Rural Safety Innovation Program: An Overview and Status Update

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ABSTRACT

Rural roads carry approximately 40 percent of the vehicle miles traveled in the United States, yet annually, they account for nearly 55 percent of the fatalities. In 2006, there were 23,339 vehicle fatalities in rural areas, compared with 18,359 that occurred in urban areas. This is alarming considering that only 23 percent of the U.S. population resides in rural areas. Further, according to the National Highway Safety Administration’s Fatality Analysis Reporting System, the fatality rate for rural crashes is more than twice the fatality rate in urban crashes.

To address this challenge, the U.S. Department of Transportation launched the Rural Safety Initiative in February 2008. The focus of the Rural Safety Initiative is to highlight available options to help reduce highway fatalities and injuries on the nation’s rural roads. The Rural Safety Innovation Program (RSIP) is one element of the Rural Safety Initiative. The goal of the RSIP is to improve rural road safety by assisting rural communities in addressing highway safety problems and by providing rural communities the opportunity to compete for project funding to address these problems. This paper provides an overview and status of the Intelligent Transportation System (ITS) projects funded through the RSIP.

Key words: rural—safety
RURAL SAFETY CHALLENGE

Rural roads carry approximately 40 percent of the vehicle miles traveled in the United States, yet annually, they account for nearly 55 percent of the fatalities. In 2006, there were 23,339 vehicle fatalities in rural areas, compared with 18,359 that occurred in urban areas. This is even more alarming considering that only 23 percent of the U.S. population resides in rural areas. Further, according to the National Highway Safety Administration’s (NHTSA’s) Fatality Analysis Reporting System (FARS), the fatality rate for rural crashes is more than twice the fatality rate in urban crashes. The fatality rate for rural areas in 2006 was 2.25 fatalities per 100 million vehicle miles traveled (VMT), compared with 0.93 fatalities per 100 million VMT in urban areas.

Rural areas in the United States face a number of unique highway safety challenges that contribute to the severity of and frequency of accidents, including

- Seat belt usage—In 2006, 57 percent of all the people who died on rural roads were not restrained, compared with 52 percent in urban areas. In addition, 68 percent of fatally injured pickup truck drivers were unrestrained; the restraint use rate among these drivers is the lowest of any vehicle type.
- Speed—In 2006, 12,190 drivers involved in fatal crashes were speeding; of these fatalities, 57 percent were drivers in rural areas.
- Impaired drivers—Of the passenger-vehicle occupant fatalities involving impaired-driving crashes (blood alcohol concentration 0.08+) in 2006, 58 percent were in rural areas. At most blood alcohol concentration levels, the percentage of rural drivers involved in fatal crashes exceeds the percentage of urban drivers involved at the same blood alcohol concentration.
- Post-crash—In 2006, 66 percent of rural drivers killed in crashes died at the scene, compared with 51 percent of urban drivers. Seventy-two percent of drivers who died en route to a hospital were in rural areas.
- Implementation challenges—Implementing countermeasures through an interdisciplinary approach that includes engineering, enforcement, education, and emergency medical services is more challenging in rural areas, where engineering teams vary widely in their ability to develop, implement, and operate safety strategies.
- Outdated roadway design and roadside hazards such as utility poles, sharp-edged pavement drop-offs, and trees close to the roadway also are major contributors to the severity of rural crashes.

RURAL SAFETY INNOVATION PROGRAM

To address the challenges of rural safety, the U.S. Department of Transportation (U.S. DOT) initiated the Rural Safety Initiative in February 2008. The focus of the Rural Safety Initiative is to highlight available options to help reduce highway fatalities and injuries on the nation’s rural roads. This targeted national campaign is taking advantage of opportunities to raise awareness of the risks drivers face on America’s rural roads and provide communities with tools and assistance to address these risks where the Department’s resources can be leveraged quickly and effectively.

The Rural Safety Innovation Program (RSIP), published in the Federal Register on February 29, 2008, is one element of the Rural Safety Initiative. This one-time opportunity is using funds from the Intelligent Transportation Systems (ITS) Program and the Delta Region Transportation Development Program (DRTDP). The RSIP requested applications for funds from road owners for projects to improve safety on rural roads. Eighty applications were received for ITS Program funds and 16 applications were received for DRTDP funds. There were 96 initial applications received from state and local governments in 28
states by the April 14, 2008, due date. Twenty-four applications were selected to be developed into comprehensive proposals for ITS program funds. The comprehensive Phase II application, review, and selection process was completed, and the final project selections were announced on August 27, 2008.

The U.S. DOT has awarded funding to 10 state and local transportation agencies through the ITS Program for 12 projects that aim to improve safety on local and rural roads. Funding recipients are

- Arizona Department of Transportation (ADOT)
- California Department of Transportation (Caltrans) (2 grants)
- Colorado Department of Transportation (CDOT) (2 grants)
- Illinois Department of Transportation (IDOT)
- Minnesota Department of Transportation (Mn/DOT)
- Iowa Department of Transportation (Iowa DOT)
- Kansas Department of Transportation (KDOT)
- South Carolina Department of Transportation (SCDOT)
- King County, Washington Department of Transportation (KCDOT)
- Wisconsin Department of Transportation (WisDOT)

The goal of the RSIP is to improve rural road safety by assisting rural communities in addressing highway safety problems and by providing rural communities the opportunity to compete for project funding to address these problems. The primary objectives of the RSIP are to

- Improve safety on local and rural roads with innovative approaches in which rural communities develop and design local solutions to their roadway safety problems
- Provide best practices and lessons learned on innovative safety technologies to assist local and rural road owners and operators in developing and implementing infrastructure-based safety countermeasures that complement behavioral safety efforts
- Promote national awareness and interest in addressing rural safety issues,
- Promote the use of ITS technologies to improve safety on rural roads
- Implement and test ITS technologies in the rural environment that have been successfully deployed and operated in an urban environment

**RURAL SAFETY INNOVATION PROGRAM PROJECTS**

**Minnesota Department of Transportation**

Approximately 27 percent of all the crash fatalities reported in Minnesota between 2001 and 2005 were on curves in rural areas. To address this challenge, the Mn/DOT in partnership with the University of Minnesota is developing a low-cost technology that may help drivers select an appropriate speed, thereby enhancing safety when approaching a horizontal curve. The system currently under development is the dynamic curve warning system (DCWS) that may help drivers select an appropriate speed when approaching a horizontal curve. The DCWS consists of a warning sign combined with a speed measuring device (e.g., radar) that activates a variable message sign (e.g., slow down) when vehicles are traveling above a set specified threshold. The goal of the proposed DCWS is to evaluate the speed and actual or possible predicted (based on speed changes) of DCWS installations at three rural roadway horizontal curve locations (with speed-related safety concerns). Through the RSIP, Mn/DOT will evaluate the potential effects on speed and crash impacts of three permanently installed DCWSs in three Minnesota counties. If this system proves feasible in enhancing safety, it will be implemented elsewhere in the state of Wisconsin. The development of DCWS will begin the summer of 2009.
Wisconsin Department of Transportation

Using RSIP funds, the WisDOT will implement, demonstrate, and validate a new Rural Intersection Collision Avoidance System (RICAS). This new intersection collision avoidance system will use emerging sensing, computation, and display technology to provide real-time warnings to drivers before the conditions that lead to a crash can develop. RICAS is being developed to specifically address crashes that result from gap selection errors.

The intersection of US 53 and State Trunk Highway (STH) 77 will serve as the RICAS test site. RICAS comprises three components: sensing, computation, and an infrastructure-based Driver Infrastructure Interface (DII), which is an active variable message sign.

Sensors are used on US 53 (mainline road) to determine the position, speed, and lane of travel for vehicles approaching the intersection crossroads. Automotive radar was selected for this application, as it is accurate, durable, reliable, available, relatively inexpensive, and works in all weather conditions. Loop detectors are installed in the median and minor road approaches to sense vehicle presence. If a vehicle has been detected, the system will activate the DII. The DII relays alerts and warnings to drivers as determined by the computational system. If no vehicle is sensed, the DII will remain inactive, thereby limiting unnecessary distraction to the driver.

The DII that will be used in the project has been tested in driving simulators and was on-road tested during the summer of 2008 under the Cooperative Intersection Collision Avoidance Systems—Stop Sign Assist (CICAS-SSA) program. Figure 1 illustrates the layout of the equipment that RICAS will use at the US 53/STH 77 test site. It is anticipated that RICAS will be operational by October 2009. RICAS will be implemented at other critical intersections along US 53 and other high-risk rural roads throughout Wisconsin if it proves successful at the US 53/STH 77 site.
Using RSIP funding, CDOT is in the process of designing a system that consists of in-road, light-emitting diode (LED) lighting and dynamic speed messaging signs (DMS). The system is being developed to address collisions involving vehicles crossing over the centerline of the roadway in Wolf Creek Avalanche Shed. DMSs will be implemented in advance of both entrances to the Wolf Creek Pass Snow Shed that is located along a curve of US 160 in Mineral County, Colorado. Trucks transporting freight, ski travelers, tourists, and recreational vehicles heavily use this route. The in-road LED lighting system will illuminate/delineate the centerline of the roadway and reduce wall hits and crossover accidents in the snow shed.

The LED lighting will be augmented with speed messaging signs to warn drivers to reduce travel speeds to decrease the likelihood of over-driving the curve in the snow shed, resulting in lane departures. By combining speed warning signs and the in-road light delineation, CDOT anticipates that this system will lower vehicle accident rates and increase vehicle compliance for the posted speeds approaching the curves.

The uniqueness of this project is that CDOT will use the LED in-pavement lighting system to delineate a centerline, no-passing zone within the snow shed where lighting conditions are less than desirable and snow removal operations tend to obliterate conventional stripe delineation. LED in-road marking is also relatively new to the market, and no standards or design specifications exist. Consequently, CDOT is
currently in the process of developing design specifications relevant for the project. The construction of the system is to begin in late 2009.

**Colorado Department of Transportation—US 50**

CDOT was also selected through the RSIP to develop and implement a truck tip-over warning system on US 50, a rural, low-volume roadway with low-speed curves. The system will warn all motorists of their speeds prior to the curves. Most of the accidents occurring on US 50 between mileposts 230 and 231 are fixed-object crashes (primarily involving guardrail) and overturning. These accidents are frequently due to drivers approaching the tight curves on the highway at unsafe speeds.

To address this problem, CDOT will develop an innovative stand-alone ITS application that is independent of a fiber backbone for management and operation. This application will include dynamic speed warning devices and speed-actuated variable message signs (VMS) that flash warning messages to drivers who travel too fast in advance of each horizontal curve. Due to lack of power at the location, two of the three signs must be operated with solar power. To do this, CDOT will use low-power LED blank-out signs, rather than the VMS boards used elsewhere in the state, with separate battery packs and solar arrays to power the blank-out signs and radar devices. CDOT anticipates this system will be operational in spring of 2010.

**California Department of Transportation**

A team consisting of (Caltrans) and Western Transportation Institute at Montana State University is using RSIP funding to research whether the deployment of an augmented Speed Enforcement (aSE) system on State Route 12 (SR 12) in San Joaquin County, California, will help to change driver behavior and reduce crash rates in work zones. The primary function of this system is to communicate relevant speed, violation, and hazard information to the stakeholders in this work zone context. Stakeholders are the driver, California Highway Patrol (CHP) officers, and the workers. The aSE includes the following functional components that are illustrated in Figure 2:

A. Portable radar stations (sensors) that track the speed of vehicles exceeding the advanced work zone speed limit sign.

B. Violators identified by their license plate will receive a speed warning on a changeable message sign (CMS) at the entrance to the work zone.

C. Once entering the work zone, a series of “smart cones” that are each fitted with a light display (beacon) and with non-radar sensors (e.g., sonar, light) track individual vehicle speed and synchronize the cone light display to “highlight” and follow any violating vehicle. These lights automatically cancel when the violation is corrected by reducing speed. This is intended to provide a visual warning to drivers that they are violating the speed limit.

D. A local pager network will be configured to automatically alert (vibration mode) only those workers in direct proximity to the detected hazard. This pager system will also incorporate a “panic mode” that any worker can trigger in the case of an injury to automatically contact the site supervisor, who can request public safety assistance to the work zone. This panic mode may also trigger a unique and conspicuous sequence of cone lights to alert all workers to the potential injury event.

E. Those vehicles that do not adhere or adjust to the posted speed limit for the work zone will be notified that they may be subject to a speed citation with an additional CMS at the exit of the work zone.

F. Relevant information about the violating vehicle (e.g., duration of violation, maximum speed, average speed, license plate, vehicle photograph, etc.) will be communicated and displayed to
downstream CHP officers, who can then use their judgment to locate the vehicle and cite the driver based on the information documented by the aSE

Figure 2. Functional components of aSE

Development of aSE is scheduled to begin during the summer 2009.

South Carolina Department of Transportation

SCDOT is using RSIP funds to implement a number of innovative technology-oriented solutions to improve safety by reducing speed-related, wet weather-related, and roadway departure crashes on a two-mile segment of rural US 25 immediately south of the North Carolina border in Greenville County. The roadway segment is located in an isolated mountainous area of the county. Some of the characteristics that make this an ideal location to deploy and test technologies are

- The area is subject to unusual weather patterns with frequent fog that dissipates slowly
- Roadway geometry changes dramatically from a long, straight parkway with grass shoulders in North Carolina to a curved grade with no shoulders in South Carolina
- There is insufficient signage for the grade and curve after entering South Carolina
- There are no retroreflective lane delineators along this area of US 25

With 87 percent of the crashes on this segment related to speeding, the use of variable speed limit (VSL) signing is a particularly important component of the system. The use of VSL, specifically during wet conditions, will enforce the need for reduced regulatory speeds during varying weather conditions. VSL may be extended along US 25 beyond project limits to address safety issues where weather and speed are significant contributing factors if proven useful at this site. This project will be the first application of VSL in South Carolina.

SCDOT will also construct overhead CMSs at the beginning of the northbound and southbound segments of the project. The proposed overhead signs will provide multiple safety benefits. The signs will be
connected to both speed and weather sensors and display information as conditions warrant. This capability is particularly important as 62 of the 71 crashes on this short segment of roadway between 2003 and 2007 were listed “Driving Too Fast for Conditions” as a contributing factor, and over 84 percent of the crashes occurred during “Wet” conditions.

This section of roadway has also been identified as a location where cameras will prove both cost-effective and beneficial in determining the level of emergency response. The District Traffic Management Center in Greenville will receive live feed from these cameras to assist in managing any potential congestion and safety issues.

The goal of this project is to reduce speed-related and hydroplaning crashes by 50 percent within one year of project implementation on the two-mile segment of the project through the implementation of multiple ITS components. Development of the system will begin in the fall of 2009.

**Arizona Department of Transportation**

ADOT is using RSIP funds to develop the Dual Use Safety Technology (DUST) Warning System to help reduce the loss of life, injury, and property damage on rural Interstate 10 in Cochise County. The proposed system has been designed to focus on two primary challenges:

- Visibility hazards caused by blowing dust on a 60-mile segment of Interstate 10 between Bowie and the New Mexico State Line
- Unexpected snow and ice in the Texas Canyon area of Interstate 10

The project will also provide early warning and detection for icy conditions in Texas Canyon as well as wind borne dust along Interstate 10 using several Environmental Sensor Stations (ESS) with a comprehensive sensor array. Each ESS site will also be equipped with a snapshot CCTV camera to confirm any potential low-visibility conditions. The enabling technologies that will be integrated to form the DUST Warning System include:

- **Wireless Ethernet Networks**—Based on the WIMAX IEEE 802.16 standard, the wireless network solution will be integrated to serve as a cost-effective and reliable long-range communications backbone for the DUST Warning System.
- **Photovoltaic Cells**—Power for the remote telemetry sites will be derived from renewable solar energy generated using photovoltaic cells. Initially developed to power satellites, the technology has gained recent widespread acceptance for solar-powered remote telemetry and warning applications.
- **Anemometers**—These devices will be applied to measure wind speed to predict the potential for onset of high-wind conditions that may lead to reduced-visibility conditions.
- **Forward Scatter Visibility Sensors technology**—This uses the forward scatter principle of light in the presence of atmospheric particles to measure the coefficient and visibility. A high-intensity, infra-red LED transmitter is used to illuminate the sensor’s scatter volume. This results in a high signal-to-noise ratio and reduces the effects of background light variations. Visibility measurements are possible over a standard range of more than 10 miles.
- **Light Emitting Diodes**—LEDs have been in use as indicators for decades. As the reliability, heat tolerance, brightness, and efficiency have increased, LED technology has gained widespread acceptance for application as traffic signal or warning beacon indications.
The proposed system has been designed to reduce the loss of life, injury, and property damage by focusing on visibility hazards caused by blowing dust on a 60-mile segment between Bowie and the New Mexico State Line and unexpected snow and ice in the Texas Canyon area of Interstate 10.

**Illinois Department of Transportation**

IDOT is using RSIP funds to develop a countermeasure for two sections of roadway that have serious injury and fatal crash histories. At one location, a system alerts drivers of changing conditions by detecting any approaching vehicles. This will activate an LED-flashing beacon that is mounted over advanced curve warning signs.

At the second location, a countermeasure will be implemented to provide advanced warning of a two-way stop. The countermeasure will also use a vehicle-actuated LED to highlight the stop condition for motorists on the lower-volume minor route, as well as warn the driver on the major route of an upcoming intersection. A total of four beacons will be used at the intersection—one for each approaching leg of the intersection. It is anticipated that these systems will be operational in late 2009.

**King County, Washington Department of Transportation**

KCDOT is using RSIP funds to develop and implement two driver feedback signs that activate when a vehicle is detected and display the vehicle’s speed at two sites. The system will use radar to measure the vehicle’s speed. The display will flash when the measured speed is greater than the advised speed.

Warning signs will use radar to measure the speed of approaching vehicles. The display will then flash when the speed of the vehicle exceeds the advisory speeds. A variable message sign (VMS) may also be implemented, as part of the project. If implemented, signs will display a message (e.g., slow down) when the measured speed of the approaching vehicle exceeds the advised speed. It is anticipated that this system will be operational in late 2009.

**California Department of Transportation**

Caltrans in partnership with El Dorado County (California) Department of Transportation is developing a collision countermeasure system (CCS) on US 50 near the community of Camino in El Dorado County. The system consists of two types of actively illuminated warning signs located on the eastbound and westbound lanes of US 50 and loop detectors on an intersecting road. When a vehicle on the minor road is detected approaching the intersection, the illuminated signs will warn drivers on US 50 the presence of vehicles approaching the roadway. It is anticipated that the system will be operational in late 2009.

**Iowa Department of Transportation**

The Iowa DOT is developing a web-based version of the Traffic and Criminal Software (TraCS). TraCS provides rural law enforcement agencies the capability to improve the accuracy and completeness of crash data, make use of the crash data locally, and improve the timeliness of the crash data submission for inclusion in a statewide database for use by analysts and decision makers.

The goal of the web-based TraCS system is to electronically transmit and load the data into the state’s statewide crash database, with local agencies able to print a copy and query their crash reports to generate reports and create pin maps. This project, when completed, will assist Iowa, along with the 15 other
TraCS states and hundreds of rural areas within those states, to collect the crash data needed to make data-driven decisions about allocation of scarce resources, including safety improvements.

Web-based TraCS will allow states to deploy the data collection software to rural law enforcement agencies. Iowa has approximately 450 law enforcement agencies and has deployed TraCS to 190 of those agencies. Iowa DOT does not have the staff resources to deploy to the other agencies, which are the small rural agencies. If the data collection software is made available over the internet, the Iowa DOT will be able to provide password-protected access to all Iowa agencies. This will result in higher-quality data (edits and validations preclude many errors) in a timelier manner. This can and will be replicated by the 15 other states using TraCS. Development of TraCS is currently underway and is anticipated to be completed during the summer 2010.

**Kansas Department of Transportation**

Using RSIP funds, KDOT has entered into a unique partnership with the Prairie Band Potawatomi Nation to deploy ITS at three intersections along US 75 that provide access to the reservation’s housing population and medical and Tribal Government operations. ITS technologies that will deployed to enhance safety and improve winter road maintenance activities include one roadway weather information system station, one closed-circuit television camera, two portable DMSs, and flashing beacons and queue detection systems at two other locations along US 75.

**PROJECT EVALUATIONS**

Recipients of RSIP funds have agreed to collaborate with an independent entity in the evaluation of their projects. Projects funded through the ITS Program will be evaluated through a combination of evaluation studies that examine system component performance and the systems impact on enhancing safety on local and rural roads. As part of the evaluation process, institutional and technical challenges, as well as lessons learned and best practices, will be addressed and documented to assist other state and local transportation agencies. The independent evaluator will engage each funding recipient early in the development process to ensure that the results of the evaluations are as useful as possible to others considering similar projects.
REFERENCES

vi Led by the Minnesota Department of Transportation (Mn/DOT) and University of Minnesota, Cooperative Intersection Collision Avoidance Systems—Stop Sign Assist (CICAS-SSA) targets the national problem of crashes at rural through-stop intersections, particularly those where low-speed, low-volume roads intersect high-speed, high-volume expressways.

vii TraCS is a sophisticated data collection and reporting software application for the public safety community. It provides organizations with a state-of-the-art information management tool to streamline and automate the capture and transfer of incident data in the field. Using the latest mobile computing technologies to capture and report incident data where it occurs, TraCS improves the accuracy, completeness, and timeliness of incident data and reduces user’s administrative duties and paperwork. TraCS was developed by the Iowa DOT with funding assistance from several federal agencies. From its conception, TraCS was designed and developed using a flexible architecture that, with minor modifications, could be transferable and easily adapted and customized for use by agencies in states/provinces other than Iowa.