NORTH CAROLINA "SEALED CORRIDOR" PHASE I, II, AND III ASSESSMENT

Submission Date: August 1, 2009

Word Count: 2,679
Figures: 3
Tables: 1

Patrick Bien-Aime (Corresponding author)
Volpe National Transportation Systems Center
55 Broadway
RVT-62
Cambridge, MA 02142
Phone: (617) 494-3907
Fax: (617) 494-1186
E-mail: patrick.bien-aime@dot.gov

ABSTRACT

The U.S. Department of Transportation's (USDOT) Research & Innovative Technology Administration's (RITA) John A. Volpe National Transportation Systems Center (Volpe Center), under the direction of the USDOT Federal Railroad Administration's (FRA) Office of Research and Development (R&D), conducted a study to document the success of the North Carolina DOT "Sealed Corridor" project through Phases I, II and III. The "Sealed Corridor" is the section of the designated Southeast High Speed Rail (SEHSR) Corridor that runs through North Carolina. The "Sealed Corridor" program aims at improving or consolidating every highway-rail grade crossing, public and private, along the Charlotte to Raleigh rail route in North Carolina. The research on the "Sealed Corridor" assessed the progress made at the 189 crossings that have been treated with improved warning devices or closed between Charlotte and Raleigh, from March 1995 through September 2004. Two approaches were used to describe benefits in terms of "lives saved": a fatal crash analysis to derive "lives saved," and prediction of "lives saved" based on the reduction of risk at the treated crossings. Both methods estimated that over 19 lives have been saved as a result of the 189 improvements implemented through December 2004. Analysis also shows that the resulting reduction in accidents, due to the crossing improvements, is sustainable through the year 2010, when anticipated exposure and train speeds along the corridor will be increased.

INTRODUCTION

Legislation including the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the Swift Rail Development Act of 1994, and the Transportation Equity Act for the 21st Century (TEA-21) in 1995 provided evidence that high-speed rail passenger service was going to increase in the United States (1). As a result of this legislation and other initiatives, ten high-speed rail passenger service corridors were designated in the United States. High-speed rail operations on these and other emerging corridors could eventually result in train speeds above 110 mph by the year 2010. Creating a high-speed rail corridor in any growing state will impact safety due to the increase in exposure of vehicles to trains and higher train speeds.

The North Carolina Department of Transportation (NC DOT) plays a prominent role among states pursuing High-Speed Ground Transportation (HSGT) development. Part of the "Southeast High Speed Rail (SEHSR) Corridor", which connects Washington, DC, through Richmond, VA, to Raleigh and Charlotte, NC, with extensions south to Columbia, SC, Savannah, GA, and southwest to Greenville, SC, Atlanta and Macon, GA, and Jacksonville, FL, runs through the State of North Carolina. The SEHSR Corridor, shown in Figure 1, is approximately 500 miles in length. The segment of the SEHSR corridor from Washington, DC to Charlotte, NC was one of the five original national high-speed rail corridors designated for improvements to high-speed status under ISTEA in 1991.

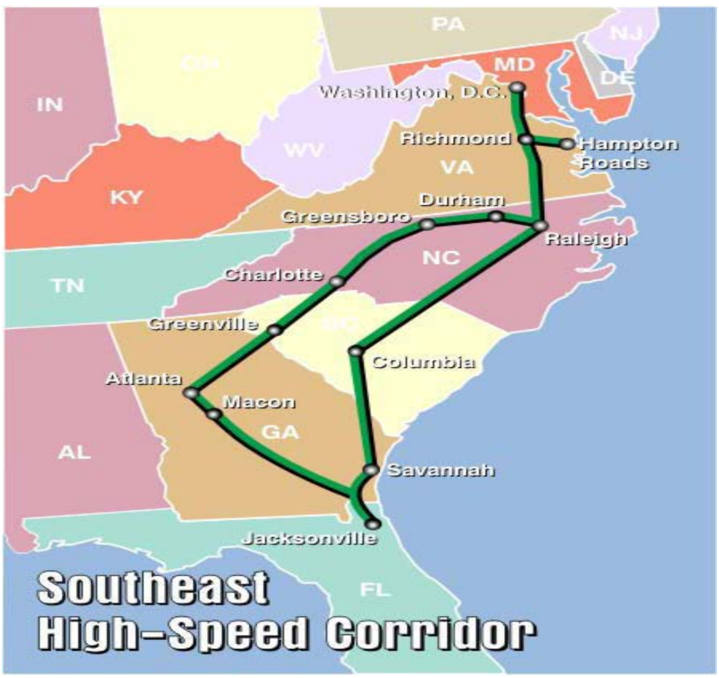

Figure 1. Southeast High Speed Rail Corridor

The NC DOT corridor is usually single track including sidings with approximately one crossing per mile. The route carries 35 freight trains per day and approximately six daily passenger trains. It has a mix of public and private crossings and the route contains both urban and rural environs. Future plans for this corridor include operation at speeds up to 110 mph by the year 2010. North Carolina realized the increasing service has the potential of increasing the number of incidents along its High Speed Rail (HSR) corridor. For safety reasons, North Carolina has organized an innovative “Sealed Corridor” program, which aims at improving or closing every grade crossing, public and private along the Charlotte to Raleigh rail route. The warning devices and other improvement type include: four quadrant gates, traffic channelization devices, long gates, closure, video enforcement, grade separation, signs, pavement markings and health monitoring. The NC DOT “Sealed Corridor” includes 216 grade crossings, 44 of which are private crossings, over a distance of 173.3 miles.

The corridor has been broken into four phases, based on location:

- Phase I: E. 36th Street, Charlotte northeastwards to S. Elm Street, Greensboro
- Phase II: Gillespie Street, Greensboro eastward to Academy Street, Cary
- Phase III: Reedy Creek Road, Cary eastward to Royal Avenue, Raleigh
- Phase IV: Private Crossing Safety Improvement (PCSI) program, 44 private crossings between Charlotte and Raleigh

Phase I, II, and III of the implementation plan for the corridor addresses 208 crossings between Charlotte and Raleigh. A total of 189 of the 208 crossings have been improved and/or closed. The research documented in this report calculates the number of “Lives Saved” based on the improvements made to the highway-rail intersections from March 1995 to September 2004. The results of this research provide a substantive analysis of the “Sealed Corridor” implementation and provide Federal, State and local organizations a successful model to utilize on their HSR corridor.

OBJECTIVE

The United States Department of Transportation (USDOT) Research and Innovative Technology Administration’s Volpe National Transportation Systems Center (Volpe Center) was requested by the USDOT’s Federal Railroad Administration (FRA) Office of Research and Development in 2000 to assess Phase I between Charlotte and Greensboro of North Carolina’s “Sealed Corridor” program for all improvement crossings completed from 1987 to September 2000. Phase I addressed a total of 100 crossings, 52 of which were improved and/ or closed as of September 2000. The objective was to determine the “Lives Saved” through December 2000 along the “Sealed Corridor” Phase I program, and to determine whether the planned treatments for the entire Phase I corridor would provide a sustainable crash reduction condition through 2010.

The purpose of the study detailed in this paper was to update the Phase I analysis, which was published in a 2001 Report to Congress(2), and document the additional benefits of Phase II and III of the “Sealed Corridor” Program. This included an assessment of the benefits resulting from all 208 crossings of the Phase I, II, and III “Sealed Corridor” Program that have been improved through September 2004. A Fatal Crash Analysis method and a modified U.S. DOT Accident Prediction Formula were employed utilizing crash histories and fatalities from 1987 through 2004. Benefits were estimated for the treatments used along the “Sealed Corridor” through December 2004 in terms of “Lives Saved.”

This paper documents an assessment of the benefits resulting from closure of all 208 crossings of the Phase I, II, and III “Sealed Corridor” Program that have been improved through

September 2004, and also contains an analysis and evaluation of whether the resulting reduction in crashes is sustainable through the year 2010, when train speeds along the corridor are projected to achieve 110 mph and all 208 crossings have been treated and/or closed. The baseline information for the study was obtained from the FRA Railroad Accident Incident Reporting System (RAIRS) database (3) from 1987 through 2004, NC DOT collision reports, police reports, and newspaper articles.

RESEARCH METHODS

The intent of this research was to assess the progress on crossings that have been treated with improved warning devices or closed on the “Sealed Corridor.” Treatments implemented on the corridor include: crossing consolidation, grade separations, photo enforcement, four-quadrant gate systems, long-arm gate systems, channelization devices, signs, pavement markings, and crossing health monitoring systems.

Progress was measured in terms of safety benefits, using crash data up through December 2004. Safety benefits were developed through the use of two techniques:

1. Fatal Crash Analysis estimate of “lives saved,” and
2. Modified United States Department of Transportation (USDOT) Accident Prediction Formula (APF) prediction of “lives saved,” based on the reduction of risk at those treated crossings.

In the Fatal Crash Analysis, the crossing environment was not considered and only fatal crashes were used. This baseline crash information was obtained from the FRA RAIRS database from 1987 through 2004, NCDOT collision reports, and newspaper articles. Historical fatality data for fives years prior to treatment was used to get an average fatalities per year. Pre-treatment condition and “lives saved” under the post-treatment condition through December 2004 were also estimated using fatal crashes from 1987 through 2004. The pre and post treatment conditions were compared to estimate the “lives saved.”

In the Modified USDOT APF, adjustments to train speed, annual average daily traffic (AADT), train movements, and warning device changes were considered. All fatal and non-fatal collisions were used for the crash data.

The model estimated a 5-year pre- and post-treatment period for warning device effectiveness calculations. Populated year-by-year input variables from both FRA Inventory and NCDOT inventory data were used in the model. The model calculated the effect of the 5-year actual incident history for prediction of future incidents. A 2 percent per year growth in AADT and train frequency were assumed in the model after the year 2004, all treatments were assumed completed by 2008, and train speeds were increased to 110 mph, for 2010 only.

Further predictions for the risk reduction sustainability were completed by determining future reduction in risk for the total Phase I, II, and III corridor through 2010, when train speeds along the corridor are projected to achieve 110 mph and all crossings would have been treated and/or closed. The condition of the corridor in 2004 was projected for 2010 after application of modest growth factors.

RESULTS

The implementation of the North Carolina "Sealed Corridor" initiative is a demonstration of nonstandard corridor highway-railroad grade crossing improvements. This technique can serve as a basis for assessing the potential impact of similar programs in other corridors, high-speed rail or not. The Fatal Crash Analysis estimated 19.7 potential "lives saved" through December 2004, as shown in Table 1.

Table 1. Summary of "Lives Saved" Analysis Results by Warning Device Type

Phase I, II, and III	Pre-Treatment		Post-Treatment		
Warning Device Improvement	**Fatalities**	**Average Time Frame (Months)**	**Fatalities**	**Average Time Frame (Months)**	**Analysis of "Lives Saved"**
Closure Subtotal	15	142	0	68	8.727
4-Quadrant Gate Subtotal	14	139	2	49	6.013
Long Gate Subtotal	16	135	1	36	4.012
Median Barrier Subtotal	3	157	0	51	0.988
Totals	**48**		**3**		**19.74**

The Modified USDOT Accident Prediction Formula (APF) estimated that the improvements implemented through 2004 are reducing fatalities by approximately 2 each year or about ten "lives saved" over five years. The APF predicted 9 fewer lives saved compared to the Fatal Crash Analysis results. This may be due to the fact that the APF contains more variables, and addresses the crossing environment risk.

Comparing the change of risk to highway occupants (Figure 2) along the "Sealed Corridor" from 1991 (208 crossings) to 2004 for the 189 treated plus 19 untreated crossings, the risk of fatality is decreased by a substantial 50.9%. The entire corridor risk, had it been completed by 2004, would have been reduced by an additional 6.4 percent.

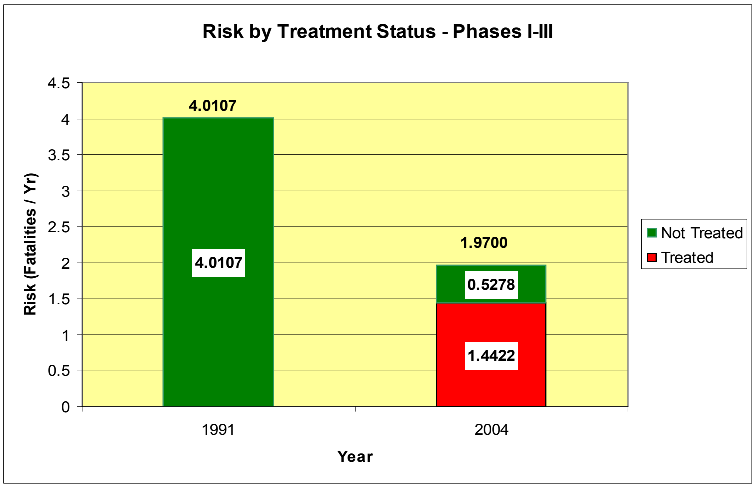

Figure 2. Corridor Risk for Phases I, II, and III

In order to estimate future incident reduction rates and to estimate that the reduction result was sustainable, the Modified USDOT APF was used to ensure increases in train and vehicle exposure over time were considered in the analysis. Figure 3 shows the estimated annual fatalities under two conditions: (1) all 208 crossings have been treated (Full Build), and (2) without any improvements to the 208 crossings (No Build). The graph shows a decrease in risk from 1992 to 1996, and an increase in risk with the introduction of the HSR. The graph shows the influence of the improvements, which were initiated in March 1995, on reducing the annual fatalities through the year 2004. The improvements at the remaining 19 crossings in the corridor were assumed to be implemented in 2008, resulting in a further reduction in annual fatalities.

By 2010 (Figure 3), the fatality rate resulting from full implementation of the entire "Sealed Corridor" would be 53 % lower than if no implementation was executed and speed increased to 110 mph. Further analysis indicates the fatality rate would be 51.9 % lower if the speed increased to 79 mph only in 2010, and 46.7 % lower with no increase in speed in 2010. The gradual increase in traffic volume and train frequency from 2004 through 2010 is expected to gradually increase annual fatalities under all conditions. Finally, the increase in train speed to 110 mph assumed to occur in 2010 would further increase all fatality rates.

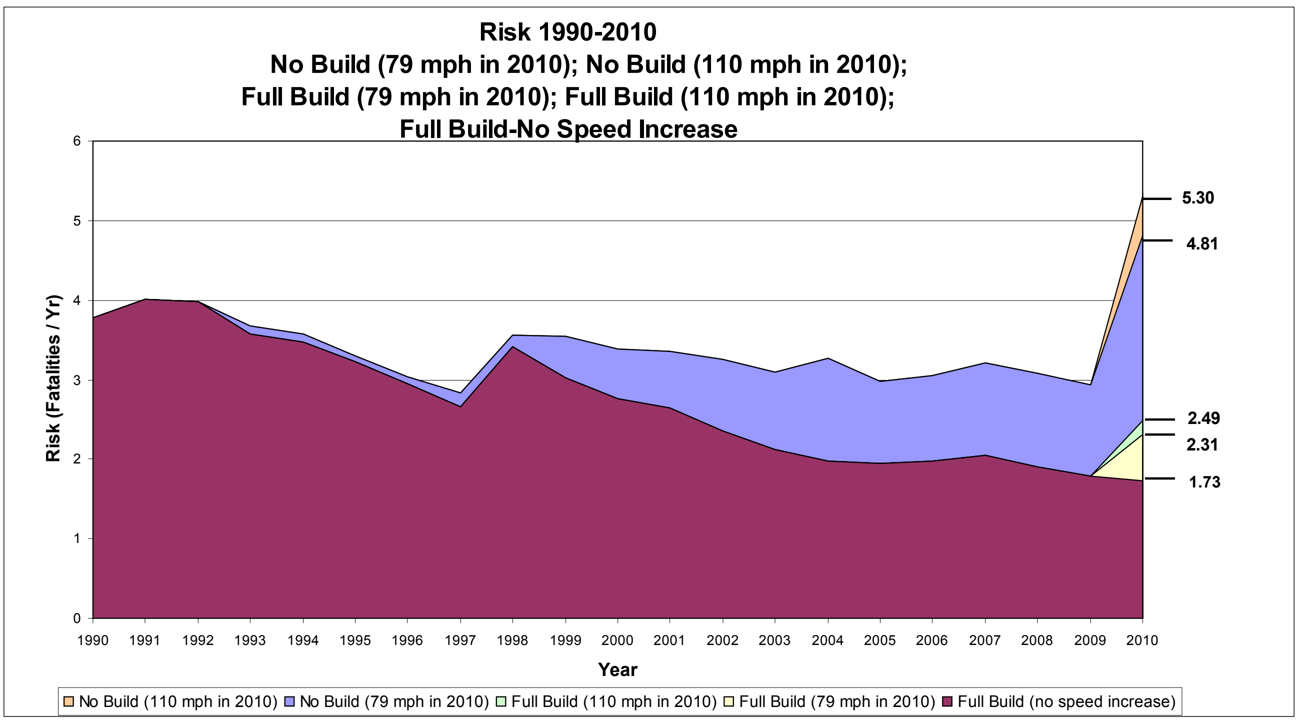

Figure 3. Risk Reduction through 2010 for Phases I, II, and III

CONCLUSION

This study documented the benefits of North Carolina's "Sealed Corridor" Program at highway-rail grade crossings. The total "Sealed Corridor" includes 216 crossings, 172 of which are public crossings and 44 are private crossings. This report assesses Phase I, II, and III of the "Sealed Corridor" program that encompasses rail lines that run between Charlotte and Greensboro with future predictions for reductions in fatalities through 2010. Several types of grade crossing treatments to reduce the risk of fatality were investigated by NC DOT. These grade crossing improvements included: four quadrant gates, traffic channelization devices, long gates, closure, video enforcement, grade separation, signs, pavement markings, health monitoring and combinations thereof.

A review was conducted of the 189 treated crossings along the “Sealed Corridor.” The “Sealed Corridor” consists of 208 crossings, but 19 crossings have not been treated. The crash history for the “Sealed Corridor” indicates there were 282 crashes occurred between 1987 and September 2004. A total of 55 fatalities were reported for those 282 highway vehicle-train crashes. Examination of the accident reports of the 33 treated crossings with fatal accident histories was conducted. A total of 51 fatalities resulting from 40 crashes occurred among the treated crossings. Ninety percent of the crashes resulted from the driver of the vehicle driving around or through the grade crossing gates.

The “fatal crash analysis method” was used to calculate the differences between the annual (or monthly) fatality rates, based on actual experience at the improved crossings, before and after the improvements were made at each crossing. To calculate “Lives Saved”, those differences were multiplied by the number of years (or months) that have transpired through December 2004 since each of the respective improvements were made. The sum of these results was then calculated over all of the crossings that were improved. This resulted in an estimate of 19.7, or, conservatively, 19 lives saved as a result of the 189 improvements implemented through December 2004.

The “modified U.S.DOT APF” recognizes the probabilistic nature of grade crossing fatalities and relies on a combination of actual experience at the improved crossings and an extensive database of experience at similar crossings nationwide. The formula was used to estimate the annual fatality rates at each crossing before and after each improvement and these were accumulated for corridor-wide results. This method estimated that the improvements implemented through 2004 are reducing fatalities by approximately 2.04 each year, or over two lives saved each year. The Modified USDOT APF predicted 9 fewer lives saved compared to the Fatal Crash Analysis results. This may be due to the fact that the APF contains more variables, and addresses the crossing environment risk.

ACKNOWLEDGEMENTS

The U.S. Department of Transportation (USDOT) Federal Railroad Administration (FRA) Office of Research and Development sponsored the work referenced in this paper. The author would like to extend special appreciation to Sam Alibrahim, PE, Chief of the Signals, Train Control and Communications Division, FRA, Leonard Allen, Program Manager, Signals, Train Control and Communications Division, FRA, Gary Carr, Chief of the Track Research Division, FRA and James Smailes, former Program Manager, Track Research Division, FRA for their guidance and support. The author also thanks the North Carolina Department of Transportation’s Rail Division for their assistance and input for this report, Paul Worley, and Andrew Thomas.

The author would also like to acknowledge Anya A. Carroll, Principal Investigator of Intermodal Surface Transportation Systems, Center of Innovation for Physical Infrastructure Systems, USDOT Research and Innovative Technology Administration’s John A. Volpe National Transportation Systems (Volpe Center), and Marco daSilva, Principal Investigator of the Highway-Rail Grade Crossing and Trespass Research Program, Systems Engineering and Safety Division, Volpe Center, for their leadership and direction. This study was conducted under the auspices of the Highway-Rail Grade Crossing Safety Research Program, Systems Engineering and Safety Division, Volpe Center.

REFERENCES

(1) U.S. Department of Transportation, Secretary of Transportation, "Rail-Highway Crossing Safety Action Plan," Washington, DC: U.S. DOT, June 1994.

(2) Carroll, A. North Carolina "Sealed Corridor" Phase I: U.S. DOT Assessment Report. Report to Congress". August 2001. www.bytrain.org/SAFETY/sealed/pdf/esvolpe.pdf, retrieved August 27, 2008.

(3) Federal Railroad Administration. Railroad Accident Incident Reporting System [Electronic version]. Retrieved July 21, 2008. http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/crossing/crossing.aspx