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Transportation
**Federal Railroad
Administration**

Railroad Infrastructure Trespass Detection Performance Guidelines

Office of Research
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Washington, DC 20590

Safety of Highway Railroad Grade Crossings

DOT/FRA/ORD-11/01

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13. ABSTRACT (Maximum 200 words)
The U.S. Department of Transportation's John A. Volpe National Transportation Systems Center, under the direction of the Federal Railroad Administration, conducted a 3-year demonstration of an automated prototype railroad infrastructure security system on a railroad bridge in the town of Pittsford, NY [1]. The main objective was to demonstrate a stand-alone, video-based trespass monitoring and deterrent system for railroad infrastructure applications using commercial off-the-shelf technology. The final report, entitled "Railroad Infrastructure Trespassing Detection Systems Research in Pittsford, New York," details the project location, system technology and operation, system costs, results, potential benefits, and lessons learned. The results indicate this interactive system could serve as a model or prototype railroad infrastructure security system for other railroad rights-of-way or bridges deemed prone to intrusion. Additionally, the authors' recommendation to develop performance guidelines for this type of system is contained in this document.

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F	=	y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

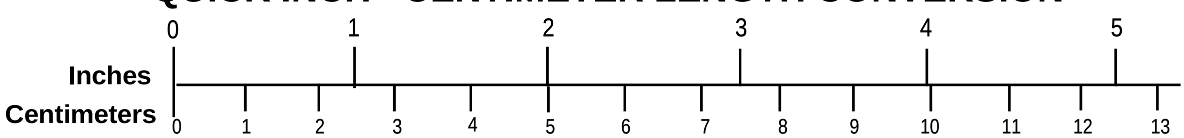
VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

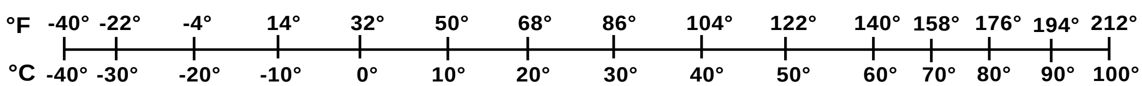
TEMPERATURE (EXACT)

[(9/5) y + 32] °C	=	x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSIO



For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures.

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Under sponsorship from the United States Department of Transportation (USDOT) Federal Railroad Administration (FRA) Office of Railroad Safety, the USDOT Research and Innovative Technology Administration's John A. Volpe National Transportation Systems Center (Volpe Center), demonstrated an automated prototype railroad infrastructure security system on a railroad bridge and developed performance guidelines based on that research. The author of this document, which delineates those performance guidelines, is Mr. Marco P. daSilva. The author wishes to thank Ron Ries, Office of Railroad Safety, FRA, for his guidance and support.

The author gratefully acknowledges the overall direction provided by Anya A. Carroll, Principal Investigator of the Highway-Rail Grade Crossing Safety Research Program, Systems Engineering and Safety Division, USDOT Volpe Center. This project was conducted under the auspices of the Highway-Rail Grade Crossing Safety Research Program, Systems Engineering and Safety Division, Volpe Center.

Contents

Figures

1. Introduction

The U.S. Department of Transportation Research and Innovative Technology Administration's John A. Volpe National Transportation Systems Center, under the direction of the Federal Railroad Administration, was tasked with demonstrating an automated, prototype railroad infrastructure security system on a railroad bridge in Pittsford, NY. The main objective was to demonstrate a stand-alone, video-based trespass monitoring and deterrent system for railroad infrastructure applications using commercial off-the-shelf technology. The system was installed in summer 2001 and initially intended to run for 1 year. The evaluation period was eventually extended for an additional 2 years, and a further year for monitoring purposes only.

The prototype system was then transferred to CSX Railroad during its fifth year of operation (November 2005). A final report was published in August 2006 [1]. The report details the project location, system technology and operation, system costs, results, potential benefits, and lessons learned. The results indicated this interactive system could serve as a model railroad infrastructure security system for other railroad rights-of-way (ROWs) or bridges deemed prone to intrusion. The development of function-based performance guidelines for these types of systems was one of the recommendations delineated by the authors of the final report [1].

Function-based performance guidelines are defined as a set of recommendations that specify the expected outcomes of the technology performance or system but do not provide physical component specifications. A wealth of information was collected during the 4+ year duration of the Pittsford project, and much of it was used to enhance the operational capabilities of the system throughout the life of the project, especially in terms of increasing system component reliability and positive detection rate. The various observations made throughout the course of the project, along with the Pittsford system prototype results and lessons learned, provide an excellent resource from which a set of performance guidelines can be developed for similar future railway safety and security systems. The purpose of these guidelines is to assist local authorities and railroads that are considering the use of such stand-alone systems to minimize trespass on the railroad's ROW. These guidelines were drafted from the analysis of a proven and effective trespassing detection and deterrent system field-tested and evaluated in Pittsford, NY [1].

2. Assessing the Problem

Trespass on railroad ROWs has long been a safety concern, especially since many tragic incidents involve children and young adults. About 500 people per year sustain fatal injuries as a result of trespassing on our Nation's railroads. Figure 1 displays the number of trespass-related as well as highway-rail grade crossing-related fatalities per year from 1990 through 2006 [2]. As shown in Figure 1, crossing-related fatalities have steadily decreased over the years while trespass-related fatalities have not. In fact, aside from slight yearly fluctuations, trespass fatalities have stayed at about the 500-per-year level.

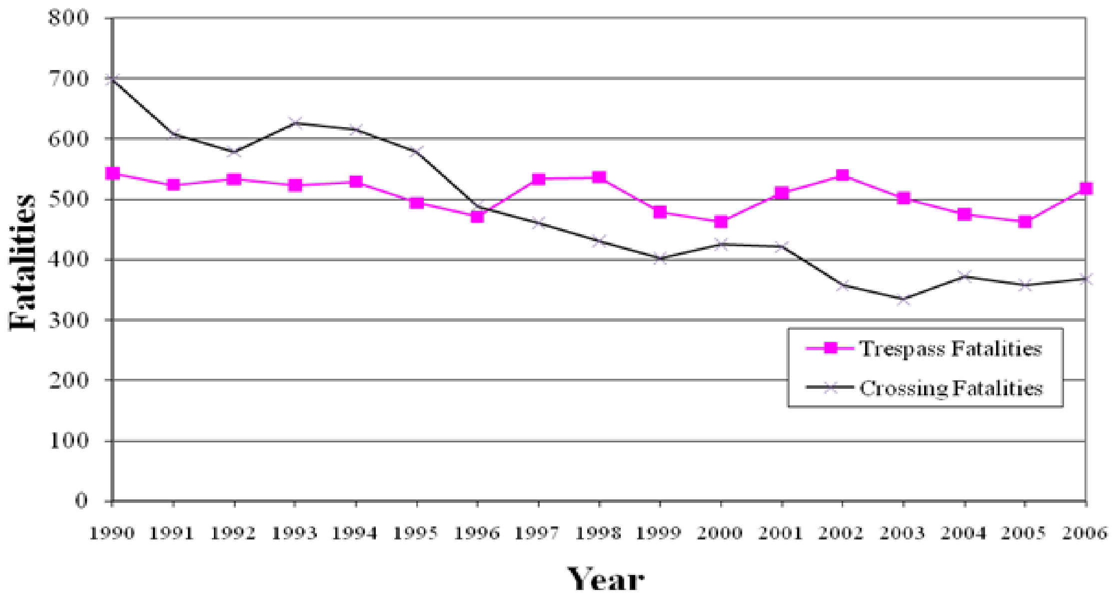


Figure 1. Railroad Trespass/Grade Crossing Fatalities (1990–2006) [2]

Another developing concern is railway security, which has been gaining much attention since the terrorist events of September 2001, as well as later train bombings in Madrid, Moscow, and London. Securing the rolling stock as well as the infrastructure (track and signals/switches, bridges, tunnels, and facilities) has become a top priority within the rail industry, as well as within all levels of government. Many new technologies and integrated systems have been recently developed to deal with this particular issue [3]. Although developed for a slightly different situation, these systems can be viewed in the same light as the trespass and deterrent systems. Therefore, the guidelines set forth in this report can and should also be used for similar security-related detection and deterrent systems.

A fatal incident involving two young teenagers was the catalyst for the trespass detection work conducted in Pittsford, NY [1]. That tragedy drove the research effort that resulted in the development of these performance guidelines for similar intrusion detection and deterrent systems. Once a particular location has been targeted, the first step should be to assess the trespassing problem.

2.1. Factors Contributing to Trespassing on Railroad ROWs

Trespass on the railroad ROWs occurs because of many circumstances. An important deciding factor for trespass concerns the layout and features of the railroad location, for example, whether it is a crossing, bridge, or tunnel. Once a particular location of interest has been identified, an initial site survey should be conducted to identify conditions that may be present and contribute to trespass. Such conditions may include but are not limited to:

- Accessibility (poor or no fencing, no landscaping, proximity to school, or other heavily trafficked attractions)
- Poor visibility (curve/crest near accessible areas, location not easily visible from nearest road or developments)
- Shortcut potential (fastest way between popular destinations)

Anecdotal historic information about trespassing at specific locations should also be gathered from the local police, town representatives, and even the local media. However, as noted in the Pittsford final report [1], this information is not necessarily correct. In that study, local sources indicated that the trespassing was mostly done by teenagers loitering on the bridge. Upon review of 3 years worth of trespass data gathered by the system installed at the Pittsford location, it became very clear that many of the trespassers were, in fact, adults or a combination of adults and small children that were using the bridge as a shortcut between the two sides of the canal. Very few trespass events involved teenagers using the location to loiter. The correct information can be of great value, especially to local railroad safety campaigns.

2.2. Engineering Countermeasures

The site survey results should be reviewed to determine the factors contributing to trespassing at that specific location and identify appropriate countermeasures that should be implemented to reduce or eliminate the trespass problem. A trespass detection and deterrent system is one of many countermeasures available that may be effective in preventing or mitigating the consequences of trespass. There may be other potential solutions, aside from installing a technology system, that could alleviate the trespass problem at the location. The site survey can also reveal factors that would make installing a technology-based system very difficult, such as the lack of power, communications, or viable sensor placement locations.

Other countermeasures can be initially more expensive but can prove to be more cost-effective in the long term. Some examples are:

- More effective signage
- Better fencing, landscaping (e.g., rows of bushes)
- Dedicated pedestrian/cyclist path above/under/parallel to ROW

If these other methods don't apply to the particular situation, then an infrastructure-based trespass detection and deterrent system should be designed specifically for the location. In some instances, it still may be beneficial to incorporate other countermeasures (such as fencing) along with the technology system. Once the decision is made regarding appropriate countermeasures, then the design phase of the project can begin.

2.3. Technology Concepts

A wide variety of technologies have been used for trespass detection in many operational environments including on railroad ROWs. Integrated systems have also been field-tested in recent years, including the system recently evaluated at the Pittsford, NY, location. A report entitled "State-of-The-Art Technologies for Intrusion and Obstacle Detection for Railroad Operations" contains a comprehensive list of existing and potential technology solutions that could be considered for use as intruder and obstacle detection systems or that are capable of performing integral functions within such systems [3]. The most common technologies currently in use throughout the transportation and security industries in obstacle and intrusion detection include radar, magnetic, infrared, and video motion detection sensors.

Many technical lessons were learned throughout the evaluation period of the system installed at Pittsford, NY, and were documented in the final report entitled "Railroad Infrastructure Trespassing Detection Systems Research in Pittsford, New York" [1]. Some of these lessons were based on current railroad operational procedures and directly apply to the technology concepts considered for use around the railroad environment. The two major technology-related findings, described in detail in the Pittsford report [1], are as follows:

- The use of proven technology increases the probability of success. Many technology solutions currently exist throughout the transportation and security industries. Some have been successfully used for extended periods of time, whereas others are newer concepts that may still prove to be less effective. Therefore, the use of proven technology, even if not cutting-edge, may be a better choice for the project.
- The use of a broadband communications infrastructure (or better) for communication of trespass events increases the probability of detection of the event. A broadband connection between the wayside equipment and monitoring station enables constant live video surveillance and instantaneous alarm notification and allows a frequent image refresh rate. Anything less than broadband, including dial-up and digital subscriber line (DSL), may cause delays in video transmission because of significantly slower video refresh rates as well as inferior video quality. Wireless data transmission options should be considered if no existing communications infrastructure exists or if dial-up is the only option at or near the location.

3. Trespass Detection/Deterrent System Design

Even though this section does not directly address performance guidelines, which are discussed in Section 4, it does provide direction for the preliminary work that should be conducted prior to the selection of any particular system design. The two major tasks, initial planning and site survey, are described below.

3.1. Initial Planning

The first step in designing any system is to properly identify all stakeholders and include them throughout the entire process in the form of a public-private-partnership (P3) to resolve any safety concerns. The Canadian Government developed such a P3 called "Direction 2006" aimed at reducing trespass and crossing incidents and published a very useful guide for community-involved trespass prevention on railroads [4]. Typical stakeholders include but are not limited to:

- Railroad companies (property owners and users of the infrastructure)
- City/Town representatives (Mayor's Office, Engineering/Planning Department, Police, Public Works Departments)
- Utility companies (power, telephone, cable/other communications)
- Community representatives
- Other organizations
- General public

Once the stakeholders are identified, a meeting should be held and key issues shared among all involved. The outcomes of the stakeholder meeting may include but are not limited to:

- Designating a point-of-contact for each stakeholder
- Defining the expectations of the system—what will the system do? Identify trespass event(s)? Notify who? Deter trespassers?
    - Clear statement of the objectives
    - Concept of Operations of the system
- Defining the stakeholder level of expected involvement and associated responsibilities
- Providing input to some site survey observations

3.2. Site Survey

A comprehensive site survey should be completed before any decisions are made on what type of system should be installed. Particular attention should be given to:

- Railroad and city/town plats (denoting property lines)
- Police reports and city/town understanding of the trespass problem at that location
    - Gives anecdotal (not necessarily accurate but still useful) historical perspective on trespassing characteristics and patterns.
    - Provides useful information on the potential for vandalism to equipment.

- Easement agreements
- Availability of electricity
- Availability of telephone/DSL/broadband
- Rail traffic patterns (passenger, freight, mixed) and frequency (regular, infrequent)
- Average and maximum train speed at that location
- Number of entry points (bridge/tunnel) and area to be monitored
- Potential system placement locations
- Atmospheric considerations (mount and weatherize components accordingly)
- Lighting (or lack of it, indicating the probable use of infrared (IR) illumination)

An important observation from the site survey is the definition of the detection zone. A well-defined detection zone should be identified before the system design proceeds so that the system design accounts for the specific requirements of the site. Great care should be taken to identify all of the entry/exit points as well as potential false alarm triggers. Such triggers could include vegetation, boats or vehicle traffic (if at a bridge location), and large animals. Once the detection zone and all other observations have been gathered from the site survey, a sample of which is attached in Appendix A, the system design process can begin.

3.3. System Design

This paper does not provide guidance on system design or the use of specific technologies. However, the performance guidelines contained in Section 4 should be considered during the design stage. Other more general procedural recommendations, as noted below, should also be weighed.

The system's design and installation plans should be presented to the stakeholder committee for comments, especially from local authorities, affected utilities, and railroad companies. These plans should be in accordance with all local and State building codes as well as the product manufacturers' specifications. They should detail the physical placement of all sensor and communication components, all associated conduit and utility service connection points, and any other physical design components.

Revisions recommended by the committee should be incorporated into the design and again presented to the committee for approval. Once the committee is in agreement, proper local construction permitting should be sought for the installation. The system's installation should begin only after stakeholder committee approval and issuance of the proper permitting.

The development and operation of trespass detection systems can be handled in one of two ways. Either the local authority—the town, city, or State—can elect to be responsible for the system operations or it can outsource this activity to a private contractor. If the latter is chosen, the local authority should establish a well-drafted contract delineating the contractor's responsibilities and requirements as well as clear operation and maintenance plans and protocols.

4. Performance Guidelines

Various system performance issues were identified throughout the operational period of the trespass detection and deterrent system installed at the railroad bridge location in Pittsford, NY. The results from that research aided in the development of function-based performance guidelines delineated herein. These guidelines are not designed to address specific types of devices or component technologies. They refer, however, to the basic functionality and operation of trespass detection and deterrent systems.

If the site survey results, as described in Subsection 3.2, indicate that an infrastructure-based trespasser detection and deterrent system should be installed, then the following elements should be considered.

4.1. Atmospheric Conditions

The system should be designed to withstand the rigors of year-round environmental conditions at the location. It should function in all weather and ambient lighting conditions, including day, night, sunrise, and sunset conditions. The wayside cabinet should be well ventilated, especially if inside temperatures reach above 80 degrees Fahrenheit. The wayside cabinet should also be heated if temperatures are expected to reach below freezing, less than 32 degrees Fahrenheit. The Pittsford System experienced both of these conditions, and therefore, the wayside cabinet was equipped with both a heater and fan, and these were activated accordingly as part of the seasonal maintenance procedures [5].

4.2. Lighting

Determine lighting conditions at the location to be monitored. Specific attention should be given to the monitored area and whether there exists sufficient nighttime lighting for the proper operation of image-based sensors, if such are used. If insufficient lighting is available, determine whether it can be provided from existing curbside/overhead lighting poles. If this is not feasible, then determine whether floodlighting should be incorporated into the design of the system or if IR illumination should be used instead. Particular attention should be given to placement of extra lighting to avoid interfering with railroad operations.

4.3. Communications

Depending on the concept of operations laid out for the trespass detection system, the appropriate communications component should be incorporated into the system design. A reliable communication link should be established using the most suitable option available at the location. The system's design and concept of operations should indicate the necessary bandwidth needed for relaying all of the necessary information to the appropriate channels, whether they are the local authorities, a local monitoring station, the maintenance personnel, or the railroad company as well as for real-time audible warning notification to the trespasser(s). Common options are telephone lines (DSL), broadband, fiber-optic, and microwave. (The site survey should have noted the availability of the first three options.)

4.4. Sensor and Other Components Housing

All wayside-mounted processing and communication equipment should be housed in National Electrical Manufacturers Association (NEMA) compliant weatherproof outdoor enclosures intended to house electrical circuits and components [6]. These weather and damage resistant cabinets should also be equipped with a locking mechanism to ward off potential vandalism. The cabinet should also be grounded and equipped with surge suppressors. Consideration should also be given to installing a lightning rod above all equipment poles especially if the area is prone to lightning strikes or the poles stand higher than the surrounding structures and landscape. Figure 2 shows the enclosure used to house the various wayside-mounted components of the Pittsford system [5].

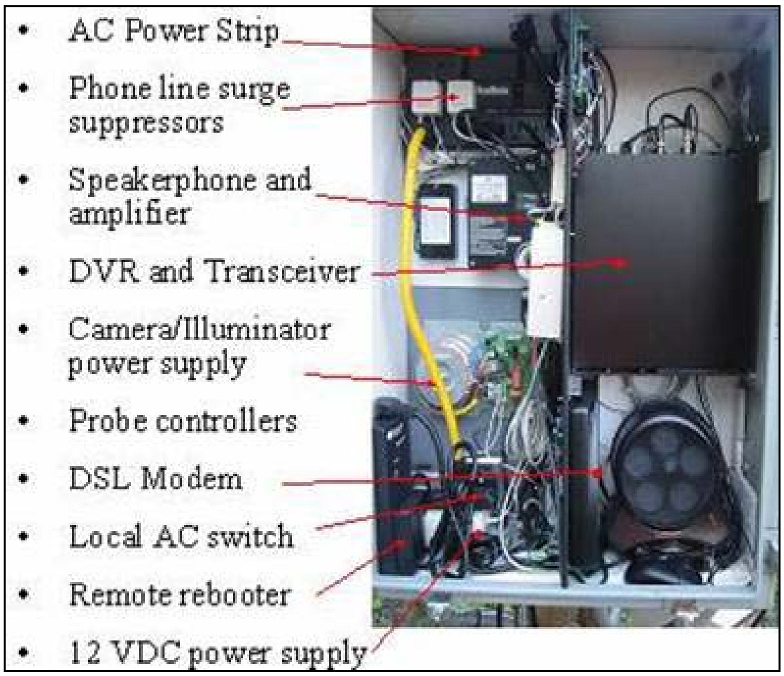


Figure 2. NEMA Outdoor Enclosure Housing Pittsford System Components [5]

All external sensors should be pole-mounted out of reach of potential trespassers, at least 10 feet off the ground, and installed in weatherproof and damage-resistant enclosures if not already manufactured to those specifications. This guideline should also be in accordance with sensor performance specifications, especially in relation to each sensor's field of detection. The sensors should be placed at a suitable location to both satisfy this guideline and also provide adequate coverage of the detection zone.

4.5 Sensing Functions

The trespass detection sensing package of the system, which is composed of all of the wayside sensors, should adhere to the following recommendations:

- Achieve 100 percent trespass detection rate within the detection zone, which should be well defined per the site survey.

- Minimize false alarm rate (mask out trains, hi-rail vehicles, boats, animals).
    - The system should have a false alarm rate of less than 1 per true alarm. Ideally, the false alarm rate should achieve a tolerance level of 0. However, because of the nature of the local environment and sensors used, there may be a significant false alarm rate. If so, care must be taken to minimize its occurrence and determine the effect on the system's operation, especially if human operators are involved.

- Issue a warning to monitoring station and trespasser if trespassing is detected within the detection zone.
    - Auditory warning to the trespasser should be focused in the direction of the detection zone and loud enough to be heard within the entire detection zone. The auditory warning should not, however, be a nuisance to nearby homes or businesses.

- Objects outside the detection zone must not cause an alarm or warning to be issued.

- Incorporate local recording as well as sensor and system data transmission.
    - This capability is critical for remote system maintenance. It is also invaluable for reviewing system and alarm activity, analyzing system performance, and performing forensic research.

- Reduce or eliminate system failures through fail-safe design.
    - System should be able to self-diagnose a failure
    - System should have a means to alert the monitoring station when a system failure condition is detected.
    - System should have a reboot utility that can be activated remotely. The remote reboot capability should be applied to both the wayside system controller as well as individual sensor components. As evidenced throughout the Pittsford, NY, system evaluation, components sometimes failed but regained their functionality after a reboot.

- Ensure component redundancy.
    - Redundancy should be incorporated into as many components as possible. A typical system relies on various sensors and other components that are each an integral part of the overall system. Failure in any of these parts may render the whole system inoperable. The system's design should

incorporate redundant sensors and other components. This ultimately increases the reliability of the overall system.

- Protect public safety.
  - System must pose no threat to human safety and must meet or exceed all regulations for the provided technologies.

- Avoid electronic interference.
  - Sensing subsystem should not interfere electronically (emit electromagnetic interference that would interfere with normal railroad operations) or visually with any other system on the ROW or on authorized railway users (locomotives, hi-rail vehicles)—especially IR lamps that may glow red at nighttime, which may interfere with the railroad visual signaling system cues.

- Develop and share an operations plan.
  - Protocols must be developed to address the range of operational situations from the positive detection of intruders or obstacles on the ROW to false detection or failure of the warning system. These protocols must be shared with all entities that interact with the system (railroad companies, monitoring station, police, and others). This core group of stakeholders should provide input to the development of the initial operational plans. Additionally, the group should provide feedback while the system is operational so that improvements to the plans can be incorporated during periodic reviews.

- Create a site-specific maintenance plan.
  - A site-specific system maintenance plan should include plans for regular inspections as well as for preventative maintenance and cleaning.

5. Conclusion

This performance guidance document has been developed to assist local authorities and railroads that are considering the use of stand-alone trespass detection and deterrent systems similar to the one installed and evaluated at a railroad bridge in Pittsford, NY.

The various observations made throughout the course of the operation and evaluation of that prototype system, which has been in operation since 2001, provided an excellent resource from which this set of performance guidelines were developed for similar future railroad safety and/or security systems. The guidelines presented in this document, ranging from overall system operation to specific sensor issues, should provide a valuable tool for future work in the area of public safety within the railroad operating environment.

6. References

[1] daSilva, M. P., Carroll, A., & Baron, W. *Railroad Infrastructure Trespassing Detection Systems Research in Pittsford, New York*. Report No. DOT/FRA/ORD-06/03. Washington, DC: Federal Railroad Administration, August 2006.

[2] http://safetydata.fra.dot.gov/officeofsafety/, viewed September 14, 2007.

[3] daSilva, M. P., Carroll, A., & Baron, W. *State of The Art Technologies for Intrusion and Obstacle Detection for Railroad Operations*. Report No. DOT/FRA/ORD-07/06. Washington, DC: Federal Railroad Administration, February 2007.

[4] http://www.direction2006.com/documents/pdf/en_TrespGuide2003.pdf, viewed June 26, 2007.

[5] daSilva, M. P., Carroll, A., & Baron, W. *Railroad Infrastructure Trespasser Detection Research*. 2005 National Highway-Rail Grade Crossing Safety Training Conference, Austin, TX, November 6-9, 2005.

[6] http://www.nema.org/, viewed June 26, 2007.

Appendix A. Site Survey Form

If Crossing, location or over/underpass, Street or Highway Name:
County: Township: City:
If Crossing, ID: Milepost: Survey Date:
Detection System Proposed by: ☐State ☐Local Government ☐Railroad ☐Private or Public Agency ☐Individual
Name of Proposing Agency:

1.2.1 Site Survey Team

	Team Member	Title	Agency
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

1.2.2 Roadway Data (If Crossing Location)

Total number of lanes crossing railway: ________________________
Span across Roadway (ft): ________________________
Warning Devices: ☐Gates ☐Lights ☐Other Train Activated ☐Crossbucks ☐Stop sign ☐None ☐Other
AADT: ______________ Posted Speed Limit: _______ mph
Type of Development: ☐Residential ☐Commercial ☐Industrial ☐Rural
Sight Obstruction: ☐Yes ☐No Crossing Angle: ☐0-29 ☐30-59 ☐60-90

1.2.3 Railroad Data

Railroad Responsible for location: ____
Number of Tracks: _____________ Total Trains per Day: __________
Maximum Train Timetable: _________ mph
Type of Trains: ☐Freight ☐Commuter ☐Passenger ☐Other

1.2.4 Five-Year Accident History

Date	Fatality	Injury	Property Damage
Total			

Describe signage, fencing, and strategic (trespass-deterring) landscaping at the location. Could this be improved?

Define all detection zones and potential issues for each detection zone (obstructions, very wide area…):

Nearest electrical service location for each detection zone:

Nearest telephone service location for each detection zone and communications options (DSL, broadband…):

Artificial lighting conditions (nearest light poles):

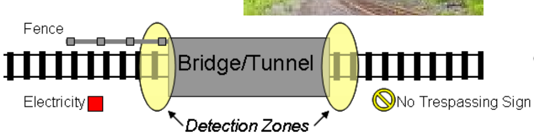
Can existing infrastructure (bridge components, tunnel walls, existing poles) be used to mount detection system components?

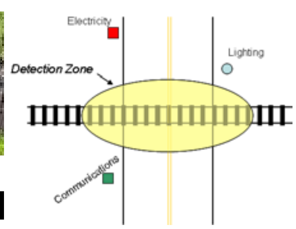
Other Observations:

Location Sketches:

Location Sketches (continued):

Samples





Abbreviations and Acronyms

AADT	annual average daily traffic
DSL	digital subscriber line
IR	infrared
NEMA	National Electrical Manufacturers Association
P3	public-private partnership
ROW	right-of-way