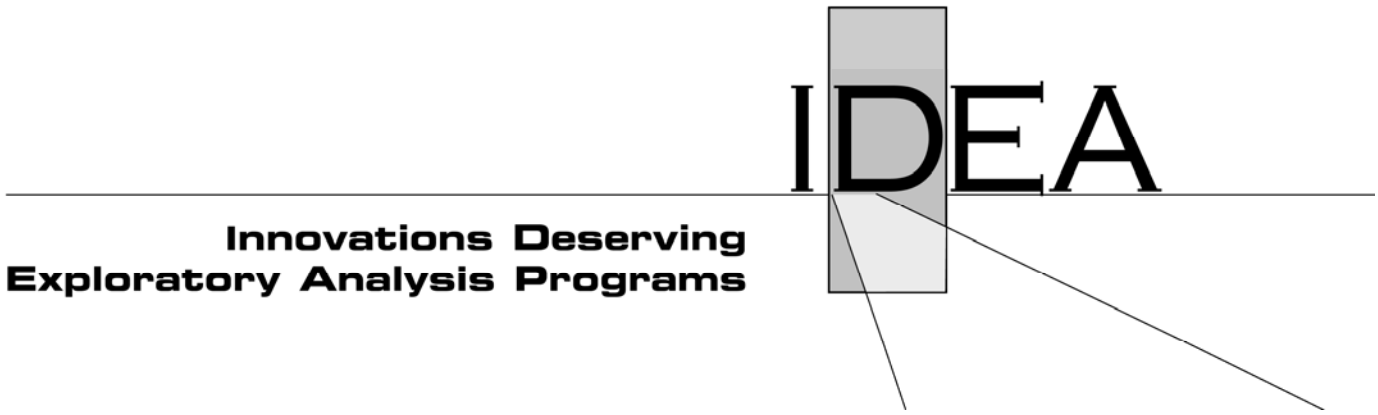

Transit IDEA Program

Warning Device for Rail Transit Personnel for Approaching Trains

Final Report for
Transit IDEA Project 55

Prepared by:
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December 2008

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Innovations Deserving Exploratory Analysis (IDEA) Programs Managed by the Transportation Research Board

This Transit IDEA project was funded by the Transit IDEA Program, which fosters development and testing of innovative concepts and methods for advancing transit practice. The Transit IDEA Program is funded by the Federal Transit Administration (FTA) as part of the Transit Cooperative Research Program (TCRP), a cooperative effort of the FTA, the Transportation Research Board (TRB) and the Transit Development Corporation, a nonprofit educational and research organization of the American Public Transportation Association (APTA).

The Transit IDEA Program is one of four IDEA programs managed by TRB. The other IDEA programs are listed below.

- NCHRP Highway IDEA Program, which focuses on advances in the design, construction, safety, and maintenance of highway systems, is part of the National Cooperative Highway Research Program.
- High-Speed Rail IDEA Program, which focuses on innovative methods and technology in support of the Federal Railroad Administration's (FRA) next-generation high-speed rail technology development program.
- Safety IDEA Program, which focuses on innovative approaches for improving railroad safety and intercity bus and truck safety. The Safety IDEA program is funded by the Federal Motor Carrier Safety Administration and the FRA.

Management of the four IDEA programs is coordinated to promote the development and testing of innovative concepts, methods, and technologies.

For information on the IDEA programs, look on the Internet at www.trb.org/idea or contact the IDEA programs office by telephone at (202) 334-3310 or by fax at (202) 334-3471.

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National Research Council

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Acknowledgements

The participation in this Transit IDEA project and the guidance of the following professional staff of transit agencies and others has been valuable and is appreciated.

Transit Agencies:

- Maryland Transit Administration: Michael S. Davis, Assistant Deputy Administrator of Transit Operations.
- Massachusetts Bay Transportation Authority (MBTA): John Lewis, Deputy Chief Operating Officer
- MBTA: Sean Carney, Power Division Engineer.
- Greater Cleveland Regional Transit Authority (GCRTA): Joseph A. Calabrese, CEO
- GCRTA: Pamela McCombe, Director of Safety
- GCRTA: Daniel Collins, Manager of Power and Way.
- Southeastern Pennsylvania Transit Authority (SEPTA) – Andy Gillespie, Chief Engineer-Power
- New York City Transit (NYCT): Maurice Lewis, Assistant Chief Transportation Officer.

Others:

- Thomas F. O'Hara Jr, Traction Power Project Manager, STV (Formally Power Division Engineer for the MBTA).
- International Brotherhood of Electrical Workers (IBEW) Local 103 Boston, Jim O'Connell, Safety Business Agent
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- Joe Vassallo, Engineer, MBTA
- Jimmy Condry, MBTA
- Paul J. Larrousse, Director, National Transit Institute
- Christopher A. Kozub, Assistant Director, National Transit Institute
- Harvey Berlin, Senior Program Officer, Transit IDEA Program, Transportation Research Board

Expert Review Panel

This Transit IDEA project has been guided and reviewed by the expert review panel. The purpose of this panel is to provide guidance to the Principal Investigator for the IDEA product development and transfer of results to practice. The panel members' comments and recommendations have been incorporated into the project reports and plans for implementing the results of the Transit IDEA project.

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Executive Summary

The purpose of this Transit IDEA project was to develop and test a device to give early warning to rail transit personnel of an approaching train and to give early warning to the train operator that personnel are ahead on the tracks. This device can provide a reliable way of giving the track worker and train operator, a warning in enough time to avoid potential accidents, injuries, or death.

Special appreciation goes to the following transit agencies where pilot testing was accomplished as part of this Transit IDEA project: The Massachusetts Bay Transportation Authority (MBTA), Greater Cleveland Regional Transit Authority (GCRTA), and Maryland Transit Administration in Baltimore MD.

MBTA, GCRTA, Los Angeles County Metropolitan Transportation Authority (LACMTA), Washington Metropolitan Area Transit Authority (WMATA), Dallas Area Rapid Transit (DART) and Southeastern Pennsylvania Transportation Authority (SEPTA) have purchased devices that were developed in this project for subsequent pilot testing and evaluation by the transit agencies under their operating conditions on their transit facilities. Maryland Transit Administration is implementing the technology on their heavy rail rapid transit line in Baltimore.

The information provided in this report will enable other rail rapid transit agencies the ability to consider using such devices to give early warning of approaching trains to track workers, track walkers, track inspectors, first responders and signal personnel and also to give the train operator early warning of the presence of personnel in the track area.

Data from between October 2005 and May 2008, from the Federal Transit Administration (FTA) and the Federal Railroad Administration (FRA) showed a “three-fold increase in the number of rail transit worker fatalities and a significant increase in injuries”.

These devices can provide an effective means to give advance warning of approaching trains for Track work crews, track inspectors, track walkers and signal personnel and warning to train operators of track personnel ahead.

IDEA Concept and Product

There were two key major sets of devices that were developed and tested in this Transit IDEA project.

First was the development of a portable early warning device to warn track workers of an approaching train. This system uses secure wireless technology and is comprised of a Portable Train Detector, Personal Alert Device, Flagger Supervisory Device and a Portable Warning Light/Horn unit as shown in figure 1. The concept works as follows: The Portable Train Detector shown in figure 2 will detect the presence of a train by an ultrasonic detector and send a secure signal that turns on the Personal Alert Device(s) worn by the worker shown in figure 3 and to the Portable Warning Light/Horn placed near the work zone shown in figure 4. The unit also has a Flagger Supervisory Device that allows the flagger to activate the alarms at the work zone areas if required as shown in figure 5. The special ultrasonic transducers can also indicate the speed and direction of the train.

Second was the development of a train mounted early warning device. This system also uses secure wireless technology and gives early warning to train operators when approaching track work crews, track walkers, inspectors, signal personnel and contractors. This device is a compact device that gets mounted in the train cab as shown in figure 7. When the train is the required distance from the track walker, inspector, signal personnel, contractors or work zone it turns on alarms and LED lights on the train mounted device and sends a secured signal turning on the Personal Alert Device(s) and Portable Warning Light/Horn used by the track work crews, track walker, inspectors, signal personnel and contractors as shown in figure 8.

The portable early warning device and train mounted early warning device can work independent of one another or could provide an additional redundancy means to improve safety for track workers.

Under stage III of this three stage project, a failsafe portable automatic tripper was developed to minimize the flaggers' exposure to fouling the track and to allow the flagger to automatically (through wireless means) lower and raise the tripper arm to stop the train. Currently flaggers have to foul the track to remove the tripper arm when a train is approaching. The automatic tripper, which is shown in figure 6, would not require this. None of the agencies have shown interest in this automatic tripper at this time.

Portable Warning Light/Horn | Personal Alert Device w/ safety blue tooth | Portable Train Detector | Flagger Supervisory Device

Figure 1

Figure 2
Portable train detector placed near track detecting the early presence of a train.

Figure 3
Track workers wearing the personal alert Device w/ safety blue tooth.

Figure 4
Portable light/horn unit place within the work zone.

Figure 5
Flagger using the flagger supervisory device to activate the personal alert device, portable light/horn and rail vehicles.

Figure 6
Flagger supervisory device activating the automatic portable tripper up and down.

Figure 7
Train Mounted Device installed in a train operators cab.

Figure 8
Train mounted device activating the workers arm-band personal alert devices, and portable light/horn unit at Maryland Transit Administration in Baltimore.

Potential Impact on Transit Practice

The development of these early warning devices has already generated follow-on activities in the transit industry. These warning devices can provide transit agencies the ability to:

- Warn track work crews, track inspectors, walkers and signal personnel of approaching trains.
- Warn train operators of track personnel ahead.

Massachusetts Bay Transportation Authority (MBTA), Greater Cleveland Regional Transit Authority (GCRTA), Los Angeles County Metropolitan Transportation Authority (LACMTA), Washington Metropolitan Area Transit Authority (WMATA), and Southeastern Pennsylvania Transportation Authority (SEPTA) have purchased some of the devices that were developed in this project for pilot testing by the transit agencies on their rail transit facilities. Maryland Transit Administration is implementing the technology on their complete heavy rail rapid transit line in Baltimore.

The National Transportation Safety Board (NTSB) Board determined that technology can provide additional protection for wayside workers, especially in a work environment in which a brief lapse of attention can quickly result in serious injury or death. There is technology that can provide alerts to both the train operator and the wayside workers, the Board noted. At the January 2008 NTSB public board meeting, NTSB staff demonstrated early warning technology that was developed in this project. These systems provide train operators with an audible and visual alarm when they are approaching wayside workers who are near the tracks and warnings to wayside workers who are wearing a personal warning device. The NTSB recommended that WMATA should implement appropriate technology that would automatically alert wayside workers of approaching trains and automatically alert train operators when approaching areas with workers on or near the tracks (NTSB Report SB-08-05).

APTA and the IEEE Overhead Contact Systems committee are identifying best practices that include the use of warning devices such as the work done under this project. Also the National Transit Institute and the Transportation Safety Institute are both developing training courses that show the importance of using this technology as part of an overall safety program.

Concept and Innovation

Components used in the devices focused on existing and proven parts and processes to formulate a successful program. This is what allowed this technology to go from early development to implementation so quickly.

Stage I of this project developed a train detection device, and sending device to activate wireless warning lights and personal pocket devices under three (3) tasks. Task 1) Train detection device. Task 2) Secure radio frequency activating device to activate wireless warning lights and personal pocket devices. Task 3) transit site investigations and trials, develop a detailed application site work plan.

Stage II of this project demonstrated a functional redundant device that can accurately detect the presence using special ultrasonic transducers.

Stage II also included development of a system that can detect the direction of the train as well as train over speed (>=10 MPH). This system was designed to improve transit personnel's ability to know what direction a train is approaching a track work zone and to know if it is exceeding > 10 MPH. Other key parts under this stage were to develop a reliable, durable and redundant device that is light weight, portable and simple to use and implement in the field.

The final stage III of the project developed an automatic portable tripper and flagger supervisory device (activator). This device could allow the flagger to use a hand held device to activate the portable warning light/horn and personal alert devices to warn of oncoming dangers to the work crews. It was also to activate an automatic portable tripper that allowed the flagger to activate (lift) the tripper in a dangerous situation. The device had to be developed with several special features that allowed the flagger supervisory device to have two independent and redundant features of activating the automatic portable tripper and activating the portable light/horn unit and personal alert device. An additional feature was added that allowed the flagger supervisory device to also activate the train mounted device to add another redundancy to alert the train operator when approaching a work zone. This also allowed the flagger to stay involved in his key duties of looking out for a train. Options such as data recording were added to indicate if the flagger activated the device prior to the portable train detector

Investigation

Prior to developing this technology project research team investigated relevant sources. Sources included NTSB reports, transit agencies' standard operating procedures and right of way safety training programs and visits and interviews with transit agencies in the United States, Switzerland, China and Belgium. The investigation in this project further met with track workers, track walkers, flaggers, emergency responders, signal personnel, contractors, CEO's of transit agencies, and members of transit unions. Our main goal was to come up with a working device and reliable technology that could be easily applied, industry accepted and improve track worker safety.

The Swiss railway incorporates a model of safety layering with technology for their track work zones. With a strong training program and strong pre-work safety briefings, independent safety personnel and the use of technology, their safety program has yielded impressive results. Some European railroads have used early warning technology. They further hire independent track safety companies to set-up their work zones. In many cases, they provide an experienced and well trained flagger as shown in figure 9. The results of using these early warning technologies along with a good training program and procedures have resulted in the Swiss railway having one of the safest records in the world.

When we started working with the Massachusetts Bay Transportation Authority, Greater Cleveland Regional Transit Authority and Maryland Transit Administration, their personnel requested that we develop a technology that is reliable, easy to setup and can function independent from Operational Control Center. Some flaggers wanted a device that they could use to alert the work crews along with the train operators. The train operator wanted to get an early alert if a work crew, walkers, inspectors, signal personnel and contractors are ahead.

After compiling the data from our investigation we formulated our benchmark model to develop technology for the US transit industry as shown in this project.

Figure 9
Some European railroads use hard wired early warning technology and stress a strong training program that includes track worker safety training.

Testing and Evaluation

The following testing and conclusions have been provided by staff of transit agencies listed below. The complete testing and evaluations sheets are provided in the appendix. All testing procedures were conducted by transit agency personnel or agency consultants.

GCRTA, Cleveland, OH (Test report is Appendix a.)

Testing of the ProTracker and Portable ProTracker performed better than expected.

Maryland Transit Administration, Baltimore, MD (Test report is Appendix b.)

ProTracker operated as promised and proved effective as a secondary early warning device for track workers. MTA has committed to implement on their heavy rail rapid transit line in Baltimore, MD.

MBTA, Boston, MA (Test report is Appendix c.)

MBTA staff reported that the ProTran1 ProTracker early warning device met or exceeded performance requirements. No evidence of any signal saturation detected, 100% consistently warned all track workers and train operators at a safe distance. No evidence of any Electromagnet Interference (EMI) or Radio Frequency Interference (RFI).

SEPTA, Philadelphia, PA (Test report is Appendix d.)

Portable ProTracker performed as requested.

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Amtrak, Northeast Corridor (Test report is Appendix e.)

The Portable ProTracker detected the train and alerted the track worker every time.

Toronto Transit Commission (Test report - Appendix f.)

The Portable ProTracker operated as advertised

Plans for implementation

After the successful testing, we have been working with the NTSB, IEEE, APTA, National Transit Institute, FTA and DHS on developing procedures to enable these technologies to be implemented as secondary warning in current right of way safety procedures. Developing detailed testing procedures, on operations and maintenance manuals with updated standard operating procedure are important to do in conjunction with the technology. Massachusetts Bay Transportation Authority, Greater Cleveland Regional Transit Authority, Los Angeles County Metropolitan Transportation Authority, Washington Metropolitan Area Transit Authority, Southeastern Pennsylvania Transportation Authority have purchased devices for pilot testing by the transit agencies on their transit facilities. Maryland Transit Administration is implementing the technology on their complete heavy rail rapid transit line in Baltimore.

Approximate cost of the devices:

- Portable Warning Kit for advance work zone warning (comprised of Portable Train Detector, Personal Alert Device, Portable Warning Light/Horn and Flagger Supervisory Device). $12,000/kit
- Train Mounted Device for advance warning to the train operator. $3,000/unit.

A US Patent Application has been filed for this device and process.

Conclusions

We spent hours traveling, talking with transit agency staff, and developing technology to address transit industry requirements.

Special appreciation goes to the following transit agencies where pilot testing was accomplished: The Massachusetts Bay Transportation Authority, Greater Cleveland Regional Transit Authority, and Maryland Transit Administration.

Further appreciation to go out to the Expert Review Panel for this project whom were able to effectively review the results of the testing and field comments and direct our development into a usable device for transit agencies.

As part of this project, we successfully developed two reliable devices. The first is a wireless Portable Train Detector to give advance warning track work crews, track inspectors, track walkers, hi-rail operators, signal personnel and contractors of approaching trains. The second device is the Wireless Train Mounted Device that gives the train operator advance warning of track personnel ahead. During testing, these wireless devices proved to be immune to electromagnetic interference (EMI) and radio frequency interference (RFI). They also proved to be an effective and reliable means of adding additional safety. Options that were developed such as the Flagger Supervisory Device could add an additional redundant means for the flagger to warn the work crew, work vehicles and train operator of dangers ahead.

Track personnel found the devices easy to install, lightweight and user friendly. This project concluded that these technologies can help to improved track worker safety and reduce human error.

These devices can provide an effective means to give advance warning of approaching trains for Track work crews, track inspectors, track walkers and signal personnel and warning to train operators of track personnel ahead.

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