

# Freight Rail Safety Inspections

Across the network, railroads employ thousands of well-trained inspectors — qualified per Federal Railroad Administration (FRA) regulations — who monitor and assess the health and safety of the equipment that moves essential goods and materials and the track that spans nearly 140,000 miles.

There are prescribed training standards for any employee who [inspects](#) or performs tasks covered by a federal rule, including those who inspect such things as signals, tracks, railcars, locomotives and bridges. In addition to conducting the various inspections required by FRA, railroads have — for decades — voluntarily invested in testing, implementing and advocating for advanced inspection [technology](#) to supplement manual inspections.

Every day, around the clock, thousands of sensors throughout the rail network collect billions of data points that generate alerts for issues that require immediate attention.

Furthermore, advanced computer programs, machine learning and AI analyze the data, identifying patterns and predicting what network elements may soon need to repair or replaced days or even months in advance. These elements include tracks, wheels, bearings, locomotive components and more. This information helps give railroads lead time to proactively schedule maintenance and fix issues before they become dangerous.

## Key Takeaway

Thanks in part to rail's multi-layered inspection practices, FRA data show that the last decade has been the [safest ever](#) for railroads, with the Class I railroads' mainline train accident rate at an all-time low and down 49% since 2000.



## Track Inspections

Track inspection technologies have helped railroads achieve substantial safety gains in recent years, with 2022 marking the lowest-ever rate of track-related accidents.



## Freight Train & Equipment Inspections

Railroads have significantly invested in testing and deploying equipment inspection technologies without federal requirements. [FRA research](#) shows these devices help enhance safety. Since 2000, the equipment-caused accident rate is down 21%.



DEEP DIVE

## Track Inspections

The American Society of Civil Engineers (ASCE) has repeatedly awarded railroads the highest grade in their [Infrastructure Report Card](#). ASCE cited sustained private investments by the nation's freight railroads as the primary reason for the network's good condition. From 1980 to 2022, America's privately owned freight railroads spent about \$780 billion — averaging well over \$23 billion per year over the past five years — to maintain and improve their network. In the last 10 years, U.S. Class I railroads have spent more than \$250 billion on infrastructure and equipment and have laid approximately six million tons of new rail.

All disciplines perform, at a minimum, the federally required inspections as well as additional inspections as called for in each railroad's maintenance rules. On top of these federally required visual inspections, there are also federally mandated internal rail inspections, bridge inspections, signal, crossing and geometry inspections. Many railroads do each of these at a higher frequency than prescribed by the regulations, and advanced technologies increase the speed of these inspections while improving their quality.

For example, track geometry and ultrasonic track inspections help pinpoint defects that are usually not visible to the human eye or can only be identified when the track is in use. They also allow railroads to inspect more track in less time and provide data to schedule maintenance proactively.

**ATI technologies measure how the track structure performs under the weight of a train.** [Automated Track Inspection \(ATI\) systems](#) use lasers and cameras mounted onto locomotives or railcars to inspect track as the train travels across the network. Track inspection vehicles, or "track geometry cars," can measure hundreds of thousands of track miles yearly. An advanced algorithm can analyze track alignment of more than 1,500 curves in track in just a few hours, whereas it would have taken a team of four people 10 months to complete the same task manually.

**Ultrasound looks for flaws inside tracks and ties.** As a train travels over any track segment, energy is transmitted through the track and into the ground below. This energy can be measured as a series of sound waves, collectively called an acoustic signature. The acoustic signature of a track is different depending on the health of the track. Going further down, ground-penetrating radar looks inside track foundation — known as ballast — to see water damage or deterioration.

**Drones inspect tracks and ballast.** Loose or missing fasteners in track, for example, or soft spots in ballast could cause more stress on the track structure and lead to signal problems. Railroads use drones most frequently after weather events to look for washouts, downed trees, misaligned track and other conditions caused by weather. Drones can also look at areas of track affected by severe weather. This technology provides trending data because railroads can analyze older snapshots with newer ones.

**Signal inspectors inspect active grade crossing devices.** Railroad employees also help ensure safety at the points where trains cross roads. Inspectors climb up on the lights to ensure they are pointed in the right direction, open the bungalow and check everything in the case, and look at the timing and distance between the train coming into the crossing circuit and the crossing protection coming down.

**Bridge inspectors and sonar technology help safeguard bridges.** Regular inspections of [railroad bridges](#) by inspectors or drones are vital for trains safely transporting goods across bodies of water. More frequent inspections occur for bridges with more intensive traffic or whose conditions may warrant closer monitoring. Railroads follow an aggressive "safety first" policy and immediately alter or suspend service on any bridge until all concerns are addressed, and repairs are made if necessary. Railroads use drones to inspect bridges and to take video and pictures of hard-to-reach areas within the bridge. Sonar identifies increased erosion around the piers, which can compromise a bridge's integrity.



DEEP DIVE

## Train & Equipment Inspections

FRA regulations and AAR interchange standards establish stringent thresholds to ensure the health and safety of the more than 1.6 million railcars (and 12 million wheels) traveling across the country daily. Rail employees visually inspect each train before departure in accordance with those standards. If a car does not meet those standards, railroads make appropriate repairs to ensure safety. The customer owns more than 99.9% of all tank cars, while entities other than railroads own more than 80% of all covered hopper cars, such as all cars that carry plastic pellets.

Some defects can only be identified when the asset moves, which only technology can accomplish. This technology also helps increase the safety of the inspector. To ascertain the equipment's current condition, wayside detectors use various technologies — such as infrared and lasers — to assess the health and safety of locomotives and railcars traveling along the national network. They alert railroads to anomalies or troubles with locomotive or railcar components that could affect their performance, damage track or become a safety hazard. The [Asset Health Strategic Initiative](#), a program developed in the mid-2000s and led by AAR and its data management subsidiary, [Railinc](#), maintains the "Equipment Health Management System (EHMS). Through the EHMS, Railinc collects and centralizes detector-generated data to help car owners and railroads see alerts and proactively repair equipment based on AAR or FRA rules. Here are just a few examples of the wayside detectors railroads use:

**While a train is on the move, hundreds of sensors throughout the locomotive continually gather data on the performance of individual components.** Sensors transmit the data to analysts using real-time software to identify equipment needing maintenance. Locomotives also have fuel management systems that use sensors that provide engineers with real-time recommendations on how to operate the train to maximize fuel efficiency, but also sense when an engine is getting too hot or when oil is contaminated.

**Machine visioning inspects passing trains.** Machine visioning technology uses cameras that collect 40,000 images per second of trains as they pass by at up to 60 MPH. This technology reduces inspection times to mere seconds. A series of algorithms then analyze the images to identify any anomalies, allowing railroads to resolve issues faster than they could with manual inspections alone. The technology helps railroads look at many elements simultaneously, providing a comprehensive view of locomotives, trains and their components.

**Lasers and scanners measure the wheel profiles of moving trains.** Wheel Profile Detectors (WPDs) measure wheel profiles of moving trains using laser and optical scanning devices to take images of the flange, tread and other aspects of the wheel. The WPD data summary aims to get an aggregate view of these measurements. The data summary can be used to analyze wheel trends and determine wheel wear and condition. This data can alert railroads when immediate action must be taken to remove a car from service or if a wheel is worn beyond the FRA and AAR thresholds.

**Hot bearing detectors sense overheating bearings.** Railroads monitor bearing temperatures using heat-sensing detectors placed at intervals along the right-of-way to notify the engineer if it is necessary to stop a train due to an overheated bearing. Some hot bearing detectors (also known as hot box detectors) transmit bearing temperature data so that bearings that are warmer than average but still safe to operate can be tracked and replaced before they reach the end of their useful life.

**Wheel impact load detectors reduce broken rails and wheel and bearing failures.** These detectors identify wheels that are heavily pounding on the tracks and cull them out of service if they are reaching the end of their useful life.