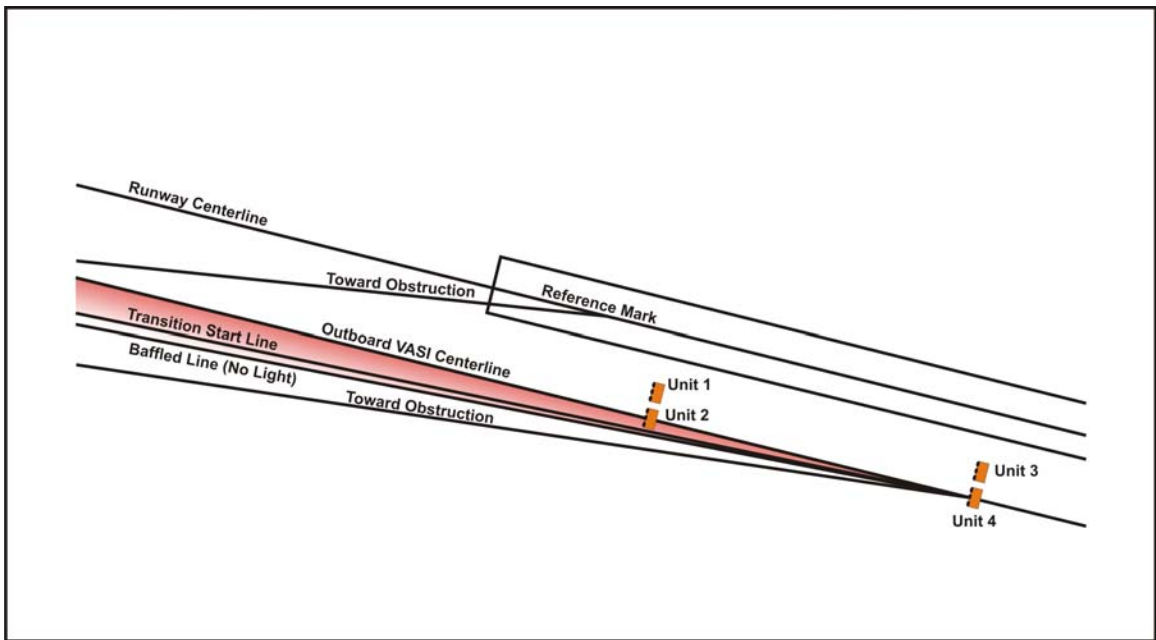


Figure 2. Diagram of VASI Unit Farther From Runway 8 Threshold

Table 1. Angles Measured From VASI Centerline to Indicated Line

Reference Lines	Angular Measurements in Figure 1	Angular Measurements in Figure 2
Transition Start Line	3° 30' 00"	1° 57' 20"
Baffled Line	4° 00' 00"	2° 14' 00"
Toward Obstruction Line	6° 00' 00"	5° 19' 20"

## EVALUATION APPROACH

### REQUIRED EQUIPMENT.

The following equipment was necessary to complete the described procedure.

- Theodolite survey instrument or survey instrument of equal ability
- Aluminum sheet metal strips at least 18 in. long and a height sufficient to reach beyond the lower and upper lips of the VASI unit openings
- Sheet metal tools including, but not limited to,
  - Tin snips or other metal cutting tool
  - Square or level
  - Metal drill
  - Rivet gun or rivet tool
  - Appropriately sized rivets

### METHOD.

Initial measurements were taken of the previously installed baffles in each of the four VASI units, which are shown in figures A-1 through A-4 in appendix A. These measurements were taken for two purposes: (1) to provide information on the dimensions of the previously installed baffles and provide information on any nonsymmetrical dimensions that may be contributing to the problem at Pearson and (2) to provide the Visual Guidance Team with backup data that would allow the Team to return the system to its original configuration, if necessary. After the measurements were recorded, the outer baffles were removed (see figure B-4 in appendix B) and reattached with a temporary adhesive material in such a way that they could be easily moved to the left or right or used to extend the edges of the baffles if they were not long enough.

A naming system for the VASI units was adopted consistent with what is shown in figure 2. Two sets of horizontal, angular measurements were recorded between the bridge obstruction and the extended centerline of the VASI units labeled Unit 2 and Unit 4. A theodolite (a surveying instrument shown in figure B-3), was used to take these measurements. When positioned directly behind VASI Unit 2 at the center, the theodolite was aimed to the center of VASI Unit 4 for the purpose of calibrating, or zeroing, the instrument. After being properly calibrated, the

theodolite was rotated 180 degrees so that it faced outward towards the approach of the runway. The instrument was zeroed again and was then rotated slightly to the left until the instrument was pointing at the bridge obstruction. The measurement of the angle displayed on the theodolite was then recorded. This measurement represents the angle between the VASI Unit 2 centerline, which is parallel to the runway centerline, and the bridge obstruction. A similar process of calibration and measurement was taken to determine the same value between the VASI Unit 4 centerline and the bridge obstruction. These measurements are shown in table 1 as the Toward Obstruction Line.

Angular measurements for Unit 1 and Unit 3 were not taken because they were not considered to be critical as long as the outer-most units were documented. Taking the outer measurements (Units 2 and 4) created a worst-case scenario where, after proper configuration, they would be the first two fixtures to be seen by an approaching pilot that is near the obstruction.

To obtain the angles that defined the toward obstruction line, baffled line, and the transition start line, two Team members walked outward along the VASI unit centerline approximately 1000 ft (as far as was feasibly permitted by ground conditions) and maintained radio contact with Team members manning the theodolite at the respective VASI unit. Upon instruction from the Team member at the theodolite, the other two Team members placed a reference marker at a point that was in line with the obstruction and the theodolite, which represented the toward obstruction line.

The Team walked back towards the runway centerline and placed two additional reference markers on it. The first marker was placed at a point where the Team determined that no visible light should be observed by the pilot. This path is referred to as the baffled line and is shown in figures 1 and 2. The Team determined that this angle was to be 2 degrees less than the angle to the obstruction, which would provide sufficient separation between the aircraft and the obstruction should the pilot attempt to use the edge of the signal of the baffled VASI. The second marker was placed at a location where the Team determined that the light from the VASI units would begin decreasing in intensity. This path is referred to as the transition start line, also shown in figures 1 and 2. The distance between the transition start line and the baffled line is determined by the physical geometry of the VASI unit and the baffles. Typically, this angle is approximately 1°, 30' wide.

Any lateral point between the VASI centerline and the transition start line should contain unbaffled, full-intensity light. An observer located within this zone should not see any significant reduction of light while in this area.

The Team members then moved between the two markers that marked the transition start line and the baffled line, and communicated with the Team members at the VASI units to have the outer baffles for each lamp adjusted with either tape or baffle panels so that the transition between the two markers resulted in a smooth ramp down from full intensity to fully blocked. This process was completed for each lamp in the three-lamp VASI unit. The team re-evaluated the unit as a whole, making sure that all three lamps ramped down at the same time, and that the baffles completely blocked the light at the same time. Once the first unit was completed, the process was repeated for the three remaining units.

## EVALUATION PROCESS.

After the units were satisfactorily baffled, a Cessna 172 was used to conduct airborne flight evaluations of the VASI units. A series of approaches to runway 8 were flown from about 6 mi out, over the Columbia River, along the right-most limits of the usable VASI signal. The flight evaluations revealed that the baffle modifications made to the VASI units were successfully blocking light along the baffled line path. Visible light from the units was detected at distances greater than 3 nautical miles along the runway centerline. During each approach, the pilot flew the aircraft towards the VASI units, wavering left and right of the baffled lines, to evaluate the point at which the VASI signal was visible (see figure B-7 in appendix B) and not visible (see figure B-8 in appendix B).

During night or dusk conditions, there is typically an increased amount of light that emits from the VASI units that is not visible during the day, but is visible during the night. When VASIs are baffled, it is imperative that the angle at which the units are baffled be evaluated at night to ensure that the baffled line has not moved closer to the bridge obstruction. In the case at Pearson, nighttime evaluations yielded the same favorable results found during the daytime evaluations. The baffles performed as intended.

On the following day, Team members returned to the VASI site to make the temporary modifications to the VASI units permanent. The final locations of the baffles were marked, and permanent sheet metal strips were installed (see figure B-5 in appendix B). All temporary material was removed, leaving the new baffles secured in their proper locations. After the baffles were installed, another series of daytime approaches were made to verify that the permanent baffles performed the same as the temporary baffles. This final evaluation ensured that no mistakes were made in the transition from temporary to permanent modifications. After the conclusion of final flight evaluations, a coat of nonreflective black paint was applied to the front of each VASI unit, thus completing the modification process (see figure B-9 in appendix B).

## RESULTS

After completion of the evaluation, inspection of the final baffle locations showed that only some baffles were increased in length to provide more blockage of light. In some cases, some openings created by the baffles were actually opened wider to provide more signal coverage towards the obstruction. On VASI Unit 1, for example, the second, third, and fourth baffles (facing the unit counting from the runway outward) were moved to the right to enlarge the opening widths and provide more light coverage towards the obstruction. For the majority of the baffle openings, however, the baffles were increased in size to provide more blockage of light so that no light was visible at the baffled line. Figure A-1 in appendix A shows the before and after modifications. Team members made sure that the light visible at each unit at the transition start line was uniform for all the lamps within each VASI unit, as well as being uniform in the entire four-unit system.

At the end of the evaluation, the baffle openings that required a decrease in opening size were decreased an average of 4/10 in. to provide proper cutoff at the baffled line position. The baffle openings that required an increase in opening were moved up to 3/4 in. to provide more light towards the obstruction. Further analysis of the baffle movement showed that the VASI units that were closer to the obstruction (Units 1 and 2) were given wider berths in opening sizes, and the VASI units farther from the obstruction (Units 3 and 4) were given smaller opening widths. These measurements correlate to a wider angle formed by the VASI units closer to the threshold of the runway and the obstruction, and the smaller angles formed by the VASI units farthest from the threshold of the runway at those same positions.

The configuration of the system before modifications (where opening widths were very comparable in all units of the system) indicated the need for modification. The proportional decrease of outer baffle opening widths to the increase of distance from runway threshold was an expected result of the modification process.

## CONCLUSIONS

Having completed the research, the following conclusions were made:

Site surveys of the Pearson Field Airpark Visual Approach Slope Indicator (VASI) units determined that there was a need for modification to the existing baffles, as the existing condition and arrangement of the previously installed baffles were providing a signal where an obstruction existed for aircraft approaching runway 8.

Visual Guidance Team members were able to design, fabricate, and install baffles that provided a VASI signal where needed at Pearson Field Airpark using typical baffling materials and the expertise of the Team members.

The performance of the new baffles was verified by both day- and nighttime flight evaluations to ensure that the VASI system performed as designed, that the baffles did not affect the intensity or useable range of the VASI signal, and that the baffles correctly blocked the light at a path 2 degrees from the bridge obstruction. In addition, the Team verified that the transition of the light from full intensity to fully baffled occurred at a uniform rate within each VASI unit, as well as within the entire four-unit system.

Special Note:

Approximately 1 month after the Visual Guidance Team completed the baffling project on runway 8 at Pearson Field Airpark, the Federal Aviation Administration Flight Inspection Operations Group flight checked the VASI units again and passed the units as being acceptable for operation. The VASI units were immediately returned to service.

APPENDIX A—FIGURES INDICATING VASI UNIT MEASUREMENTS

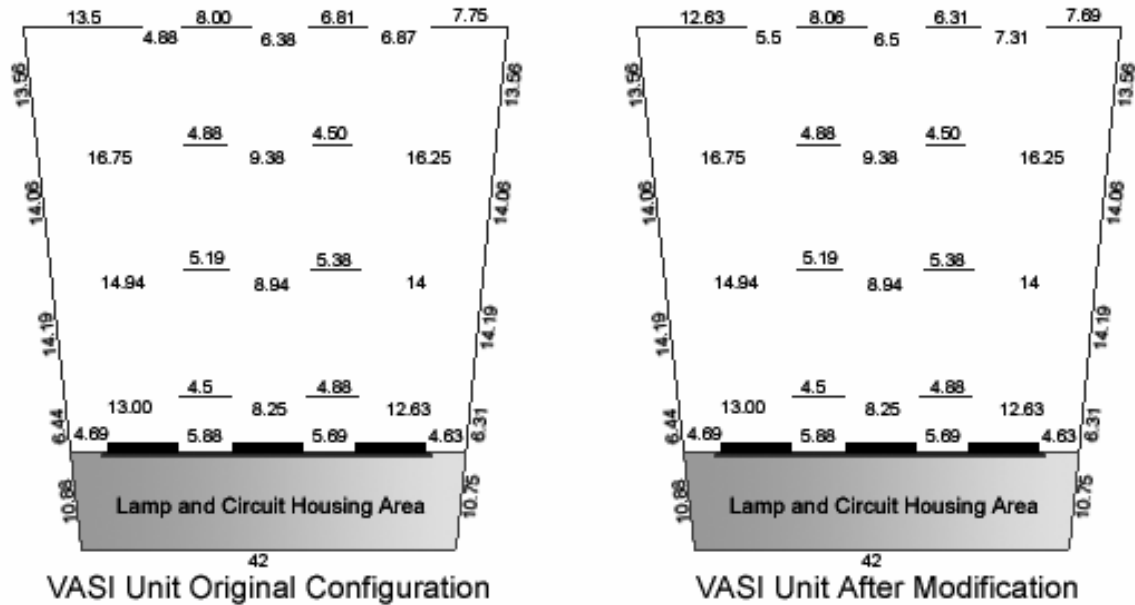
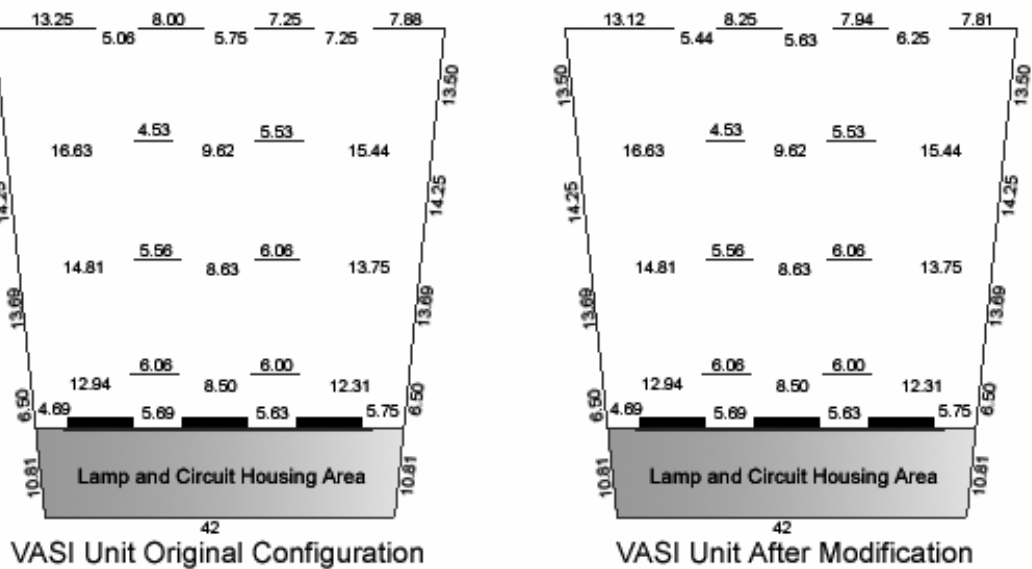


Figure A-1. The VASI Unit 1 Measurements



All measurements recorded in inches, taken to within +/- .07 in., figures are drawn to scale.  
 Measurements are recorded with respect to a horizontal cross section, top down perspective  
 with diagonal walls running along the inner wall next to the horizontal support beam.  
 Each lens housing assembly was 7.88 inches diameter.

Figure A-2. The VASI Unit 2 Measurements

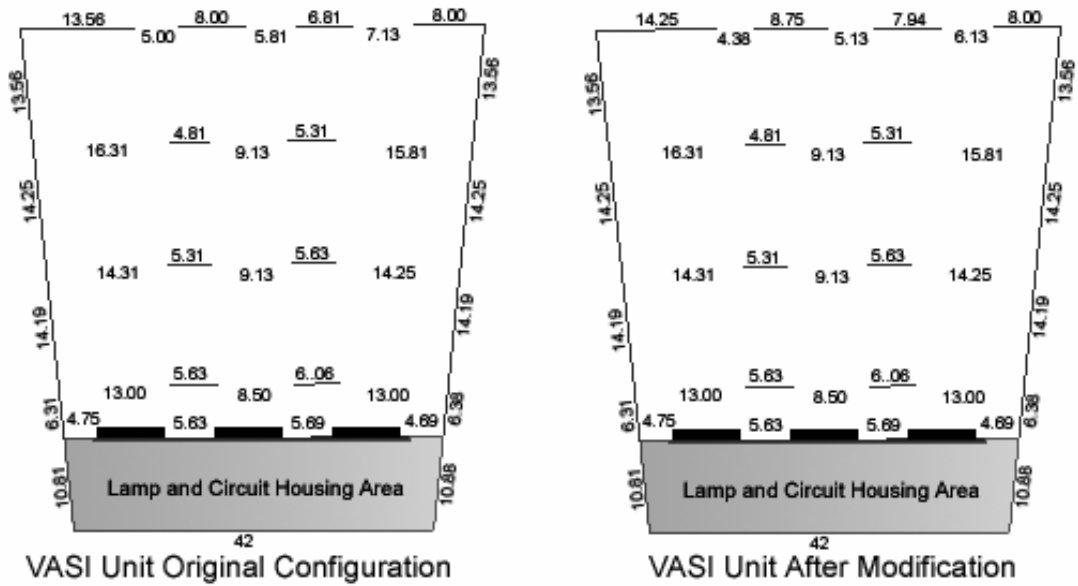
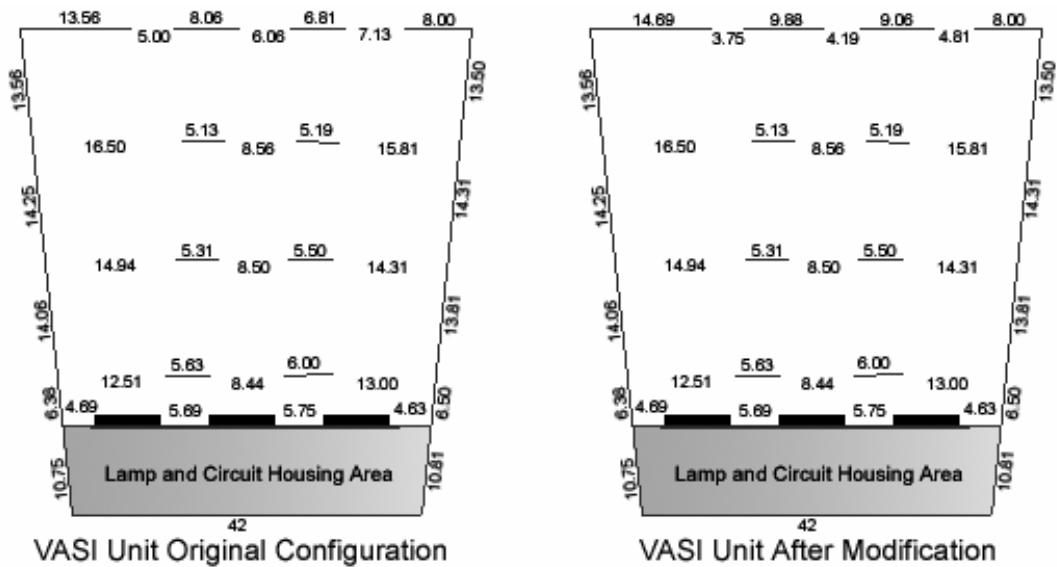


Figure A-3. The VASI Unit 3 Measurements



All measurements recorded in inches, taken to within +/- .07 in., figures are drawn to scale.  
 Measurements are recorded with respect to a horizontal cross section, top down perspective with diagonal walls running along the inner wall next to the horizontal support beam.  
 Each lens housing assembly was 7.88 inches diameter.

Figure A-4. The VASI Unit 4 Measurements

APPENDIX B—PHOTOGRAPHS OF THE SITE AND FINAL MODIFICATION



Figure B-1. Interstate I-5 Bridge Forming Obstruction



Figure B-2. The VASI Units Before Modification

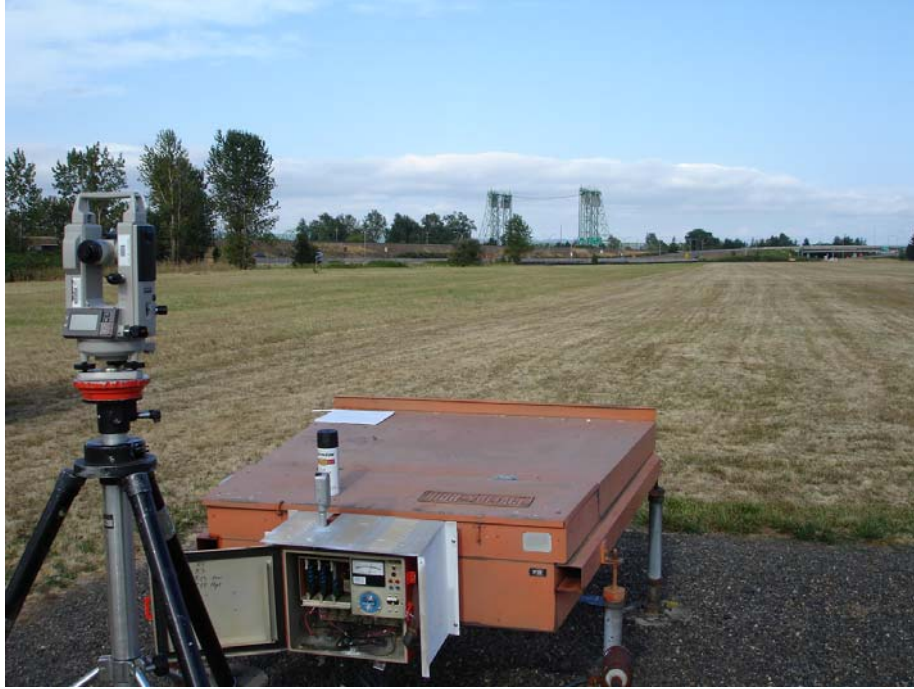


Figure B-3. Aiming and Positioning of the Theodolite



Figure B-4. Removing Rivets From Older Outer Baffles

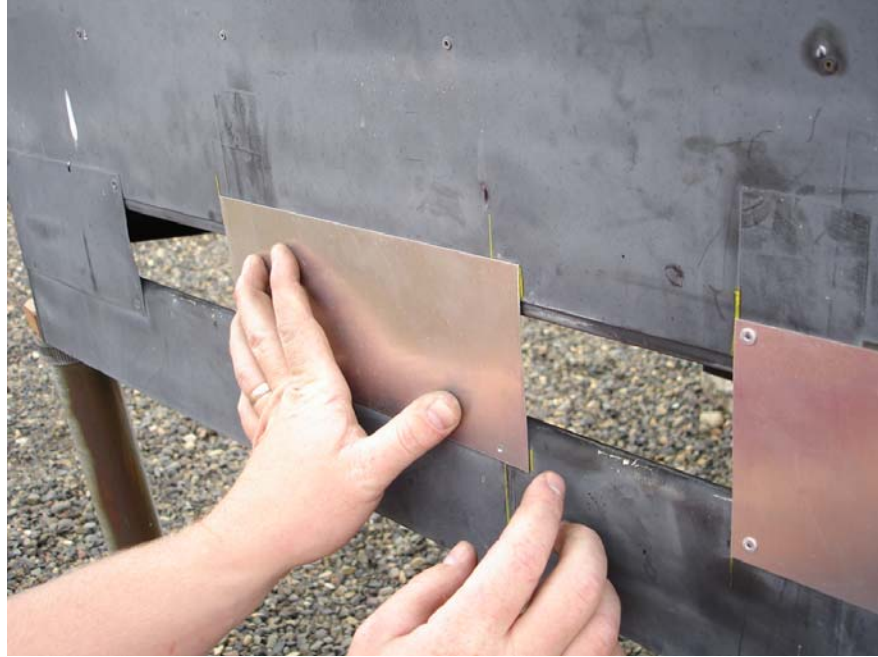


Figure B-5. Riveting Permanent Modifications

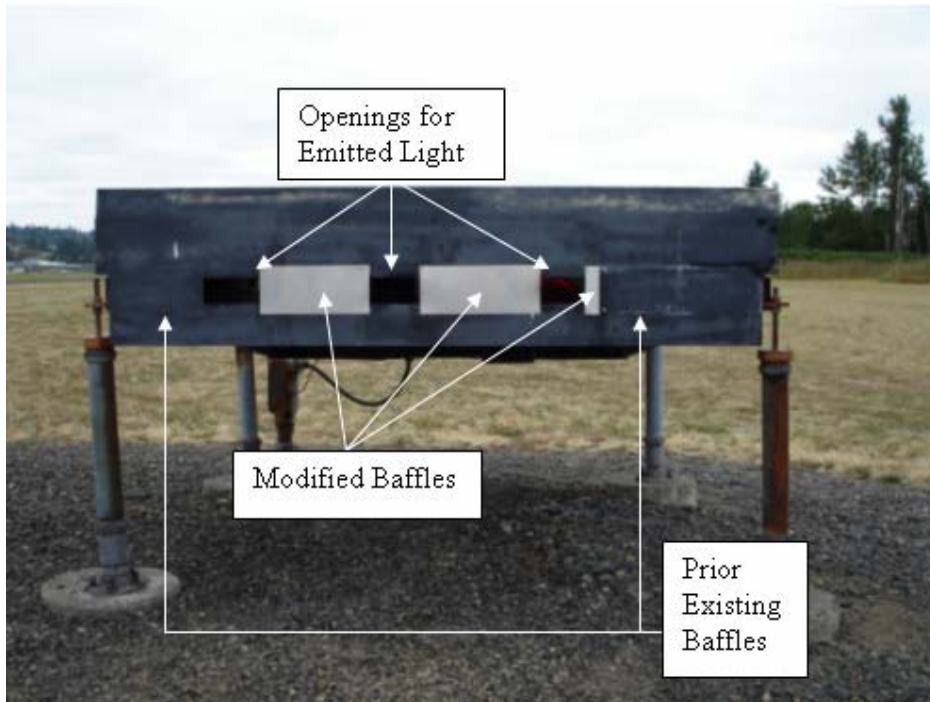


Figure B-6. Front View of a Modified VASI Unit



Figure B-7. Flight Evaluation Left of Baffled Line—VASI Signal Visible



Figure B-8. Flight Evaluation Right of Baffled Line—VASI Signal not Visible



Figure B-9. Final Results of Modification Process