

The goal of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce commercial vehicle related fatalities, as well as the number of persons injured in commercial vehicle related crashes, by 50 percent by the year 2010.

FMCSA's Research and Technology programs encompass a range of issues and disciplines, all related to motor carrier and bus safety and security. FMCSA defines a "research program" as any systematic study directed toward fuller scientific discovery, knowledge, or understanding that will improve safety and security, and reduce the number and severity of commercial motor vehicle crashes. Similarly, a "technology program" includes those that adopt, develop, test and/or deploy innovative driver and/or vehicle best practices, and technologies that will improve safety and security, and reduce the number and severity of commercial motor vehicle crashes.

Currently, FMCSA's Office of Research and Technology conducts programs in the area of *Driver Safety Performance, Commercial Vehicle Safety Performance, Carrier Compliance and Safety, Safety Systems and Technology, Cross-Cutting Safety Initiatives, and Security*. The study described in the following Tech Brief was designed and developed as part of FMCSA's Research and Technology *Commercial Vehicle Safety Performance Program*. The primary goal of this program is to improve truck and bus performance through vehicle-based safety technologies.



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# Evaluation of Infrared Brake Screening Technology

## Introduction

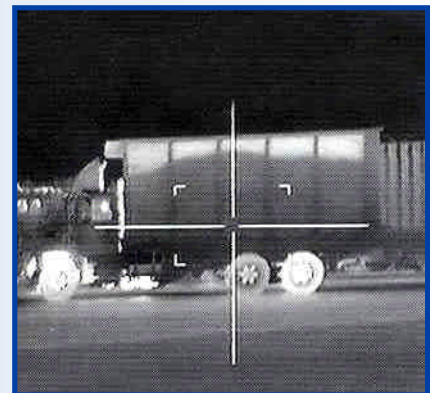
The Federal Motor Carrier Safety Administration (FMCSA) sponsored a field study to evaluate the effectiveness of a technology that uses infrared imaging to screen commercial motor vehicles (i.e., large trucks and buses) for subsequent inspection. The technology detects malfunctioning brakes and other problems such as flat tires. This Tech Brief summarizes the final report, *Evaluation of Infrared Brake Screening Technology: Final Report*, which is available from the National Technical Information Service, and the Department of Transportation's Intelligent Transportation Systems Electronic Document Library at [www.its.dot.gov/itsweb/welcome.htm](http://www.its.dot.gov/itsweb/welcome.htm).

## Background

The Infrared Inspection System (IRISystem) is a minivan equipped with an infrared camera on the roof and a display screen inside the vehicle. Enforcement personnel tested its effectiveness at roadside inspection facilities by screening for brake defects and producing results in a matter of seconds, known as "real time." As a commercial motor vehicle decelerates to enter a roadside inspection facility, an IRISystem operator scans the wheels with the camera. A thermal image of the wheels, showing their relative temperature, is displayed on the screen inside the van. Because the application of brakes creates heat, the wheels with functional (warm) brakes appear bright white in the infrared image, while the wheels with inoperative (cold) brakes appear dark. A color image enables the operator to easily identify a vehicle with functional or inoperative brakes.



**Before:** Shot of Commercial Motor Vehicle (CMV) as it enters a roadside inspection facility.



**After:** Shot of Commercial Motor Vehicle (CMV) after it has been scanned by the Infrared Inspection System (IRISystem). Wheels that are white indicate that they are warm/functional. Wheels that are dark indicate they are cold/inoperable.

## Purpose

The purpose of the study was to determine the effectiveness of infrared technology in enhancing the safety screening of commercial motor vehicles in “real time” at the roadside. Researchers evaluated the IRISystem as a means to:

- Detect problematic commercial motor vehicle conditions (mainly brake-related defects)
- Improve existing screening methods

## Methodology

Four states participated in the yearlong evaluation: Kentucky, Georgia, North Carolina, and Tennessee. States used the IRISystem at various locations—primarily scale sites on highways—where commercial motor vehicles could be readily screened and inspected. Operators usually screened vehicles traveling less than 10 miles per hour (16 kilometers per hour), though experienced operators assessed vehicles moving up to approximately 40 miles per hour (64 kilometers per hour). At each site the vehicles were screened by an IRISystem operator and then subjected to a standard Commercial Vehicle Safety Alliance Level 1 inspection. The inspector was unaware of the results of the IRISystem screening.

Approximately 400 vehicles were screened by the IRISystem and subjected to a Level 1 inspection. To improve the objectivity of the study, 62 vehicles with no apparent problems (according to IRISystem operators) were selected for Level 1 inspections. These non-problematic vehicles represented 16 percent of the total population of commercial motor vehicles tested.

Eighty-eight percent of the commercial motor vehicles screened were tractor-trailer combinations. Operators also inspected bobtail tractors, straight two- and three-axle trucks, and other tractor-trailer combinations. Approximately 70 percent of the vehicles inspected were loaded.

The IRISystem results were compared directly with the roadside inspection results. Researchers conducted both a wheel-by-wheel and a vehicle-by-vehicle comparison. To evaluate the system as a screening device, researchers then compared the IRISystem results to current screening method results using SAFETYNET data for the four participating states. SAFETYNET is a state-level information management system for motor carrier safety. It includes interstate and intrastate driver and vehicle inspection data, accident data, carrier compliance reviews, enforcement data, and carrier identification data.

## Results and Implications

Researchers determined that the IRISystem could be used to effectively screen commercial vehicles for inspection of brake-related problems. Sixty-nine to 76 percent of the wheels identified as problematic by the IRISystem—whether for malfunctioning brakes, flat tires, under-inflated tires, hot bearings, or other problems—were confirmed as defective by the Level 1 inspections. Most of these were brake-related defects.

Kentucky established an effectiveness criterion that 50 percent of the vehicles identified as problematic by the IRISystem should be confirmed as defective by the Level 1 inspections. All four states met this criterion. Overall, 59 percent of the vehicles identified as problematic by the IRISystem were placed out-of-service for brake violations.

Approximately 10 percent (399 of 3769) of the wheels screened by the IRISystem were identified as problematic and cold (typically a wheel without braking action). About 1 percent (44 of 3769) were identified as problematic and hot (usually caused by hot bearings, flat tires, or dragging brakes). The trailer wheels on the far side (with respect to the IRISystem van) of the commercial motor vehicle exhibited most of the problems during the screening. Wheel covers on the near-side wheels tended to obscure the infrared image, whereas the far-side wheels were easier to evaluate because of a better view of the back of the wheel, and slightly more viewing time as the vehicle passed in front of the IRISystem van. Researchers found that the presence of brake defects or deficiencies on a commercial motor vehicle often indicated that other repairs were needed.

## Identification of Out-of-Service Commercial Motor Vehicles

Fifty-nine percent (194 of 330) of vehicles identified by the IRISystem as problematic were subsequently placed out-of-service in the Level 1 inspection. Of these vehicles, 79 percent (153) were placed out-of-service as a result of brake violations. Twenty-two percent (42) had brake violations and other out-of-service violations, such as driver-related violations. Of the vehicles initially identified as non-problematic in the IRISystem screening, 19 percent (12 of 62) were ultimately placed out-of-service.

## IRISystem As a Screening Device

The results of the evaluation were compared to 1997-1999 SAFETYNET data for the four participating states. Fifty-nine percent of vehicles were placed out-of-service after IRISystem screening, more than double the 27 percent placed out-of-service using the current screening methods. The percentage of vehicles placed out-of-service with brake problems more than doubled after using the IRISystem to screen vehicles for inspection, from 34 percent with current screening to 84 percent with IRISystem screening.

## Other Considerations

### Training

One-half to one day of training was necessary. Officers with previous IRISystem experience shared their insight with new trainees.

### Skill Level Requirements

The IRISystem is an operator friendly device and its use is relatively easy to learn. Prior experience with infrared imaging or the joystick control configuration of the camera helped some operators collect data more quickly and accurately than less experienced operators. Screening effectiveness increased with practice.

### Owner's Manual

The owner's manual was detailed and included all documentation needed to operate the IRISystem. However, the manual would benefit from the inclusion of sample IRISystem photographs of commercial vehicles with typical problems.

### System Set Up and Shutdown

The IRISystem can be set up and shut down with relative ease.

### Mainline Screening

Although mainline screening (tests at speeds greater than 55 miles per hour/88.5 kilometers per hour) was attempted with the IRISystem, no useful results were obtained. Officers indicated that mainline screening was not practical because of the difficulty in identifying the target vehicle, the inability to observe all wheels on a commercial motor vehicle traveling at highway speeds, the difficulty of intercepting the target commercial motor vehicle downstream, and overall safety concerns.

### Identification of Non-Brake Related Problems

The IRISystem frequently identified flat tires. Although the system has the capability, no exhaust leaks, or frame cracks were identified during the testing.

### **Researcher**

This study was performed by Battelle Memorial Institute 505 King Avenue, Columbus, OH 43201. Contract No. DTFH61-96-C-00077.

### **Distribution**

This Tech Brief is distributed according to a standard distribution. Direct distribution is made to the Service Centers and Divisions.

### **Availability**

The study final report DOT-MC-01-007 is available from the National Technical Information Service (PB2001-100010INZ).

### **Key Words**

brake, brake tester, brake testing, infrared, screening, inspection, commercial motor vehicle

### **Notice**

This Tech Brief is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The Tech Brief provides a synopsis of the study's final publication. The Tech Brief does not establish policies or regulations, nor does it imply USDOT endorsement of the conclusions or recommendations. The U.S. Government assumes no liability for its contents or their use.

### **Web Site**

All FMCSA Tech and Analysis Briefs may be accessed at: [www.fmcsa.dot.gov](http://www.fmcsa.dot.gov).

### **Technical Writer**

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### **Location and Speed**

The IRISystem is a mobile device and can be used at various scale sites and other suitable inspection locations. To achieve effective use, the IRISystem should be placed at sites where commercial motor vehicles must apply their brakes to enter. Vehicles are typically screened at speeds less than 10 miles per hour (16 kilometers per hour), although experienced and skilled operators can screen vehicles moving up to about 40 miles per hour (64 kilometers per hour). It is recommended that the IRISystem van be set up with the center of the camera range roughly perpendicular to the direction of the traffic flow, so the operator can track vehicles easily and with an unobstructed view of the wheels.

### **Temperature**

The use of the IRISystem is not dependent upon outside temperature or day/night conditions.

### **Funding/Eligibility**

FMCSA has approved the IRISystem as an eligible expense under the Motor Carrier Safety Assistance Program, which enables states to use Federal funds toward the purchase of the technology.

### **References**

Christiaen, Anne-Claire; and Steve J. Shaffer. *Evaluation of Infrared Brake Screening Technology: Final Report*, FMCSA, Publication No. DOT-MC-01-007, NTIS No. PB2001-100010INZ, Washington, DC, December 2000.



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