Freight Rail Safety Inspections

Key Takeaway: Railroads follow rigorous inspection regulations and leverage well-trained inspectors, sophisticated equipment, and data-driven analysis to identify and address potential issues with equipment and tracks proactively. These efforts will continue to help reduce Class I railroads' train and equipment-caused accident rates.

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 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.

Freight Railroad 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. That investment breaks down to more than $260,000 spent on average per mile of the freight rail network. Inspections and maintenance make up a significant amount of spending.

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. Here are additional examples:

ATI measures how track structure performs under a train's weight.

ATI systems use lasers and cameras mounted onto locomotives or railcars to inspect track as a train travels across the network. The system tests each foot of track, which detects issues that may not be visible when a track is not occupied. The data from the inspection devices transmits to a centralized location where employees verify and schedule maintenance as necessary. ATI speeds up safety inspections and safeguards employees.

Track inspection vehicles, or "track geometry cars," can measure hundreds of thousands of track miles yearly. The cars travel along the tracks, measuring every inch for track alignment, elevation in curves, gauge (the distance between the two rails) and many other track geometry measurements. 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 by ultrasound, 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 track, ballast and bridges.

Loose or missing fasteners in track 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. This technology provides trending data because railroads can analyze older snapshots with newer ones.

Regular inspections of railroad bridges by inspectors or drones are vital for trains safely transporting goods across bodies of water. Sonar also identifies increased erosion around the piers, which can compromise a bridge's integrity. Sonar sends sound waves that bounce off the bridge piers and the ground surface below the water. Then, based on the nature of the echo, railroads determine whether there are any concerns with the stability of the bridge piers.

Signal inspectors look at active grade crossings.

Railroad employees also help ensure safety at the points where trains cross roads, known as grade crossings. Signal 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.

Freight 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 as they travel 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.

Locomotive sensors monitor individual components.

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 and more inspect moving wheels.

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.

Additionally, hot bearing detectors are strategically placed along the right-of-way to sense overheating bearings, alerting engineers to stop a train when necessary. Some detectors transmit temperature data, allowing proactive tracking and replacement of bearings. Wheel impact load detectors greatly reduce broken rails and prevent wheel and bearing failures by identifying heavily pounding wheels so they can be removed from service.

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