Pilot Testing of a School Bus Stop-Arm Camera System

Prepared for the
North Carolina Department of Public Instruction

Prepared by
Thomas Cook, Jeffrey Tsai
Institute for Transportation Research and Education
North Carolina State University
Raleigh, NC 27695-8601

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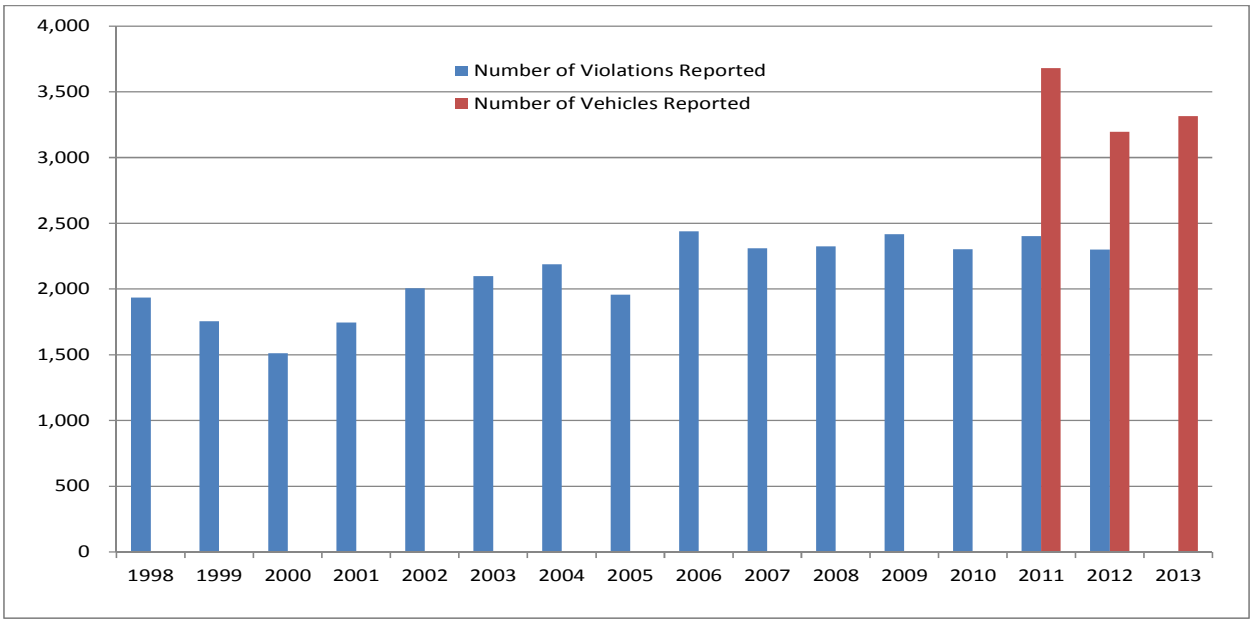
Introduction to the Problem

During a one-day count in 2013, North Carolina school bus drivers witnessed 3,316 vehicles illegally passing stopped school buses. These violations occurred while the buses were stopped, the stop-arm was extended with flashing red lights, and children were in the process of boarding or disembarking from buses. One-day school bus stop-arm violation reports have been collected by North Carolina public schools since 1998 and they reveal a persistent problem which exposes school children to danger at bus stops. The figure below shows the numbers of violation incidents and vehicles for 1998-2013.



This problem is not unique to North Carolina, as revealed by results from similar surveys conducted nationally in many states starting in 2011. Summary data for the 2011, 2012, and 2013 surveys are provided in the table below

Year	No. Buses Participating	No. Passing Vehicles – One Day	No. States Participating
2011	111,914	76,685	28
2012	99,930	88,025	28
2013	108,436	85,279	29
Totals	320,280	249,989	

The majority of violations have involved vehicles traveling in the opposite direction of the school bus (passing from the front), with nearly all violations occurring on the driver's side of the bus. Disturbingly, some violations do occur on the passenger loading side of the bus!

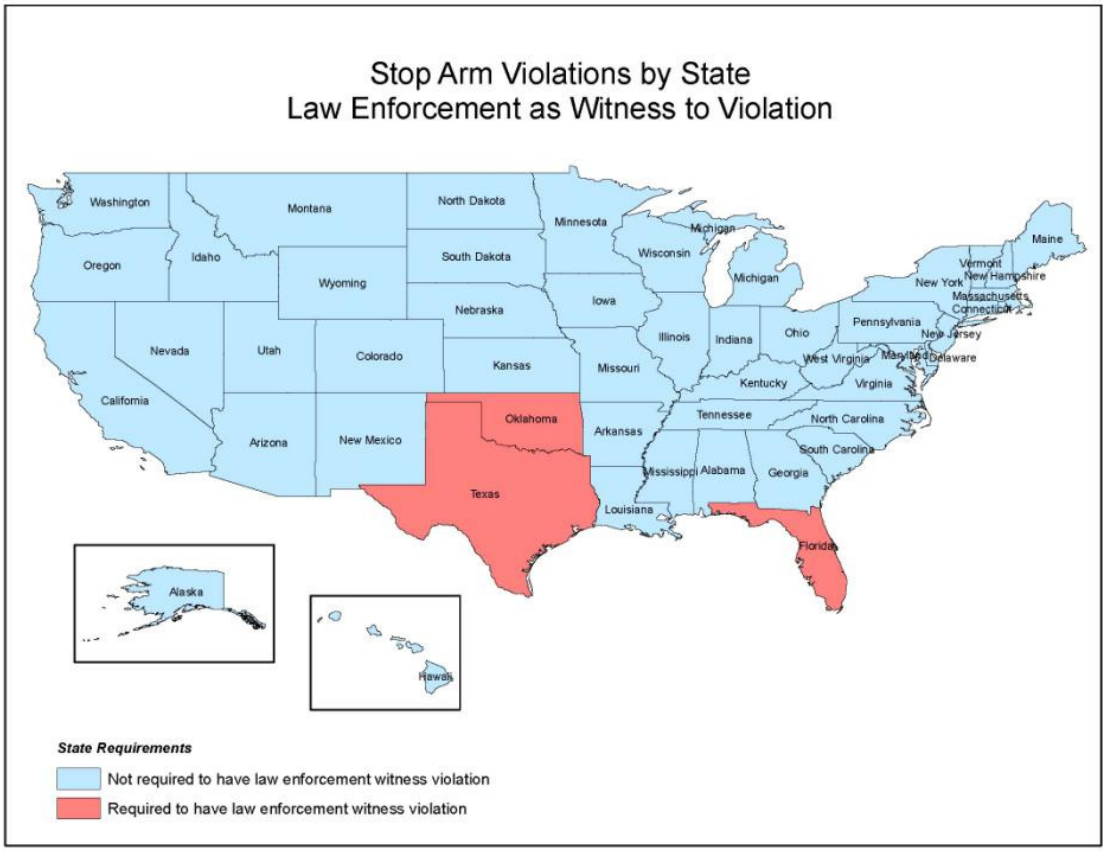
Solutions

Effective strategies to reduce school bus stop-arm violations are subject to state legislation and regulations. Requirements as to methods to collect evidence of a violation vary from state to state. While technology can provide solutions to the problem, use of a specific technology may be constrained by state laws or regulations. In this instance, solutions to this problem involved both legislative and technology implementation activities, as described below.

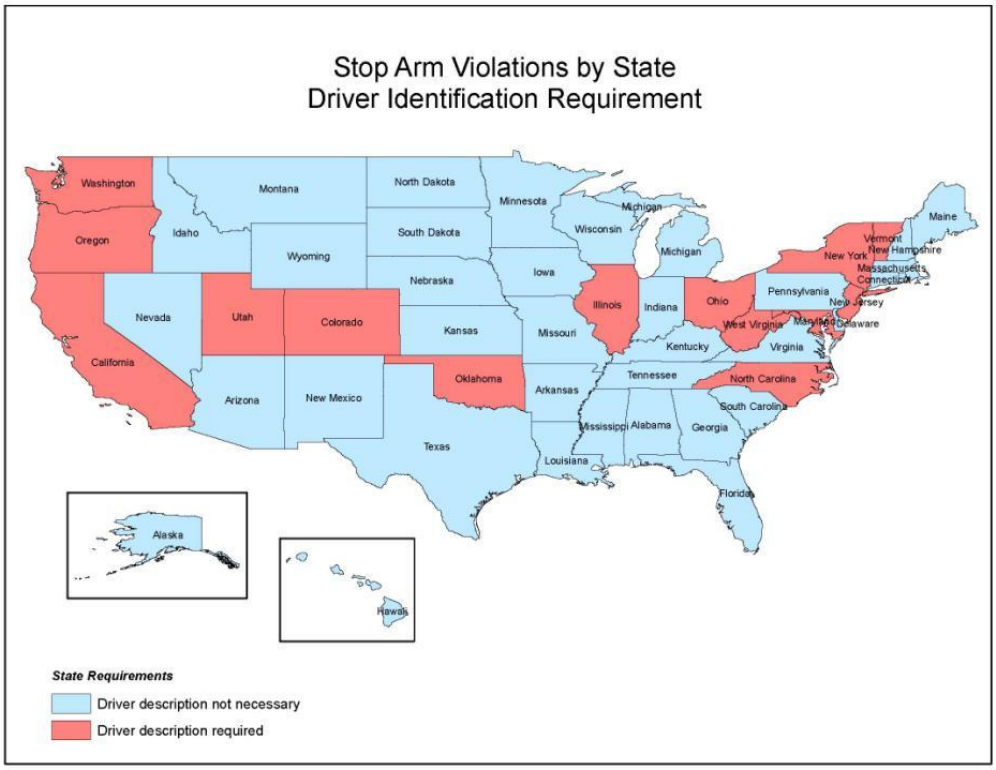
State Requirements

Requirements to be considered when developing solutions to reduce stop-arm violations vary from state to state, as illustrated in the following series of maps.

As shown on the map below, three states—Florida, Oklahoma, and Texas, require that a law enforcement individual witness a violation. In those states, stop-arm cameras alone would not provide sufficient evidence to convict a motorist involved in a stop-arm violation.



As illustrated on the map below, fourteen states, including North Carolina, require identification of the driver of a vehicle involved in a stop-arm violation.



The requirement to identify the driver of an offending vehicle typically necessitates having another individual, such as the school bus driver, a passing motorist, or a law enforcement official identify the driver.

North Carolina Legislative Actions

Since 2001, the North Carolina legislature has passed successive bills that have increased the penalties for, and closed loopholes on school stop-arm violations. The list below highlights key legislative acts enacted from 2001 to 2013. Full versions of the legislation are provided in Appendix A.

NC School Bus Stop Arm Legislation

2001: House Bill 774

- Rental car companies must display notification of the North Carolina school bus stop-arm law in English, German, Japanese, and Spanish.

2005: House Bill 1400

- Increased the penalty for passing a school bus with the stop-arm extended from a Class 2 misdemeanor to a Class 1 misdemeanor.
- Conviction becomes a Class I felony if a driver has willfully caused bodily injury.

2006: House Bill 2880

- No prayer for judgment continued (PJC) allowed under any circumstances.

2007: Senate Bill 924

- Removed the reference of stringent 8" letter signage height requirement.
- Conviction becomes a Class I felony if a driver strikes any person regardless of bodily injury.

2009: House Bill 440 (Nicholas Adkins School Bus Safety Act)

- Conviction becomes a Class H felony if the violation results in the death of a student.
- Allows the use of automated camera and video recording systems to detect and prosecute violations.

2013: House Bill 428 (Hasani N. Wesley Students' School Bus Safety Act)

- Increases the penalty for passing a stopped school bus to include a minimum fine of $500 for the Class 1 misdemeanor.
- Increases the penalty for violators who strike a person to include a minimum fine of $1,250. The minimum fine is $2,500 if the incident results in the death of the person who was struck.
- Revokes the violator's driver's license for:
  - One year for conviction of a second misdemeanor violation in a three-year period;
  - Two years for conviction of a Class I felony violation;
  - Three years for conviction of a Class H felony violation; and
  - Permanently for conviction of a second felony violation and conviction of a third misdemeanor violation within any period of time.
- A violator whose driver's license is revoked under this statute is disqualified from driving a commercial vehicle during the period of license revocation.
- Failure to pay a fine results in withholding the motor vehicle registration renewal for all vehicles owned by the violator.

House Bill 440, the Nicholas Adkins School Bus Safety Act enacted in 2009, added a critical provision to an existing law - allowing the use of automated camera and video recording systems to detect and prosecute violators. This act, named in memory of a 16 year old student killed when a driver did not stop for a stopped school bus, created an opportunity to use video technology to document illegal passing events, including the vehicle make and model, the license plate, and most importantly, images of the offending drivers. All these elements are needed to successfully prosecute a stop-arm violation in North Carolina.

Technology Implementation

Implementation of stop-arm camera technologies has involved two projects to test and evaluate camera and recording systems. An initial trial in the late 1990's used analog cameras and was able to temporarily reduce passing rates. A report of this project is available at www.ncbussafety.org/Stoparm/documents/NHTSAFinalReport.PDF .
Another trial was conducted in 2009-2010. Findings from that test were incorporated into another trial conducted in 2011 and 2012. The 2009-2012 trial is described briefly, with more detail provided on the second, more recent test.

First Generation Digital Stop-Arm Camera Trial

Digital stop-arm cameras were first mounted on school buses in North Carolina during a trial conducted during 2009-2010. The initial installation added cameras to several buses that had

multi-camera interior video systems. The cost of adding the exterior cameras was relatively small, $300-$500 per vehicle. One or two cameras were mounted on a total of 46 buses in 10 school districts. Equipment from four vendors was involved in the installations, which were funded by Local Education Agencies (LEAs), vendors, and the Governor's Highway Safety Program (GHSP). Video from secured onboard recording devices was downloaded and stored by school district personnel using secure passwords. Local school district personnel were also trained in how to discuss the procedures used to create the video in court. Findings from this initial installation are summarized in the table below.

Successes	Challenges
Overall	
• High success rate capturing license tag • Showed bus signalization activities (amber lights, red lights/stop arm deployment)	• Unable to identify driver of passing vehicle • Low rate of coverage • Cumbersome software to view video
Local Education Agency	
• Minimal distraction for bus driver to "time-mark" violations in the video stream • Video displayed opportunities to improve driver training	• Lack of historical information on locations with high numbers of violations prevented optimal use of camera-equipped buses to record violations • No time savings when reporting violations (reporting form must be completed manually)
Law Enforcement	
• Embedded GIS mapping • Sufficient evidence gathered to seek admission of guilt from drivers	• Lack of uniformity in follow-up on recordings by law enforcement personnel (some violations were dismissed due to the lack of a positive driver identification, some personnel sought a driver's admission of guilt)
Judicial System	
• Untested	• Untested

The trial found that technology could be used to capture stop-arm passing events, and that vehicle information could be recorded by retooling the onboard school bus camera system then in use. However, the camera systems often failed to capture the offending driver's image, which is necessary to prosecute those individuals in court. One recommendation resulting from this initial trial was to test a high-end video camera system that would be capable of capturing images of both the license tag and the identity of the driver of vehicles passing stopped school buses with the stop-arm deployed. This led to the testing of the second generation digital stop-arm camera system, as described below.

Second Generation Stop-Arm Camera System

A Request for Information was issued in the fall of 2010. The purpose of the request was to gather, compile, and assess the capabilities of companies to provide a camera system capable of recording the following:

- Images of the offending vehicle, with resolution sufficient to identify the vehicle color, make, and model;
- Images of the offending vehicle's license plate with resolution sufficient to clearly read the plate; and

- Images of the offending vehicle's driver with resolution sufficient to identify the driver.

The video also needed to be capable of:

- Capturing images when vehicles passed a bus traveling in both the same, and the opposite direction as the bus;
- Capturing the entire sequence of the school bus passenger stop violation (before, during, and after the violation) including the date and time of the violation;
- Capturing evidence that the bus was completely stopped and the stop-arm was completely deployed; and
- Capable of performing under low light conditions.

Finally, the system needed to be equipped with imaging management software secured both digitally and physically that would:

- Allow extracting images from the illegal passing sequence;
- Allow a frame-by-frame examination of the violation; and
- Allow exporting images of a violation to a standard digital file format (.avi, mp4, wmv, etc.) for review and use. A proprietary format was to be maintained for the purpose of documenting a chain of evidence.

After evaluating responses from potential vendors, an Invitation for Bids (IFB #201100143) was developed and issued in the spring of 2011 for a dedicated stop-arm violation camera system capable of capturing stop-arm passing events, vehicle information, and violator's images. Funding was provided by the North Carolina Governor's Highway Safety Program, and the North Carolina Department of Public Instruction (DPI). The Institute for Transportation Research and Education at North Carolina State University (ITRE) assisted with the evaluation of responses to the IFB, which was issued by the NC Department of Administration, Division of Purchase and Contract, for the purpose of establishing an agency-specific term contract for school bus stop arm camera systems.

Proposers were required to demonstrate through a video sample that their system could adequately capture the identity of the driver in a moving vehicle while illegally passing a stopped school bus. As few stop-arm camera installations were in effect, a real world simulation could suffice for the video sample. Several videos were required:

1. Vehicle passing from front of the test unit traveling at 15 mph on a two-lane roadway;
2. Vehicle passing from rear of the test unit traveling at 15 mph on a two-lane roadway;
3. Vehicle passing from front of the test unit traveling at 15 mph on a two-lane roadway with a center turning lane;
4. Vehicle passing from front of the test unit traveling at 15 mph on a four-lane roadway with passing vehicle traveling on the near lane; and
5. Vehicle passing from front of the test unit traveling at 15 mph on a four-lane roadway with passing vehicle traveling on the far lane.

The minimum content of the sample videos was to include:

- The license plate of vehicle passing from either the front or the rear of the bus
- An image of driver of the offending vehicle whether approaching from the front or the rear of the bus

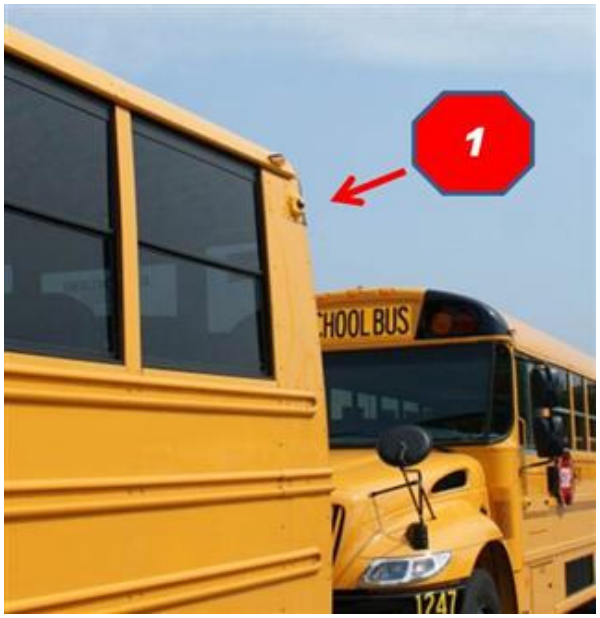
- An identifiable image of offending vehicle make, model, and color
- The date, time, event location (lat., long. or map, or both), evidence that the stop arm is fully deployed and the bus is stopped
- The ability to position at least one camera to see both the stop arm and any passing vehicles

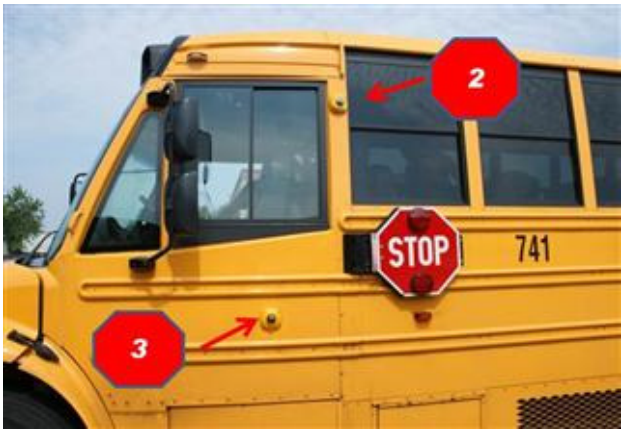
Requirements for recording, data storage, and image extraction included:

- Data security that allows an unbroken, unalterable chain of evidence for legal purposes.
- The ability to download or export video and or images in a commonly available format.
- Clear descriptions of the video or image file extraction or transfer procedure.
- The ability to "time stamp" video or images so that the extraction protocol isolates violation events only. The "time stamp" can be initiated manually by bus drivers to 'tag' an observed violation or by auto-detection by the test unit.
- The test system should require only one recording unit (DVR). Playback should include simultaneous views from all cameras along with the other captured data (time, bus speed, etc.).
- Sufficient storage capacity to capture approximately 5 days of video.

After review of proposals, a contract was awarded to Fortress Mobile of Charlotte, NC. In the summer of 2011, the first camera system was installed on school buses in Iredell County. In the following months, additional camera systems were installed on buses in Carteret, Rowan, Stokes, and Wake Counties. One bus was equipped with the camera system in Carteret, Iredell, and Stokes Counties, and two buses were equipped with camera systems in Rowan and Wake Counties.

Each installation involved mounting three high resolution video cameras (Internet Protocol (IP) with HDTV image quality and a recording speed of 25-30 frames per second) on the exterior of the school buses, as shown in the photographs on the following page. Interior cameras were already in place, and all cameras were connected to a single recording device.

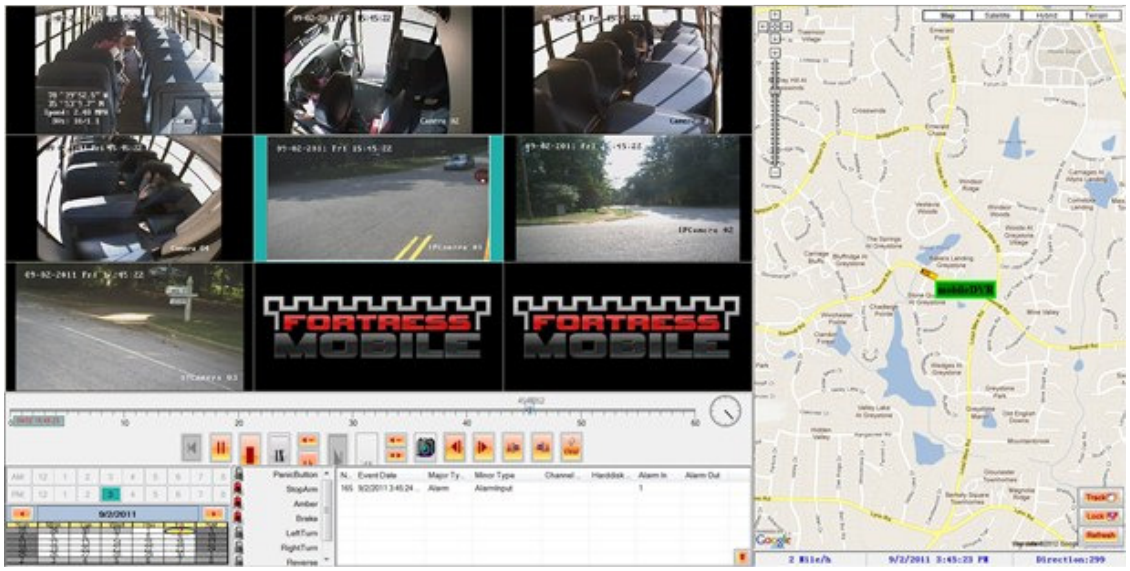




Other aspects of the recording system included:

- Capability for continuous recording on a spring-dampened digital recording system;
- Capture of vehicle dynamics (braking, activation of warning lights, and stop-arm deployment);
- Geographic positioning system (GPS) vehicle tracking, mapping, and speed calculation;
- An event button to time-mark violations; and
- Secured playback software to extract images for use as court evidence.

The exterior and interior video cameras record continuously during a bus run. The recording system captures the following bus activities: speed, braking, deployment of amber warning lights and deployment of stop-arm, as shown below.



When a stop-arm violation is observed, the bus driver triggers a sensor to time-stamp the video. Embedded with GPS and mapping, the playback software enables the transportation department to study each passing event in detail. The video can be reviewed from each camera on a frame-by-frame basis, which is useful not only to school transportation departments, but also.to local law enforcement officials. The photo below illustrates a camera photographing a driver.

The process used by the Rowan-Salisbury School System was as follows:

1. A school bus with the stop-arm camera system is operated on a route through an area in which bus drivers have noted as having a relatively high rate of passing violations.
2. The bus driver is instructed on how to use the button that marks the recording on the hard drive with the time that a violation occurred.
3. At the end of a run, the driver notifies the Bus Coordinator of the violation(s), and fills out a form to report the violation(s). The form asks for information such as the date, time, and location of the incident, as well as information on the vehicle and driver, and any witnesses available for prosecution.
4. The Bus Coordinator or the school principal reports that a violation has occurred and sends the report to the Transportation Department.
5. A designated Transportation Department staff member removes the hard drive from the bus and replaces it with another one.
6. The video is reviewed to confirm the violation.
7. Video and still images are captured on a laptop computer and copied to a CD. The CD is provided to the District Attorney's office (and to law enforcement personnel, if requested).
8. The report and still pictures are provided to law enforcement personnel so that they may issue a citation.
9. After a citation has been issued, law enforcement personnel contact the school transportation department to provide the name of the violator and the court date.
10. The report, still pictures, and video are provided to the District Attorney's office prior to the scheduled court date.
11. The bus driver and transportation director testify in court, as necessary. Initially, they had to report to the court at 9:00 am and stay until the case was heard. In some instances in which a case was continued, school personnel would need to go to court on multiple days. As a result of increased cooperation between the District Attorney and the school system, the bus driver and transportation director are on standby on the scheduled court date and do not have to be in court for prolonged periods of time.
12. The video and still pictures have proven to be sufficient evidence to warrant a guilty plea, or to find the violator guilty if the case goes to trial.

As of September 2013, 77 violations had been recorded by the five piloting counties as a result of the camera system. The status of those violations was as follows:

- Carteret County—four violations, one of which was pending in court
- Iredell County—three violations, all convicted
- Stokes County—two violations pending in court
- Wake County—one violation continued in court seven times; case dropped
- Rowan County—32 violations noted during School Year 2011-2012, plus six incidents that were not recorded due to equipment problems. Of the 31 violations, 21 violators pled or were found guilty. The other 11 violations could not be prosecuted as a result of an inability to identify the license tag, or the license tag could not be confirmed for the vehicle.

35 violations were noted during School Year 2012-2013, plus ten incidents that were not recorded as a result of equipment problems. Of the 35 violations, 22 violators pled or were found guilty. The other 13 violations could not be prosecuted as a result of an inability to identify the license tag, the driver, or an incident was judged to have been too close to call.

Rowan County recorded the greatest number of violations, and additional work was conducted with that school district in an effort to learn more about, and reduce the number of violations. Analysis of the data from the violation recordings revealed four locations with relatively high numbers of violations. All four locations were on a four-lane roadway in Spencer, NC (North and South Salisbury Avenue). Two locations were in mixed-use areas with a speed limit of 45 miles per hour (mph). One location was in a business district with a speed limit of 20 mph, and the fourth location was in a mixed-use area with a speed limit of 35 mph. Six school bus routes travel through these locations.

Variable message signs were installed at locations to the north and south of the roadway section with the four locations with high rate of violations. The signs were in place and active for a three-week period between August 23, 2012 and September 13, 2012. The signs displayed two messages—Watch for School Buses—and Do Not Pass Stopped Bus.

During the weeks when the signs were in place and active, only two stop-arm violations were reported in the affected area. However, during the three-week period following removal of the signs, eight violations were reported. Seven permanent signs warning motorists not to pass a stopped school bus have since been installed in that highway corridor. Since the use of stop-arm equipped school buses and the installation of signs, the transportation director at Rowan-Salisbury Schools noted that violations have ceased in the Salisbury/East Spencer highway corridor that had initially experienced a high number of violations, and the camera-equipped buses have been moved to other routes.

The transportation director also noted that cases are no longer continued in court. After the first violations were reported, some cases were continued four or five times, requiring school transportation personnel to make multiple court appearances. That is no longer the case. Now, attorneys ask to view the recording before advising their client on a plea, and that has resulted in quick resolutions to many cases.

Findings from the Second Generation Stop-Arm Camera Deployment

Overall findings from the second generation stop-arm camera deployment include:

- No challenges to date from a defense attorney
- Building a relationship with local District Attorneys during the installation of cameras on the vehicles can be helpful. Having a good working relationship with local prosecutors can help to minimize the amount of time school transportation staff are required to spend in a courtroom, and can facilitate the introduction of the video as evidence.
- Additional school district resources will be required to manage a camera system in districts with high violation rates.
- Initial use of camera-equipped buses helps in determining the routes on which those buses should be operated to maximize recording of violations.

- Additional investigation is required to determine why drivers pass stopped school buses illegally, and to devise effective methods to prevent such occurrences.

2013 Legislative Appropriations

In July 2013, the North Carolina Legislature passed, and Governor McCrory signed Senate Bill 402, the Appropriations Act of 2013, which included $690,000 for State Fiscal Year (FY) 2014 and an equal amount for FY 2015 to install cameras in two school buses at each of the 115 Local Education Agencies (LEAs) in the state.

Challenges Remain

Even though the stop-arm violation camera system has shown success in these pilot school districts, two challenges remain.

First, the court system is slow in processing citations. If staff members from a school transportation department are subpoenaed to appear in court, it will take a good portion of their workday waiting for the case to be heard in court. If, as happens periodically, a case is continued several times, that results in a significant demand on time for the staff who are subpoenaed. Some county courts only subpoena law enforcement officials who have reviewed the video for the trial and do not subpoena the transportation staff. There is further work required in learning more about learn how to work efficiently with the judicial system.

Second, the ultimate goal is to prevent stop-arm violations. These violations expose children to grave danger. There is still much to learn from these violations. For example; why do drivers not stop for a school bus when the stop-arm is extended? Is that due to driver distraction or a lack of familiarity with the law? Or, confusing school bus warning signals? Further research on these questions is warranted.

Appendices

Appendix A: North Carolina Legislation

Appendix B: North Carolina School Bus Stop Law

Legislation, the stop arm law and other related information is available at the following web site: www.ncbussafety.org/Stoparm

Appendix A: North Carolina Legislation

GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 2001

SESSION LAW 2001-331
HOUSE BILL 774

AN ACT TO PROVIDE FOR HOW DRIVERS SHALL OPERATE THEIR MOTOR VEHICLES WHEN PASSING PARKED OR STANDING EMERGENCY VEHICLES THAT HAVE THEIR EMERGENCY LIGHTS ILLUMINATED, AND TO REQUIRE RENTAL CAR COMPANIES TO NOTIFY RENTERS OF THE LAW FORBIDDING PASSING OF A STOPPED SCHOOL BUS.

The General Assembly of North Carolina enacts:

SECTION 1. G.S. 20-157 is amended by adding a new subsection to read:

"(f) When an authorized emergency vehicle as described in subsection (a) of this section is parked or standing within 12 feet of a roadway and is giving a warning signal by appropriate light, the driver of every other approaching vehicle shall, as soon as it is safe and when not otherwise directed by an individual lawfully directing traffic, do one of the following:

(1) Move the vehicle into a lane that is not the lane nearest the parked or standing authorized emergency vehicle and continue traveling in that lane until safely clear of the authorized emergency vehicle. This paragraph applies only if the roadway has at least two lanes for traffic proceeding in the direction of the approaching vehicle and if the approaching vehicle may change lanes safely and without interfering with any vehicular traffic.

(2) Slow the vehicle, maintaining a safe speed for traffic conditions, and operate the vehicle at a reduced speed until completely past the authorized emergency vehicle. This paragraph applies only if the roadway has only one lane for traffic proceeding in the direction of the approaching vehicle or if the approaching vehicle may not change lanes safely and without interfering with any vehicular traffic.

Violation of this subsection shall not be negligence per se."

SECTION 2. Article 28 of Chapter 66 of the General Statutes is amended by adding a new section to read:

"**§ 66-207. Rental car companies assist in publicizing law.**

(a) A rental car company shall notify renters of the law requiring motorists to stop for and not pass stopped school buses that are properly marked and designated and that are receiving or discharging passengers. The Division of Motor Vehicles shall design a written notification in English, French, German, Japanese, and Spanish and the notification shall be no more than one side of a page. The Division of Motor Vehicles shall also develop a design for use on placards under subdivisions (b)(2) and (b)(3) of this section. The design may be used or adapted by the rental car company. The placards shall consist of the words "It is unlawful in North Carolina to pass a school bus that is stopped and receiving or discharging passengers.", or a visual symbol

indicating passing a stopped school bus is unlawful in North Carolina, or both. The Division of Motor Vehicles shall publish the written notification and the design for placards on the Internet and rental car companies shall obtain both by downloading and printing them from that source.

(b) The notification required under subsection (a) of this section may be made either:

(1) By handing each renter who presents an International Driver Permit with a copy of the written notification prepared by the Division of Motor Vehicles under subsection (a) of this section;

(2) If the rental car company operates airport shuttle buses to transport renters to pick up vehicles, by posting on each bus at least one placard containing a written notification or visual symbol, or both; or

(3) If the rental car company operates a counter at which renters pick up documentation, by posting on that counter or at a place easily visible from the counter at least one placard containing a written notification or visual symbol, or both.

Each placard that contains a written notification shall provide that information in all the languages listed in subsection (a) of this section.

(c) There shall be no civil or criminal liability in negligence nor shall an action under G.S. 66-206 apply for any car rental company that fails to provide the information or post the placard required by this section."

SECTION 3. Section 2 of this act becomes effective December 1, 2001. The remaining sections of this act become effective October 1, 2001.

In the General Assembly read three times and ratified this the 24th day of July, 2001.

s/ Beverly E. Perdue
President of the Senate

s/ James B. Black
Speaker of the House of Representatives

s/ Michael F. Easley
Governor

Approved 11:26 a.m. this 2nd day of August, 2001