



CIVIL ENGINEERING STUDIES
Illinois Center for Transportation Series No. 09-046
UIIU-ENG-2009-2017
ISSN: 0197-9191

EVALUATION OF VIDEO DETECTION SYSTEMS VOLUME 2— EFFECTS OF ILLUMINATION CONDITIONS IN THE PERFORMANCE OF VIDEO DETECTION SYSTEMS

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Research Report ICT-09-046

A report of the findings of
ICT-R43
Traffic Operations Lab – Signal Systems Testing
Illinois Center for Transportation

May 2009

Technical Report Documentation Page

1. Report No. FHWA-ICT-09-046		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Evaluation of Video Detection Systems Volume 2 - Effects of Illumination Conditions in the Performance of Video Detection Systems				5. Report Date May 2009	
				6. Performing Organization Code	
7. Author(s) Juan C. Medina, Rahim F. Benekohal, Madhav Chitturi				8. Performing Organization Report No. ICT-09-046 UILU-ENG-2009-2017	
9. Performing Organization Name and Address Department of Civil and environmental Engineering University of Illinois at Urbana-Champaign 205 N. Mathews Ave Urbana, IL 61801				10. Work Unit (TRAIS)	
				11. Contract or Grant No. ICT- R43	
				13. Type of Report and Period Covered	
12. Sponsoring Agency Name and Address Illinois Department of Transportation Bureau of Materials and Physical Research 126 E. Ash Street Springfield, IL 62704				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract The evaluation of three Video Detection Systems (VDS) at an instrumented signalized intersection in Rantoul Illinois, at both stop bar and advance detection zones, was performed under a wide range of lighting and weather conditions. The evaluated VDS are: Autoscope, Iteris and Peek. This document describes the effects of different illumination conditions (dawn, sunny morning, cloudy noon, dusk, and night) on false, missed, stuck-on, and dropped calls (errors in detection). Results showed that the illumination conditions significantly affect the performance of VDS. The best performance was found during cloudy noon conditions, with false calls lower than 4% for four of the six detection zones, but for the other two zones false calls were up to 18% and up to 21%, missed calls lower than 1% at stop bar, and up to 2.8% at advance zones, stuck-on calls lower than 1%, and no dropped calls. During dawn, false calls increased for the three VDS (up to 23%), and missed calls increased by 18% only in one system in one specific zone. During a sunny morning, false calls increased in greater proportion in zones where vehicle shadows were more prominent (up to 21% at stop bar and up to 43% at advance zones). Results during the dusk condition followed trends similar to the dawn, but with higher increases in false calls (ranging from no change to about 50% increase), and higher increases in the missed calls observed for one VDS. Lastly, during night, false calls increased for specific zones and systems, and various trends with relatively small changes were found in terms of missed calls. The findings of this study are published in four separate volumes. The other three volumes cover the effects of detection zone configuration changes, windy conditions, and adverse weather conditions.					
17. Key Words Video detection system performance; intersection detection zone; Iteris, Peek, Autoscope; light illumination; false, missed, stuck-on, dropped call, dawn, dusk, sunny, cloudy, nighttime, daytime			18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages	22. Price

ACKNOWLEDGEMENT

This publication is based on the results of ICT-R43, Video Detection Evaluation at Traffic Operations Lab. ICT-R43 was conducted in cooperation with the Illinois Center for Transportation; the Illinois Department of Transportation; and the U.S. Department of Transportation, Federal Highway Administration.

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DISCLAIMER

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EXECUTIVE SUMMARY

The evaluation of three Video Detection Systems (VDS) at a signalized intersection, at both stop bar and advance detection zones, was performed under a wide range of lighting and weather conditions. The VDS used are: Autoscope, Iteris, and Peek. This document describes the effects of different illumination conditions (dawn, sunny morning, cloudy noon, dusk, and night) on false, missed, stuck-on, and dropped calls (errors in detection). Results showed that the illumination conditions significantly affect the performance of VDS. The best performance was found during cloudy noon conditions, with false calls lower than 4% for four of the six detection zones, but for the other two zones false calls were up to 18% and up to 21%, missed calls lower than 1% at stop bar, and up to 2.8% at advance zones, stuck-on calls lower than 1%, and no dropped calls. During dawn, false calls increased for the three VDS (up to 23%), and missed calls increased by 18% only in one system in one specific zone. During sunny morning, false calls increased in greater proportion in zones where vehicle shadows were more prominent (up to 21% at stop bar and up to 43% at advance zones). Results during the dusk condition followed trends similar to the dawn, but with higher increases in false calls (ranging from no change to about 50% increase); and higher increases in the missed calls observed for one VDS. Lastly, during night, false calls increased for specific zones and systems, and various trends with relatively small changes were found in terms of missed calls.

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CHAPTER 1 INTRODUCTION AND BACKGROUND

The use of video detection systems (VDS) at intersections has increased significantly in the last few years. This is in part due to their flexibility and adaptability to changing conditions given their non-intrusive nature. However, even though their use has become more popular, only limited information on their performance in a wide variety of conditions is available.

Previous research has assessed VDS performance under various conditions, such as day time or night time, using different approaches. An evaluation of the Vantage Video Traffic Detection System (VTDS) at three intersections was presented by MacCarley (1998). Performance was evaluated under twelve conditions, including combinations of weather, time of day, traffic volume, and electromagnetic interference. Results were based on 15-minute data sets and showed good performance under ideal lighting and light traffic conditions. Performance degradation due to shadows and low lighting conditions, among others, was also found. Overall, video detection systems were considered not reliable for general signal actuation.

Later, Minnesota DOT and SRF Consulting Group (2001) also evaluated the performance of VDS at intersections. In this case Peek Video Trak 900, Autoscope 2004, EVA 2000 and TraffiCam systems were installed at different mounting locations and heights. Similar to the MacCarley study, factors such as shadows (both stationary and moving) and wind were also found to affect VDS performance. Grenard, Bullock and Tarko (2001) also evaluated Econolite Autoscope and Peek VideoTrak-905 for their performance at a signalized intersection. Results from overcast, night rain, and partly sunny conditions from three days were presented. It was concluded that night-time detection was a concern and VDS should not be used for dilemma zone protection. More recently, a study by Rhodes et al. (2006, 2007) that followed a study by Grenard, Bullock and Tarko (2001), indicated significantly more false and missed detections using VDS than inductive loop detectors. The study installed three systems next to each other: Autoscope (version 8.10), Peek UniTrak (version 2), and Iteris Vantage (Camera CAM-RZ3). Results from two full days of data were analyzed, finding that all the three VDS had moderate to high degree of missed and false calls and none was superior to the others. An additional publication by Rhodes et al. (2007b) evaluated the stochastic variation of activation/deactivation times between day and night condition using data from one day, finding earlier detections at night due to headlight reflection in the pavement.

It is very difficult to compare the performance of two or more VDS at installations located at different intersections or at different points in time. Setups using side-by-side comparisons can clearly provide an advantage over other installations as the VDS are processing the same images using their own camera. Moreover, data used in previous studies seem rather limited, being very difficult to control or to account for specific factors that affect VDS performance. In studies of McCarley and Grenard a real-time side-by-side comparison of the VDS was not performed. In Rhodes and MnDOT 2002 studies a real-time side-by-side comparison of the VDS was performed, but limited data sets were used in these two studies (2 days in Rhodes and 1 day in McCarley). Also, given the VDS manufacturers claims in recent years regarding improved detection due to shadow processing or compensation for camera movement, among others, some of these evaluations may not represent the performance of VDS installations currently in use, but rather the systems available at the time.

The analysis presented in this report aims to overcome some of the limitations of previous comparative studies on the performance of VDS. Some of the key features of this study are: 1) a true side-by-side installation to obtain the field data and compare three of the leading VDS in the market; 2) data sets from multiple days, obtained through a multistage analysis procedure that includes automation in the computation of the performance measures (PMs), and final visual inspection of every PM using video recorded images of the selected site; and 3) very specific conditions chosen for the analysis, controlling for individual factors affecting VDS performance and quantifying their effect on the different PMs.

This report focuses on the VDS performance under five illumination conditions without wind or any other adverse weather factors. The five illumination conditions are: dawn, sunny morning, cloudy noon, dusk, and night. These conditions cover light settings from a typical 24-period during a calm day with good weather. It is noted that periods under sunny conditions were selected from morning hours since shadows from vehicles were the longest at this time, and the greatest shadow effects could be studied.

Data was carefully chosen to avoid confounding effects of additional factors not analyzed in the selected condition. For example, data sets from cloudy days were obtained from calm noon hours with no significant wind, no rain, and no cloudy to sunny changes. Also, data sets for a given condition were selected from different days but came from the same or very similar time of day. This makes the analysis more precise and allows for the quantification of true effects from individual factors affecting VDS performance, in this case the illumination condition.

The subsequent sections briefly introduce the data collection and methodology, including a description on the data analysis procedure and the performance measures. However, detailed information on data setup, data collection and methodology is presented in Volume I of this study: "Effects of Configuration Changes in the Performance of Video Detection Systems". Then, the results from comparisons of the VDS performances under scenarios with different illumination conditions are presented, and findings and conclusions are included next.

CHAPTER 2 DATA COLLECTION

Video detection systems from three major manufacturers (Image Sensing Systems - Autoscope, Peek Traffic, and Iteris) were installed at the intersection of Century Blvd and Veteran's Pkwy in Rantoul, Illinois. A camera from each system was mounted next to each other on the luminaire arm of the southeast corner of the intersection at a height of approximate 40 ft above the ground, facing the eastbound approach. No vertical extensions were used in this setup. None of these cameras was connected to the actual traffic controller managing the traffic lights, therefore they had no impact on the operation of the intersection and VDS do not obtain feedback from the signal controller. The layout of the eastbound approach consists of two left-turn lanes and one shared right-through lane (See Figure 2-1). This approach was equipped with six inductive loops 6ft by 6ft in size. Three loops were installed before the stop bar, one on each lane, and the other three were installed at advance locations on all three lanes, about 250ft upstream from the stop bar.

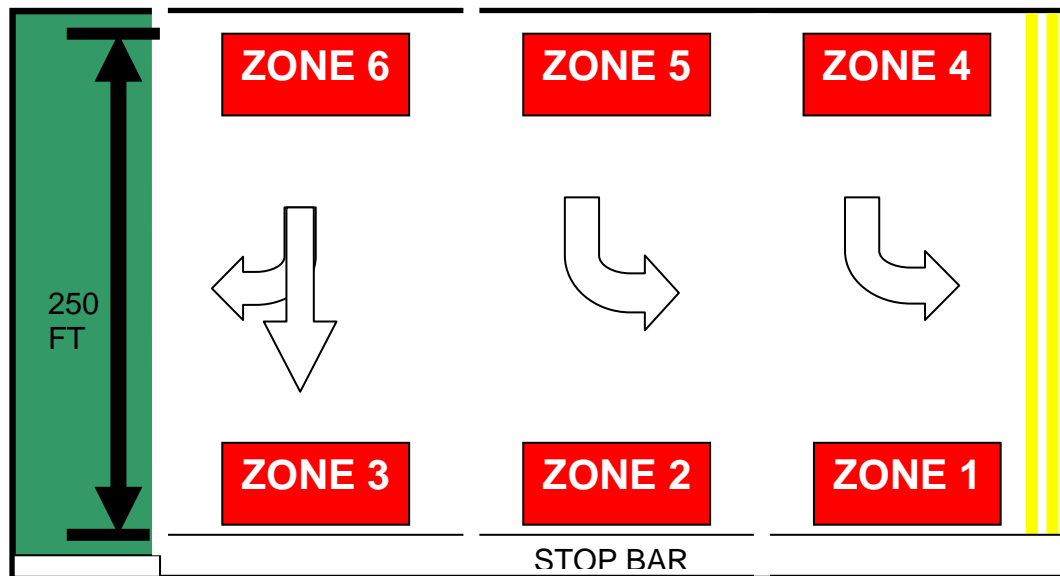


Figure 2.1. Intersection layout.

Video detection systems were configured by the manufacturer or the distributor using the same arrangement of detection zones the loops had, with three advance and three stop bar locations. Distributors and manufacturers were informed about the installation and both had the opportunity to give their input in the VDS setup. A representative from one of the manufacturers was present at the evaluation site during the setup, and for the other two systems the distributors were present and received technical support from the manufacturers via telephone. The following product versions were installed: Autoscope (SoloPro with v 8.13), Peek (Unitrak with v 2.2), and Iteris (Edge 2 with v 1.08). Manufacturers/distributors were given a chance to improve their configuration after receiving results from preliminary analysis done during day time and night time by the research team conducting the study. The analysis presented in this paper reflects the performance of VDS after two rounds of modifications from the manufacturers/distributors. Modifications after initial installation is normal practice and appropriate. Based on information given by Illinois Department of Transportation staffs, it is not unusual to do modifications to the initial VDS configurations, and the authors are aware of situations that required changes more than once to fine tune the video detection system. Thus, the authors believe that the

manufacturers/distributors were given fair amount of opportunity to improve the performance of their system and that the final configurations were the result of the best efforts from manufacturer/distributor teams in all three VDS. This process is also consistent with the importance given to evaluating the best configuration settings from manufacturers/distributors in this study.

Two types of data were collected: time stamps and video. The times at which each of the VDS zones and inductive loops were activated or deactivated were recorded and are referred to as time stamps. A programmable input/output communications processor was used to monitor every change in all zones and loops and generate the time stamps. The time stamps were recorded 24 hrs a day and transferred to the computer in the data collection cabinet every hour.

The video data consisted of a quad image showing, in three of the quadrants, images taken by the cameras from the three VDS after the video was processed by the company's video card. This made possible to visually analyze the detection zones and their activations/deactivations. The fourth quadrant displayed a real-time graphical depiction of the detection states in each VDS zone and loop in the last two minutes and it was updated every 125 milliseconds for the advance locations and every 250 milliseconds for the stop bar locations. A sample image from the videos is shown in Figure 2-2.



Figure 2.2. Quad image.

CHAPTER 3 METHODOLOGY

Four measures of performance (MOEs) were defined to quantify the detection errors from the VDS and to evaluate their performance: False calls, missed calls, dropped calls, and stuck-on calls. These MOEs were estimated for each detection zone following a three step procedure, where the two first steps were performed in an automated way, and the third step consisted of a manual verification of the errors. Without automated preliminary data analysis, it was not possible to analyze large data sets, limiting the scope of the study.

First, a computer code was developed to accomplish the automated steps of the analysis, by reading the time stamps from both VDS and loops and establishing if there was a discrepancy between the loop indication and the VDS indication. Loop calls were used as a base for the automated steps only, but all errors were ultimately manually verified at the end of the analysis procedure. Comparing the exact times of activation and deactivation of loops and VDS would not be fair unless the location and size of the detection zones of the different technologies are identical, but this was not the case. In this study, it was important to evaluate the video detection systems when they are performing their best and are not restricted by a set of conditions (e.g. field of view or location of detection zone). Therefore, manufacturers/distributors were given the freedom to choose the field of view and zoom level that would yield best performance, given that detection was required on each lane at advance and stop bar locations. We believe the freedom to choose their best camera setup provides a fair condition for all three VDS, and helps avoiding possible bias towards a system that could have advantages over the others if an exact field of view and zoom level had been imposed. In this light, activation and deactivation times from VDS and loops are not expected to match exactly, and it was necessary to define time windows around loop calls or VDS calls where detections are considered acceptable and are not classified as errors. The concepts used to define MOEs, as well as the logic used in the computer code, including acceptable time windows, are briefly discussed as follows:

3.1 MISSED CALLS

These occur when the VDS fails to detect vehicles in the detection zone. These errors have adverse safety effects due to potential red light runners in cases where the corresponding phase is not called by the controller. In terms of time stamps, for every loop call if there is no corresponding VDS call, it is considered a missed call. The algorithm identifies loop calls and search for VDS calls in a window that starts “X” seconds before the start of loop call and ends “Y” seconds after the end of the loop call. If no VDS call is found in this window, this is counted as a missed call.

3.2 FALSE CALLS

These are defined as calls placed by the VDS when there was no vehicle in the detection zone, having a potential negative effect in the operational efficiency of the intersection. In the algorithm, for every call by a VDS, if there is no corresponding call from the loop detector, it is considered a false call. The algorithm identifies VDS calls and then searches for a loop call placed in a window that starts “X” seconds before the beginning of the VDS call and ends “Y” seconds after the VDS call is dropped.

3.3 DROPPED CALLS

These occur when a call by the VDS is dropped even while the vehicle is still present in the detection zone. If VDS prematurely drop the call placed to the controller, this may prevent the corresponding phase from being called, generating potential safety issues due to red light runners. In terms of time stamps, if the VDS call is terminated more than “X” seconds before the end of loop call, it is considered as a dropped call.

3.4 STUCK-ON CALLS

These are defined as those calls which are held by the VDS (after detecting the vehicle correctly) after the departure of the vehicle from the detection zone. Stuck-on calls affect operational efficiency of the signalized intersection. In the algorithm, if a VDS call continues to be active more than “X” seconds after the end of the loop call, it is counted as a stuck-on call.

Values assigned for the acceptable windows (X, Y) were not necessarily the same for all types of errors, and could change from one VDS to the other, depending on the location and size of their detection zones. Different thresholds were used to avoid unfair classification of calls as errors (false, missed, stuck-on, or dropped calls) when they actually are not errors. From Figure 2-2, it is clearly seen that Peek zones are longer and closer to the stop bar in the back and shorter in the front compared to Iiteris and Autoscope zones. These differences translate in vehicle detections from Peek starting at slightly different time and in calls not having the exact same duration as those from the other two systems. Considering these facts, different X and Y values were used so the detections systems are judged fairly. The selected time windows (X and Y values) were obtained to work for day and night conditions based on calibration and validation efforts that used day and night data. Calibration was performed by matching the errors from the computer code with the errors from manual verification watching the videos; and for validation we compared results from the calibrated computer code with manually verified errors from data sets not used in the calibration. An exact match between results from manual verification and the computer code was found after calibration and validation (final X and Y values after validation are showed in Table 1).

It is also noted that no errors were observed in the loop detection. If any error had occurred it would have been identified since it would have indicated a discrepancy with the VDS. Furthermore, given that the loop information is only used for initially screen the data and for pointing to the time period that a discrepancy occurred, the manual verification that took place in a later analysis stage would prevent it from having any effect in the evaluation of the VDS performance.

Table 3.1. X and Y Values for Calculating Measures of Performance

Location	MOE					
	Missed Calls		False Calls		Dropped Call	Stuck-on Call
	X	Y	X	Y	X	X
Stop Bar	2 (3*)	1 (0*)	1 (1*)	2 (3*)	5	10
Advance	1 (0*)	2 (4*)	3 (5*)	1 (0*)	5	10

* Peek Values; ** All values in seconds

The second step in the analysis procedure, after an initial automated calculation of MOEs values, was the refinement of the results using additional routines to identify the following issues: vehicles changing lanes at the advance zone locations, shadows from vehicles on adjacent lanes, flickering calls, and long-false VDS calls. Additional detailed information about the time window selection, calibration, and validation, as well as the details on the algorithm logic for detecting potential errors is presented in Volume I of this study: "Effects of Configuration Changes in the Performance of Video Detection Systems".

The third and final step in the data analysis procedure was the manual verification of the MOEs obtained from the computer algorithms. Each false, missed, stuck-on, and dropped call was verified using the videos recorded from the three systems in the quad image. This ensured the reliability of the numbers reported and also provided the research team with an understanding of the possible causes and solutions that can potentially improve the performance of the VDS.

CHAPTER 4 RESULTS

The effects of the illumination conditions on the performance of the VDS will be determined by comparing the errors in the “base condition”, which represents the cloudy noon, no wind, no rain condition, to the errors in each of the four following conditions: dawn, sunny morning (long shadows), dusk, and night. The base condition was chosen to represent the most favorable scenario for video detection, as it does not have periods of adverse weather or illumination conditions that could potentially affect the performance of the VDS.

Results from detection zones at stop bar and advance locations are presented separately, given that their characteristics and objectives are different. To evaluate stop bar and advance zones, the four types of errors (performance measures or PMs) described in Chapter 3 are used (false, missed, stuck-on, and dropped calls) and the causes of these errors are also investigated.

Data sets were carefully selected so each of the conditions remained unchanged throughout the whole analysis period. Thus, no mixed periods of sunny/cloudy patches or wind/no wind, or rain/no rain, etc, were found in any of the selected data sets for a given condition. This procedure made possible the combination of data sets from the same condition but from different days into one single data set that represents that specific condition.

The analysis of the errors for the base condition is presented next, followed by the comparisons of the different illumination conditions with the base case.

4.1 BASE CONDITION (CLOUDY NOON, NO WIND)

Errors in the “base condition” were quantified from selected data sets during periods of no wind, rain, or any other adverse weather condition, and under cloudy skies (to avoid shadows due to direct sunlight). As mentioned above, this scenario is expected to provide optimum conditions for VDS, and therefore it was used as a benchmark for measuring the effects of selected scenarios on each of the four types of errors. Some data sets from cloudy morning time were suitable for use as part of the base condition, but only data sets from cloudy noon were used to keep the consistency in the data collection procedure.

For the base condition, a total of 10 hours of data were selected from 5 different days (2 hours from each day, from 12pm to 2pm), and it was analyzed based on the multistage methodology described in Chapter 3. A sample image of the base condition is shown in Figure 4-1.



Figure 4.1. Sample image of cloudy noon (base condition).

4.1.1 Stop Bar Zones

4.1.1.1. False Calls

In the base condition, there were 4% to 7% false calls when all stop bar zones were combined (See Table 4.1). However, it is noted that these errors were not distributed evenly across the stop bar zones. For all three systems, false calls were highest in Zone 1, with 9.5% for Autoscope, 20.5% for Peek, and 15.1% for Iteris, while false calls in zones 2 and 3 were below 3%.

Table 4.1. False Calls at Stop Bar Zones in the Base Condition

FALSE CALLS						
Zone	Autoscope		Peek		Iteris	
	Number of Calls	Error	Number of Calls	Error	Number of Calls	Error
Average of Stop Bar Zones	1584	3.54%	1928	6.95%	1730	5.72%
Z1	484	9.50%	615	20.49%	549	15.12%
Z2	585	0.85%	698	1.00%	637	2.35%
Z3	515	0.97%	615	0.16%	544	0.18%

All false calls in Zone 1 were caused by turning vehicles traveling on the center lane. These vehicles placed calls on the leftmost lane when making a left turn or while waiting for the green light. The latter case was mostly caused due to images of tall vehicles, such as semi trailers or trucks, falling over Zone 1.

Similarly, false calls in Zone 2 (which did not exceed 3% in any system) were caused by tall vehicles traveling on the rightmost lane, when their image fell over the zone.

The few false calls observed in Zone 3 (<1%) were due to multiple calls placed by a single vehicle, which happened either when they entered or when they left the zone, and due to a very specific case of exhaust fumes from a vehicle in Zone 2 that generated two false calls in Zone 3.

4.1.1.2. Missed Calls

Out of more than 2000 vehicles only one missed call was found. It occurred in Peek Zone 3, accounting for only 0.05% of the total number of vehicles in the three lanes combined. The reason for missing the vehicle was not clear from the manual verification of the videos. Overall, no issues in terms of missed calls were observed in any of the three systems at the stop bar locations.

Table 4.2. Missed Calls at Stop Bar Zones in the Base Condition

MISSED CALLS						
Zone	Autoscope		Peek		Iteris	
	Number of Calls	Error	Number of Calls	Error	Number of Calls	Error
Average of Stop Bar Zones	2070	0.00%	2070	0.05%	2070	0.00%
Z1	553	0.00%	553	0.00%	553	0.00%
Z2	849	0.00%	849	0.00%	849	0.00%
Z3	668	0.00%	668	0.15%	668	0.00%

4.1.1.3. Stuck-on Calls

Stuck-on calls at the stop bar zones were only observed in Autoscope, with only two stuck-on calls in all three zones combined: one in Zone 1 (lasting 20 seconds), and one in Zone 3 (lasting 55 seconds). The cause of the stuck-on calls could not be determined from the manual verification of the videos. It was concluded for the base condition, that the stuck-on calls were not of a significant concern at the stop bar locations for any of the three VDS.

Table 4.3. Stuck-on Calls at Stop Bar Zones in the Base Condition

STUCK ON CALLS						
Zone	Autoscope		Peek		Iteris	
	Number of Calls	Error	Number of Calls	Error	Number of Calls	Error
Average of Stop Bar Zones	1584	0.13%	1928	0.00%	1730	0.00%
Z1	484	0.21%	615	0.00%	549	0.00%
Z2	585	0.00%	698	0.00%	637	0.00%
Z3	515	0.19%	615	0.00%	544	0.00%

4.1.1.4. Dropped Calls

No dropped calls were observed in any system at the stop bar locations.

4.1.2 Advance Zones

4.1.2.1. False Calls

The average false calls across the three advance zones varied from 1.6% to 6.1%. False calls in the advance zones were highest in Zone 4, followed by Zones 5 and 6. In Zone 4, Autoscope had 4.9% false calls, while Peek had 17.7%, and Iteris had 12%. Almost all of these errors were caused by vehicles in the adjacent lane (Zone 5) when their image fell over Zone 4, and a very small proportion was due to other factors such as pedestrians.

Table 4.4. False Calls at Advance Zones in the Base Condition

FALSE CALLS						
Zone	Autoscope		Peek		Iteris	
	Number of Calls	Error	Number of Calls	Error	Number of Calls	Error
Average of Advance Zones	2011	1.64%	2033	6.10%	2065	4.99%
Z4	474	4.85%	581	17.73%	575	12.00%
Z5	895	0.89%	818	2.44%	845	3.31%
Z6	642	0.31%	634	0.16%	645	0.93%

In Zone 5, false calls were much lower than in Zone 4, representing 0.9% of the calls in Autoscope, 2.4% in Peek, and 3.3% in Iteris. The cause of most of these errors was very similar to those in Zone 4, where the image of vehicles in the adjacent lane (Zone 6) fell over Zone 5. On the other hand, only few false calls were not caused by adjacent vehicles or any other reason that could be identified from the videos, including 1 false call in Peek (out of 20 false calls), and 5 false calls in Iteris (out of 28 false calls).

In Zone 6, false calls in all three systems were lower than 1%. This is expected since Zone 6 is on the rightmost lane and the images of adjacent vehicles do not fall over it. For Autoscope, two false calls were generated when cars traveling between the middle lane and the rightmost lane placed calls in both Zone 6 and Zone 5. This was the same cause for the only false call observed in Peek. In Iteris, three false calls were caused by trucks that placed multiple calls (flickering) while traveling over the Zone, and three additional false calls were generated by reasons not clear from the video recordings.

4.1.2.2. Missed Calls

Table 4.5. Missed Calls at Advance Zones in the Base Condition

MISSED CALLS						
Zone	Autoscope		Peek		Iteris	
	Number of Calls	Error	Number of Calls	Error	Number of Calls	Error
Average of Advance Zones	2180	0.92%	2180	0.64%	2180	1.65%
Z4	514	1.56%	514	0.00%	514	1.17%
Z5	985	0.71%	985	1.02%	985	2.84%
Z6	681	0.73%	681	0.59%	681	0.29%

The average missed calls across the three advance zones varied from 0.6% to 1.7%. Note that at the individual zone level missed calls were not evenly distributed, being higher for Autoscope in Zone 4, and higher for Peek and Iteris in Zone 5.

Even though the percentages of missed calls seem rather small, they translate into several missed vehicles. In Zone 4, 8 vehicles were missed by Autoscope, 6 by Iteris, and none by Peek. All vehicles missed by Iteris and 2 of the vehicles missed by Autoscope were traveling between zones 4 and 5 but did not activate any of these detection zones. In addition, the 6 remaining missed vehicles in Autoscope traveled directly over the zone without being detected. No clear causes for these errors could be identified after reviewing the video images.

Zone 5 showed an increased number of missed calls with respect to Zone 4, particularly for Iteris and Peek. In Iteris, from the total 28 vehicles missed in Zone 5, 15 traveled right over the zone, two of them were motorcycles and the rest 13 were vehicles traveling between the detection zones. While in Peek 10 vehicles were missed, 4 of which traveled straight over the zone (including a motorcycle) and the other 6 were missed because vehicles traveled between detection zones. Lastly, in Autoscope a total of 7 vehicles were missed in Zone 5 and all of them were traveling between detection zones.

In Zone 6, a total of 5 vehicles were missed by Autoscope, 4 of which were traveling off the center of the lane, between the detection zone and the curb. The remaining vehicle was missed because it was changing lanes and traveled between Zones 5 and 6. In Peek, 2 of the 4 missed calls were also due to vehicles traveling between the zones, but in the other 2 cases the vehicles traveled right over the detection zone without being detected. In Iteris, only two missed calls were observed and both of them due to vehicles traveling between the zones.

4.1.2.3. Stuck-on Calls

Table 4.6. Stuck-on Calls at Advance Zones in the Base Condition

STUCK ON CALLS						
Zone	Autoscope		Peek		Iteris	
	Number of Calls	Error	Number of Calls	Error	Number of Calls	Error
Average of Advance Zones	2011	0.05%	2033	0.00%	2065	0.00%
Z4	474	0.00%	581	0.00%	575	0.00%
Z5	895	0.00%	818	0.00%	845	0.00%
Z6	642	0.16%	634	0.00%	645	0.00%

Stuck-on calls were not a significant concern in the advance zones for any of the systems. Only one stuck-on call (< 0.2%) was observed in Autoscope Zone 6, lasting for less than 30 seconds, and none was observed in Peek or Iteris.

4.1.2.4. Dropped Calls

No dropped calls were observed in any system at the advance locations.

4.2 EFFECTS OF ILLUMINATION CONDITIONS

So far, errors from the base condition have provided an indication of the detection performance and the capability of the VDS under very favorable weather and illumination conditions, when their performance is expected to be at its best. In this section, these errors will serve as a reference to determine the impact of different illumination conditions on each of the four measures of performance.

The effects of the following four scenarios, typical of a day with favorable weather conditions, are compared with the base condition:

- Dawn
- Sunny Morning
- Dusk
- Night

Comparisons are presented for each individual detection zone, for the average of all stop bar zones together, and for the average of all advance zones together. Statistical comparisons between the evaluated condition and the base condition were obtained using Z tests for proportions and a confidence interval of 95% to interpret the test result. The Z values from all tests are also included, thus the results can easily be interpreted at different confidence levels.

4.2.1 Dawn Vs. Base Condition

A total of 315 minutes from 10 different days were selected for the analysis of the dawn condition. No wind, rain or any other weather condition were observed in the videos, so the conditions over the 10 selected days remained similar. Data sets between 25 to 35 minutes long were selected from each day, capturing the whole transition from night to daytime condition. Traffic volume at this time of day was very low, with just over 250 vehicles in the whole analysis period (315 minutes). Dropped calls are not shown since none was observed in the dawn condition.

4.2.1.1 Stop Bar Zones

- False calls. For all three VDS in the dawn condition, the average false calls across the stop bar zones varied from 12.8% to 21.7% and they were significantly higher compared to the base condition (see Table 4.7). However, not all individual zones showed a significant change. For Autoscope Zones 2 and 3, false calls significantly increased from 0.9% to 23.8% and from 1% to 23.4%, respectively, whereas the difference for Zone 1 from 9.5% to 16% was not statistically significant given the low traffic volume in the dawn condition. For Peek, the false calls in Zone 1 increased from 20.5% to 28.7% and for Zone 2 from 1% to 4.7%, and both increases are significant with 90% confidence level. For Iteris, false calls significantly increased in Zone 1 only, from 15.1% to 29.7%.

Table 4.7. False Calls at Stop Bar Zones during Dawn

False Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Dawn	318	21.7%	-7.69	Increased	267	12.7%	-2.72	Increased	278	13.3%	-3.59	Increased
	Base	1584	3.5%			1928	7.0%			1730	5.7%		
Zone 1	Dawn	81	16.0%	-1.52	Not Significant	101	28.7%	-1.71	Not Significant	101	29.7%	-3.03	Increased
	Base	484	9.5%			615	20.5%			549	15.1%		
Zone 2	Dawn	130	23.8%	-6.10	Increased	107	4.7%	-1.76	Not Significant	98	5.1%	-1.19	Not Significant
	Base	585	0.9%			698	1.0%			637	2.4%		
Zone 3	Dawn	107	23.4%	-5.42	Increased	59	0.0%	1.00	Not Significant	79	2.5%	-1.31	Not Significant
	Base	515	1.0%			615	0.2%			544	0.2%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

The main cause for the increase in false calls for Autoscope was the headlight reflection from vehicles traveling on the adjacent lane. For example, the headlights of vehicles traveling on the leftmost lane (Zone 1) fell over Zone 2, and generated false calls. A similar situation occurred when vehicles traveling in the center lane (Zone 2) placed false calls in Zone 3.

On the other hand, false calls in Iteris Zone 1 increased due to the combination of multiple factors. Out of the 30 false calls in Zone 1, 14 were due to tall vehicles stopped over Zone 2 or traveling on the center lane and turning left, 11 were caused by automobiles traveling on the center lane and making a sharp left turn, 4 were caused by automobiles approaching the stop bar (due to their image occupying the zone or some headlight reflection), and one false call due to a semi trailer on the crossing street that occupied a portion of Zone 1.

- Missed calls. No missed calls were observed in the stop bar zones for Autoscope or Iteris in the dawn condition. For Peek, missed calls were observed in Zone 3 only, which increased from 0.1% (1 missed call) in the base condition to 18.8% (16 missed calls) during dawn. From the manual verification of the videos, it was determined that 9 of the 16 missed vehicles were right turners. During the transition from night to day time, particularly at the early stage of dawn when daylight is the lowest and vehicles have their headlights on, detection seemed to be more difficult when vehicles wait at the stop bar to make a right turn. This could be caused due to the position of vehicles before making the right turn, as their headlights pointed towards the crossing street and reduced the contrast change between dark background and the vehicle.

The remaining 7 vehicles that Peek Zone 3 missed traveled straight through the intersection, but there was no clear indication from viewing the videos why Peek did not detect them. These missed vehicles arrived and departed the detection zone without any obvious difference from other vehicles that were detected.

Table 4.8. Missed Calls at Stop Bar Zones during Dawn

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Dawn	257	0.0%	0.00	Not Significant	257	6.2%	-4.09	Increased	257	0.0%	0.00	Not Significant
	Base	2070	0.0%			2070	0.0%			2070	0.0%		
Zone 1	Dawn	72	0.0%	0.00	Not Significant	72	0.0%	0.00	Not Significant	72	0.0%	0.00	Not Significant
	Base	553	0.0%			553	0.0%			553	0.0%		
Zone 2	Dawn	100	0.0%	0.00	Not Significant	100	0.0%	0.00	Not Significant	100	0.0%	0.00	Not Significant
	Base	849	0.0%			849	0.0%			849	0.0%		
Zone 3	Dawn	85	0.0%	0.00	Not Significant	85	18.8%	-4.38	Increased	85	0.0%	0.00	Not Significant
	Base	668	0.0%			668	0.1%			668	0.0%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

- Stuck-on calls. At the stop bar zones, the dawn condition had no significant impact in the stuck-on calls compared to the base condition. For all three VDS, no stuck-on calls were observed in any system during dawn, compared to only two stuck-on calls in the base condition.

Table 4.9. Stuck-on Calls at Stop Bar Zones during Dawn

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Dawn	318	0.0%	1.41	Not Significant	265	0.0%	0.00	Not Significant	273	0.0%	0.00	Not Significant
	Base	1584	0.1%			1928	0.0%			1730	0.0%		
Zone 1	Dawn	81	0.0%	1.00	Not Significant	99	0.0%	0.00	Not Significant	96	0.0%	0.00	Not Significant
	Base	484	0.2%			615	0.0%			549	0.0%		
Zone 2	Dawn	130	0.0%	0.00	Not Significant	107	0.0%	0.00	Not Significant	98	0.0%	0.00	Not Significant
	Base	585	0.0%			698	0.0%			637	0.0%		
Zone 3	Dawn	107	0.0%	1.00	Not Significant	59	0.0%	0.00	Not Significant	79	0.0%	0.00	Not Significant
	Base	515	0.2%			615	0.0%			544	0.0%		

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system

4.2.1.2 Advance Zones

- False calls. For all advance zones combined, an overall increase in the false calls was observed for Autoscope (from 1.6% to 11.8%) and Iteris (from 5% to 11.1%). False calls in Peek during dawn (5.2%) remained similar to those in the base condition 6.1% (see Table 5.9) at the advance zones.

Table 4.10. False Calls at Advance Zones during Dawn

False Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Dawn	296	11.8%	-5.36	Increased	269	5.2%	0.61	Not Significant	314	11.1%	-3.34	Increased
	Base	2011	1.6%			2033	6.1%			2065	5.0%		
Zone 4	Dawn	66	10.6%	-1.46	Not Significant	82	14.6%	0.73	Not Significant	110	25.5%	-3.07	Increased
	Base	474	4.9%			581	17.7%			575	12.0%		
Zone 5	Dawn	130	11.5%	-3.76	Increased	103	14.6%	0.34	Not Significant	119	5.0%	-0.82	Not Significant
	Base	895	0.9%			818	2.4%			845	3.3%		
Zone 6	Dawn	100	13.0%	-3.75	Increased	84	0.0%	1.00	Not Significant	85	1.2%	-0.20	Not Significant
	Base	642	0.3%			634	0.2%			645	0.9%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

For Autoscope, the increase in false calls was mostly due to errors in Zones 5 and 6. In these two zones, the headlights of vehicles approaching in the adjacent lane were reflected over the pavement, causing 25 of the 28 false calls in zone 5 and 6 combined. As expected, these errors were mostly observed in the darker portions of the dawn intervals, when headlight reflections were more prominent.

For Iteris, which had a significant increase in false calls in Zone 4, the main cause of these errors was the image of tall vehicles traveling in the center lane that fell over the Zone (18 out of 28 false calls). The remaining false calls were due to very little camera movement or due to multiple calls placed by a single approaching vehicle.

- Missed calls. For all advance zones combined, a significant decrease in missed calls during dawn was observed in Iteris, and no significant change occurred in Autoscope or Peek (Table 4.11). The slightly lower rates of missed calls observed in dawn were apparently due to the high contrast generated by vehicle headlights during darker periods of the dawn data sets.

Table 4.11. Missed Calls at Advance Zones during Dawn

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Dawn	272	0.7%	0.33	Not Significant	272	0.4%	0.68	Not Significant	272	0.0%	6.05	Decreased
	Base	2180	0.9%			2180	0.6%			2180	1.7%		
Zone 4	Dawn	68	2.9%	-0.65	Not Significant	68	1.5%	-1.00	Not Significant	68	0.0%	2.46	Decreased
	Base	514	1.6%			514	0.0%			514	1.2%		
Zone 5	Dawn	118	0.0%	2.65	Decreased	118	0.0%	3.18	Decreased	118	0.0%	5.37	Decreased
	Base	985	0.7%			985	1.0%			985	2.8%		
Zone 6	Dawn	86	0.0%	2.24	Decreased	86	0.0%	2.00	Decreased	86	0.0%	1.42	Not Significant
	Base	681	0.7%			681	0.6%			681	0.3%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

At the individual zone level, the most significant improvements were observed in Iteris in zones 4 and 5, where missed calls changed from 93 vehicles missed in the base condition (for the two zones combined) to zero vehicles missed in the dawn condition. In addition, significant decreases in missed calls were also observed for Autoscope and Peek in Zones 5 and 6, where missed calls were 0.6% to 1% in the base condition (for Zones 4 and 5 together, 12 vehicles were missed by Autoscope and 14 by Peek) and became to 0% in the dawn condition.

- Stuck-on calls. There were no stuck-on calls in any of the systems at the advance zones during the dawn condition. This is similar to the findings for the base condition, where only one stuck-on call was observed for three systems combined.

Table 4.12. Stuck-on Calls at Advance Zones during Dawn

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Dawn	296	0.0%	1.00	Not Significant	269	0.0%	0.00	Not Significant	314	0.0%	0.00	Not Significant
	Base	2011	0.0%			2033	0.0%			2065	0.0%		
Zone 4	Dawn	66	0.0%	0.00	Not Significant	82	0.0%	0.00	Not Significant	110	0.0%	0.00	Not Significant
	Base	474	0.0%			581	0.0%			575	0.0%		
Zone 5	Dawn	130	0.0%	0.00	Not Significant	103	0.0%	0.00	Not Significant	119	0.0%	0.00	Not Significant
	Base	895	0.0%			818	0.0%			845	0.0%		
Zone 6	Dawn	100	0.0%	1.00	Not Significant	84	0.0%	0.00	Not Significant	85	0.0%	0.00	Not Significant
	Base	642	0.2%			634	0.0%			645	0.0%		

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system

4.2.2 Sunny Morning Vs. Base Condition

Data sets for the sunny morning condition were selected from 5 different days with no wind, or any other adverse weather conditions, and under clear skies. No cloud patches or overcast conditions were observed in this period. A sample image from a selected sunny morning data set is shown next to a sample image from the base condition in Figure 4-2, for illustration purposes. Two hours were analyzed from each selected morning, from 8am to 10am, for a total of 10 hours of data. At this location, sunny morning conditions created the longest shadows of the day. Shadows from tall vehicles (e.g. semi-trailers) could be long enough to fall over a zone on the immediately adjacent lane and even over the zone located two lanes away from the actual vehicle. It is noted that the sunny morning condition is expected to show the greatest effects of shadows without any confounding effects from additional weather factors. Dropped calls are not shown since none was observed in the sunny morning condition.

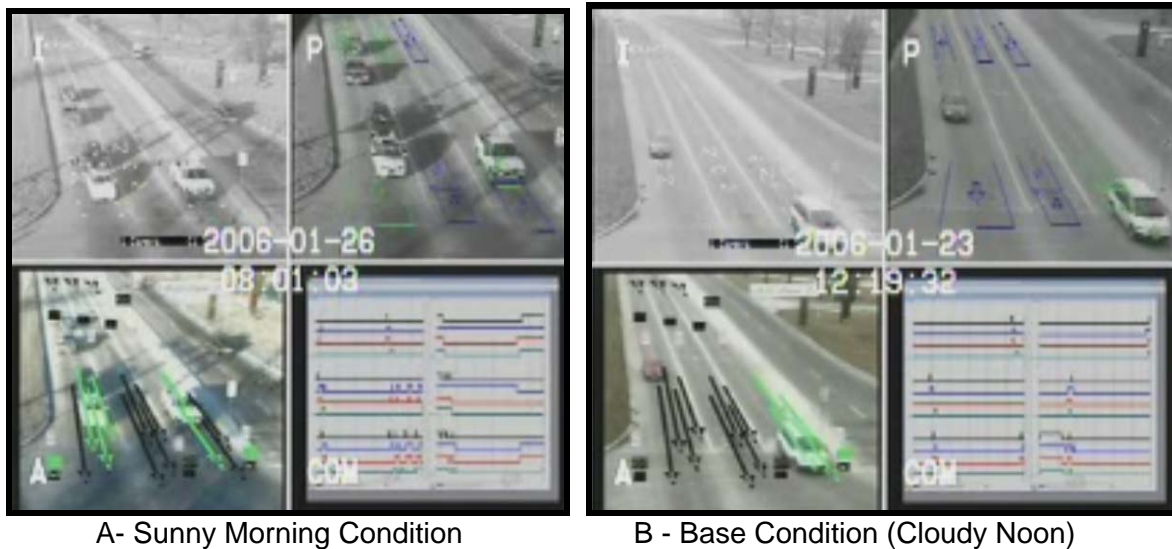


Figure 4.2. Sample image of sunny morning condition.

4.2.2.1 Stop Bar Zones

- False calls. For all three systems, average false calls from the three stop bar zones combined increased during sunny morning (Table 4.13). Autoscope increased from 3.5% to 11.2%, Peek from 7% to 14.4%, and Iteris from 5.7% to 20.7%.

Table 4.13. False Calls at Stop Bar Zones in Sunny Morning Conditions

		False Calls											
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Sunny Morning	1139	11.2%	-7.37	Increased	1398	14.4%	-6.73	Increased	1429	20.7%	-12.40	Increased
	Base	1584	3.5%			1928	7.0%			1730	5.7%		
Zone 1	Sunny Morning	421	25.2%	-6.26	Increased	546	30.6%	-3.95	Increased	586	36.2%	-8.40	Increased
	Base	484	9.5%			615	20.5%			549	15.1%		
Zone 2	Sunny Morning	402	5.0%	-3.58	Increased	487	6.8%	-4.81	Increased	504	16.7%	-8.10	Increased
	Base	585	0.9%			698	1.0%			637	2.4%		
Zone 3	Sunny Morning	316	0.6%	0.54	Not Significant	365	0.3%	-0.35	Not Significant	339	0.0%	1.00	Not Significant
	Base	515	1.0%			615	0.2%			544	0.2%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

At the individual zone level there were significant changes for the three systems in Zones 1 and 2 only. This was expected since shadows in the morning are projected towards the median side, thus vehicles in the center lane (Zone 2) could generate false calls in the left-most lane (Zone 1), and shadows from vehicles in the right-through lane (Zone 3) could affect the center lane (Zone 2), and even the left-most lane (Zone 1). An example of a long shadow during sunny morning time is observed in Figure 4.3. No shadows were expected to fall in the right-through lane, which resulted in Zone 3 having similar performance as in the base condition.



Figure 4.3. Sample false call in zone 1 due to vehicle in zone 3.

In Zone 1, false calls in sunny morning increased for Autoscope from 9.5% to 25.2%, for Peek from 20.5% to 30.6%, and for Iteris from 15.1% to 36.2%. Similarly, false calls in Zone 2 increased for Autoscope from 0.9% to 5%, for Peek from 1% to 6.8%, and for Iteris from 2.4% to 16.7%. These changes clearly show a significant effect of shadows in false calls, negatively affecting the performance of all three systems.

- Missed calls. In terms of missed calls, no significant changes were observed during sunny morning in any system or any zone. Overall, 5 missed calls were observed and all of them occurred in Peek zones: one in Zone 1, two in Zone 2, and two in Zone 3. These missed vehicles traveled straight over the zone without being detected and manual verification of the videos did not show a clear indication of the cause of these errors. In comparison, no missed calls were observed in any system or any zone in the base condition.

Table 4.14. Missed Calls at Stop Bar Zones in Sunny Morning Conditions

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Sunny Morning	1312	0.0%	0.00	Not Significant	1312	0.4%	-1.88	Not Significant	1312	0.0%	0.00	Not Significant
	Base	2070	0.0%			2070	0.0%			2070	0.0%		
Zone 1	Sunny Morning	422	0.0%	0.00	Not Significant	422	0.2%	-1.00	Not Significant	422	0.0%	0.00	Not Significant
	Base	553	0.0%			553	0.0%			553	0.0%		
Zone 2	Sunny Morning	500	0.0%	0.00	Not Significant	500	0.4%	-1.42	Not Significant	500	0.0%	0.00	Not Significant
	Base	849	0.0%			849	0.0%			849	0.0%		
Zone 3	Sunny Morning	390	0.0%	0.00	Not Significant	390	0.5%	-0.93	Not Significant	390	0.0%	0.00	Not Significant
	Base	668	0.0%			668	0.1%			668	0.0%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

- Stuck-on calls. Stuck-on calls significantly increased for Autoscope and Peek, changing from 0.1% and 0% to 6.9% and 0.9% respectively for all stop bar zones combined (Table 4.15). Most stuck-on calls were generated by the shadow of the pole and mast arm from the crossing street, which fell over portions of the three stop bar zones. This situation can be seen in Figure 4-4.

Table 4.15. Stuck-on Calls at Stop Bar Zones in Sunny Morning Conditions

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Sunny Morning	1139	6.9%	-8.98	Increased	1398	0.9%	-3.62	Increased	1429	0.1%	-1.00	Not Significant
	Base	1584	0.1%			1928	0.0%			1730	0.0%		
Zone 1	Sunny Morning	421	8.1%	-5.85	Increased	546	1.5%	-2.85	Increased	586	0.0%	0.00	Not Significant
	Base	484	0.2%			615	0.0%			549	0.0%		
Zone 2	Sunny Morning	402	7.5%	-5.69	Increased	487	1.0%	-2.25	Increased	504	0.0%	0.00	Not Significant
	Base	585	0.0%			698	0.0%			637	0.0%		
Zone 3	Sunny Morning	316	4.7%	-3.75	Increased	365	0.0%	0.00	Not Significant	339	0.3%	-1.00	Not Significant
	Base	515	0.2%			615	0.0%			544	0.0%		

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system



Figure 4.4. Image of shadow from pole and mast arm of crossing street.

The slow moving shadow from the pole and mast arm (shown in Figure 4-4) affected mostly Autoscope, with 34 stuck-on calls in Zone 1, 30 stuck-on calls in Zone 2, and 15 stuck-on calls in Zone 3. Peek was also affected, but in a lesser degree, with 8 stuck-on calls in Zone 1, 5 in Zone 2, and none in Zone 3. On the other hand, only one stuck-on call was observed for Iteris in all stop bar zones.

4.2.2.2 Advance Zones

- False calls. In the advance zones, false calls increased for the three systems in sunny morning conditions (See Table 4.16). False calls from all advance zones combined accounted for 32.1% of the calls in Autoscope (from 1.6% in the base data), 12.4% in Peek (from 6.1%), and 35.2% in Iteris (from 5%).

These changes were mainly generated in Zones 4 and 5 due to shadows from vehicles traveling on the adjacent lanes, false calls due to the image of adjacent tall vehicles, and vehicles changing lanes. On the other hand, a decrease was observed in Iteris Zone 6, which did not have any false calls in sunny morning, compared to six false calls in the base condition (three of them caused by a single vehicle placing multiple calls, and three in which the causes were not obvious from the video images).

Table 4.16. False Calls at Advance Zones in Sunny Morning Conditions

		False Calls											
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Sunny Morning	1828	32.1%	-26.96	Increased	1230	12.4%	-5.80	Increased	1873	35.2%	-25.10	Increased
	Base	2011	1.6%			2033	6.1%			2065	5.0%		
Zone 4	Sunny Morning	740	47.6%	-20.48	Increased	428	31.1%	-4.86	Increased	826	53.1%	-18.67	Increased
	Base	474	4.9%			581	17.7%			575	12.0%		
Zone 5	Sunny Morning	713	32.8%	-17.86	Increased	446	4.3%	-1.65	Not Significant	669	32.9%	-15.41	Increased
	Base	895	0.9%			818	2.4%			845	3.3%		
Zone 6	Sunny Morning	375	0.0%	1.42	Not Significant	356	0.0%	1.00	Not Significant	378	0.0%	2.46	Decreased
	Base	642	0.3%			634	0.2%			645	0.9%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

- Missed calls. Sunny morning conditions had different effects on missed calls for the three VDS (see Table 4.17). On average, missed calls decreased in Autoscope advance zones from 0.9% (20 missed vehicles) in the base condition to none in the sunny morning condition. For Peek, missed calls increased from 0.6% (14 missed vehicles) to 8.4% (121 vehicles missed), and no significant change was found for Iteris, with 1.4% (20 missed vehicles) in sunny condition.

Table 4.17. Missed Calls at Advance Zones in Sunny Morning Conditions

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Sunny Morning	1438	0.0%	4.49	Decreased	1438	8.4%	-10.33	Increased	1438	1.4%	0.63	Not Significant
	Base	2180	0.9%			2180	0.6%			2180	1.7%		
Zone 4	Sunny Morning	389	0.0%	2.85	Decreased	389	17.7%	-9.15	Increased	389	1.3%	-0.16	Not Significant
	Base	514	1.6%			514	0.0%			514	1.2%		
Zone 5	Sunny Morning	653	0.0%	2.65	Decreased	653	6.7%	-5.54	Increased	653	2.3%	0.69	Not Significant
	Base	985	0.7%			985	1.0%			985	2.8%		
Zone 6	Sunny Morning	396	0.0%	2.24	Decreased	396	2.0%	-1.87	Not Significant	396	0.0%	1.42	Not Significant
	Base	681	0.7%			681	0.6%			681	0.3%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

Most missed calls in Peek occurred when vehicles traveled between detection Zones 4 and 5, or 5 and 6, and were missed by both zones. However, from a visual inspection of the videos, there was no clear effect of shadows in missing vehicles. A potential side effect of sunny conditions could be the increase of image brightness, which could have reduced contrast between pavement and vehicles, thus increasing the chances of missing a vehicle.

- Stuck-on calls. No significant changes were observed in the advance zones, with no stuck-on calls in any system or any zone during sunny morning conditions. Recall that only one stuck-on call was found in the base condition (in Autoscope Zone 6).

Table 4.18. Stuck-on Calls at Advance Zones in Sunny Morning Conditions

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Sunny Morning	1828	0.0%	1.00	Not Significant	1230	0.0%	0.00	Not Significant	1873	0.0%	0.00	Not Significant
	Base	2011	0.0%			2033	0.0%			2065	0.0%		
Zone 4	Sunny Morning	740	0.0%	0.00	Not Significant	428	0.0%	0.00	Not Significant	826	0.0%	0.00	Not Significant
	Base	474	0.0%			581	0.0%			575	0.0%		
Zone 5	Sunny Morning	713	0.0%	0.00	Not Significant	446	0.0%	0.00	Not Significant	669	0.0%	0.00	Not Significant
	Base	895	0.0%			818	0.0%			845	0.0%		
Zone 6	Sunny Morning	375	0.0%	1.00	Not Significant	356	0.0%	0.00	Not Significant	378	0.0%	0.00	Not Significant
	Base	642	0.2%			634	0.0%			645	0.0%		

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system

4.2.3 Dusk Vs. Base Condition

Data from 20 days with no wind or any additional adverse weather conditions were selected for the analysis of dusk. From each day, 10-minute intervals were manually identified by watching the video recordings, for a total of 200 minutes of selected data. The exact beginning and ending time of the selected data sets were chosen as to capture the transition from day to night. The differences between the illumination conditions at the beginning and end of the selected 10-minute intervals are noticeable, with more influence of

headlights towards the end of each interval, when the illumination had already decreased (See Figure 4-5). Dropped calls are not shown since none was observed in the dusk condition.

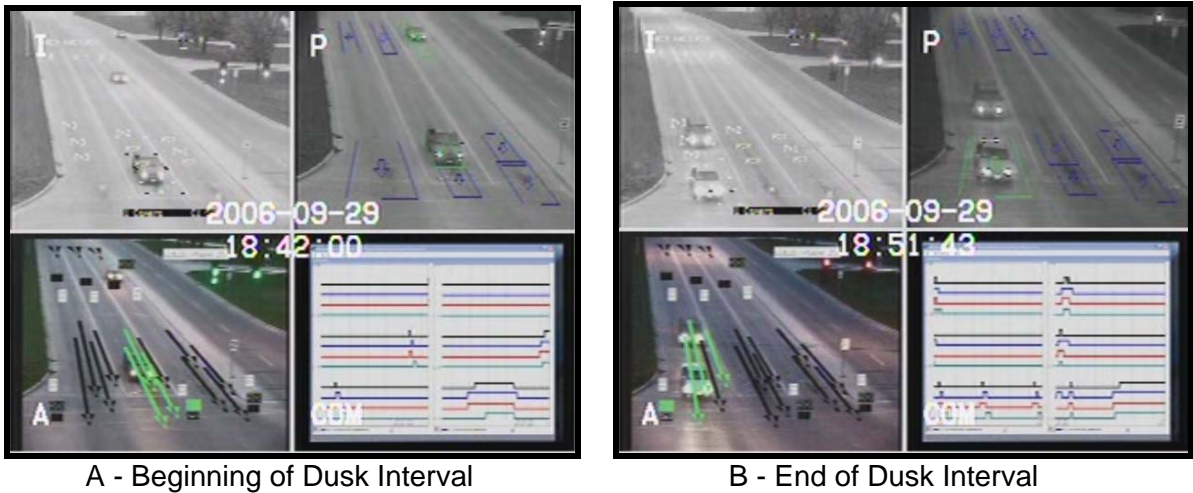


Figure 4.5. Sample images of beginning and end of dusk condition.

4.2.3.1 Stop Bar Zones

- False calls. For all stop bar zones combined, false calls increased for Autoscope from 3.5% to 33.7%, and for Peek from 7% to 12.2%. There was no significant increase for Iteris, which had 8.7% of false calls in the dusk condition compared to 5.7% in the base condition.

Table 4.19. False Calls at Stop Bar Zones during Dusk

Zone	Condition	False Calls											
		Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Dusk	433	33.7%	-13.00	Increased	427	12.2%	-3.10	Increased	403	8.7%	-1.96	Not Significant
	Base	1584	3.5%			1928	7.0%			1730	5.7%		
Zone 1	Dusk	162	7.4%	0.85	Not Significant	218	19.3%	0.39	Not Significant	186	11.8%	1.16	Not Significant
	Base	484	9.5%			615	20.5%			549	15.1%		
Zone 2	Dusk	140	51.4%	-11.88	Increased	126	7.9%	-2.83	Increased	114	10.5%	-2.77	Increased
	Base	585	0.9%			698	1.0%			637	2.4%		
Zone 3	Dusk	131	47.3%	-10.53	Increased	83	0.0%	1.00	Not Significant	103	1.0%	-0.80	Not Significant
	Base	515	1.0%			615	0.2%			544	0.2%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

As expected, changes at the individual zone level occurred only on zones 2 and 3, mainly due to the effects of the vehicle headlights on the adjacent lanes. No changes were observed in any system in Zone 1. Significant increases in false calls in Zone 2 were due to vehicles approaching on the leftmost lane, where false calls accounting for 51.4% of the calls in Autoscope, 7.9% in Peek, and 10.5% in Iteris. Headlights also had a significant impact on Zone 3 but only on Autoscope, which increased from 1% false calls to 47.3%. Zone 3 for Peek and Iteris had only a few false calls, with 0% and 1% respectively, similar to those observed in the base condition.

- Missed calls. At the stop bar zones, missed calls were only observed in Peek Zone 3, where 29.1% of the vehicles (39 vehicles) were not detected during dusk, compared to only 0.1% (1 vehicle) in the base condition. From the 39 vehicles missed in dusk, only 5 were right turners and the remaining traveled straight over the detection zone. From the manual verification of the videos, a clear explanation for the missed calls could not be identified.

Table 4.20. Missed Calls at Stop Bar Zones during Dusk

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Dusk	474	0.0%	0.00	Not Significant	474	8.2%	-6.47	Increased	474	0.0%	0.00	Not Significant
	Base	2070	0.0%			2070	0.0%			2070	0.0%		
Zone 1	Dusk	201	0.0%	0.00	Not Significant	201	0.0%	0.00	Not Significant	201	0.0%	0.00	Not Significant
	Base	553	0.0%			553	0.0%			553	0.0%		
Zone 2	Dusk	139	0.0%	0.00	Not Significant	139	0.0%	0.00	Not Significant	139	0.0%	0.00	Not Significant
	Base	849	0.0%			849	0.0%			849	0.0%		
Zone 3	Dusk	134	0.0%	0.00	Not Significant	134	29.1%	-7.35	Increased	134	0.0%	0.00	Not Significant
	Base	668	0.0%			668	0.1%			668	0.0%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

- Stuck-on calls. No significant dusk effects were found on stuck-on calls. Similar to the base condition, no stuck-on calls occurred in any of the stop bar zones in Iteris or Peek. For Autoscope, only one stuck-on call was observed during dusk in Zone 3, lasting for about 55 seconds. This is also similar to the base condition, where two stuck-on calls were observed in Autoscope, one in Zone 1 and one in Zone 3.

Table 4.21. Stuck-on Calls at Stop Bar Zones during Dusk

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Dusk	433	0.2%	-0.42	Not Significant	427	0.0%	0.00	Not Significant	403	0.0%	0.00	Not Significant
	Base	1584	0.1%			1928	0.0%			1730	0.0%		
Zone 1	Dusk	162	0.0%	1.00	Not Significant	218	0.0%	0.00	Not Significant	186	0.0%	0.00	Not Significant
	Base	484	0.2%			615	0.0%			549	0.0%		
Zone 2	Dusk	140	0.0%	0.00	Not Significant	126	0.0%	0.00	Not Significant	114	0.0%	0.00	Not Significant
	Base	585	0.0%			698	0.0%			637	0.0%		
Zone 3	Dusk	131	0.8%	-0.72	Not Significant	83	0.0%	0.00	Not Significant	103	0.0%	0.00	Not Significant
	Base	515	0.2%			615	0.0%			544	0.0%		

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system

4.2.3.2 Advance Zones

- False calls. Effects of dusk in false calls at advance zones did not follow a single trend among all VDS. For all advance zones combined false calls increased for Autoscope and Iteris, while they decreased for Peek (see Table 4.22).

Table 4.22. False Calls at Advance Zones during Dusk

False Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Dusk	463	13.2%	-7.21	Increased	449	1.3%	6.28	Decreased	502	9.6%	-3.27	Increased
	Base	2011	1.6%			2033	6.1%			2065	5.0%		
Zone 4	Dusk	163	1.2%	2.76	Decreased	191	2.6%	7.69	Decreased	210	13.8%	-0.66	Not Significant
	Base	474	4.9%			581	17.7%			575	12.0%		
Zone 5	Dusk	162	19.1%	-5.85	Increased	134	2.6%	1.84	Not Significant	175	5.7%	-1.29	Not Significant
	Base	895	0.9%			818	2.4%			845	3.3%		
Zone 6	Dusk	138	20.3%	-5.80	Increased	124	0.0%	1.00	Not Significant	117	7.7%	-2.70	Increased
	Base	642	0.3%			634	0.2%			645	0.9%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

For all Autoscope advance zones combined false calls increased during dusk to 13.2%, from 1.6% in the base condition. This change was due to increases in Zone 5, from 0.9% to 19.1%, and in Zone 6, from 0.3% to 20.3%, and despite the decrease in Zone 4 (from 4.9% to 1.2%). False calls in Zones 5 and 6 were mostly caused by the headlights of vehicles approaching on the adjacent lane (on the leftmost lane for Zone 5, and on the center lane for Zone 6).

For Iteris, the average false calls increased significantly from 5% to 9.6%. At the individual zone level, however, only Zone 6 had a significant increase from 0.9% to 7.7%. These errors were generated due to vehicles that placed multiple calls in the zone, e.g. when a truck activated the zone, the call was dropped, and then the call was picked up again shortly.

For Peek, the trend in false calls during dusk was completely different, with an average decrease for all advance zones combined, from 6.1% to 1.3%. At the individual zone level, only Zone 4 had a significant decrease in the dusk condition from 17.7% to 2.6%. During dusk, vehicles in the center lane did not place as many false calls on the leftmost lane while turning, decreasing the errors compared to the base condition. From a manual check of the videos it seems that as the ambient light decreased, towards the end of the selected dusk period, false calls also decreased. This is because the vehicles would be detected mainly by their headlights, which fall ahead of the rest of the vehicle and also ahead (not over) Zone 1 while making a left turn.

- Missed calls. Effects of dusk in missed calls were not the same for all VDS. Overall, for all advance zones combined, missed calls decreased for Iteris from 1.7% to 0%, but no significant changes occurred in Autoscope or Peek, with 1.8% and 1.2% respectively in the dusk condition.

Table 4.23. Missed Calls at Advance Zones during Dusk

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Dusk	490	1.8%	-1.43	Not Significant	490	1.2%	-1.11	Not Significant	490	0.0%	6.05	Decreased
	Base	2180	0.9%			2180	0.6%			2180	1.7%		
Zone 4	Dusk	184	0.5%	1.31	Not Significant	184	1.1%	-1.42	Not Significant	184	0.0%	2.46	Decreased
	Base	514	1.6%			514	0.0%			514	1.2%		
Zone 5	Dusk	175	1.1%	-0.51	Not Significant	175	1.7%	-0.68	Not Significant	175	0.0%	5.37	Decreased
	Base	985	0.7%			985	1.0%			985	2.8%		
Zone 6	Dusk	131	4.6%	-2.06	Increased	131	0.8%	-0.22	Not Significant	131	0.0%	1.42	Not Significant
	Base	681	0.7%			681	0.6%			681	0.3%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

At the individual zone level, it is noted that the decrease in Iiteris was caused by less missed calls in Zones 4 and 5. This decrease is statistically significant in both zones, from 1.2% in Zone 4 (6 vehicles) and 2.8% in Zone 5 (28 vehicles), to zero missed vehicles in the dusk condition.

On the other hand, missed calls in Autoscope increased in Zone 6 from 0.7% to 4.6% in dusk, representing six vehicles, five of which were missed when the vehicle headlights created a bright area of size much larger than the actual vehicle traveling over the zone. This situation was also found in the night condition, explained below, and can be observed for a night data set in Figure 4-6.



Figure 4.6. Sample of a missed vehicle due to bright vehicle headlights.

- Stuck-on calls. Stuck-on calls were only observed in Autoscope, which had more errors of this type during dusk compared to the base condition. On average, a significant increase in stuck-on calls for all three advance zones was found, changing from 0% in the base condition to 1.3% in dusk (6 stuck-on calls). The cause of these errors was not clear from the manual verification of the videos, and the duration of the stuck-on calls ranged between 11 and 27 seconds.

Table 4.24. Stuck-on Calls at Advance Zones during Dusk

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iiteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Dusk	463	1.3%	-2.36	Increased	449	0.0%	0.00	Not Significant	502	0.0%	0.00	Not Significant
	Base	2011	0.0%			2033	0.0%			2065	0.0%		
Zone 4	Dusk	163	0.6%	-1.00	Not Significant	191	0.0%	0.00	Not Significant	210	0.0%	0.00	Not Significant
	Base	474	0.0%			581	0.0%			575	0.0%		
Zone 5	Dusk	162	1.2%	-1.42	Not Significant	134	0.0%	0.00	Not Significant	175	0.0%	0.00	Not Significant
	Base	895	0.0%			818	0.0%			845	0.0%		
Zone 6	Dusk	138	2.2%	-1.61	Not Significant	124	0.0%	0.00	Not Significant	117	0.0%	0.00	Not Significant
	Base	642	0.2%			634	0.0%			645	0.0%		

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system

4.2.4 Night Vs. Base Condition

For the night condition, data sets from 5 different days (2 hours long each) were selected, for a total of 10 hours of data. In all selected data sets, only night time with no wind, rain, or any other adverse weather factor was observed. A sample image from a data set in night time is shown next to a sample image from the base condition in Figure 4-7, for illustration purposes. Dropped calls are not shown as only one error of this type was observed during nighttime, when Zone 1 in Peek dropped the call from a motorcycle for 19 seconds until it departed.

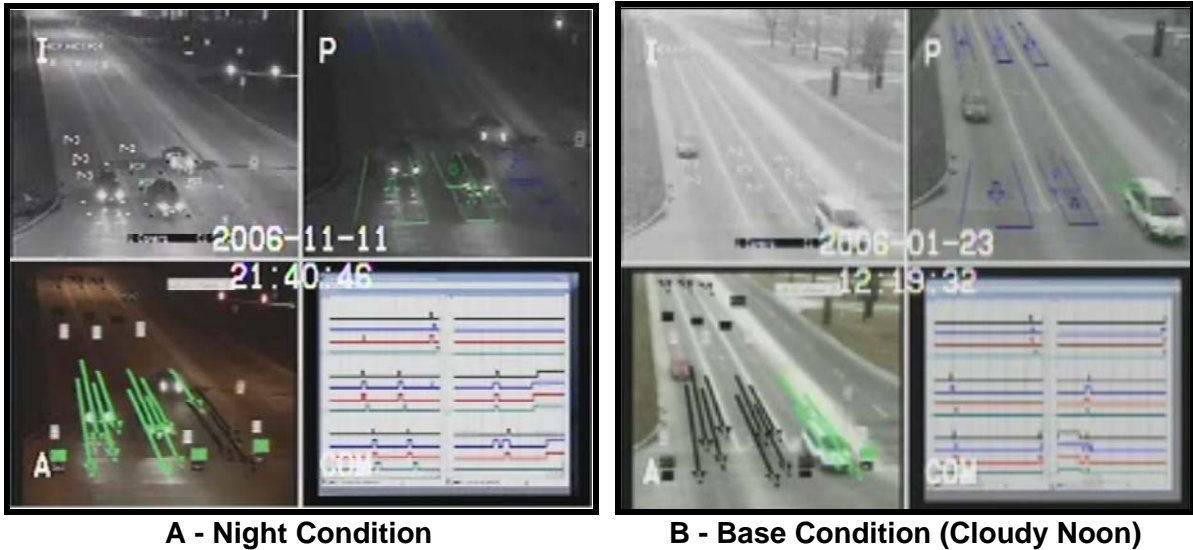


Figure 4.7. Sample images from night and base conditions.

4.2.4.1 Stop Bar Zones

False calls. Changes in false calls did not follow a single trend for all VDS during nighttime. On average, no significant changes were observed for Peek and Iteris when all stop bar zones were combined, having 8.5% and 6.2% errors respectively. However, the false calls for Autoscope increased to 29.5% during nighttime, from 3.5% in the base condition. Table

4.25. False Calls at Stop Bar Zones in Night Conditions

False Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Night	1801	29.5%	-22.17	Increased	1616	8.5%	-1.76	Not Significant	1411	6.2%	-0.52	Not Significant
	Base	1584	3.5%			1928	7.0%			1730	5.7%		
Zone 1	Night	366	9.3%	0.11	Not Significant	502	7.4%	6.55	Decreased	383	11.0%	1.88	Not Significant
	Base	484	9.5%			615	20.5%			549	15.1%		
Zone 2	Night	707	34.7%	-18.46	Increased	720	13.8%	-9.52	Increased	513	5.5%	-2.65	Increased
	Base	585	0.9%			698	1.0%			637	2.4%		
Zone 3	Night	728	34.6%	-18.52	Increased	394	0.5%	-0.88	Not Significant	515	3.3%	-3.85	Increased
	Base	515	1.0%			615	0.2%			544	0.2%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

Individual zones also showed different trends from one system to the other. For Peek, false calls in Zone 1 decreased from 20.5% to 7.4%, increased in Zone 2 from 1.0% to 13.8%, and remained similar in Zone 3 (0.2% to 0.5%). The decrease in Zone 1 was due to a lower effect of turning vehicles, given that their headlights fall ahead of the zone and there is low contrast between the body of the vehicle and the roadway, reducing the potential for false calls under low illumination conditions (similar effect was found during dusk). For Zone 2, false calls increased due to the headlights of vehicles approaching Zone 1 (the adjacent lane). However, Zone 3 was not significantly affected by headlights of vehicles approaching Zone 2, showing less sensitivity at detecting the headlight reflection from vehicles on the adjacent lane.

For Autoscope and Iteris, an increase in false calls was observed in zones 2 and 3 due to headlights of vehicles on the adjacent lane. No significant changes occurred in Zone 1. In zones 2 and 3, changes in Autoscope were in the order of +30% false calls, while in Iteris these were much smaller, with about +3% false calls in nighttime. In consequence, the average of all three stop bar zones produced no significant increase in false calls for Iteris, but it clearly did for Autoscope.

- Missed calls. No missed calls were found in Autoscope or Iteris during nighttime, similar to what it was observed in the base condition. On the other hand, missed calls increased significantly for Peek in nighttime, with 7.3% for all stop bar zones combined, compared to zero missed calls in the base condition. These changes represented 113 vehicles missed in the total 10-hour period during nighttime, all of them traveling over Zone 3 (19.1% of the vehicles traveling over this zone).

From a manual verification of the videos, it was observed that only 9 of the 113 missed vehicles were right turners (including a motorcycle) and the rest of them traveled straight over the zone and through the intersection. It is possible that right turners could be missed because vehicles aligned towards the crossing street as they approached the stop bar, also moving the headlight reflection away from the detection zone. However, no obvious explanation for the missed through vehicles were observed from the videos.

Table 4.26. Missed Calls at Stop Bar Zones in Night Conditions

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Night	1538	0.0%	0.00	Not Significant	1538	7.3%	-10.89	Increased	1538	0.0%	0.00	Not Significant
	Base	2070	0.0%			2070	0.0%			2070	0.0%		
Zone 1	Night	391	0.0%	0.00	Not Significant	391	0.0%	0.00	Not Significant	391	0.0%	0.00	Not Significant
	Base	553	0.0%			553	0.0%			553	0.0%		
Zone 2	Night	561	0.0%	0.00	Not Significant	561	0.0%	0.00	Not Significant	561	0.0%	0.00	Not Significant
	Base	849	0.0%			849	0.0%			849	0.0%		
Zone 3	Night	586	0.0%	0.00	Not Significant	586	19.1%	-11.62	Increased	586	0.0%	0.00	Not Significant
	Base	668	0.0%			668	0.1%			668	0.0%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

- Stuck-on calls. No significant changes in stuck-on calls occurred in nighttime for Autoscope or Peek. On the other hand, average stuck-on calls at stop bar zones significantly increased for Iteris, from 0% in the base condition to 2.5% in the night condition. These changes in Iteris come from an increase in stuck-on calls in zones 2 and 3, with 5.8% and 1% respectively. In Zone 2, these errors represented 30 stuck-on calls, caused by reasons that were not obvious from the manual verification of the videos. In Zone 3 the 1% error represented 5 stuck-on calls, also caused by undetermined reasons.

Table 4.27. Stuck-on Calls at Stop Bar Zones in Night Conditions

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Stop Bar Zones	Night	1801	0.2%	-0.31	Not Significant	1616	0.0%	0.00	Not Significant	1411	2.5%	-5.99	Increased
	Base	1584	0.1%			1928	0.0%			1730	0.0%		
Zone 1	Night	366	0.0%	1.00	Not Significant	502	0.0%	0.00	Not Significant	383	0.0%	0.00	Not Significant
	Base	484	0.2%			615	0.0%			549	0.0%		
Zone 2	Night	707	0.3%	-1.42	Not Significant	720	0.0%	0.00	Not Significant	513	5.8%	-5.64	Increased
	Base	585	0.0%			698	0.0%			637	0.0%		
Zone 3	Night	728	0.1%	0.24	Not Significant	394	0.0%	0.00	Not Significant	515	1.0%	-2.24	Increased
	Base	515	0.2%			615	0.0%			544	0.0%		

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system

4.2.4.2 Advance Zones

- False calls. Different trends were found for false calls in the advance zones. On average, for all advance zones together, Autoscope showed an increase in false calls during nighttime (from 1.6% to 25.8%), while Peek had a decrease (from 6.1% to 3.3%), and no change was observed for Iteris (with 5.3% of error in nighttime).

Table 4.28. False Calls at Advance Zones in Night Conditions

False Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Night	2066	25.8%	-24.04	Increased	1432	3.3%	3.97	Decreased	1708	5.3%	-0.47	Not Significant
	Base	2011	1.6%			2033	6.1%			2065	5.0%		
Zone 4	Night	332	0.9%	3.54	Decreased	370	12.4%	2.27	Decreased	424	16.3%	-1.90	Not Significant
	Base	474	4.9%			581	17.7%			575	12.0%		
Zone 5	Night	764	18.1%	-12.02	Increased	519	0.0%	4.53	Decreased	751	2.7%	0.76	Not Significant
	Base	895	0.9%			818	2.4%			845	3.3%		
Zone 6	Night	970	40.3%	-25.14	Increased	543	0.2%	-0.11	Not Significant	533	0.4%	1.20	Not Significant
	Base	642	0.3%			634	0.2%			645	0.9%		

* The percentage of false calls is computed based on the total number of calls placed by the VD system

Individually, advance zones also did not show a single trend either. For Autoscope, Zone 4 decreased to 0.9% (from 4.9%), but zones 5 and 6 increased false calls to 18.1% and 40.3%, from 0.9% and 0.3%, respectively. For Peek zones 4 and 5, a decrease was observed from 17.7% to 12.4% in Zone 4, and from 2.4% to 0% in Zone 5.

Increases in false calls for Autoscope Zones 5 and 6 were clearly due to the effect of headlight from vehicles in the adjacent lane being reflected over the zone. Decreases in Zone 4 for both Autoscope and Peek seemed to be due to the low contrast between the body of the vehicle and the roadway, in combination to a low sensitivity to headlight reflection. These trends are similar to those found at the stop bar locations also in nighttime, and to those at the advance zones during dusk.

- Missed calls. Different trends were observed in the three VDS. For all advance zones combined, Autoscope and Iteris had less missed calls in nighttime, from 0.9% to 0.1% and 1.7% to 0.1%, respectively. On the other hand, for Peek the average missed calls increased from 0.6% to 1.9% in the nighttime.

Table 4.29. Missed Calls at Advance Zones in Night Conditions

Missed Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Night	1623	0.1%	3.58	Decreased	1623	1.9%	-3.33	Increased	1623	0.1%	5.33	Decreased
	Base	2180	0.9%			2180	0.6%			2180	1.7%		
Zone 4	Night	348	0.0%	2.85	Decreased	348	0.6%	-1.42	Not Significant	348	0.0%	2.46	Decreased
	Base	514	1.6%			514	0.0%			514	1.2%		
Zone 5	Night	686	0.1%	1.85	Not Significant	686	2.9%	-2.65	Increased	686	0.1%	4.91	Decreased
	Base	985	0.7%			985	1.0%			985	2.8%		
Zone 6	Night	589	0.2%	1.53	Not Significant	589	1.5%	-1.61	Not Significant	589	0.2%	0.46	Not Significant
	Base	681	0.7%			681	0.6%			681	0.3%		

* The percentage of missed calls is computed based on the total number of calls placed by the loops

At the individual zone level, missed calls in Zone 4 decreased for Autoscope and Iteris to 0% in the nighttime (from 0.9% and 1.2%), and remained statistically similar for Peek, where errors slightly changed from 0% to 0.6%.

The three VDS had different trends in Zone 5, with an increase for Peek (from 1% to 2.9%), a decrease for Iteris (from 2.8% to 0.1%), and no change for Autoscope (from 0.7% to 0.1%). In Zone 6, no significant changes were observed for any of the VDS, in which errors were 0.2% for Autoscope and Iteris (one vehicle missed from each system), and 1.5% for Peek (9 vehicles missed).

The overall results of nighttime at advance zones, in terms of missed calls, was positive for Autoscope and Iteris, but negatively affected performance for Peek, especially in Zones 5 and 6.

- Stuck-on calls. No significant changes were observed in any of the VDS in terms of stuck-on calls. Two stuck-on calls were observed during nighttime for all advance zones and systems together, compared to one in the base condition. The two stuck-on calls in nighttime occurred in Autoscope Zone 6, and lasted for 13 and 29 seconds. The reflection of the street lighting falling over portions of Zone 6, near the curb, is believed to have caused these errors.

Table 4.30. Stuck-on Calls at Advance Zones in Night Conditions

Stuck-on Calls													
Zone	Condition	Autoscope				Peek				Iteris			
		Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result	Number of Calls	Error	Z value	Result
Average of Advance Zones	Night	2066	0.1%	-0.56	Not Significant	1432	0.0%	0.00	Not Significant	1708	0.0%	0.00	Not Significant
	Base	2011	0.0%		2033	0.0%	2065		0.0%				
Zone 4	Night	332	0.0%	0.00	Not Significant	370	0.0%	0.00	Not Significant	424	0.0%	0.00	Not Significant
	Base	474	0.0%		581	0.0%	575		0.0%				
Zone 5	Night	764	0.0%	0.00	Not Significant	519	0.0%	0.00	Not Significant	751	0.0%	0.00	Not Significant
	Base	895	0.0%		818	0.0%	845		0.0%				
Zone 6	Night	970	0.2%	-0.24	Not Significant	543	0.0%	0.00	Not Significant	533	0.0%	0.00	Not Significant
	Base	642	0.2%		634	0.0%	645		0.0%				

* The percentage of stuck-on calls is computed based on the total number of calls placed by the VD system

4.3 SUMMARY VDS PERFORMANCE IN DIFFERENT ILLUMINATION CONDITIONS

A summary of the VDS performance in the 5 conditions presented in this report (base, dawn, sunny morning, dusk, and night) is included in this section. Results are shown in both graphical and table form, indicating for the three VDS the general performance at the stop bar zones and advance zones separated. The reader will observe the general picture of the VDS performance on each condition from the graphical representation of the errors, where the maximum and minimum values are shown to illustrate the range of errors in the three systems. This glance to the error range could be used by VDS users to observe in general terms potential strengths and critical errors on each zone and illumination condition.

4.3.1 False Calls

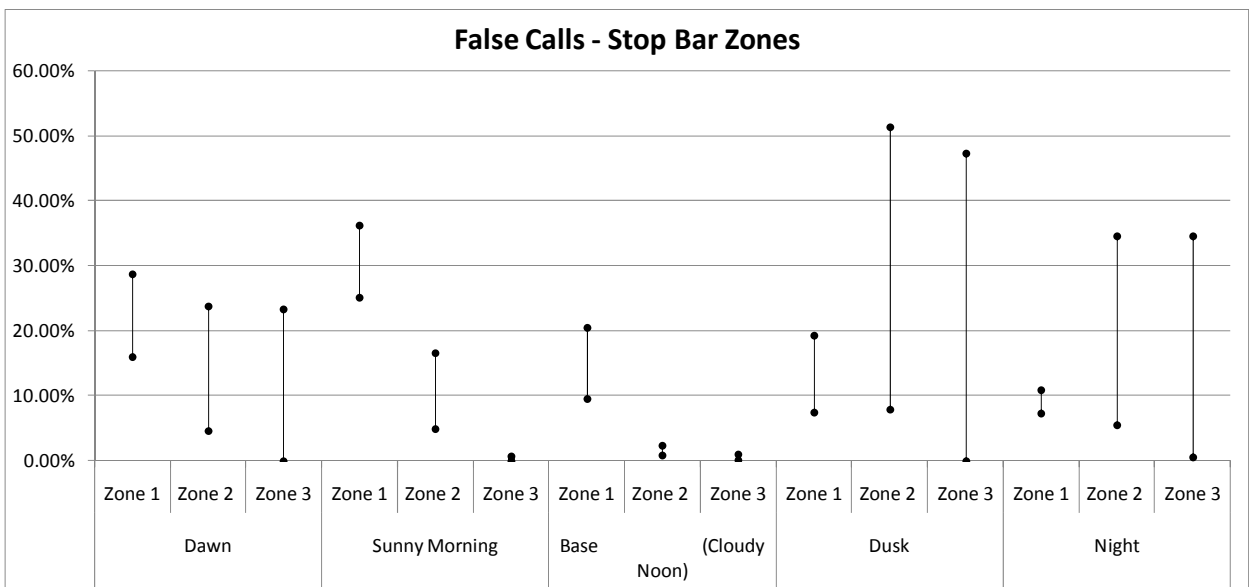


Figure 4.8. Summary false calls at stop bar zones.

Table 4.31. Summary False Calls at Stop Bar Zones

Error Type	Condition	Zone	Autoscope	Peek	Iteris
False Calls	Dawn	Zone 1	16.05%	28.71%	27.72%
		Zone 2	23.85%	4.67%	5.10%
		Zone 3	23.36%	0.00%	2.53%
	Sunny Morning	Zone 1	25.18%	30.59%	36.18%
		Zone 2	4.98%	6.78%	16.67%
		Zone 3	0.63%	0.27%	0.00%
	Base (Cloudy Noon)	Zone 1	9.50%	20.49%	15.12%
		Zone 2	0.85%	1.00%	2.35%
		Zone 3	0.97%	0.16%	0.18%
	Dusk	Zone 1	7.41%	19.27%	11.83%
		Zone 2	51.43%	7.94%	10.53%
		Zone 3	47.33%	0.00%	0.97%
	Night	Zone 1	9.29%	7.37%	10.97%
		Zone 2	34.65%	13.75%	5.46%
		Zone 3	34.62%	0.51%	3.30%

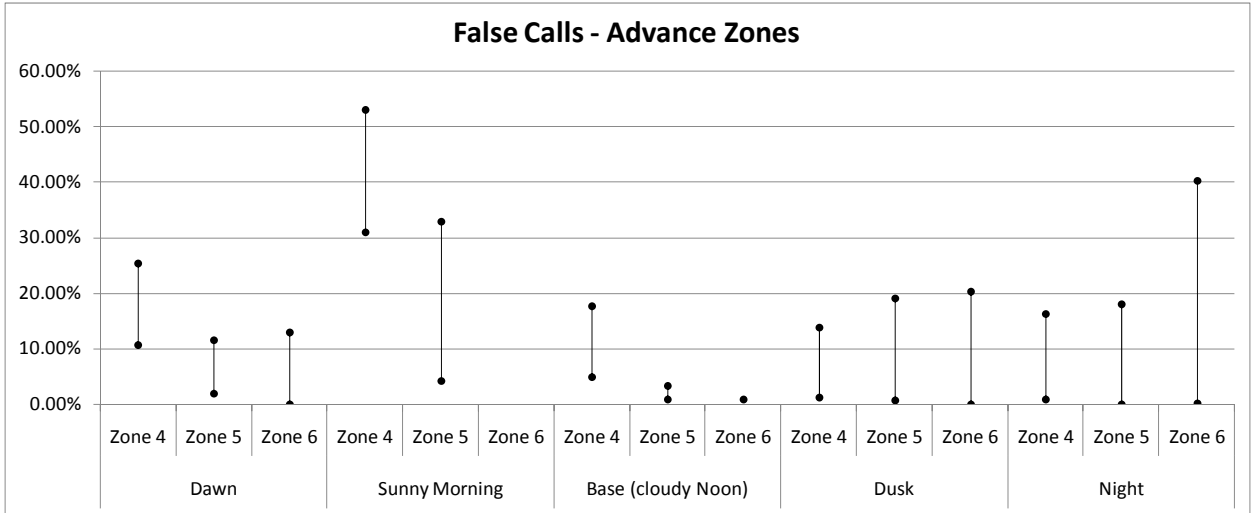


Figure 4.9. Summary false calls at advance zones.

Table 4.32. Summary False Calls at Advance Zones

Error Type	Condition	Zone	Autoscopy	Peek	Iiteris
False Calls	Dawn	Zone 4	10.61%	14.63%	25.45%
		Zone 5	11.54%	1.94%	5.04%
		Zone 6	13.00%	0.00%	1.18%
	Sunny Morning	Zone 4	47.57%	31.07%	53.15%
		Zone 5	32.82%	4.26%	32.88%
		Zone 6	0.00%	0.00%	0.00%
	Base (Cloudy Noon)	Zone 4	4.85%	17.73%	12.00%
		Zone 5	0.89%	2.44%	3.31%
		Zone 6	0.31%	0.16%	0.93%
	Dusk	Zone 4	1.23%	2.62%	13.81%
		Zone 5	19.14%	0.75%	5.71%
		Zone 6	20.29%	0.00%	7.69%
	Night	Zone 4	0.90%	12.43%	16.27%
		Zone 5	18.06%	0.00%	2.66%
		Zone 6	40.31%	0.18%	0.38%

4.3.2 Stuck-on Calls

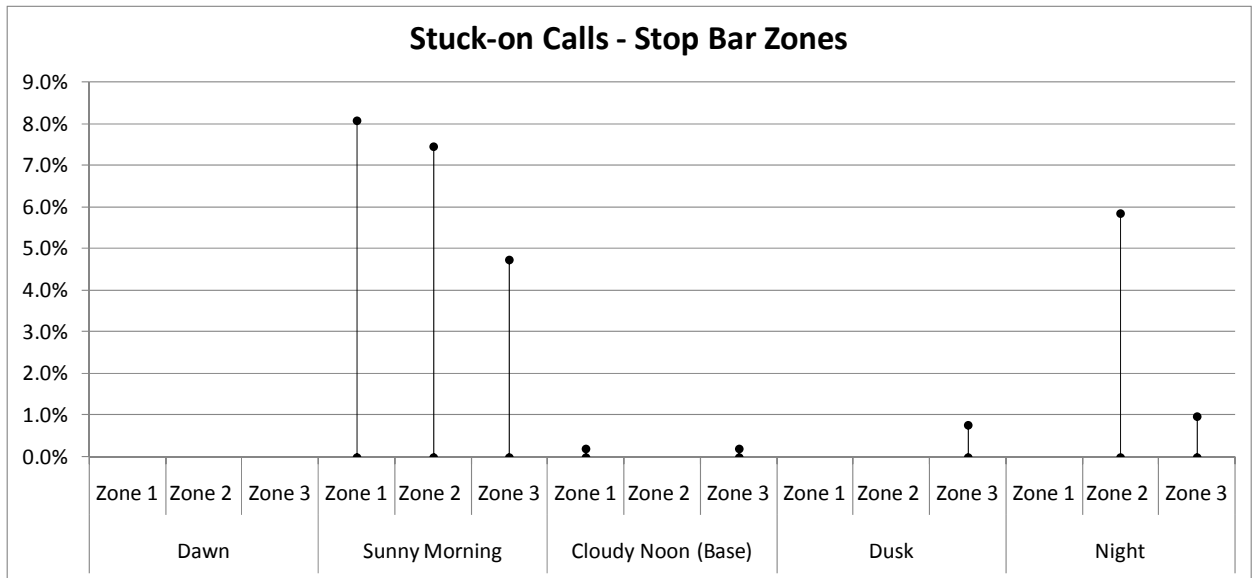


Figure 4.10. Summary stuck-on calls at stop bar zones.

Table 4.33. Summary Stuck-on Calls at Stop Bar Zones

Error Type	Condition	Zone	Autoscope	Peek	Iteris
Stuck-on Calls	Dawn	Zone 1	0.00%	0.00%	0.00%
		Zone 2	0.00%	0.00%	0.00%
		Zone 3	0.00%	0.00%	0.00%
	Sunny Morning	Zone 1	8.08%	1.47%	0.00%
		Zone 2	7.46%	1.03%	0.00%
		Zone 3	4.75%	0.00%	0.29%
	Cloudy Noon (Base)	Zone 1	0.21%	0.00%	0.00%
		Zone 2	0.00%	0.00%	0.00%
		Zone 3	0.19%	0.00%	0.00%
	Dusk	Zone 1	0.00%	0.00%	0.00%
		Zone 2	0.00%	0.00%	0.00%
		Zone 3	0.76%	0.00%	0.00%
	Night	Zone 1	0.00%	0.00%	0.00%
		Zone 2	0.28%	0.00%	5.85%
		Zone 3	0.14%	0.00%	0.97%

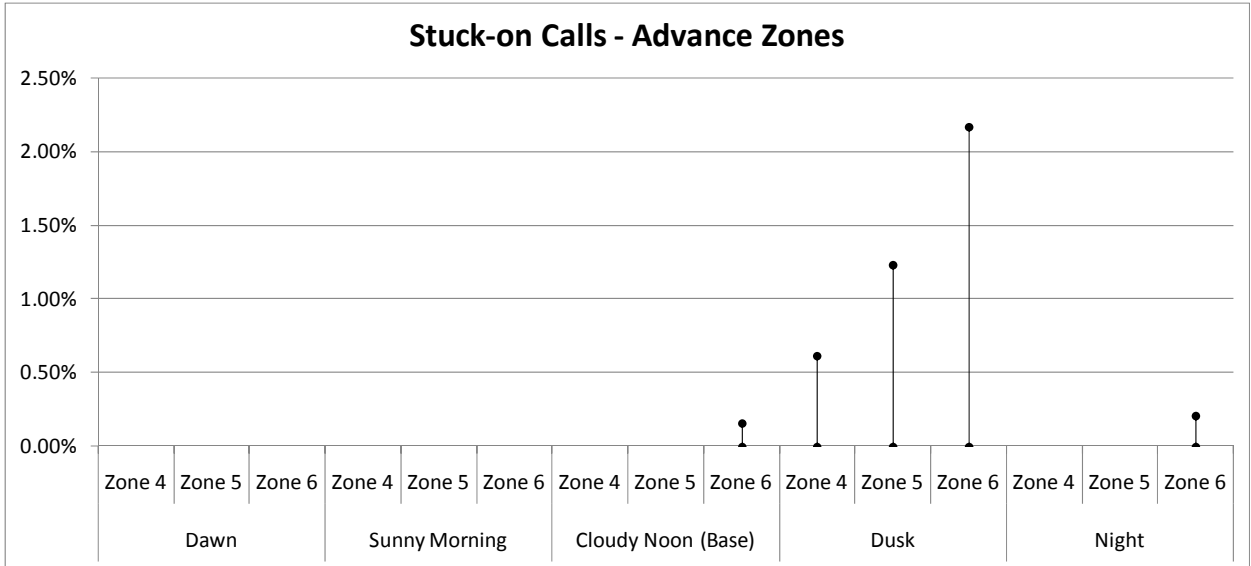


Figure 4.11. Summary stuck-on calls at advance zones.

Table 4.34. Summary Stuck-on Calls at Advance Zones

Error Type	Condition	Zone	Autoscope	Peek	Iiteris
Stuck-on Calls	Dawn	Zone 4	0.00%	0.00%	0.00%
		Zone 5	0.00%	0.00%	0.00%
		Zone 6	0.00%	0.00%	0.00%
	Sunny Morning	Zone 4	0.00%	0.00%	0.00%
		Zone 5	0.00%	0.00%	0.00%
		Zone 6	0.00%	0.00%	0.00%
	Cloudy Noon (Base)	Zone 4	0.00%	0.00%	0.00%
		Zone 5	0.00%	0.00%	0.00%
		Zone 6	0.16%	0.00%	0.00%
	Dusk	Zone 4	0.61%	0.00%	0.00%
		Zone 5	1.23%	0.00%	0.00%
		Zone 6	2.17%	0.00%	0.00%
	Night	Zone 4	0.00%	0.00%	0.00%
		Zone 5	0.00%	0.00%	0.00%
		Zone 6	0.21%	0.00%	0.00%

4.3.3 Missed Calls

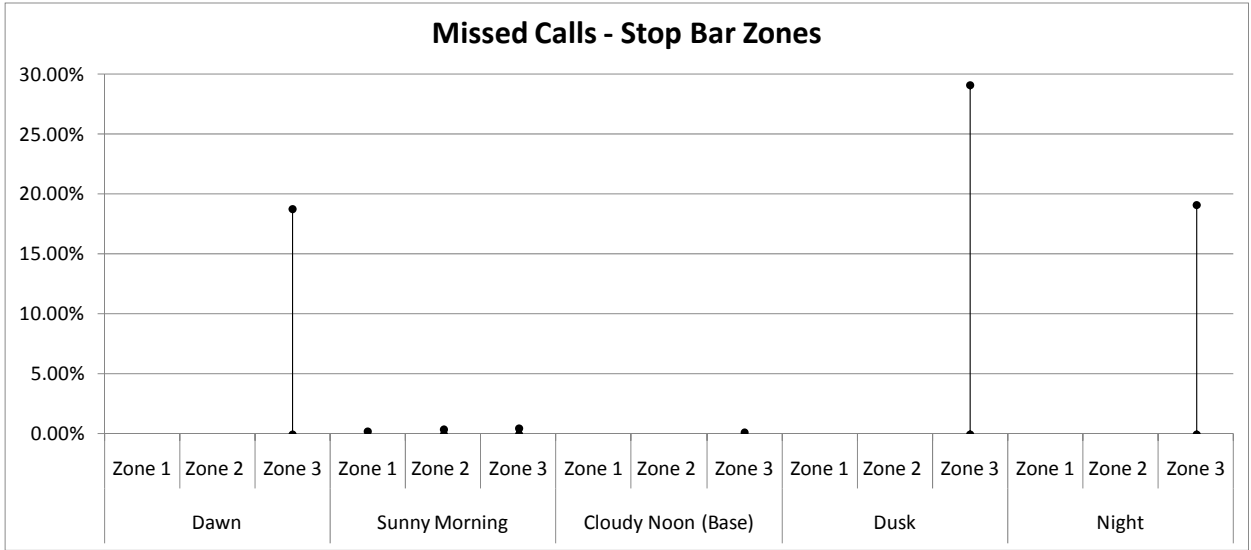


Figure 4.12. Summary missed calls at stop bar zones.

Table 4.35. Summary Missed Calls at Stop Bar Zones

Error Type	Condition	Zone	Autoscope	Peek	Iteris
Missed Calls	Dawn	Zone 1	0.00%	0.00%	0.00%
		Zone 2	0.00%	0.00%	0.00%
		Zone 3	0.00%	18.82%	0.00%
	Sunny Morning	Zone 1	0.00%	0.24%	0.00%
		Zone 2	0.00%	0.40%	0.00%
		Zone 3	0.00%	0.51%	0.00%
	Base (Cloudy Noon)	Zone 1	0.00%	0.00%	0.00%
		Zone 2	0.00%	0.00%	0.00%
		Zone 3	0.00%	0.15%	0.00%
	Dusk	Zone 1	0.00%	0.00%	0.00%
		Zone 2	0.00%	0.00%	0.00%
		Zone 3	0.00%	29.10%	0.00%
	Night	Zone 1	0.00%	0.00%	0.00%
		Zone 2	0.00%	0.00%	0.00%
		Zone 3	0.00%	19.11%	0.00%

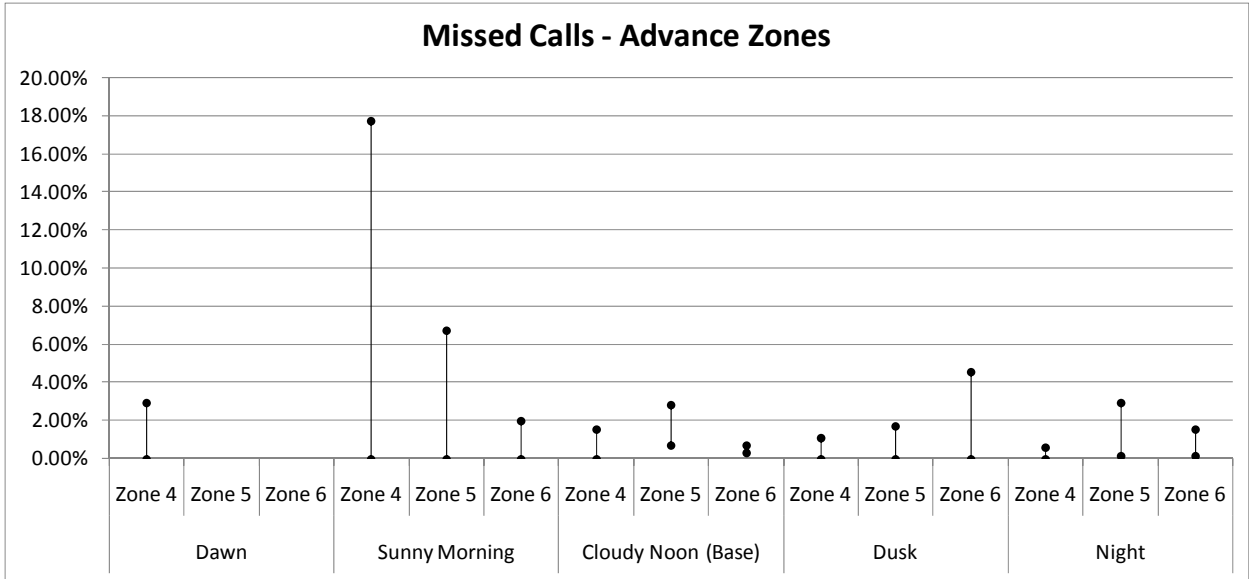


Figure 4.13. Summary missed calls at advance zones.

Table 4.36. Summary Missed Calls at Advance Zones

Error Type	Condition	Zone	Autoscope	Peek	Iteris
Missed Calls	Dawn	Zone 4	2.94%	1.47%	0.00%
		Zone 5	0.00%	0.00%	0.00%
		Zone 6	0.00%	0.00%	0.00%
	Sunny Morning	Zone 4	0.00%	17.74%	1.29%
		Zone 5	0.00%	6.74%	2.30%
		Zone 6	0.00%	2.02%	0.00%
	Base (Cloudy Noon)	Zone 4	1.56%	0.00%	1.17%
		Zone 5	0.71%	1.02%	2.84%
		Zone 6	0.73%	0.59%	0.29%
	Dusk	Zone 4	0.54%	1.09%	0.00%
		Zone 5	1.14%	1.71%	0.00%
		Zone 6	4.58%	0.76%	0.00%
	Night	Zone 4	0.00%	0.57%	0.00%
		Zone 5	0.15%	2.92%	0.15%
		Zone 6	0.17%	1.53%	0.17%

CHAPTER 5 FINDINGS AND CONCLUSIONS

5.1 BASE CONDITION (CLOUDY NOON)

The performance of video detection systems in both stop bar and advance locations was affected differently depending on the illumination conditions evaluated in this report. In the base condition (cloudy noon), when the illumination conditions were considered most favorable, no major concern was observed in terms of any of the four types of error, being the most prominent cause of error the image of tall vehicles falling on the adjacent lane and generating false calls. This situation was mainly observed in the left-most lane, where Zones 1 and 4 were located, with false calls between 9.5% and 20.5% in Zone 1, and between 4.9% and 17.7% in Zone 4, for all three VDS. For Zones 2 and 5 false calls were lower than 3.4%, and for Zones 3 and 6 they were lower than 1%. On the other hand, stuck-on calls were very rare accounting for only 0.2% of the calls or less for every zone and every system. Missed calls were very rare at stop bar zones (only one missed call in all three advance zones – 0.15% for that zone), but varied between 2.8% and 0% for all systems at the advance zones.

No dropped calls were observed in any system during any of the five illumination conditions evaluated in this report.

5.2 DAWN CONDITION

During dawn conditions at the stop bar zones, some increases in false calls were found in Autoscope Zone 2 (from 0.9% to 23.8%) and Zone 3 (from 1% to 23.4%) due to reflection of headlights from vehicles approaching on the adjacent lane, and in Iteris Zone 1 (from 15.1% to 31.3%) due to tall vehicles in the adjacent lane. Missed calls did not change significantly except for an increase in Peek Zone 3 (from 0.1% to 18.8%), and stuck-on calls did not change in any zone or system.

At the advance locations, the same pattern described for the stop bar zones was also observed, with increases in Autoscope Zone 5 (from 0.9% to 11.5%) and Zone 6 (from 0.3% to 13%), and increases in Iteris Zone 4 (from 12% to 25.5%). Missed calls decreased compared to the base condition, with no missed vehicles in Zones 5 and 6 for any system, and between 0% and 3% missed in Zone 4. Stuck-on calls did not change at the advance locations, similar to the trend observed for stop bar locations.

5.3 SUNNY MORNING CONDITION

At the stop bar locations, false calls increased for Zones 1 and 2 with errors between 25.2% and 36.2%, and between 5% and 16.7%, respectively. The increase in false calls was mainly due to shadows from adjacent vehicles, which also explains the unchanged level of false calls in Zone 3, given that no shadows fell over this zone. Regarding stuck-on calls, an increase was observed for Autoscope (from 0.1% to 6.9% for all three zones combined) and in lesser degree for Peek (from 0% to 0.9%), due to the shadow of the pole and mast arm from the crossing street. Missed calls, on the other hand were unaffected during sunny morning conditions compared to the base condition.

At the advance zones, shadows also increased false calls in Zones 4 and 5, with errors between 31.1% and 53.1%, and between 4.3% and 32.9%, respectively. Missed calls were affected differently in the three systems, with an overall decrease from 0.9% to 0% in Autoscope, an increase from 0.6% to 8.4% in Peek, and no changes in Iteris with 1.4% missed vehicles compared to 1.7% in the base condition. Stuck-on calls remained unchanged.

5.4 DUSK CONDITION

At the stop bar zones, false calls increased for Zone 2 in all three systems (from 0.9%-2.4% to 7.9%-51.4%) and also for Autoscope Zone 3 from 1% to 47.3%. These increases were mainly due to the reflection of headlights from vehicles approaching on the adjacent lane. Missed calls only changed in Peek Zone 3, where 29.1% of the vehicles were missed compared to only 0.1% in the base condition. Stuck-on calls remained unchanged in the dusk condition.

At the advance zones different trends were observed in terms of false calls. In Autoscope false calls increased in Zone 5 (from 0.9% to 19.1%) and Zone 6 (from 0.3% to 20.3%), and decreased in Zone 4 (from 4.9% to 1.2%). In Peek, a decrease was observed in Zone 4, from 17.7% to 2.6%, and in Iteris an increase was found in Zone 6, from 0.9% to 7.7%. Regarding missed calls, Zone 6 in Autoscope increased from 0.7% to 4.6%, and in Iteris Zones 4 and 5 decreased from 1.2% and 2.8% to none in the dusk condition. Stuck-on calls remained unchanged at the individual zone level.

5.5 NIGHT CONDITION

At the stop bar zones, false calls had different trends for all three systems. In Autoscope, false calls increased for Zones 2 and 3, from 0.9% and 1% to 34.7% and 34.6%, respectively. This increase was due to reflection of headlights from vehicles approaching on the adjacent lane. In Peek, an increase was found in Zone 2 (from 1% to 13.8%), and a decrease in false calls occurred in Zone 1 (from 20.5% to 7.4%). It is noted that when false calls from all three stop bar zones in Peek are combined, the net change compared to the base condition was not significantly different. In Iteris, small increases were observed in Zones 2 and 3, from 2.4% and 0.2% to 5.5% to 3.3%, respectively. Similar to Peek, when all three stop bar zones in Iteris are combined, the net change in false calls compared to the base condition was not significantly different.

Missed calls at the stop bar zones only changed significantly for Peek in Zone 3, where they increased from 0.1% to 19.1%. In terms of stuck-on calls, changes were only observed in Iteris, with an increase in Zone 2 and 3, from 0% in both zones, to 5.8% and 1%, respectively, during the night condition.

At the advance locations, false calls in Autoscope increased in Zone 5 (from 0.9% to 18.1%) and Zone 6 (from 0.3% to 40.3%) and decreased in Zone 4, from 4.9% to 0.9%. These changes were clearly due to the effect of headlights from vehicles approaching on the adjacent lane. On the other hand, in Peek false calls decreased in Zone 4 (from 17.7% to 12.4%) and Zone 5 (from 2.4% to 0%), and no changes were observed in Iteris in any of the advance zones.

Missed calls at the advance zones also changed differently for the three VDS in the night condition. For Autoscope, Zone 4 decreased missed calls from 1.6% to none. For Peek, Zone 5 increased from 1% to 2.9%, and for Iteris Zones 4 and 5 decreased from 1.7%

and 1.2% to 0.1% and 0%, respectively. Overall, for all systems if all advance zones are combined missed calls during nighttime were lower than 2%.

Stuck-on calls did not change significantly in any system or any zone during the night, and remained very low with only one occurrence.

It is noted that at stop bar locations false and stuck-on calls are expected to mainly affect the operation efficiency of the intersection, whereas missed calls may raise safety concerns because the VDS may fail in calling the controller phase, increasing the chances for red light running. In this sense, results indicate that low illumination and shadows mostly deteriorate operation efficiency of the intersection, with small potential for safety issues in very specific zones and systems, being this a specific and not a generalized effect in the performance of the VDS.

REFERENCES

- Chitturi, M., Medina, J.C., Benekohal, R.F. Accuracy of Video Detection Systems for Traffic Counting. Proceedings of the 2007 ITE International Annual Meeting and Exhibit, August 5th -8th, 2007.
- Grenard, J., D. Bullock, and A. Tarko. *Evaluation of Selected Video Detection Systems at Signalized Intersections*. Publication Rep. FHWA/IN/JTRP-2001/22. Purdue University, West Lafayette, IN, 2001.
- MacCarley, A. *City of Anaheim/Caltrans/FHWA Advanced Traffic Control System Field Operational Test Evaluation: Task C Video Traffic Detection System*. California Polytechnic State University, San Luis Obispo, CA, 1998.
- MnDOT and SRF Consulting Group Inc. *Evaluation of Non-intrusive Technologies for Traffic Detection. Evaluation Test Plan*. Vol. 1, Minneapolis, MN, 2001.
- Rhodes A., K. Jennings, and D. Bullock. Consistencies of Video Detection Activation and De-activation Times Between Day and Night Periods, *Journal of Transportation Engineering, ASCE*. Vol. 133, No. 9, 2007, pp. 505-512.
- Rhodes, A., E.J Smaglik, and D. Bullock. *Vendor Comparison of Video Detection Systems*. Publication Rep. FHWA/IN/JTRP-2005/30. Purdue University, West Lafayette, IN, 2006.
- Rhodes, A., E.J Smaglik, D. Bullock, and J. Sturdevant. Operational Performance Comparison of Video Detection Systems. Proceedings of the 2007 ITE International Annual Meeting and Exhibit, Pittsburgh, PA, Institute of Transportation Engineers, August 5-8, 2007.

APPENDIX A. DAILY VARIATION OF VIDEO DETECTION PERFORMANCE

As explained in Chapter 4, performance from the Base Condition (Cloudy Noon) was compared with the performance of different illumination conditions (dawn, sunny morning, dusk, and night). The duration and number of data sets from each condition could vary from one condition to the other, but the lighting and weather conditions to be evaluated remained very similar throughout all the selected data. Thus, the VDS performance was analyzed when all data sets from a given condition were aggregated into one single data set. In this Appendix, the VDS performance is presented on a day-by-day basis, so it is possible to observe the daily variation of the performance measures for each of three the systems. To do this, tables with the actual percentage of the four types of error from each day, and in each detection zone are provided. Also, a graphical representation indicating the variation range (maximum and minimum) and the average percentage for all types of errors in all detection zones are included for an easier interpretation of the data.

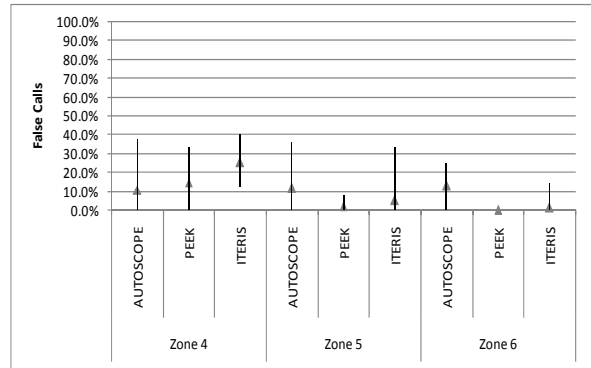
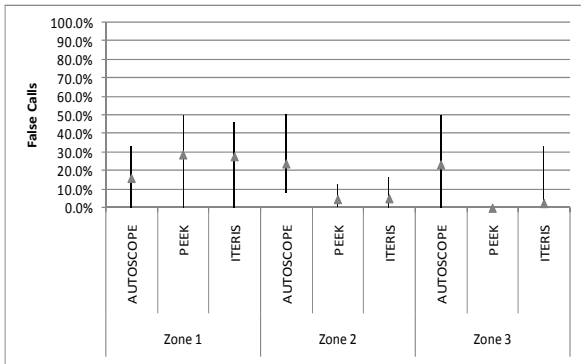
Dawn Condition

False Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	66.7%	100.0%	ZONE 4	DAY 1	0.0%	33.3%	33.3%
	DAY 2	30.0%	46.2%	46.2%		DAY 2	14.3%	30.0%	25.0%
	DAY 3	0.0%	11.1%	11.1%		DAY 3	12.5%	0.0%	14.3%
	DAY 4	14.3%	22.2%	12.5%		DAY 4	0.0%	14.3%	28.6%
	DAY 5	33.3%	42.9%	33.3%		DAY 5	25.0%	20.0%	33.3%
	DAY 6	25.0%	50.0%	46.2%		DAY 6	16.7%	22.2%	17.6%
	DAY 7	12.5%	22.2%	30.0%		DAY 7	0.0%	0.0%	12.5%
	DAY 8	22.2%	22.2%	22.2%		DAY 8	37.5%	33.3%	40.0%
	DAY 9	6.3%	0.0%	0.0%		DAY 9	0.0%	0.0%	31.8%
	DAY 10	14.3%	36.4%	45.5%		DAY 10	0.0%	12.5%	27.3%
ZONE 2	DAY 1	8.3%	0.0%	0.0%	ZONE 5	DAY 1	8.3%	0.0%	0.0%
	DAY 2	18.8%	7.7%	7.7%		DAY 2	18.8%	0.0%	6.7%
	DAY 3	38.5%	12.5%	0.0%		DAY 3	10.0%	0.0%	0.0%
	DAY 4	33.3%	0.0%	0.0%		DAY 4	10.0%	0.0%	0.0%
	DAY 5	11.1%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	11.1%	0.0%	0.0%		DAY 6	4.3%	0.0%	0.0%
	DAY 7	28.6%	9.1%	9.1%		DAY 7	7.1%	7.7%	7.1%
	DAY 8	12.5%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	50.0%	0.0%	16.7%		DAY 9	35.7%	0.0%	33.3%
	DAY 10	25.0%	10.0%	13.3%		DAY 10	11.8%	7.1%	6.3%
ZONE 3	DAY 1	33.3%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.0%
	DAY 2	10.0%	0.0%	0.0%		DAY 2	25.0%	0.0%	0.0%
	DAY 3	25.0%	0.0%	0.0%		DAY 3	18.2%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	22.2%	0.0%	0.0%		DAY 5	22.2%	0.0%	14.3%
	DAY 6	35.7%	0.0%	0.0%		DAY 6	10.0%	0.0%	0.0%
	DAY 7	6.7%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	25.0%	0.0%	0.0%		DAY 8	22.2%	0.0%	0.0%
	DAY 9	50.0%	0.0%	33.3%		DAY 9	20.0%	0.0%	0.0%
	DAY 10	25.0%	0.0%	0.0%		DAY 10	13.3%	0.0%	0.0%

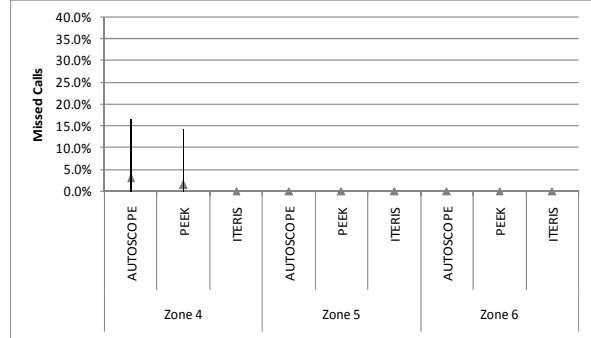
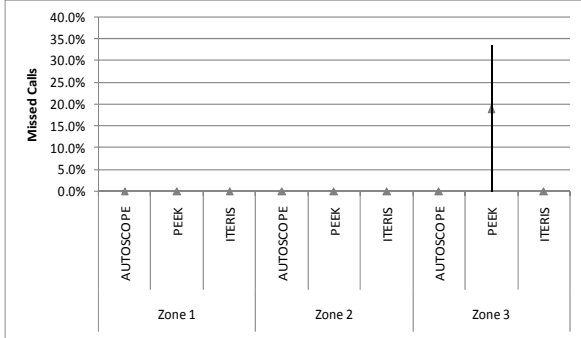


Missed Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	14.3%	14.3%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	16.7%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	33.3%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	11.1%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	33.3%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	14.3%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	11.1%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	26.7%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	33.3%	0.0%		DAY 10	0.0%	0.0%	0.0%

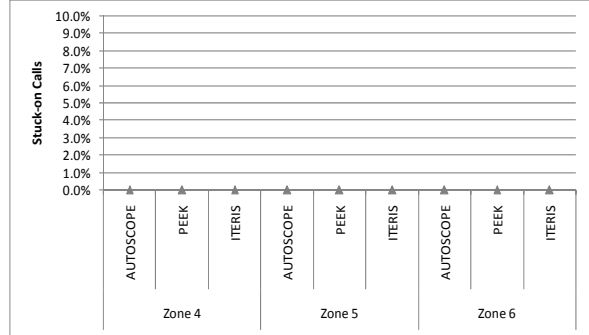
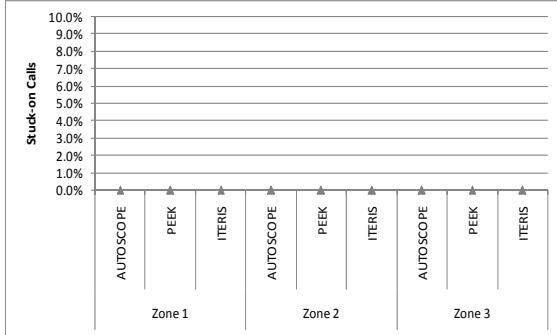


Stuck-on Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%



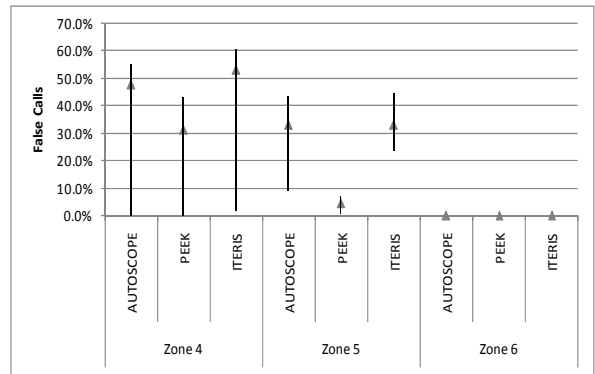
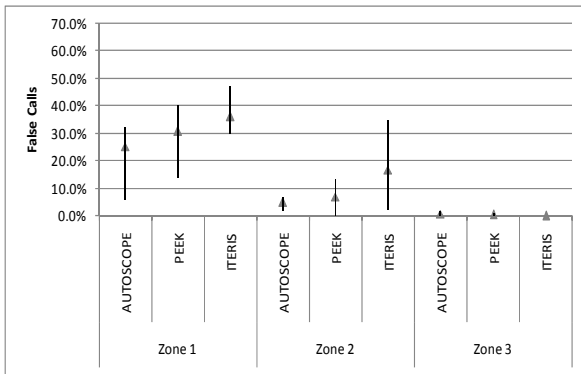
Sunny Morning Condition

False Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	24.1%	13.9%	32.6%	ZONE 4	DAY 1	42.8%	20.3%	46.4%
	DAY 2	30.9%	33.3%	35.2%		DAY 2	55.4%	24.3%	49.6%
	DAY 3	25.0%	34.5%	30.0%		DAY 3	50.8%	43.1%	55.6%
	DAY 4	32.2%	40.2%	36.6%		DAY 4	53.8%	40.0%	60.8%
	DAY 5	6.0%	28.8%	47.1%		DAY 5	0.0%	0.0%	1.9%
ZONE 2	DAY 1	4.4%	1.0%	2.2%	ZONE 5	DAY 1	25.0%	1.0%	26.6%
	DAY 2	6.9%	2.1%	5.6%		DAY 2	31.3%	2.2%	23.5%
	DAY 3	4.8%	12.0%	24.4%		DAY 3	40.2%	6.6%	44.6%
	DAY 4	5.8%	13.4%	12.7%		DAY 4	43.2%	7.3%	35.5%
	DAY 5	1.8%	0.0%	35.0%		DAY 5	9.0%	3.6%	26.6%
ZONE 3	DAY 1	1.9%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	1.1%	0.9%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%

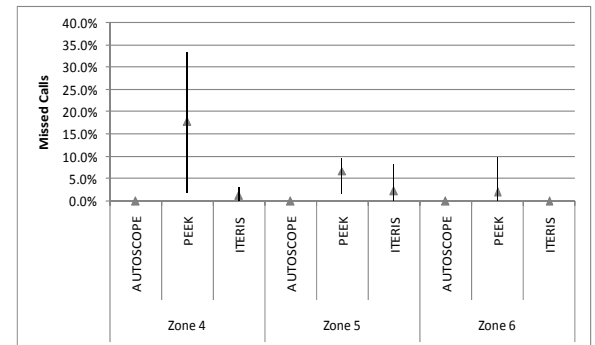
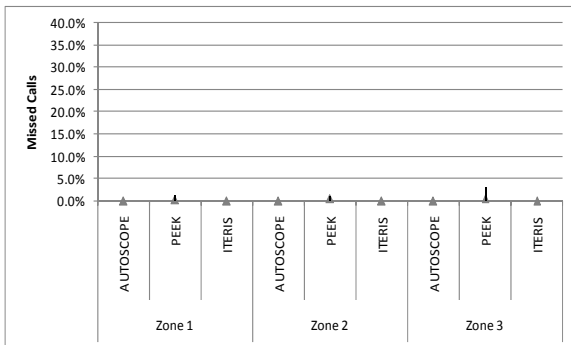


Missed Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	1.8%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	3.4%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	33.3%	3.0%
	DAY 4	0.0%	1.3%	0.0%		DAY 4	0.0%	27.8%	2.8%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	24.5%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	1.6%	1.6%
	DAY 2	0.0%	1.0%	0.0%		DAY 2	0.0%	7.4%	8.3%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	9.5%	0.6%
	DAY 4	0.0%	0.9%	0.0%		DAY 4	0.0%	8.1%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	5.5%	2.7%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	1.2%	0.0%		DAY 2	0.0%	1.2%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	2.5%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	1.0%	0.0%
	DAY 5	0.0%	3.1%	0.0%		DAY 5	0.0%	9.7%	0.0%

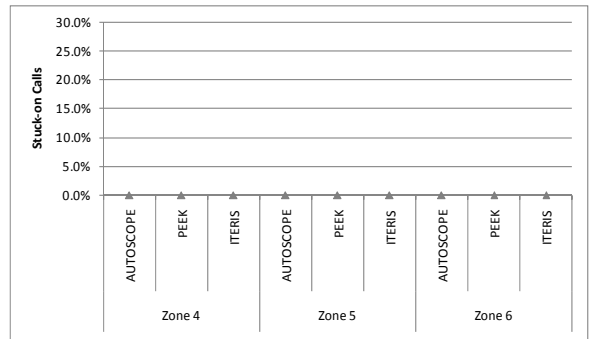
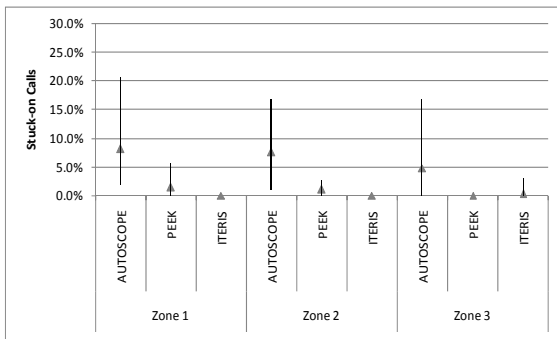


Stuck-on Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	1.8%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	0.0%
	DAY 2	3.7%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	20.5%	5.6%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	10.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	4.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
ZONE 2	DAY 1	1.1%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	2.3%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	16.7%	2.6%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	14.0%	1.7%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	1.8%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.0%
	DAY 2	1.3%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	3.4%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	8.6%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	16.7%	0.0%	3.0%		DAY 5	0.0%	0.0%	0.0%



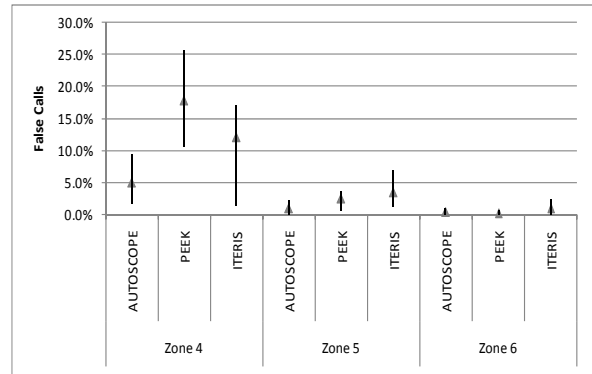
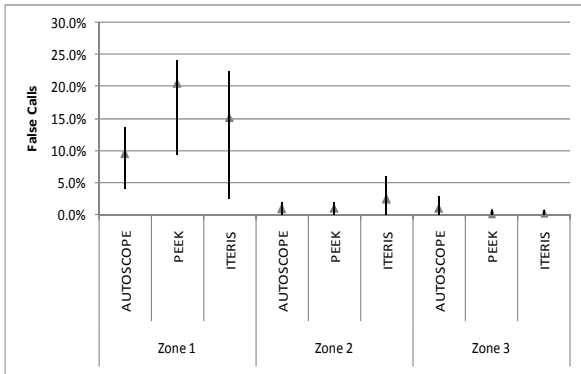
Cloudy Noon Condition

False Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	13.5%	23.9%	21.4%	ZONE 4	DAY 1	4.7%	25.5%	16.9%
	DAY 2	6.4%	23.7%	13.1%		DAY 2	5.9%	14.4%	11.2%
	DAY 3	3.9%	9.4%	2.5%		DAY 3	1.7%	10.4%	1.4%
	DAY 4	9.5%	17.7%	11.4%		DAY 4	1.8%	16.2%	9.9%
	DAY 5	12.4%	23.6%	22.2%		DAY 5	9.3%	18.5%	16.0%
ZONE 2	DAY 1	0.8%	0.6%	2.9%	ZONE 5	DAY 1	2.3%	3.6%	1.5%
	DAY 2	1.8%	1.6%	5.8%		DAY 2	1.3%	2.7%	6.9%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	1.4%	2.7%
	DAY 4	0.8%	2.0%	0.8%		DAY 4	0.0%	3.6%	4.8%
	DAY 5	0.8%	0.7%	2.3%		DAY 5	0.6%	0.6%	1.1%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.7%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.8%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.7%	0.8%	0.7%
	DAY 4	2.8%	0.8%	0.0%		DAY 4	0.0%	0.0%	2.4%
	DAY 5	1.6%	0.0%	0.8%		DAY 5	0.0%	0.0%	0.6%

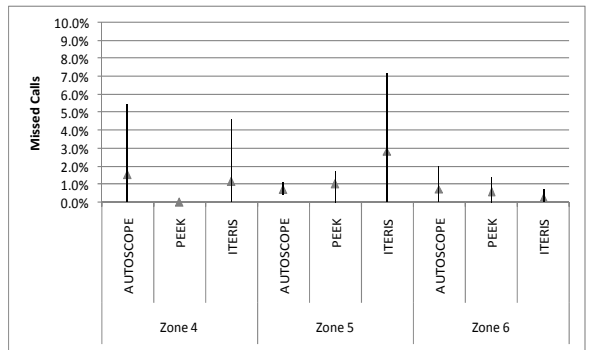
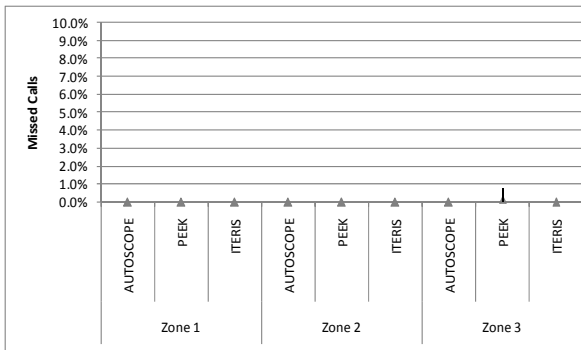


Missed Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.9%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.9%	0.0%	4.6%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	5.4%	0.0%	1.4%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	2.0%	0.0%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.4%	0.4%	1.3%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	1.1%	0.0%	3.4%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.6%	1.7%	2.9%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.5%	1.5%	7.2%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	1.0%	1.5%	0.0%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	2.0%	0.0%	0.0%
	DAY 2	0.0%	0.8%	0.0%		DAY 2	1.5%	0.8%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	1.4%	0.7%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.7%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.6%	0.0%

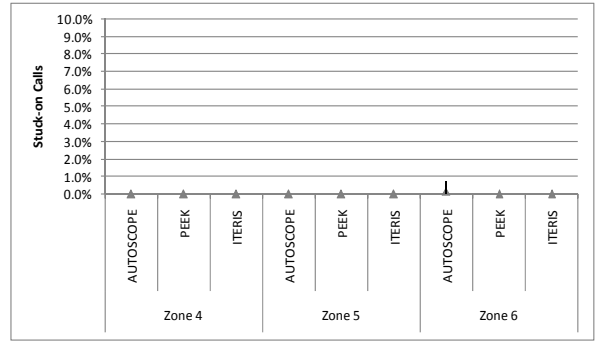
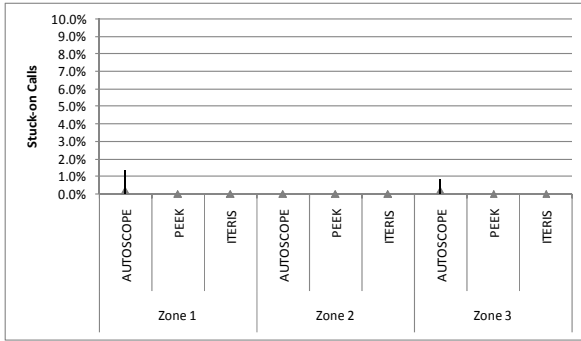


Stuck-on Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	1.3%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	0.7%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.8%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%



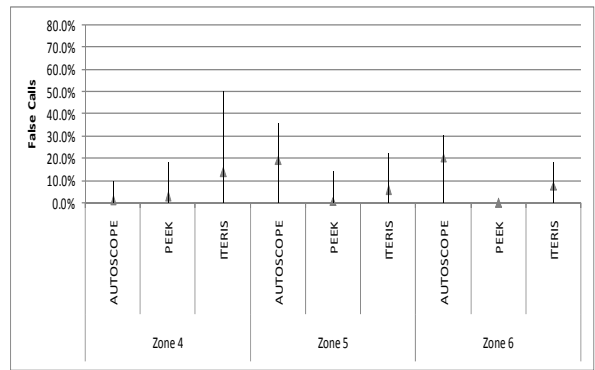
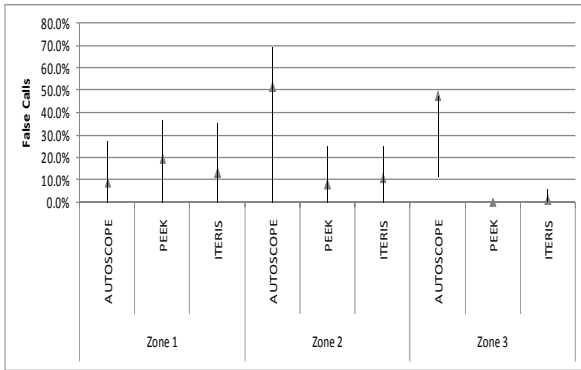
Dusk Condition

False Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	50.0%
	DAY 2	0.0%	27.3%	10.0%		DAY 2	0.0%	0.0%	12.5%
	DAY 3	0.0%	30.0%	11.1%		DAY 3	0.0%	0.0%	14.3%
	DAY 4	22.2%	36.4%	12.5%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	11.1%	30.8%	10.0%		DAY 5	0.0%	0.0%	22.2%
	DAY 6	10.0%	20.0%	35.7%		DAY 6	0.0%	12.5%	12.5%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	22.2%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	22.2%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	27.3%	0.0%		DAY 10	0.0%	0.0%	0.0%
	DAY 11	0.0%	23.1%	27.3%		DAY 11	10.0%	10.0%	35.3%
	DAY 12	9.1%	0.0%	16.7%		DAY 12	0.0%	0.0%	15.4%
	DAY 13	25.0%	30.0%	25.0%		DAY 13	0.0%	18.2%	23.1%
	DAY 14	25.0%	20.0%	33.3%		DAY 14	0.0%	7.7%	12.5%
	DAY 15	0.0%	50.0%	12.5%		DAY 15	0.0%	0.0%	0.0%
	DAY 16	27.3%	0.0%	0.0%		DAY 16	0.0%	0.0%	0.0%
	DAY 17	12.5%	10.0%	22.2%		DAY 17	0.0%	0.0%	27.3%
	DAY 18	0.0%	0.0%	7.1%		DAY 18	0.0%	0.0%	9.1%
	DAY 19	9.1%	26.7%	0.0%		DAY 19	7.7%	0.0%	7.1%
	DAY 20	0.0%	15.4%	12.5%		DAY 20	0.0%	0.0%	0.0%
ZONE 2	DAY 1	11.1%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	40.0%	11.1%	14.3%		DAY 2	18.2%	0.0%	0.0%
	DAY 3	28.6%	0.0%	0.0%		DAY 3	8.3%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	5.0%	0.0%	0.0%
	DAY 5	16.7%	0.0%	0.0%		DAY 5	6.3%	0.0%	0.0%
	DAY 6	60.0%	25.0%	25.0%		DAY 6	10.0%	14.3%	22.2%
	DAY 7	25.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	6.7%
	DAY 8	50.0%	14.3%	0.0%		DAY 8	27.3%	0.0%	0.0%
	DAY 9	21.4%	8.3%	7.1%		DAY 9	5.9%	0.0%	0.0%
	DAY 10	14.3%	6.7%	7.7%		DAY 10	10.0%	0.0%	0.0%
	DAY 11	5.9%	0.0%	0.0%		DAY 11	0.0%	0.0%	8.3%
	DAY 12	18.8%	0.0%	0.0%		DAY 12	4.5%	0.0%	0.0%
	DAY 13	16.7%	0.0%	0.0%		DAY 13	0.0%	0.0%	0.0%
	DAY 14	33.3%	0.0%	0.0%		DAY 14	7.1%	0.0%	0.0%
	DAY 15	0.0%	0.0%	0.0%		DAY 15	5.6%	0.0%	11.5%
	DAY 16	69.2%	0.0%	16.7%		DAY 16	35.7%	0.0%	0.0%
	DAY 17	40.0%	6.3%	0.0%		DAY 17	23.5%	0.0%	5.3%
	DAY 18	37.5%	6.7%	21.4%		DAY 18	12.0%	0.0%	0.0%
	DAY 19	33.3%	10.0%	15.8%		DAY 19	9.5%	0.0%	3.8%
	DAY 20	25.0%	0.0%	0.0%		DAY 20	8.7%	0.0%	0.0%
ZONE 3	DAY 1	20.0%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	7.1%
	DAY 2	11.1%	0.0%	0.0%		DAY 2	18.2%	0.0%	9.1%
	DAY 3	14.3%	0.0%	0.0%		DAY 3	7.7%	0.0%	0.0%
	DAY 4	22.2%	0.0%	0.0%		DAY 4	14.3%	0.0%	0.0%
	DAY 5	14.3%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	30.8%	0.0%	0.0%		DAY 6	15.4%	0.0%	9.1%
	DAY 7	23.1%	0.0%	0.0%		DAY 7	0.0%	0.0%	18.2%
	DAY 8	22.2%	0.0%	0.0%		DAY 8	8.3%	0.0%	0.0%
	DAY 9	30.8%	0.0%	0.0%		DAY 9	0.0%	0.0%	6.7%
	DAY 10	20.0%	0.0%	0.0%		DAY 10	11.8%	0.0%	5.6%
	DAY 11	28.6%	0.0%	0.0%		DAY 11	7.7%	0.0%	7.1%
	DAY 12	23.1%	0.0%	0.0%		DAY 12	0.0%	0.0%	0.0%
	DAY 13	16.7%	0.0%	0.0%		DAY 13	8.3%	0.0%	0.0%
	DAY 14	15.4%	0.0%	0.0%		DAY 14	0.0%	0.0%	0.0%
	DAY 15	29.4%	0.0%	0.0%		DAY 15	23.5%	0.0%	0.0%
	DAY 16	35.7%	0.0%	0.0%		DAY 16	18.2%	0.0%	0.0%
	DAY 17	46.2%	0.0%	0.0%		DAY 17	30.8%	0.0%	0.0%
	DAY 18	25.0%	0.0%	0.0%		DAY 18	10.0%	0.0%	0.0%
	DAY 19	21.1%	0.0%	0.0%		DAY 19	20.8%	0.0%	5.6%
	DAY 20	17.6%	0.0%	5.9%		DAY 20	0.0%	0.0%	0.0%

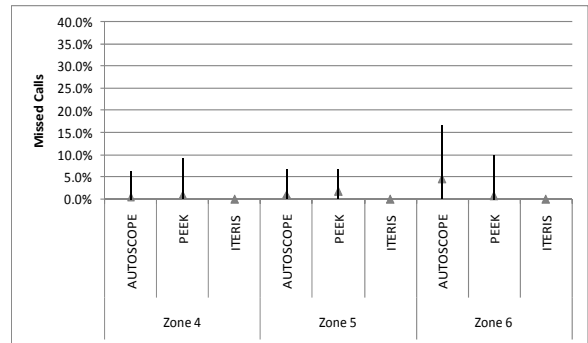
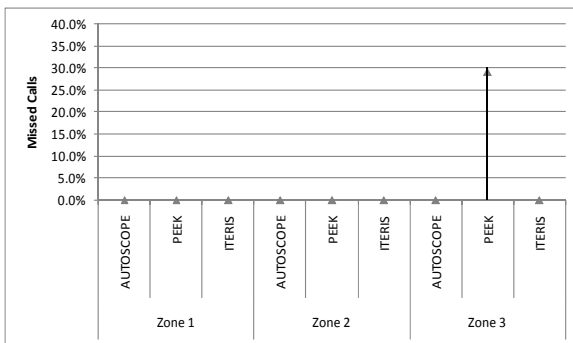


Missed Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
	DAY 11	0.0%	0.0%	0.0%		DAY 11	0.0%	9.1%	0.0%
	DAY 12	0.0%	0.0%	0.0%		DAY 12	0.0%	0.0%	0.0%
	DAY 13	0.0%	0.0%	0.0%		DAY 13	0.0%	0.0%	0.0%
	DAY 14	0.0%	0.0%	0.0%		DAY 14	0.0%	0.0%	0.0%
	DAY 15	0.0%	0.0%	0.0%		DAY 15	0.0%	0.0%	0.0%
	DAY 16	0.0%	0.0%	0.0%		DAY 16	0.0%	0.0%	0.0%
	DAY 17	0.0%	0.0%	0.0%		DAY 17	0.0%	0.0%	0.0%
	DAY 18	0.0%	0.0%	0.0%		DAY 18	0.0%	9.1%	0.0%
	DAY 19	0.0%	0.0%	0.0%		DAY 19	0.0%	0.0%	0.0%
	DAY 20	0.0%	0.0%	0.0%		DAY 20	6.3%	0.0%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	6.7%	6.7%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
	DAY 11	0.0%	0.0%	0.0%		DAY 11	0.0%	0.0%	0.0%
	DAY 12	0.0%	0.0%	0.0%		DAY 12	0.0%	0.0%	0.0%
	DAY 13	0.0%	0.0%	0.0%		DAY 13	0.0%	0.0%	0.0%
	DAY 14	0.0%	0.0%	0.0%		DAY 14	0.0%	0.0%	0.0%
	DAY 15	0.0%	0.0%	0.0%		DAY 15	0.0%	3.6%	0.0%
	DAY 16	0.0%	0.0%	0.0%		DAY 16	0.0%	0.0%	0.0%
	DAY 17	0.0%	0.0%	0.0%		DAY 17	0.0%	0.0%	0.0%
	DAY 18	0.0%	0.0%	0.0%		DAY 18	0.0%	0.0%	0.0%
	DAY 19	0.0%	0.0%	0.0%		DAY 19	0.0%	4.3%	0.0%
	DAY 20	0.0%	0.0%	0.0%		DAY 20	3.6%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	9.1%	0.0%		DAY 2	9.1%	0.0%	0.0%
	DAY 3	0.0%	11.8%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	12.5%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	7.7%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	10.0%	0.0%		DAY 6	0.0%	10.0%	0.0%
	DAY 7	0.0%	27.3%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	20.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	5.9%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	18.8%	0.0%		DAY 10	0.0%	0.0%	0.0%
	DAY 11	0.0%	7.7%	0.0%		DAY 11	0.0%	0.0%	0.0%
	DAY 12	0.0%	0.0%	0.0%		DAY 12	0.0%	0.0%	0.0%
	DAY 13	0.0%	7.1%	0.0%		DAY 13	0.0%	0.0%	0.0%
	DAY 14	0.0%	16.7%	0.0%		DAY 14	0.0%	0.0%	0.0%
	DAY 15	0.0%	13.3%	0.0%		DAY 15	0.0%	0.0%	0.0%
	DAY 16	0.0%	30.0%	0.0%		DAY 16	16.7%	0.0%	0.0%
	DAY 17	0.0%	27.3%	0.0%		DAY 17	0.0%	0.0%	0.0%
	DAY 18	0.0%	9.5%	0.0%		DAY 18	0.0%	0.0%	0.0%
	DAY 19	0.0%	28.6%	0.0%		DAY 19	5.3%	0.0%	0.0%
	DAY 20	0.0%	12.0%	0.0%		DAY 20	7.7%	0.0%	0.0%

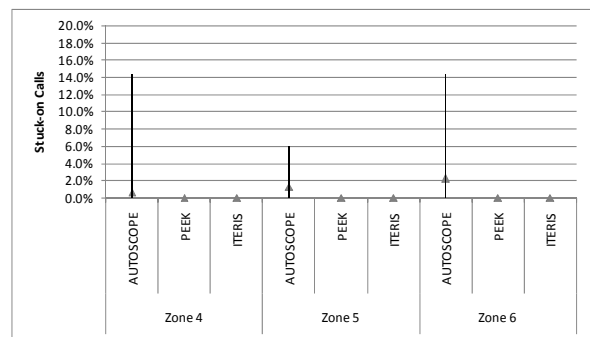
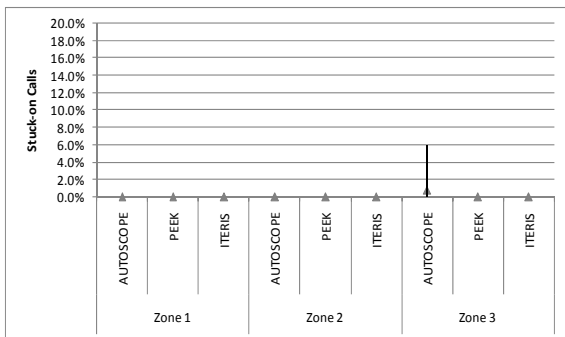


Stuck-on Calls

Stop Bar Zones

Advance Zones

Stop Bar Zones					Advance Zones				
		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
	DAY 11	0.0%	0.0%	0.0%		DAY 11	0.0%	0.0%	0.0%
	DAY 12	0.0%	0.0%	0.0%		DAY 12	0.0%	0.0%	0.0%
	DAY 13	0.0%	0.0%	0.0%		DAY 13	0.0%	0.0%	0.0%
	DAY 14	0.0%	0.0%	0.0%		DAY 14	0.0%	0.0%	0.0%
	DAY 15	0.0%	0.0%	0.0%		DAY 15	0.0%	0.0%	0.0%
	DAY 16	0.0%	0.0%	0.0%		DAY 16	0.0%	0.0%	0.0%
	DAY 17	0.0%	0.0%	0.0%		DAY 17	14.3%	0.0%	0.0%
	DAY 18	0.0%	0.0%	0.0%		DAY 18	0.0%	0.0%	0.0%
	DAY 19	0.0%	0.0%	0.0%		DAY 19	0.0%	0.0%	0.0%
	DAY 20	0.0%	0.0%	0.0%		DAY 20	0.0%	0.0%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
	DAY 11	0.0%	0.0%	0.0%		DAY 11	5.9%	0.0%	0.0%
	DAY 12	0.0%	0.0%	0.0%		DAY 12	0.0%	0.0%	0.0%
	DAY 13	0.0%	0.0%	0.0%		DAY 13	0.0%	0.0%	0.0%
	DAY 14	0.0%	0.0%	0.0%		DAY 14	0.0%	0.0%	0.0%
	DAY 15	0.0%	0.0%	0.0%		DAY 15	5.6%	0.0%	0.0%
	DAY 16	0.0%	0.0%	0.0%		DAY 16	0.0%	0.0%	0.0%
	DAY 17	0.0%	0.0%	0.0%		DAY 17	0.0%	0.0%	0.0%
	DAY 18	0.0%	0.0%	0.0%		DAY 18	0.0%	0.0%	0.0%
	DAY 19	0.0%	0.0%	0.0%		DAY 19	0.0%	0.0%	0.0%
	DAY 20	0.0%	0.0%	0.0%		DAY 20	0.0%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	9.1%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	7.7%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	14.3%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
	DAY 6	0.0%	0.0%	0.0%		DAY 6	0.0%	0.0%	0.0%
	DAY 7	0.0%	0.0%	0.0%		DAY 7	0.0%	0.0%	0.0%
	DAY 8	0.0%	0.0%	0.0%		DAY 8	0.0%	0.0%	0.0%
	DAY 9	0.0%	0.0%	0.0%		DAY 9	0.0%	0.0%	0.0%
	DAY 10	0.0%	0.0%	0.0%		DAY 10	0.0%	0.0%	0.0%
	DAY 11	0.0%	0.0%	0.0%		DAY 11	0.0%	0.0%	0.0%
	DAY 12	0.0%	0.0%	0.0%		DAY 12	0.0%	0.0%	0.0%
	DAY 13	0.0%	0.0%	0.0%		DAY 13	0.0%	0.0%	0.0%
	DAY 14	0.0%	0.0%	0.0%		DAY 14	0.0%	0.0%	0.0%
	DAY 15	0.0%	0.0%	0.0%		DAY 15	0.0%	0.0%	0.0%
	DAY 16	0.0%	0.0%	0.0%		DAY 16	0.0%	0.0%	0.0%
	DAY 17	0.0%	0.0%	0.0%		DAY 17	0.0%	0.0%	0.0%
	DAY 18	0.0%	0.0%	0.0%		DAY 18	0.0%	0.0%	0.0%
	DAY 19	0.0%	0.0%	0.0%		DAY 19	0.0%	0.0%	0.0%
	DAY 20	5.9%	0.0%	0.0%		DAY 20	0.0%	0.0%	0.0%



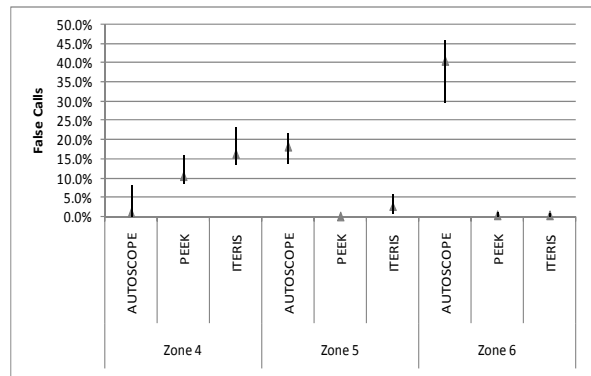
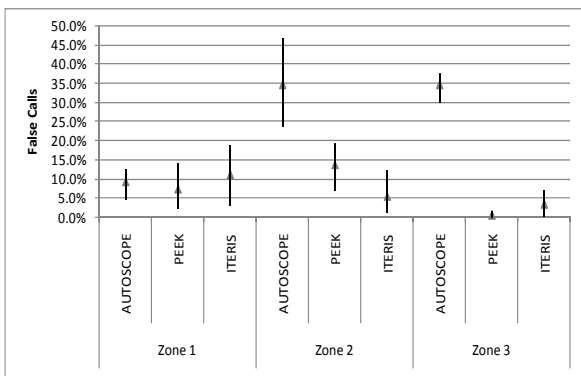
Night Condition

False Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	4.5%	14.1%	15.7%	ZONE 4	DAY 1	0.0%	13.6%	23.2%
	DAY 2	4.3%	2.1%	2.9%		DAY 2	0.0%	8.9%	17.2%
	DAY 3	11.9%	10.0%	11.9%		DAY 3	8.3%	14.3%	17.7%
	DAY 4	12.5%	12.5%	18.7%		DAY 4	1.8%	8.6%	15.5%
	DAY 5	10.9%	4.0%	8.5%		DAY 5	1.7%	15.8%	13.4%
ZONE 2	DAY 1	23.5%	8.7%	1.2%	ZONE 5	DAY 1	14.3%	0.0%	0.8%
	DAY 2	35.3%	19.4%	4.1%		DAY 2	21.6%	0.0%	5.8%
	DAY 3	31.1%	12.7%	3.3%		DAY 3	17.9%	0.0%	1.7%
	DAY 4	28.6%	7.0%	3.5%		DAY 4	13.6%	0.0%	2.5%
	DAY 5	46.7%	18.4%	12.5%		DAY 5	20.7%	0.0%	2.1%
ZONE 3	DAY 1	33.0%	0.0%	0.0%	ZONE 6	DAY 1	43.1%	1.3%	0.0%
	DAY 2	29.9%	0.0%	1.9%		DAY 2	46.0%	0.0%	0.9%
	DAY 3	34.4%	1.4%	3.4%		DAY 3	43.0%	0.0%	1.0%
	DAY 4	37.4%	0.0%	2.6%		DAY 4	42.7%	0.0%	0.0%
	DAY 5	36.8%	1.1%	7.1%		DAY 5	29.5%	0.0%	0.0%

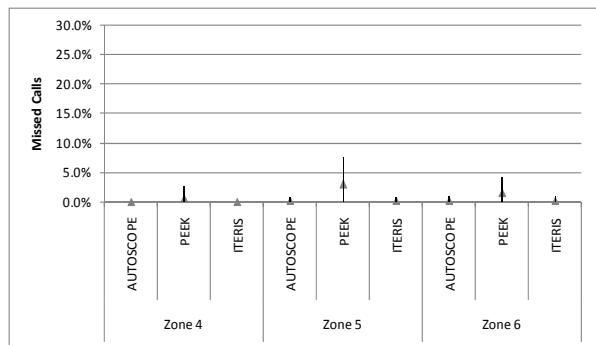
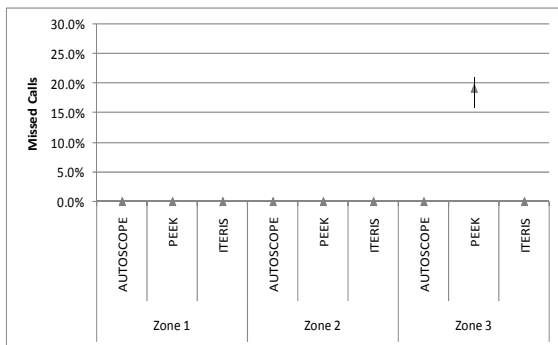


Missed Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	2.5%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	1.3%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
ZONE 2	DAY 1	0.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	7.5%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	6.7%	0.7%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.9%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.7%	1.4%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	15.9%	0.0%	ZONE 6	DAY 1	0.0%	2.3%	0.0%
	DAY 2	0.0%	20.7%	0.0%		DAY 2	0.0%	4.1%	0.8%
	DAY 3	0.0%	16.7%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	21.1%	0.0%		DAY 4	0.8%	0.0%	0.0%
	DAY 5	0.0%	19.5%	0.0%		DAY 5	0.0%	1.4%	0.0%



Stuck-on Calls

Stop Bar Zones

Advance Zones

		AUTOSCOPE	PEEK	ITERIS			AUTOSCOPE	PEEK	ITERIS
ZONE 1	DAY 1	0.0%	0.0%	0.0%	ZONE 4	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.0%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	0.0%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.0%		DAY 5	0.0%	0.0%	0.0%
ZONE 2	DAY 1	1.0%	0.0%	0.0%	ZONE 5	DAY 1	0.0%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.0%	0.0%	0.0%
	DAY 3	0.8%	0.0%	6.6%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	6.1%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	13.3%		DAY 5	0.0%	0.0%	0.0%
ZONE 3	DAY 1	0.0%	0.0%	0.0%	ZONE 6	DAY 1	0.7%	0.0%	0.0%
	DAY 2	0.0%	0.0%	0.0%		DAY 2	0.5%	0.0%	0.0%
	DAY 3	0.8%	0.0%	0.0%		DAY 3	0.0%	0.0%	0.0%
	DAY 4	0.0%	0.0%	3.4%		DAY 4	0.0%	0.0%	0.0%
	DAY 5	0.0%	0.0%	0.8%		DAY 5	0.0%	0.0%	0.0%

