Driver Reaction at Railroad Crossings

By

Dr. Jay Lindly
The University of Alabama
Tuscaloosa, Alabama

Prepared by

UTCA

University Transportation Center for Alabama
The University of Alabama, The University of Alabama at Birmingham,
and The University of Alabama in Huntsville

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16. Abstract

The Alabama Department of Transportation desires to make highway/rail crossings in Alabama as safe as practicable. Accordingly, it initiated Federal Aid Project HPPF-AL49(900) to determine whether DOT crossing number 728478C where US 231 crosses the Gulf & Ohio Railways track in Troy, Alabama would be safer and if driver behavior would be modified when a StopGate™ stop arm developed by Quixote Transportation Safety was installed at the crossing. Personnel from the University Transportation Center for Alabama (UTCA) were employed to help in two areas of the project: to analyze driver behavior characteristics based on digital images provided by Quixote and to document crashes and/or near misses at the crossing from data provided by the Gulf and Ohio railroad. Unfortunately, the digital images of driver reactions at the crossing supplied by a third party vendor were unusable for the analysis. Additionally, the Gulf & Ohio does not keep near miss records for the Shortline Railroad that includes this crossing. Without useful data, UTCA could not reach statistically verifiable conclusions. A limited amount of observations after the gates installation led to the following observation. The only violations that were observed occurred after flashing lights began but before full deployment of the gates; no vehicles drove around the gates, and there were no violations after the gates were locked in place. Rather than to attempt to draw firm conclusions from inadequate data, the UTCA team recommended instead to use the lessons learned from this installation to better prepare for future projects.

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Executive Summary

The Alabama Department of Transportation (ALDOT) installed a stop barrier gate manufactured by Quixote Transportation Safety on US 231 on both approaches to USDOT crossing number 728478C where the Gulf & Ohio Railways crosses US 231 in Troy, Alabama in September, 2008. The installation was part of Federal Aid Project HPPF-AL49(900). Before the installation of the StopGate™, the crossing had cantilever flashing lights, gates, RR crossing symbols, and stop lines. At that location, US 231 is a four-lane highway with a speed limit of 55 mph and an average daily traffic of over 36,000 (2008) vehicles per day. Generally, two train passages occur per day at this single-track crossing.

The University Transportation Center for Alabama (UTCA) contracted with the Alabama DOT to work on the project from 2/1/07 to 12/31/10. Two of the most important functions that UTCA was to perform follow:

- "Analyze driver behavior characteristics based on digital images provided by Quixote."
- "Continue documenting crashes and/or near misses at crossings from data provided by the Gulf and Ohio railroad for a total of three years."

Unfortunately, Quixote and UA communicated poorly concerning placing the cameras and initiating a system to capture the digital images. UTCA did not receive images until after the gate installation was made, and when the images arrived, fewer than 30 days of pre-gate train passages were recorded. Of those events, only two train passages were useful due to such reasons as the absence of images or poor image quality. For the post-gate data, 107 train passages were recorded, though much of that data was also compromised. For the post-gate data that was usable, UA researchers made the following observations, noting that the data on which they are based is incomplete:

- All vehicle violations were of the same type, occurred after flashing lights began but before full deployment of the gates.
- No vehicles drove around the gates, and there were no violations after the gates were deployed.
- 71% of the passages contained violations; 29% of the passages contained no violations.

Concerning the comparisons of near miss data, the Gulf and Ohio railroad does not record near misses (at least on this Shortline Railroad), so this line of analysis was also not open.

Rather than continue to draw conclusions from inadequate data, the UA team believes it may be best to use the experience from this installation to better prepare for future installations.

Section 1.0
Introduction

1.1 Problem Statement

The Federal Highway Administration (FHWA) estimates that there were 1,896 incidents at the roughly 136,000 US public highway-rail crossings in 2009, including 247 deaths and 705 injuries [1]. Alabama suffered 68 such collisions in 2010, ranking it 7th in the nation, and the eight associated fatalities ranked Alabama10th (2). Many of these crashes stem from drivers maneuvering around existing railroad crossing gates or not slowing/stopping to check for oncoming trains at passive crossings.

1.2 Project Objective

Congressional funding has provided approximately $1.98 million to install and assess an extended crossing gate (the StopGate™ Barrier Arm system from Quixote Transportation Safety) at several crossings in Alabama over three years. The StopGate™ device extends across traffic lanes and locks into a support at the far edge of the lanes. It is designed to prevent motorists from driving around the gates and can stop a 2,000 pound pickup truck traveling at 44 mph.

The objective of this project was to document the reaction of drivers to the new gates at DOT crossing inventory number 728478C where the Gulf and Ohio Railroad crosses US 231 in Troy, Alabama. The project plan included a 3-month-before/3-month-after study of driver behavior at the crossing by the project team and monitoring crashes/near misses observed by railroad personnel at the crossings for three years.

Section 2.0
Literature Review

Railroad-highway grade crossings are a point of conflict between vehicles and trains; however, these crossings are different than intersections within the road corridor because the train, due to its inability to halt quickly, always has the right of way. In a collision event, the highway vehicle bears the brunt of casualties. So, the driver is expected always to stop at the rail crossing for a passing train. The traffic-control devices located at such crossing points are intended to aid the driver to carry out this obligation, and they should be sufficient to prevent most collisions at railroad crossings. Unfortunately, highway/railroad crashes continue to be recorded throughout the country. Apparently, either the traffic control devices at the crossings do not give drivers the desired information, or users willfully violate the signs, signals, and gates. Though research continues to study driver behavior at such crossings [3], crashes persist.

2.1 Crash Characteristics

In times past, most railroad crashes occurred at crossings with passive crossing devices such as crossbucks, pavement markings, and stop signs. Now most dangerous crossings have been equipped with active devices such as gates and other sophisticated constant-warning-time devices. Yet even these measures have not been able to stop crashes from occurring. Although the general trend is toward a decrease in crashes, a worrying trend is that more than half of the accidents now occur at protected crossings [4]. However, this situation may be attributable to the fact that there are now fewer crossings with passive crossing devices than in past years.

For the past 30 years, highway/railroad crashes have declined despite great increases in traffic volumes. One reason for the decline is the improved signal systems, gating, and grade separation programs [5]. In other words, crash-avoidance measures are yielding results.

In the period from 1994 to 2007, railway grade crossing incidents nationwide declined by 44.7 percent [6]. Seven factors were identified to be largely responsible for the decline:

- Commercial driver safety- which was aided by the Motor Carrier Safety Improvement Act of 1999
- Locomotive conspicuity- which required all locomotives exceeding 20 miles per hour to have auxiliary alerting lights in addition to headlight
- More reliable motor vehicles that will not stall on tracks
- Sight lines clearance – which is the clearance of vegetation and obstructions around the grade crossing to provide adequate sight distance for highway users
- Grade crossing maintenance rule – this rule gives railroads specific roles to ensure proper performance for active crossing warning systems

- Freight car reflectorization added to the sides of freight cars and locomotives
- Installation of pedestrian safety devices [6].

2.2 Driver Behavior - The Human Element in Railroad Collisions

One method for categorizing railroad-highway grade crossing crashes follows:

- Driver Error
- Weather
- Mechanical (Automobile or Train)
- Queuing from Adjacent Intersection
- Warning System Failure
- Pedestrian/Bike Incident
- Unknown causes [7].

Other factors which have been identified to have significant effect on collisions at grade crossings include the number of daily trains, the number of tracks, highway separation, annual average daily traffic (AADT), and crossing length [8].

In the years 2003 and 2004, approximately 6,000 highway/rail crashes were recorded, out of which 71% resulted from "Driver Error" [7]. A 2008 study carried out by Khattak to compare driver behavior at highway-railway crossing in two cities revealed that drivers respond differently to the same type of safety treatment at different locations [9]. Some drivers indulge in very risky behaviors such as passing through descending gates or even driving around already lowered gates. Research shows that 20% to 60% of drivers will prefer to rush through descending gates, if they have the choice [10]. It may be appropriate to counter this behavior through the use of long-arm gates and median separators, as long arm gates have been seen to reduce collisions by 75% [10].

Data has generally shown that upgrading flashers-only systems by the addition of gates resulted in significant reduction in crash rates. Studies conducted in the Netherlands and in the US also corroborate this notion. A counter-argument contends that although gates might result in some reduction, they might not be an ideal solution to the collision problem at grade crossings because a high rate of crashes still occurs at gated crossings.

Meeker, *et al*. reported from a limited study conducted to compare driver behaviors at a gated crossing in a before and after gating case. That group concluded that the primary benefit of gates seemed to be that they reduce the number of crossings in front of approaching trains. However, for drivers who decide to zigzag around gates in the presence of approaching trains, the barriers might compel hasty decisions and thus place that category of drivers in more danger than they would be without the gates. They believed that reducing the number of drivers who violate the gates would be a way of making gated crossings safer, and the report also suggests further research into driver attitudes at gated crossings [4].

2.3 Classification of Violation Types

According to the State of Alabama Driver Manual, all vehicles must stop at a gated crossing when the lights start flashing and remain stopped until the gates are fully raised and the lights stop flashing [11]. Violation occurs when a driver fails to respond accordingly and crosses the stop line.

After reviewing the works of Byungkon Ko, *et al*. [12], the UTCA research group decided to categorize gate violations under four main types, relative to the position of the gate arm and the passage of the train.

- Type 1 – This violation involves the time frame from the start of flashing to the time the gates are fully deployed. It involves drivers who could have stopped at the stop bar but drove through the crossing anyway.
- Type 2- This violation occurs after the gates are fully deployed but the vehicle is driven around the gate before the passage of a train.
- Type 3 – This violation occurs when the gates are still down but the vehicle is driven around the gate after the passage of the train.
- Type 4 – This violation involves vehicles that cross the tracks after the gates start to move up but before they are fully lifted to their upright position and the lights stop flashing.

2.4 Measures For Addressing Inappropriate Driver Behaviors At Gates

Several techniques have been developed aimed at enhancing safety at crossings by discouraging drivers from violating gates. These techniques include long arm gates, median separators, photo enforcement, four-quadrant gates [13, 14].

<u>Long Arm Gates</u>
Regular gates usually extend across only half of the roadway. Long arms, on the other hand, cover at least three quarters of the roadway and have been shown to be effective in discouraging drivers from driving around gates with an efficacy rate of 75% over shorter-arm systems [15].

<u>Median Separators</u>
This technique consists of flexible median barriers, which are considered a low-cost treatment that can significantly improve safety at gated crossings and are capable of reducing violations by 77 percent [13]. The median barrier may be a flexible, striped object marker used as a vertical channelizing device. It is designed to deter motorists from driving around gates but to be flexible enough to allow emergency vehicles to cross it. One study found it to significantly reduce gate violations [12]. However, a study carried out by Khattak concluded that even though the installation of centerline barriers can reduce some dangerous behavior types, it can also result in an increase of some less dangerous activities such as vehicle backups [16].

<u>Four-Quadrant Gates With or Without Median</u>
Four-quadrant gates are used to enhance safety at intersections. Unlike two gates, these gates extend across the entire roadway and when fully engaged prevent almost all traffic movements

across the tracks. For each approach and departure from the crossing, there are a set of gates that entirely close the road, preventing almost any form of driving around, which may happen with two gate systems. Four-quadrant gates are operated in such a way as to prevent trapping of vehicles between the gates, which can be achieved by delaying the closing of the set of departure gates. Studies show this technique can reduce violations by 86% and when combined with traffic channelization, the result can yield up to 98% reduction in violations [13].

Video Enforcement

The use of video clips of violating drivers is another means of reducing traffic violations. In North Carolina's "Sealed Corridors" Project, it was demonstrated that photo-based video enforcement can be combined with a system of fines to provide an effective control, reducing violations up to 72% [13].

Section 3.0
Methodology

3.1 The Crossing

The crossing studied for this report is public, at-grade crossing number 728478C. It is located in Troy, Alabama where one set of Gulf and Ohio Railroad tracks crosses US 231 in a commercial area of town. Prior to the installation of the StopGates^{TM}, the crossing was equipped with stop bars, “RR Xing” symbols, mast-mounted flashing lights, and bells. Railroad personnel reported that the gates frequently were not operational due to damage to the arms. Typically, one train per day makes a delivery to a local industry and returns, resulting in two train passages per day at speeds of 5-10 miles per hour.

At that location, US 231 is a 4-lane road classified functionally as “urban other principal”. At the site, US 231 exhibits annual average daily traffic of roughly 38,400 vehicles per day and an estimated percent trucks of 5%. The posted highway speed is 55 miles per hour.

ALDOT and Quixote spent considerable time assessing highway/railroad crossings in Alabama to find a suitable site. Several sites were considered that had experienced greater numbers of crashes involving injuries and fatalities, but arrangements could not be made to test at those sites.

The Gulf and Ohio Railroad agreed to test at the Troy site. Before the addition of gates, teams of two of their employees routinely acted as flaggers at the crossing, and the addition of gates meant that their employees no longer had to participate in this potentially hazardous activity. The most recent FRA Highway-Rail Grade Crossing Accident/Incident Report at this location concerned a crash from January 26, 2004. That incident involved a teen-aged driver who failed to stop at the crossing, passing by other standing highway vehicles and impacting the train at an estimated 35 mph. The driver was injured in the crash.

3.2 The Barrier Arm

The StopGateT^{M} system from Energy Absorption Systems, Inc. (a Quixote Company) is described in company literature as follows [17]:

- The StopGate Barrier Arm operates like a standard automatic warning gate using the interconnect signal to raise and lower the arm.
- Arm … connects to a locking device on both sides of the road, creating a positive, crashworthy barrier.
- The Stopgate Barrier Arm has successfully passed the NCHRP 350 TL-2 tests as required using vehicles weighting both 1808 lb. (820 kg) and 4410 lb. (2000 kg) for structural

adequacy, occupancy risk, and vehicle trajectory evaluation criteria at speeds up to 43 mph (70 km/h).

- Recognized by the U.S. Department of Transportation's Highway-Railroad Grade Crossing Technical Working Group as a supplemental safety device (SSD) that should be considered for use at crossings with passenger or high speed trains, in quiet zones or as otherwise recommended by an engineering study or diagnostic team.

3.3 Camera Installation

Quixote installed cameras on existing poles at both sides of the crossing. One camera looked northbound and the other looked southbound so that the research team could study the actions of drivers as they approached the crossing. Ninety days of pre-gate data were to be gathered, and ninety days of post-gate data were to be gathered so that a comparison of driver behavior could be made. The digital images were stored locally, and they could be accessed remotely at an IP address by researchers using a login and password.

3.4 Observations of Drivers

The digital images provided by Quixote consisted of short time periods of images of vehicular movement each time a train approaches the crossing. The recordings were scheduled to start 10 seconds before the flashing lights began and to end 10 seconds after the flashing lights went off.

The key observations of interest in the video clips included the following movements:

- Vehicles in the crossing after warning flashers are activated
- Vehicles in the crossing while the gates are in motion
- U-turns in the crossing area
- Driving around the gate systems
- Passing around gates after train passes
- Gates hitting vehicles
- Gates breakage from vehicles
- Tampering with traffic control devices
- Premature crossing of the train prior to the gate being fully deployed
- Vehicles stopping on or near the tracks because of traffic queues
- Pedestrian or bicycle violations
- Cars stopped on the wrong side of the gate system after the gate has been fully deployed
- Vehicle collisions in the crossing area
- Gate system malfunctions
- Vehicle/train collisions

The research team planned to analyze the images to compare driver behavior before and after the Quixote system was added. Figure 3-1 shows a train at the crossing before the gates were added. In the pre-gate (before) case, as the train approached the crossing, two flagmen descend from the train and trigger flashing warning lights. Then, they stand in the roadway and use flags to stop vehicles prior to the passage of the train. After the train passed, they turn off the warning lights and re-join the train. In Figure 3-1, a flagman is visible in the far right lane stopping a passenger vehicle. Conversations with representatives from the Gulf and Ohio Railroad confirmed that in general, the intervention of the flaggers was required to stop traffic: signing and flashers were insufficient.

Figure 3-1. The crossing before gate installation

The cameras were installed in October 2007, and the gates were installed in October 2008. Figure 3-2 shows a plan view of the site and the positions of the gates that were installed on both approaches. Note that the arms descend to cover both approach lanes in each direction and are locked in place in the guardrail located in the raised, concrete median.

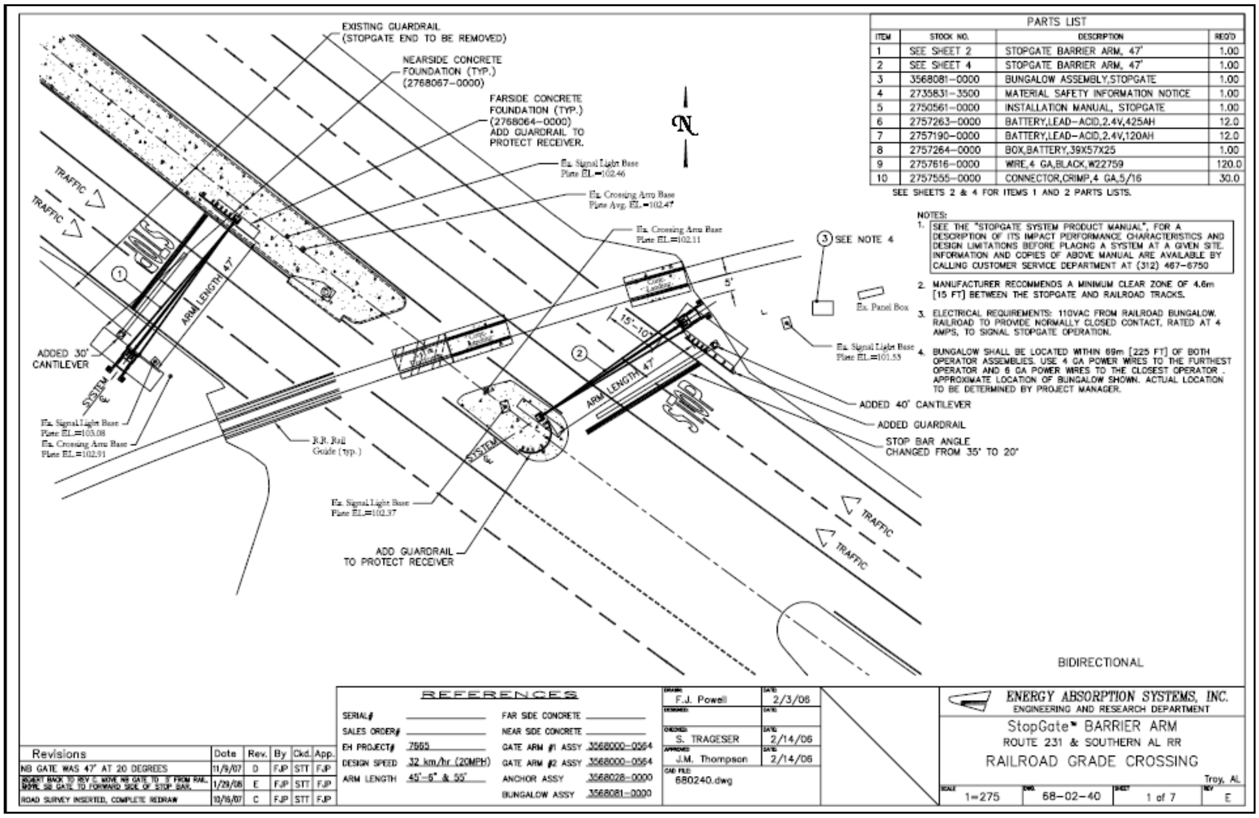

Figure 3-2. Plan view of gate installation

Figures 3-3 and 3-4 present photographs of northbound and southbound approaches after installation of the gates. Figure 3-3 depicts the northbound lanes and the gate in the vertical position. Figure 3-4 shows the southbound lanes and the gate after it has descended and been locked in place.

Figure 3-3. Northbound lanes after installation

Figure 3-4. Southbound lanes after installation

Figure 3-5 shows a closer view of the mechanism which locks the gates serving the northbound lanes.

Figure 3-5. Locking mechanism for northbound lanes

Section 4.0
Analysis

The analysis section of this report is brief. The University of Alabama (UA) research team contracted to analyze before and after data to be supplied to the team by Quixote. Due to poor communications between Quixote and the research team, Quixote had the cameras installed by a third party electronics vendor without significant input from the researchers. The third party vendor was to set the cameras to collect 90 days of before data and 90 days of after data, to store the digital data on an IP website, and to make the data available to the researchers. The data was not successfully acquired or stored, and the following sections describe the attempts by the research team to obtain and process the digital data.

4.1 Pre-gate Records

The third party vendor encountered difficulties recording the data, storing it, and transferring it to the UA team. Notwithstanding many requests from the researchers, pre-gate data was not available from the vendor until January, 2009, when it was made available over an IP site. Ultimately, only 57 recordings were obtained before the gates were installed. The recordings covered the months of April, August, and September, 2008. Many of the days of the month had no recordings. Many of the days of the month contained digital images, but the recordings did not include a train passage. Of the 20 train passages recorded, only the days of September 5 and 8 had digital images that displayed smooth playbacks. The remaining 18 playbacks displayed images at 4-second intervals (one image followed by another image four seconds later, with no images in between) and so they could not be used to make meaningful observations.

The images that were viewable revealed the potential danger at the site. Rarely did cars stop at the crossing until they were stopped by flagmen. However, once flagmen took their positions, vehicles complied with flaggers' instructions in all the situations that were observed.

4.2 Post-gate Data

After it became clear that there would be insufficient pre-gate information for analysis, the researchers realized that the original plan to compare pre-gate driver behavior against post-gate driver behavior would not be possible. However, they continued to ask for usable post-gate information. Post-gate data were available on the IP site for some days in the months of December 2008, March 2009, and April 2009. In total, 107 train passages were recorded. Complete data was not recorded for all passages. In many instances, only southbound (SB) images were available. The SB camera provided images that either streamed continuously or at one-second intervals, but in the latter case the intervals were short enough to generate usable information. When northbound (NB) images were available, images were provided at four-second intervals, which made the images unusable for analysis.

A series of other circumstances contributed to a general lack of trust in the research team for the usefulness of the digital images:

- A relatively low percentage of the images clearly show when flashing lights begin and end. Because the start and end time of these lights signal the begin and end of driver violations, this lack means lends uncertainty to the results.
- No sound accompanies the digital images.
- Both cameras are too close to the tracks, and only one or two rows of stopped vehicles can be observed.
- Many of the videos stop only four seconds after the gate arms begin to lift.

The IP site became inoperative on approximately June 1, 2009. The cameras were removed after that date.

Figures 4-1 and 4-2 show examples of the post-gate images. Both figures demonstrate the difficulties the research team experienced to detect when flashers stopped and end and the inability to see more than one or two rows of stopped vehicles.

Figure 4-1. Southbound post-gate digital image

Figure 4-2. Northbound post-gate digital image

4.3 Data Recording

Each video playback was reviewed, and a record of all usable events and vehicle maneuvers that were of interest to the study were entered into a spreadsheet for data reduction. The spreadsheets were later analyzed to reveal trends. The following list details the information recorded for each playback:

- Event number, date and time of occurrence
- Study situation (Before or after gate installation)
- Signal onset (time when the flashing lights began)
- Times gate begins descent and finishes descent
- Time of arrival of all violating vehicles at the crossing
- Vehicle types
- Time at which the vehicle crossed the railroad (time of violation occurrence)
- Types of violation
- Train position at each gate activation
- Train arrival time
- Train departure time
- Time the signal stopped flashing
- Time gates begin ascent and finish ascent

Table 4-1 presents an example of the of the data that was recorded on the spreadsheet. The data represents five days of post-gate data in March 2009. The data presents the SB camera view for the train coming and going each day. Nineteen violations are recorded, each involving a vehicle that crossed the stop bar after the flashing lights began but before the gates had fully descended.

4.4 Violations Results and Discussions

Results of the pre-gate recordings were not useful for data analysis, so no meaningful comparisons can be made between the pre-gate and post-gate data. The only useful pre-gate observation indicates that flashing lights were usually ineffective in stopping drivers at this crossing. Vehicles frequently did not stop until flaggers descended from the train to flag them to a stop. In all pre-gate situations that were observed, vehicles complied with the flaggers' requests to stop. However, with the addition of the gates, the railroad crew is now spared this potentially hazardous flagging activity.

Section 4.2 of this report lists several reasons that the camera data is suspect (poor camera location, truncated observations, etc.). However, the team analyzed the usable data as best it could and made several observations from the data. However, these observations must be considered incomplete. For example, no u-turn movements were observed; however, due to the limited field of the camera observations, it is possible that u-turn movements took place that were not recorded.

A list of the observations follows:

- All violations were Type 1 violations, that is, they occurred after flashing lights began but before full deployment of the gates.
- The 107 train passages resulted in a total of 205 violations.
- No vehicles drove around the gates, and there were no violations after the gates were deployed.
- No pedestrians or other non-motorized traffic crossed the track during the observation periods.
- 71% of the passages contained violations; 29% of the passages contained no violations.

4.5 Railroad Near-Misses

One intent of the project was to compare the number of before/after near-misses recorded by the railroad. Unfortunately, the Gulf and Ohio does not record near-misses for this short stretch of track, so this comparison could not be made.

Table 4-1. Example data set

After Gate Recordings: Basic Data											
Date		13-Mar-09		16 mar, 2009		17 mar, 2009		19 mar, 2009		20 mar, 2009	
Direction of View	N,S	SB	SB	SB	SB	SB	SB	SB	SB	SB	SB
Train Direction	E,W	EB	WB	EB	WB	EB	WB	WB	WB	EB	WB
Time Recorded	Act. Time	13:43:41	14:56:00	10:14:20	12:14:28	11:43:28	12:53:34	10:05:53	11:19:43	11:04:01	12:02:28
Flushing Light	Start-time			10:14:30	12:14:38					11:04:13	
Gate Descending	Start-time	13:43:56	14:56:30	10:14:34	12:14:42	11:43:42	12:53:48	10:06:06	11:19:56	11:04:16	12:02:41
Gate Descending	End-time	13:44:11	14:56:47	10:14:51	12:14:59	11:43:59	12:54:05	10:06:24	11:20:14	11:04:32	12:02:58
Train Passage	Arrival-time	13:44:17	14:56:59	11:15:03	12:15:32	11:44:07	12:54:18	10:06:36	11:20:20	11:04:43	12:03:11
Train Passage	Depart-time	13:45:06	14:57:07	11:15:32	12:15:46	11:44:40	12:54:59	10:07:16	11:20:28	11:05:19	12:03:46
Gate Ascending	Start-time	13:45:16	57:18	11:15:46	12:15:58	11:44:52	12:55:10	10:07:24	11:20:39	11:05:30	12:03:57
Vehicle Type : 1 2 3 4 5 6 7		2,2,2	2,2,1,1,1		2,1	1	1(x5)			1	1,1
First Violation Time(Crossing		13:43:57	56:31		12:14:40	11:43:45	12:53:49			11:04:15	12:02:42
Last Violation Time		13:44:02	14:56:40		12:14:44	11:43:45	12:53:55			11:04:15	12:02:42
Violation Type: 1 2 3 4		1	1		1	1	1			1	1
Number of violations		3	5		2	1	5			1	2
Time(Train Passage to Start of Gate Ascending)		0:00:10	0:00:11	0:00:14	0:00:12	0:00:12	0:00:11	0:00:08	0:00:11	0:00:11	0:00:11
Time(last violation to time gate finished descending		0:00:09	0:00:07		0:00:15	0:00:14	0:00:10			0:00:17	0:00:16
Time(last violation to train arrival)		0:00:15	0:00:19		0:00:48	0:00:22	0:00:23			0:00:28	0:00:29
Gate fully decended to train arrival		00:06	00:12	00:12	00:33	00:08	00:13	00:12	00:06	00:11	00:13

Types of vehicles	**Violation Types**
Type 1 - cars, pickups, vans	Type 1 – before gates fully decended
Type 2 - trucks, buses,	Type 2- gate fully horizontal and before train passage
Type 3 - emergency vehicles	Type 3 – gate horizontal and after train passage
Type 4 - motorcycles	Type 4 – when gate starts to ascend till flashing lights stop.
Type 5 - bicycles	
Type 6 - pedestrians	

Section 5.0
Conclusions

ALDOT installed a stop barrier gate manufactured by Quixote Transportation Safety on US 231 on both sides of USDOT crossing number 728478C where the Gulf & Ohio Railways crosses US 231 in Troy, Alabama as part of Federal Aid Project HPPF-AL49(900). Before the installation of the stop gates, the crossing had no StopGates™ but had cantilever flashing lights, gates, stoplines, and RR crossing symbols. At that location, US 231 is a four-lane highway with speed limit of 55 mph and average daily traffic over 36,000 vehicles per day. Generally, two train passages occur per day at this single-track crossing. For the project, ALDOT engaged The University of Alabama principally to perform two functions:

- Analyze driver behavior characteristics before and after the addition of the stop gates based on digital images provided by Quixote.
- Continue documenting crashes and/or near misses at crossings from data provided by the Gulf and Ohio railroad for a total of three years.

Due to poor communications between Quixote and the research team, Quixote had the cameras installed by a third party electronics vendor without significant input from the researchers. The third party vendor was to set the cameras to collect 90 days of pre-gate data and 90 days of post-gate data, to store the digital data on an IP website, and to make the data available to the researchers.

The researchers did not receive any data until after the stop gate installation. Unfortunately, when the data arrived, only 57 pre-gate train passages were recorded. Of those passages, only two were useful. The other data was unusable for a variety of reasons, including the following:

- For many passages, images were only provided every four seconds rather than continuously. The data for those passages was thus unusable.
- For many passages, images for only one approach (instead of both approaches) was available.
- The southbound camera was installed too close to the tracks and only showed the first two rows of vehicles.

For the post-gate data, 107 train passages were recorded, though many were not fully usable for the reasons already listed. However, the researchers reviewed the images for the information that was usable and was able to make the following observations:

- All driver violations were of the same type, occurred after flashing lights began but before full deployment of the gates.
- The 107 train passages resulted in a total of 205 violations.

- No vehicles drove around the gates, and there were no violations after the gates were deployed.
- No pedestrians or other non-motorized traffic crossed the track during the observation periods.
- 71% of the passages contained violations; 29% of the passages contained no violations.

Concerning the comparisons of near miss data, the Gulf and Ohio railroad does not record near misses (at least on this Shortline Railroad), so this line of analysis was also not available.

In conclusion, rather than to try to continue to work with the inadequate data, the research team believes it best to use the experience from this installation to better prepare for future installations. The following areas represent possible areas of improvement:

- Where possible, select a crossing with a significant crash history, and select a railroad partner that maintains records of near misses.
- Position cameras to capture the full range of vehicle movements desired.
- Ensure that the start and time of flashing lights can be recorded.
- Add sound to the digital recordings.

Section 6.0
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Section 7.0
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