

# **“Conspicuity” – A Conspicuous Approach to Officer Safety**

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## **Abstract**

*Law enforcement officers face many dangers in the performance of their duties. A dangerous hazard to the life safety of police officers involves a stopped police vehicle being struck from the rear by approaching traffic. Law enforcement agencies employ thousands of marked police vehicles across the United States to meet their mission. How can law enforcement organizations improve the visibility of their police cars and enhance the safety of their officers in order to reduce the loss of life and damage to property? Should the law enforcement community apply enhanced conspicuity to police vehicles as an effective approach to reduce the number of traffic related injuries and deaths of police officers? This report will explore the use of enhanced conspicuity for police vehicles to improve officer safety. It should be noted that the focus of this report involves police passenger vehicles, not police motorcycles, though enhanced conspicuity can also be applied to motorcycles. State Highway Patrol and State Police agencies will be surveyed in an effort to determine if enhanced conspicuity applications are being used in law enforcement, how they are being used, and how effective conspicuity applications may be to reduce crashes and enhance officer safety.*

## **Introduction**

As a profession, Law Enforcement is inherently dangerous. Every year, police officers in the United States and abroad are killed and injured in the line of duty, protecting and serving their communities. Nearly every facet of law enforcement duty poses significant danger to the law enforcement officer. There is likely no component of the law enforcement mission more dangerous than Patrol Operations, where uniformed police officers in the United States spend countless hours each day patrolling city streets, county roadways, and state highways to carry out their assigned missions. These aspects of policing are inherently dangerous and expose law enforcement officers to increased risks associated with traffic collisions.

Law enforcement officers routinely perform their assigned duties while operating vehicles painted in unique color schemes, marked with identifiable agency indicia, and equipped with emergency lights. One would likely assume that visibility would not be a serious concern for the safety of law enforcement officers working on or near the roadway in clearly marked police cars with brightly flashing emergency lights. History shows, however, that any such assumption would be flawed. Often times law enforcement officers are injured or killed in traffic related incidents, including incidents where police vehicles are struck from the rear by an approaching vehicle. What factors contribute to such “look but failed to see” collisions (Langham, Hole, Edwards, O’Neil,

Ergonomics, 2002), and how can law enforcement agencies enhance safety for their officers in the area of traffic related crashes?

One evolving safety trend for emergency responder organizations in the United States is enhanced conspicuity of emergency vehicles. Conspicuity of police vehicles in Europe has been commonplace for a number of years, and the National Fire Protection Association (NFPA) 1901 Standard for Automotive Fire Apparatus (2004) requires fire trucks and ambulances in the United States to be marked with enhanced conspicuity in the form of specific retro-reflective striping in specified areas of the vehicle, which includes a “chevron” pattern on the rear of the apparatus. A national standard for conspicuity markings on vehicles operated by law enforcement agencies in the United States does not yet exist.

There is no greater obligation of a law enforcement agency to its officers than promoting officer safety and providing leading edge technology and techniques that enhance officer safety. This report will explore the dangers associated with traffic related incidents, specifically rear-end collisions involving automobiles, that threaten the safety of law enforcement officers. Additionally, it will explore the use of conspicuity enhancements to fleet vehicles that agencies can readily employ to mitigate risks, enhance safety, and potentially reduce the numbers of injuries and deaths of police officers and the motoring public. Is conspicuity a clear choice for safety?

## **Literary Review**

In 2009 and 2010, 119 law enforcement officers in the United States died as a result of accidents, primarily traffic crashes, occurring in the line of duty, compared with 104 officers who died as a result of feloniously acts (FBI Law Enforcement Officers Killed and Assaulted website, 2010).

In 2011, the National Law Enforcement Officers Memorial Fund (NLEOMF) partnered with the National Highway Traffic Safety Administration (NHTSA) to promote law enforcement officer safety in the United States. This effort was in response to the number of traffic crash related fatalities involving police officers. In 2010, the NLEOMF reported that traffic related incidents were the leading cause of law enforcement fatalities from 1997 to 2010 (NLEOMF website, 2012). According to the Memorial Fund, in 2010, 71 police officers were killed in traffic related accidents. This figure represents officers killed in motor vehicle crashes, motorcycle crashes, and officers struck by motor vehicles while outside of their vehicles. In 2008 and 2009, 84 officers died in automobile crashes, 30 died after being struck by a vehicle outside of their patrol car, and 13 died in motorcycle crashes (NLEOMF Bulletin, 2009). Though these statistics are a mere snapshot in time, they tend to show that police officers are more likely to die in an automobile related crash than in any other traffic related incident. In 2011, the number of police officers killed in traffic related incidents dropped to 60. The loss of police officers’ lives due to traffic related crashes represents an enormous emotional loss to the law enforcement community and the families of the fallen officers (NLEOMF Bulletin, 2009).

The National Highway Safety Administration (NHTSA) "Characteristics of Law Enforcement Officers" Fatalities in Motor Vehicle Crashes' report (Noh, 2011) also indicates that motor vehicle crashes have been the leading cause of law enforcement officer deaths since the 1990s. This report draws data from the FBI Law Enforcement Officers Killed and Assaulted database and the NHTSA Fatality Analysis Reporting System (FARS).

The FARS is currently the only database that contains detailed information on fatal crashes in the United States involving police officers, but there is no national database that captures data strictly representative of law enforcement vehicle crashes. The FARS data refers to a police vehicle as being readily identifiable with markings and emergency lights. A law enforcement officer fatality is defined as a police vehicle occupant fatality. Though this data could include an occupant in a police vehicle who is not a sworn law enforcement officer, this number is presumed to be small. The statistics show that from 1980 to 2008, 1441 law enforcement officers died in the line of duty as a result of motor vehicle crashes. The report notes that the FARS data shows fewer officer deaths than the LEOKA data due to the definitional differences of police vehicles in both databases, and the FARS data only records deaths occurring within 30 days of a crash.

According to the FARS, crashes involving law enforcement officer deaths in passenger vehicles occurred more frequently during hours of darkness, 8:00 p.m. to 4:59 a.m. Fatal collisions occurred 54% of the time on rural roadways. "Going straight" was the major vehicle maneuver type reported for law enforcement vehicles involved in fatal crashes. This determination includes police vehicles in motion as well as stationary vehicles.

Some interesting details associated with the fatal traffic crashes resulting in police officer fatalities were apparent in the data. The majority of the crashes, 480 (70%) occurred on straight roadways, 448 (65%) occurred on level roadways, and 584 (85%) occurred when no adverse atmospheric conditions were present. It is apparent from the data that fatal traffic crashes involving police officers predominately occur when conditions are favorable and reduced visibility is not a contributing factor. Based upon the historical data, the police vehicles involved in the reported fatal crashes should have been visible to other traffic on the roadway.

Additionally, the FARS data shows that the majority of fatal crashes involving police vehicles occurred when the police vehicle was not in emergency use. Emergency use for the purposes of the FARS data refers to a vehicle in motion with emergency equipment such as emergency lights or sirens activated. Only 13% of fatal police crashes occurred during high-speed pursuits. The historical data clearly shows that the majority of traffic crashes resulting in officer fatalities are not attributed to emergency driving or police pursuits.

Further analysis of crash data associated with law enforcement vehicles, specific to the State of Florida, between 2005 and 2008, is referenced in a study titled "Law Enforcement Vehicle Crashes in Florida, Descriptive Analysis and Characterization" (Carrick, Srinivasan, Washburn, 2010). The study noted that research exploring crashes involving law enforcement vehicles is rare. The study analyzed 31,438 reported vehicles crashes involving 33,638 law enforcement vehicles that were recorded in the Florida Department of Highway Safety and Motor Vehicles crash report database. The

study found that most crashes occurred at low speeds on local streets. The study found that in the majority of crashes, law enforcement officers did not contribute to the cause of the crash (Carrick, Srinivasan, & Washburn, 2010).

Although law enforcement agencies operate varied fleets, the Florida study showed that passenger vehicles, nearly 85%, were the predominate type of police vehicle involved in traffic crashes. The Florida crash data indicted 52% of law enforcement vehicle crashes occurred on county or local streets. Parked patrol vehicles accounted for 13% of crashes, with 5% of the crashes occurring on the shoulder of a roadway (Carrick, Srinivasan, & Washburn, 2010).

The term “harmful event,” is used on Florida crash reports to describe the nature of a traffic collision. According to the Florida study, rear-end collisions were most common and accounted for 16% of the law enforcement collisions. This data does not specify whether the police vehicle caused the crash or was struck from the rear. The data shows that in 33% of the crashes, the law enforcement vehicles were slowing, stopped, or properly parked (Carrick, Srinivasan, & Washburn, 2010). For the stopped or parked police vehicles, one could conclude that the police vehicle was stationary and would not have contributed to the cause of the crash, but would have been struck by an approaching vehicle.

Though police vehicles operated in emergency mode would seem to present a higher probability of being involved in a collision, 76.8% of collisions involving Florida law enforcement vehicles occurred in non-emergency response situations. Additionally, the Florida study showed that in just over half of the crashes, the operator of the law enforcement vehicle did not contribute to the cause of the collision (Carrick, Srinivasan, & Washburn, 2010).

The Florida research yielded findings that nearly mirrored the NHTSA “Characteristics of Law Enforcement Officers” Fatalities in Motor Vehicle Crashes’ report concerning law enforcement crashes nationally. (Carrick, Srinivasan, & Washburn, 2010)

One difference apparent in the Florida data, as compared to the national data in the NHTSA study, is that in Florida, police crashes occurred more often during daylight hours.

In Florida, police officers are more likely to be involved in traffic crashes during daylight hours, on straight, level roadways, at times when reduced visibility due unfavorable weather conditions is not a contributing factor. And yet, collisions with law enforcement vehicles occur at times and conditions when the vehicle should be readily visible. This may highlight the consideration for the relevant enhancement of law enforcement vehicle conspicuity to improve safety for police officers.

The Center for Automotive Research produced a report titled “Rear End Crashes” (2005), which documented results of a study involving rear end crashes involving law enforcement vehicles over a five year period in Australia. It noted that rear-end crashes are one of the most common crash types occurring in South Australia (Baldock, Long, Lindsay, & McLean, 2004).

The Australian study revealed that the majority of rear–end collisions involving police vehicles occurred during daytime hours, with the overwhelmingly majority occurring on straight, level roadways, during clear weather conditions. Significant to the

application of conspicuity, is the fact the Australian data showed 92% of crashes involved stationary police vehicles (Baldock, Long, Lindsay, & McLean, 2004).

Concerning driver related factors, the study found that inadequate driver attention was a frequent contributing causation to the rear-end collisions. The authors identified four separate types of inattentive driving behaviors: cases when drivers did not sufficiently focus on the task of driving, cases when drivers were distracted by objects or events inside or outside of their vehicle, cases when drivers were unable to adequately divide their attention between two or more driver-related tasks, and cases when drivers failed to give adequate attention to aspects of the roadway or environment when changing lanes (Baldock, Long, Lindsay, & McLean, 2004).

The study discussed using vehicle based countermeasures to combat rear-end collisions and suggested that enhanced conspicuity to the rear of law enforcement vehicles decreased the likelihood of rear-end collisions. The report mentioned the use of retro-reflective material in red and white applied to the rear of police vehicles to enhance conspicuity (Baldock, Long, Lindsay, & McLean, 2004).

Crashes involving marked police vehicles certainly pose a serious risk to the safety of America's law enforcement officers as well as the motoring public. Statistics show that police vehicles are involved in crashes during day and night time hours, predominantly on straight, level roadways, during fair weather conditions. Many police vehicles are stopped or stationary when they were struck by approaching traffic and many collisions occur when the driving actions of the police officer did not contribute to the cause of the crash. How is it that so many crashes involving police vehicles occur under favorable conditions, at times when police vehicles should be clearly visible, when the police vehicle was not the at fault vehicle?

One study addressed the issue of conspicuity and the factors related to police involved collisions. An article titled "An analysis of 'looked but failed to see' accidents involving parked police vehicles" (Langham, Hole, Edwards, O'Neil, 2002), reported on crashes involving parked or stationary police vehicles that were struck by approaching traffic in so called 'looked but failed to see' incidents, where the drivers of the at fault vehicles claimed not to have seen the police vehicle until it was too late to avert collision.

This report suggests that these types of collisions may occur not because the police vehicle is difficult to see, but rather for reasons such as driver vigilance, or a false hypothesis by the driver about the conditions ahead. The report suggests that a police vehicle parked with emergency lights flashing may actually suggest to approaching drivers that the police vehicle is moving, not stationary (Langham, Hole, Edwards, & O'Neil, 2002).

This study was motivated by an increased number of crashes involving stationary police cars in the United Kingdom, and concerns that the increased crashes were related to a change in law enforcement practices for parking police vehicles. Prior to 1996, UK police parked vehicles sideways, or echelon, at a hazard so that the side of the vehicle was visible to oncoming drivers. In 1996, the Association of Chief Police Officers (ACPO) issued guidelines requiring police to park vehicles parallel, or in line, so that the roof lights of the police vehicle would be visible to approaching traffic. This approach was intended to increase the conspicuity of the emergency lights and enhance safety (Langham, Hole, Edwards, & O'Neil, 2002).

The study, aided by the Institute of Traffic Accident Investigators, identified 47 collisions involving a stationary police vehicle. The majority involved police vehicles marked with agency insignia and flashing lights, being struck by drivers who claimed they never saw the police vehicle. The majority of the police vehicles were parked in-line or parallel to the roadway. Evidence suggested that the drivers did not merely see the police vehicle too late to avoid collision, but failed to see it altogether. The study identified 11 crashes where there was no evidence that the at-fault drivers ever applied brakes prior to colliding with the police vehicles. Though these types of collisions are not common, they do occur and pose significant risks to police officers (Langham, Hole, Edwards, & O'Neil, 2002).

The researchers suggested several reasons drivers might fail to see conspicuous police cars with emergency lights flashing, parked stationary along the roadway. First, they found that the orientation of the parked police vehicle affected how quickly the approaching motorists perceived a hazard. It was also suggested that a reduced vigilance to attention by drivers who operate a vehicle for more than 20 minutes may contribute to the crashes. Driver fatigue, especially during the afternoon, coupled with the mundane task of driving is also thought to contribute to these types of failed to see collisions (Langham, Hole, Edwards, & O'Neil, 2002).

Another significant notion is that drivers detect the stationary vehicle ahead of them, but their mind misrepresents or misinterprets what they actually see. Drivers may actually believe that the vehicle is moving when it is actually stationary. The report suggests that people logically associate flashing lights with an emergency vehicle responding to an emergency. Therefore, when they observe a stationary police vehicle with flashing lights activated, they may incorrectly hypothesize that the vehicle is actually in motion, responding to an incident (Langham, Hole, Edwards, & O'Neil, 2002).

Additionally, it is noted that drivers are now more distracted than ever before, causing drivers to fail to recognize hazards on the roadways as they travel (Langham, Hole, Edwards, & O'Neil, 2002).

Though this study shows that being conspicuous does not completely eliminate the threat from collisions with approaching vehicles, it does emphasize the need for greater conspicuity for law enforcement vehicles working on and near the roadway (Langham, Hole, Edwards, & O'Neil, 2002).

One principle, coined the "Moth-Effect," (Green, 2009), may help explain how collisions with visible police vehicles occur when they seemingly should not. The term Moth Effect is used to describe situations where people become fixated and drive toward or into the rear of lighted police vehicles, presumably like a moth to a flame. Green cites evidence of a "moth-effect" in a study by Kitamura and Matsunaga, titled "Perceptual and Motor Skills," where drivers who were instructed to fixate on the emergency lights of a parked vehicle passed closer to the vehicle than drivers who were given no instructions (Green, 2009).

Green reports that drivers may steer off the road in the direction of their fixation due to an intense fixation on a roadside object. This may also occur during dark periods where drivers lose their visual sense of heading or bearing and are forced to rely on a sense of egocentric direction relative to a landmark or fixed object. According to Green, when people fixate away from the direction of travel, then they must use knowledge of eye position in order to maintain a sense of direction. (Green, 2009).

Though limited research exists to definitively support the conclusion that the moth-effect is a reality, there may very well be evidence from crash data involving police vehicles being struck from the rear to suggest circumstances occur when drivers approaching stationary police vehicles with emergency lights flashing, become fixated and crash into the vehicle.

Historical and statistical data show that police officers are in harm's way while working on or near roadways. Law enforcement officers in the United States are more likely to be killed in a motor vehicle collision than in any other manner. The majority of collisions involved marked police vehicles and occur during favorable conditions. Many collisions involve rear-end scenarios where police vehicles are struck from the rear. Enhanced conspicuity of the patrol vehicles will likely decrease the potential hazard to law enforcement officials stopped near the roadway.

The Police Scientific Development Branch (PSDB) of the Home Office of the Police, United Kingdom, issued a report titled "Specification for the Livery on Police Patrol Cars" (1998), detailing specifications for high conspicuity "livery" or markings recommended for use on police vehicles in the country. The specific recommendation was for police agencies to adopt the use retro-reflective chevrons on the rear of their vehicles to enhance visibility. Recommendations were also made concerning the use of alternating blocks of color, identified as "Battenberg" markings, similar to a checkerboard pattern, on police vehicles (Thomas, 1998).

The PSDB issued an additional report addressing the use of conspicuity for law enforcement vehicles in the United Kingdom (2004). A survey was conducted in 2003, indicating 76% of all police forces in the United Kingdom complied with the 1998 recommendations and applied high conspicuity livery to their police vehicles. (Harrison, 2004).

The PSDB defined "conspicuity" as the degree to which a specific object can be easily seen or recognized within its immediate visual context. It notes that conspicuity involves temporal and spatial uncertainty by the observer, combined with a lack of expectation concerning what the observer might see. The objectives of using the Battenberg livery scheme were to enhance officer and public safety by reducing the likelihood of collisions where visibility was a factor, and to make police vehicles uniquely identifiable (Harrison, 2004).

The factors related to daytime conspicuity are different than those for night-time conspicuity. The PSDB noted the need for enhanced conspicuity to the rear of police vehicles to enhance safety, and observed that fluorescent colors in contrasting blocks (Battenberg) offered enhanced visibility. Night-time conspicuity is achieved through the use of retro-reflective markings (Harrison, 2004).

One interesting concept identified in the PSDB report was the delineation between the uses of full Battenberg conspicuity for police vehicles used in rural areas versus a half Battenberg schemes for vehicles used in urban environments. The distinction is due to the visual clutter present in the urban environment. It was determined that full Battenberg schemes essentially worked like camouflage and reduced the visibility of vehicles in urban environments (Harrison, 2004).

Both PSDB studies referenced above cited numerous scientific studies to support the use of enhanced conspicuity livery, or Battenberg schemes, for police agencies to increase visibility to enhance officer and public safety.

The Police vehicle struck rear-end crashes: Problem Description research report (2003) reviewed 152 crash reports from the Automotive Safety Office, the Florida Highway Patrol, the Illinois State Police, and Ford Motor Company documenting police vehicles that were struck in the side or rear, moving and stationary on or near the roadway. The research was narrowed to specifically review rear end collisions involving stationary police vehicles, and identified the causation factors associated with the collisions, which sometimes involved drivers who panicked at the sight of the stopped police car and braked heavily, losing control of their vehicle and ultimately crashing into the police vehicle. It should be noted that the data reviewed was not representative of national data, and the reports from the Florida Highway Patrol accounted for 88 crashes (Kochlar & Tijerina, 2004).

Reviewing statements of the at-fault drivers revealed that many did not see the stopped police vehicles despite visible markings and flashing lights. The majority of crashes occurred during daylight hours, and more than half occurred on the shoulder of the road. (Kochlar & Tijerina, 2004).

Nearly half of the crashes involved drivers who took no evasive crash avoidance action prior to the collision, even though they were not impaired or drowsy at the time of the crash. Distracted drivers accounted for 21 crashes. The report notes that enhanced conspicuity may be relevant in mitigating crashes caused by the effects of drowsiness or distraction. The research made several recommendations, including an investigation to determine how the rear of police vehicles could be enhanced to discern whether the vehicle is stationary, or moving. (Kochlar & Tijerina, 2004).

As a result of the preceding study, a further report titled "The Committee Report: Conspicuity Enhancement for Police Interceptor Rear-end Crash Mitigation" (2003) was generated. This report addressed the dangers associated with rear-end collisions involving stationary law enforcement vehicles in the United States. Countermeasures to reduce the incidence or severity of rear-end collisions involving police vehicles are explored. Though the report discusses lighting, only conspicuity enhancements such as markings will be referenced herein (Tijerina, 2003).

The conspicuity enhancement study incorporated three sections including driver perception, characteristics of the police vehicle, and visual conspicuity enhancements to improve safety (Tijerina, 2003).

The report references visual deficiencies experienced by drivers, similar to what has been mentioned previously in this report, such as fixation, or the "Moth effect," and other aspects such as special reference failures that lead to collisions with stopped police vehicles (Tijerina, 2003).

The report addresses the need for enhanced conspicuity for police vehicles to reduce potential crashes. Vehicles that are more conspicuous will be more visible to approaching drivers. The report states that color variations enhance visibility, and notes the NHTSA specifications for ambulances and fire trucks requiring horizontal striping on the rear of these emergency vehicles. The use of rear-end chevron patterns in high contrast colors to enhance vehicle visibility were recommended over the Battenberg patterns. Based upon theory, Battenberg livery schemes break up the contours of a police vehicle and essentially camouflage it (Tijerina, 2003).

The report references the 'inattention blindness' or 'look but don't see' scenarios referenced previously in this report. People are incapable of visually processing every



piece of information in their field of view. It is suggested that the mind filters data or simply focuses on only certain portions of what we see. Important information concerning an approaching hazard may simply be missed. Additionally, drivers will make certain assumptions or affirmations based upon what they anticipate or assume, versus evaluating the true conditions at that time. This suggests that one could make an assumption a police car is in motion when emergency lights are seen, rather than recognizing that the police vehicle is actually stationary. The report also suggests that a driver approaching a stationary police vehicle parked 'in-line' with the roadway may reach a false hypothesis or expectation that the police vehicle is actually moving. The angled or 'echelon' parking configuration does not yield the same false assumption (Tijerina, 2003).

The United States Fire Administration (USFA) issued a report titled "Emergency Vehicle Visibility and Conspicuity Study" (2009), to analyze emergency vehicle visibility and the use of conspicuity to enhance the safety of emergency officials, such as firefighters, police, and emergency medical services workers, operating on the nation's roadways. The study targeted passive conspicuity markings, not active treatments such as emergency lighting. (Wieder & Thiel, 2009).

According to the USFA study, over the previous 12 years, an average of one law enforcement officer a month was struck and killed by a vehicle in the United States. The study suggests that improved vehicle conspicuity shows promise for enhancing emergency personnel safety when exposed to traffic, whether inside or outside of their vehicles (Wieder & Thiel, 2009).

The study cites recommendations in the United Kingdom based upon the "Specification for the Livery on Police Cars" study, and recognizes that livery is intended to make police vehicles on high-speed roadways readily visible and identifiable (Wieder & Thiel, 2009).

The USFA points out that there is no national standard for conspicuity in the United States, but recognizes that the Arizona Department of Public Safety (DPS) is one of the law enforcement leaders using high-visibility markings on patrol vehicles. The previously noted "NFPA 1901, Standard for Automotive Fire Apparatus," provides a national voluntary standard for conspicuity retro-reflective chevrons on the rear of fire trucks and ambulances in the United States (Wieder & Thiel, 2009).

The USAF study identified several key findings regarding the conspicuity of emergency vehicles which included the following:

- ♦ The increased use of retro-reflective materials holds great promise for enhancing the conspicuity of emergency vehicles.
- ♦ The use of contrasting colors can assist drivers with locating a hazard amid the visual clutter of the roadway.
- ♦ Fluorescent colors (especially fluorescent yellow-green and orange) offer higher visibility during daylight hours.
- ♦ It is theoretically possible to "over-do" the use of retro-reflective materials and interfere with drivers' ability to recognize other hazards.
- ♦ Battenberg patterns may have a camouflage effect in some circumstances (Wieder & Thiel, 2009).

The USFA study identified several potential opportunities for improving the safety of emergency vehicles in the United States through enhanced conspicuity. Some of these are listed below:

- ♦ Concentrate retro-reflective material lower on the emergency vehicle to optimize the interaction with approaching vehicles' headlamps.
- ♦ Use high-visibility fluorescent retro-reflective materials for a high degree of day-time and night-time visibility.
- ♦ Retro-reflective material can be concentrated on the rear of law enforcement vehicles to maintain stealth when facing traffic or patrolling.
- ♦ Utilizing distinctive emblems made with retro-reflective materials can improve vehicle visibility and recognition (Wieder & Thiel, 2009).

The USFA study concluded that advancing emergency vehicle conspicuity may involve applications of both passive and active conspicuity measures to enhance safety. The USFA identified a critical need for additional research specific to emergency vehicle visibility and conspicuity to enhance the safety of first responders working along United States roadways.

## **Methods**

Conspicuity decals incorporating Battenberg or chevron patterns comprised of fluorescent colors and retro-reflective materials employed on the rear of police patrol vehicles enhance visibility, and potentially reduce the probability of rear end collisions to ultimately reduce the risk of injury and death of LEOs working on or near roadways. The target group included other State Police and State Highway Patrol agencies similar to the Florida Highway Patrol that may or may not be using conspicuity markings. The survey is structured to do the following, keeping in mind that this type of conspicuity enhancement appears to be just recently appearing in the US after years of use in foreign countries:

- Identify any agencies currently using Battenberg (checkerboard) or chevron patterns on their fleets to determine how extensively it is or is not being utilized.
- Determine how long an agency has been using this type of conspicuity enhancement.
- Identify the type and application of conspicuity enhancements associated with this project currently being used if any.
- Identify any agencies that are studying the use of enhanced conspicuity or are developing prototypes for deployment.
- Determine if agencies that are not using this type of conspicuity would consider its use.
- Determine the reasons an agency either would not consider using conspicuity enhancements or decided not to utilize them after evaluating their use.
- Determine the number of agency crashes involving their vehicle being struck from the rear over a specified time period to show the relevance to or correlation to the focus of the project.
- Determine the number of LEOs injured or killed in the crashes reported by the responding agencies.

For any agency that affirms the use of conspicuity enhancements, the survey asks for similar crash data as noted above, focusing specifically on the numbers of crashes, injuries, and deaths since the time enhancements were implemented to identify the potential safety benefits.

## **Results**

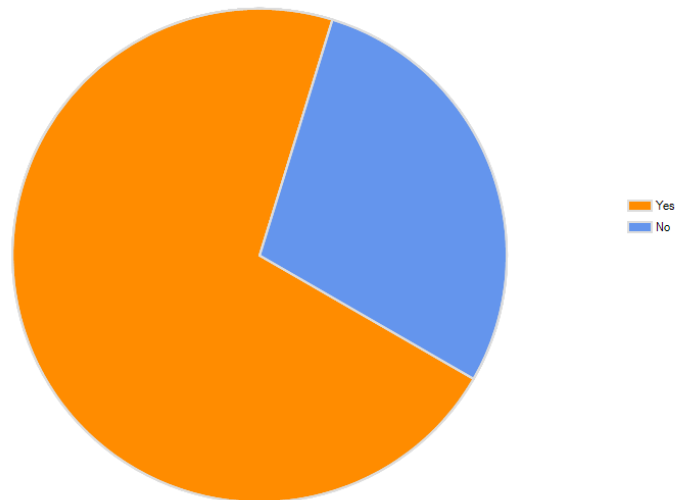
During the survey deployment, state law enforcement organizations with primary missions similar to the Florida Highway Patrol were targeted. Research surveys were sent to twenty-six State Police and State Highway Patrol organizations within the United States (Appendix A). Thirteen agencies participated in the SLP Conspicuity survey, which was designed to determine if agencies are familiar with conspicuity enhancements, if any are currently studying and or using it, and whether it has been an effective safety enhancement. It should be noted that one respondent did not provide agency identification information during the survey process and the Nebraska State Patrol submitted two surveys. The Arizona Department of Public Safety was specifically targeted due to the organization's current use of conspicuity enhancements as referenced in this report; however Arizona did not complete a survey.

After numerous telephone calls, conversations, and e-mails, the following agencies participated:

- Arkansas State Police
- Colorado State Patrol
- Florida Highway Patrol
- Georgia State Patrol
- Nebraska State Patrol
- North Dakota Highway Patrol
- Ohio State Patrol
- Oregon State Police
- South Carolina Highway Patrol
- Utah Highway Patrol
- Washington State Patrol
- Wyoming Highway Patrol
- Unidentified Agency

Ten of the agencies, or approximately 71%, reported familiarity with conspicuity as it relates to the focus of this report.

Is your agency familiar with the term "Conspicuity" as it relates to enhanced visibility markings for patrol vehicles? (Other than emergency lighting, agency identification, or agency indicia)



Only five agencies reported current use of enhanced conspicuity markings or decals on the rear of their patrol vehicles. Of these, all reported the current use of chevrons or vertical stripes comprised of two alternating colors and or retro-reflective material applied to the rear of their patrol vehicles. No agency reported the use of Battenberg or checkerboard patterns. Nine agencies (64%) do not currently utilize a form of enhanced conspicuity.

Agencies were asked to identify the number of years the agency has used conspicuity. Two reported the use of conspicuity for more than six years, one reported its use for five to six years, one reported its use for three to four years, and one reported its use for one to two years.

Of twelve respondents, seven (58%) reported their agency has not previously considered, evaluated, or studied the use of enhanced conspicuity markings. Five agencies reported that they have studied the use of chevrons or vertical stripes comprised of alternating colors and retro-reflective materials. Only one of the five has considered the use of alternating stripes displaying fluorescent colors. None of the respondent agencies have considered the use of Battenberg patterns. Two of the five agencies have studied the use of conspicuity within the last four years, and two are currently studying the use of conspicuity. Only the Florida Highway Patrol reported the current development of a prototype conspicuity scheme.

Of agencies that are not currently utilizing conspicuity or evaluating its use, six (75%) reported the agency would consider using conspicuity to enhance the safety of law enforcement personnel. Only the Georgia State Patrol and the Oregon State Patrol reported they would not consider using conspicuity. Costs associated with implementation, appearance of a conspicuity package, agency culture or resistance to change, and inability to remain inconspicuous were the reasons the two agencies reported consideration would not be given to conspicuity enhancements. The Nebraska State Patrol reported that the agency is currently involved in a joint conspicuity study

with the University of Nebraska. The specific details of the study were not provided in the survey response.

When asked to report the number of vehicle crashes in the past five years involving an agency vehicle being struck in the rear by an approaching vehicle, seven agencies reported approximate numbers of crashes from as few as three to as many as twenty-five crashes.

The North Dakota Highway Patrol reported seventeen actual crashes, resulting in three troopers being injured. The Washington State Patrol reported sixty-nine actual crashes, resulting in nine troopers being injured. Three agencies reported the number was unknown. The Georgia State Patrol did not report the number of agency vehicle crashes, but did report that the majority of the crashes involving the GSP vehicle occurred while emergency lights were activated.

Agencies that confirmed the use of enhanced conspicuity as referenced above were asked to report the number crashes involving agency vehicles occurring since the implementation of conspicuity schemes. The Wyoming Highway Patrol reported approximately forty crashes, but did not identify the number of troopers injured. The Colorado State Patrol reported approximately fifteen crashes, resulting in three troopers being injured. The North Dakota Highway Patrol reported seventeen actual crashes, resulting in three troopers being injured.

There were no reported fatalities of troopers as a result of the crashes referenced in this report by the participating agencies.

Agencies were asked to report any positive outcomes from the use of conspicuity by their agency. The Colorado State Patrol reported that agency patrol vehicles with enhanced markings are noticed from a further distance at night. There were no negative outcomes reported by the participants concerning the use of enhanced conspicuity.

## **Discussion**

State Highway Patrol and State Police organizations in the United States were surveyed in an effort to determine how familiar agencies are with conspicuity in the form of specialized decals or applications to the rear of agency vehicles to enhance safety, to determine how common the use of conspicuity is among state law enforcement agencies, to determine whether agencies would consider the use of conspicuity, and to identify any positive or negative observations related to the use of conspicuity.

The research targeted twenty-six state law enforcement agencies with similar operational missions. The focus of the targeted group was primarily with agencies located in the Southeastern United States; however, agencies from other regions were also contacted. The goal was to derive information from approximately half of the State Patrol and State Police agencies across the country to gain a national perspective. Unfortunately, only thirteen agencies responded to the call for participation in the research, thus the data collected was a small cross section of potential information available.

Based upon the information identified during the literary review, it was anticipated that the utilization of enhanced conspicuity markings on the rear of patrol vehicles by

law enforcement agencies in the United States would likely be limited. Additionally, it was theorized that any such use would have been implemented within recent years, thus limiting any significant statistical crash data related to rear end collisions, and any resultant injuries or fatalities to law enforcement officers. The limited information returned through the survey respondents appeared to affirm these anticipated results or at least suggest the validity.

The survey results yielded some relevant information related to the study. Ten of the respondent agencies reported some level of familiarity with conspicuity enhancements. As was expected, a small number of agencies, only five, reported the use of conspicuity. The results also indicated that the predominant conspicuity application involves the use of chevrons incorporating two alternating colors, fluorescent colors, and retro-reflective materials applied to the rear of the patrol vehicles. The use of Battenberg patterns, which are commonly used throughout the United Kingdom and numerous foreign countries, was not found to be routinely utilized by U.S. law enforcement agencies.

The limited survey results may also suggest that U.S. law enforcement agencies generally have not previously considered the use of conspicuity enhancements. Fifty-eight percent of the respondents affirmed this. Of significance, is the fact that the majority (75%) of participating agencies that do not currently use conspicuity would consider the use of conspicuity applications for their fleets. The Florida Highway Patrol is currently developing a conspicuity package for its fleet.

A surprising detail was that two agencies, the Georgia State Patrol and the Oregon State Patrol, reported that they would not currently consider utilizing conspicuity. Not surprisingly, the reasons cited for this position were, the appearance of conspicuity and agency culture or resistance to change, costs associated with conspicuity applications, and concern that enhancements would result in an inability to remain inconspicuous.

The Nebraska State Patrol reported that they are currently involved in a partnered conspicuity study with the University of Nebraska. A brief review of available internet reports indicates that the Nebraska study is focused on creating greater visibility for Nebraska State Patrol vehicles to reduce the incidents of the vehicle being struck by other vehicular traffic. In 2010, Nebraska State Patrol vehicles were struck 34 times, and in 2011, they were struck 17 times. The Nebraska project incorporates six patrol vehicles with conspicuity enhancements in the form of a chevron type pattern applied to the rear of the vehicle to enhance visibility.

Though the detailed Nebraska study was not available, Nebraska State Patrol Colonel David Sankey reported to media that there is very little data associated with the visibility and markings of law enforcement vehicles.

During the literary review, it was apparent that conspicuity enhancements had been previously studied by the National Fire Protection Association in the United States, and national standards for conspicuity enhancements were already being applied to fire trucks and ambulances nationally. Information associated with the Nebraska study affirms this fact.

The research survey failed to identify any hard statistical data to support the premise that conspicuity enhancements would result in reduced incidents of patrol vehicles being struck from the rear, thereby reducing the risk to law enforcement

officers. The research did however confirm that officers are injured in the United States as a result of patrol vehicles being struck from the rear. No officer fatalities were reported for the past five year period covered in the survey. It should be noted however, that far too many law enforcement officers have been killed in rear end collisions in the United States historically.

Though there is limited data nationally concerning the definitive benefits of conspicuity enhancements for police vehicles to enhance officer safety, the literary reviews and survey respondents affirm that the law enforcement community in the United States has interest in the potential benefits of conspicuity enhancements to safeguard the lives of law enforcement officers. The Nebraska State Patrol Study coupled with the Florida Highway Patrol conspicuity scheme prototype development support this premise. As anticipated at the outset of this study, the research indicates that the use of conspicuity packages for marked patrol vehicles to increase visibility, thereby reducing incidents of collision, and officer injuries and deaths, is an emerging safety concept for law enforcement agencies in the United States and further usage will potentially evolve.

To accurately assess a more clear and relevant evaluation of enhanced conspicuity use and any potential benefits of heightened safety for law enforcement officers working on or near the roadways of the United States, a more widespread and in-depth study would be necessary. A study targeted at all forty-nine State Police and Highway Patrol organizations, focused on the use and type of current conspicuity applications, coupled with factual statistical crash data indicating any potential reductions in the numbers of incidents involving law enforcement vehicles being struck from the rear by approaching vehicles and the numbers of law enforcement officers injured or killed as a result of these collisions could yield relevant conclusions that benefit the law enforcement community.

Though the focus of this study involved larger state law enforcement agencies with highway safety missions primarily targeted on Interstate highways, U.S. highways, and state roads where increased speeds pose increased risks for serious injury and death of law enforcement officers involved in rear-end collisions, it should be noted that officers of County Sheriff's Departments and Municipal Police Departments face similar dangers while performing their duties.

Certainly, one could argue that the greatest responsibility incumbent upon a law enforcement organization is to provide the best possible resources for its officers to ensure the highest level of safety while they perform their assigned missions. How does a law enforcement agency, a community, or an officer's family measure the toll that comes with the loss of life of just one police officer? Is it possible that the enhanced conspicuity of one patrol vehicle could prevent just one traffic collision and save the life of just one law enforcement officer?

Captain Jeff Dixon is a 22 year veteran of the Florida Highway Patrol. Since joining the Patrol in 1990, he has served in several operational components including Patrol Operations, Bureau of Investigations, Office of Professional Compliance, and the Department of Highway Safety and Motor Vehicles (DHSMV) Office of Inspector General. Currently, he is a district commander assigned supervisory responsibilities over the Troop H Quincy District, Traffic Homicide Unit, Criminal Interdiction Unit, and the Tallahassee Regional Communications Center. He is a graduate of the DHSMV Management Fellows Program and received a Bachelor's degree in Electrical Engineering Technology from the University of West Florida.

## References

- Baldock, M., Long, A., Lindsay, V. The University of Adelaide, South Australia, Center for Automotive Safety Research. (2004). *Rear End Crashes* (CASR018).
- Carrick, G., Srinivasan, S., & Washburn, S. (2010). Law enforcement vehicle crashes in Florida, descriptive analysis and characterization, transportation research record. *Journal of the Transportation Research Board*, 2182, 40-47.
- Department of Homeland Security, United States Fire Administration. (2009). *Emergency vehicle visibility and conspicuity study* (FEMA FA-323). Retrieved from website: [http://www.usfa.fema.gov/downloads/pdf/publications/fa\\_323.pdf](http://www.usfa.fema.gov/downloads/pdf/publications/fa_323.pdf)
- Green, Marc. (2009). *Is the Moth Effect Real*. Retrieved from website: <http://www.visualexpert.com/Resources/motheffect.html>
- Harrison, Paul. Home Office of the Police, United Kingdom, Police Scientific Development Branch. (2004). *High Conspicuity Livery for Police Vehicles* (Publication 14/04).
- Kochlar, D., Tijerina, L. Ford Motor Company. (2003). *Police Vehicle Struck Rear-end Crashes: Problem Description*.
- Langham, M., Hole, G., Edwards, J., & O'Neil, C. (2002). *An analysis of 'Looked but failed to see' accidents involving parked police vehicles*. (3 ed., Vol. 45, pp. 167-186).
- National Law Enforcement Officers Memorial Fund, (2011). *NHTSA Officer Safety Initiatives*. Retrieved from website: <http://www.nleomf.org/facts/nhtsa-officer-safety-initiatives/>
- National Law Enforcement Officers Memorial Fund, (2012). *Research bulletin*. Retrieved from website: <http://www.nleomf.org/facts/research-bulletins/>
- Noh, E. Y. U.S. Department of Transportation, National Highway Traffic Safety Administration. (2011). *Characteristics of law enforcement officer's fatalities in motor vehicle crashes*.
- Thiel, A., Wieder, M. Department of Homeland Security, United States Fire Administration. (2009). *Emergency Vehicle Visibility and Conspicuity Study* (FA-323). Retrieved from website: [http://www.usfa.fema.gov/downloads/pdf/publications/fa\\_323.pdf](http://www.usfa.fema.gov/downloads/pdf/publications/fa_323.pdf)
- Thomas, A. Home Office of the Police, United Kingdom, Police Scientific Development Branch. (1998). *Specification for the Livery on Police Patrol Cars* (Publication 2/98).



Tijerina, L. Ford Motor Company. (2003). *Conspicuity Enhancement for Police Interceptor Rear-end Mitigation*.

United States Department of Justice, Federal Bureau of Investigation. (2010). *Law enforcement officers killed and assaulted*. Retrieved from website: <http://www.fbi.gov/about-us/cjis/ucr/leoka/leoka-2010>.

## Appendix A

### Conspicuity Survey



#### SLP Conspicuity Survey

1. Is your agency familiar with the term “Conspicuity” as it relates to enhanced visibility markings for patrol vehicles (Other than emergency lighting, agency identification, or agency indicia)?
  - Yes
  - No
2. Does your agency currently utilize enhanced markings or decals on the rear of patrol vehicles to enhance visibility (Other than emergency lighting, agency identification, or agency indicia)?
  - Yes
  - No
3. If the answer to Question #2 is “Yes” – Which of the following markings does your agency currently utilize on the rear of patrol vehicles? (Check all that apply)
  - Chevrons or vertical stripes consisting of two alternating colors.
  - Chevrons or vertical stripes comprised of retro-reflective material.
  - Chevrons or vertical stripes consisting of alternating colors including fluorescent color.
  - Battenberg (checkerboard) pattern consisting of alternating colors.
  - Other: (Please Specify)

4. How many years has your agency utilized enhanced “Conspicuity” markings (Listed in Question 3) on the rear of patrol vehicles?
  - 1 to 2 years
  - 3 to 4 years
  - 5 to 6 years
  - More than 6 years
5. Has your agency previously considered, evaluated, or studied the use of any of the “Conspicuity” applications listed in Question #3 to enhance the visibility of agency patrol vehicles if the agency does not currently utilize them?
  - Yes
  - No
6. If the answer to Question #5 is “Yes” – Which of the Conspicuity applications to enhance visibility on the rear of patrol vehicles has your agency evaluated? (Check all that apply)
  - Chevrons or vertical stripes consisting of two alternating colors.
  - Chevrons or vertical stripes comprised of retro-reflective material.
  - Chevrons or vertical stripes consisting of alternating colors including fluorescent color.
  - Battenberg (checkerboard) pattern consisting of alternating colors.
  - Other: (Please Specify)
7. If the answer to Question #5 is “Yes” – How recently did your agency consider the use of visibility enhancements?
  - Currently evaluating / researching use.
  - 1 to 2 years ago
  - 3 to 4 years ago
  - 5 to 6 years ago
  - More than 6 years ago.
8. If your agency is currently evaluating or studying the use of enhanced “Conspicuity” markings on the rear of patrol vehicles, what is the current status of the project?
  - Fact gathering or initial research phase.
  - Decal or prototype development phase.
  - Evaluation phase of decal application to actual test vehicle.
  - Review by agency committee or staff.
  - Other: (Please Specify)

9. If your agency does not currently utilize enhanced “Conspicuity” markings on the rear of patrol vehicles, or is not currently evaluating the use, would your agency consider utilizing enhanced “Conspicuity” markings such as chevrons and Battenberg (checkerboard) patterns comprised of retro-reflective materials or fluorescent colors to enhance the safety of law enforcement personnel?
- Yes
  - No
10. If the answer to Question #9 is “No” – Why would your agency not consider the use of enhanced “Conspicuity markings?” (Check all that apply)
- Cost associated with implementation.
  - Appearance of Conspicuity package.
  - Agency culture linked to resistance of the agency or members to alter or change the physical appearance of patrol vehicle scheme.
  - Statutory limitations or provisions associated with authorized appearance of agency patrol vehicles.
  - Other: (Please specify)
11. In the past five years, how many vehicle crashes have occurred involving your agency vehicle being struck from the rear by an approaching vehicle? (Choose one)
- No vehicle crashes.
  - Approximate number of crashes: \_\_\_\_
  - Actual number of crashes: \_\_\_\_
  - Other or Unknown: \_\_\_\_
12. How many law enforcement officers were injured as a result of the crashes listed in Question #11? (Choose one)
- Approximate number injured: \_\_\_\_
  - Actual number injured: \_\_\_\_
  - Other or Unknown: \_\_\_\_
13. How many law enforcement officers were killed as a result of the crashes listed in Question #11? (Choose one)
- Approximate number killed: \_\_\_\_
  - Actual number killed: \_\_\_\_
  - Other or Unknown: \_\_\_\_

14. If your agency currently utilizes enhanced “conspicuity” markings such as chevrons or Battenberg (checkerboard) patterns, how many vehicle crashes have occurred involving agency vehicles being struck in the rear since the enhanced markings were implemented?  
(Choose one)
- Approximate number of crashes: \_\_\_\_
  - Actual number of crashes: \_\_\_\_
  - Other or Unknown: \_\_\_\_
15. How many law enforcement officers were injured as a result of the crashes listed in Question #14? (Choose one)
- Approximate number injured: \_\_\_\_
  - Actual number injured: \_\_\_\_
  - Other or Unknown: \_\_\_\_
16. How many law enforcement officers were killed as a result of the crashes listed in Question #14? (Choose one)
- Approximate number killed: \_\_\_\_
  - Actual number killed: \_\_\_\_
  - Other or Unknown: \_\_\_\_
17. If your agency currently utilizes enhanced “Conspicuity” markings on patrol vehicles, describe any benefits or positive outcomes that have resulted?
- Explain: \_\_\_\_
18. If your agency currently utilizes enhanced “Conspicuity” markings on patrol vehicles, describe any negative consequences or outcomes that have resulted?
- Explain: \_\_\_\_
19. Contact information:
- Title / Rank
  - Name
  - Agency
  - Address
  - Phone number
  - E-mail address