AAR Safety, Regulations, Machine Vision, and AI

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Association of American Railroads

Association of American Railroads

- Safety Statistics
- Government Regulations
- Machine Vision
- Artificial Intelligence

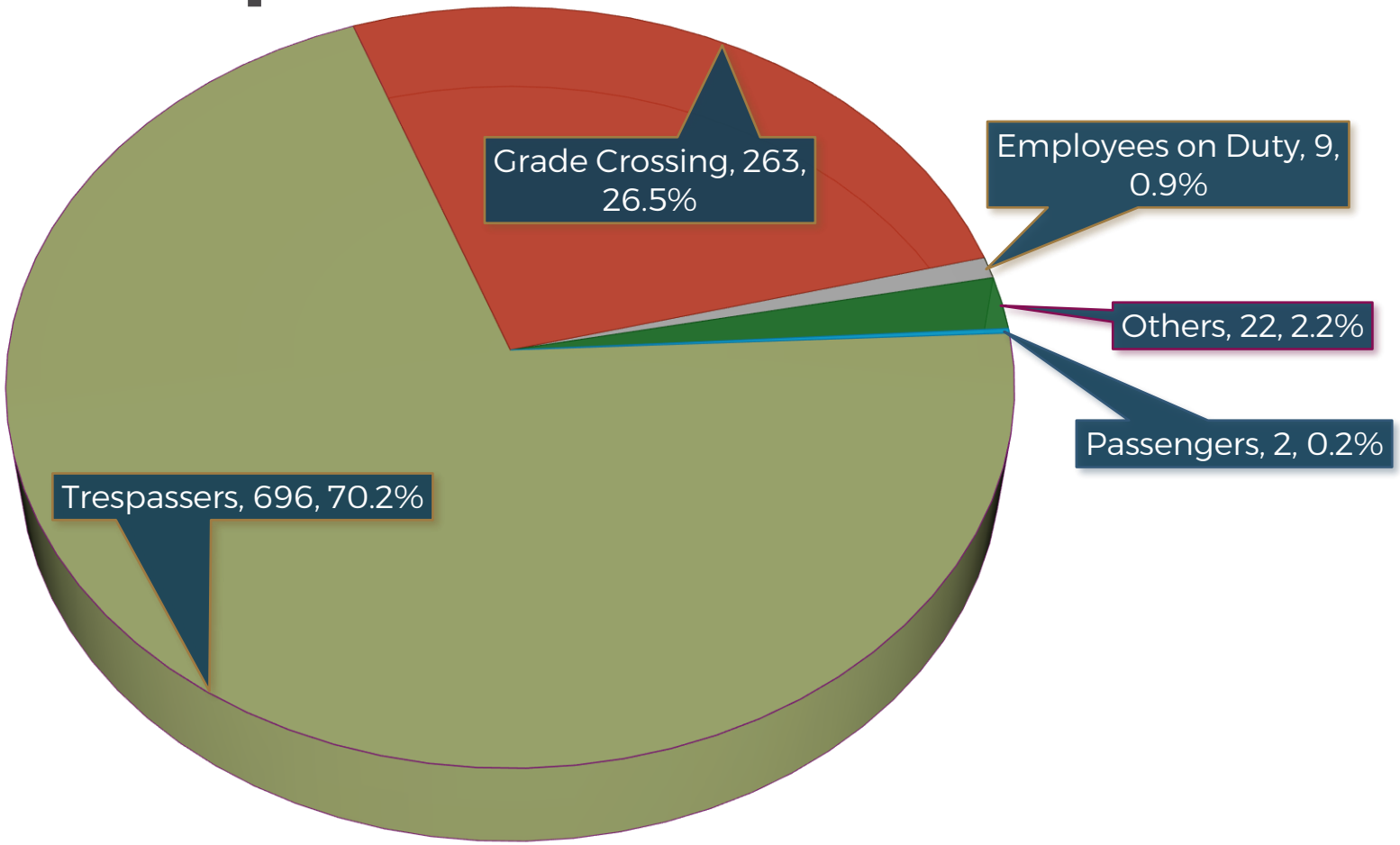
1st Topic

Federal Railroad Safety Statistics

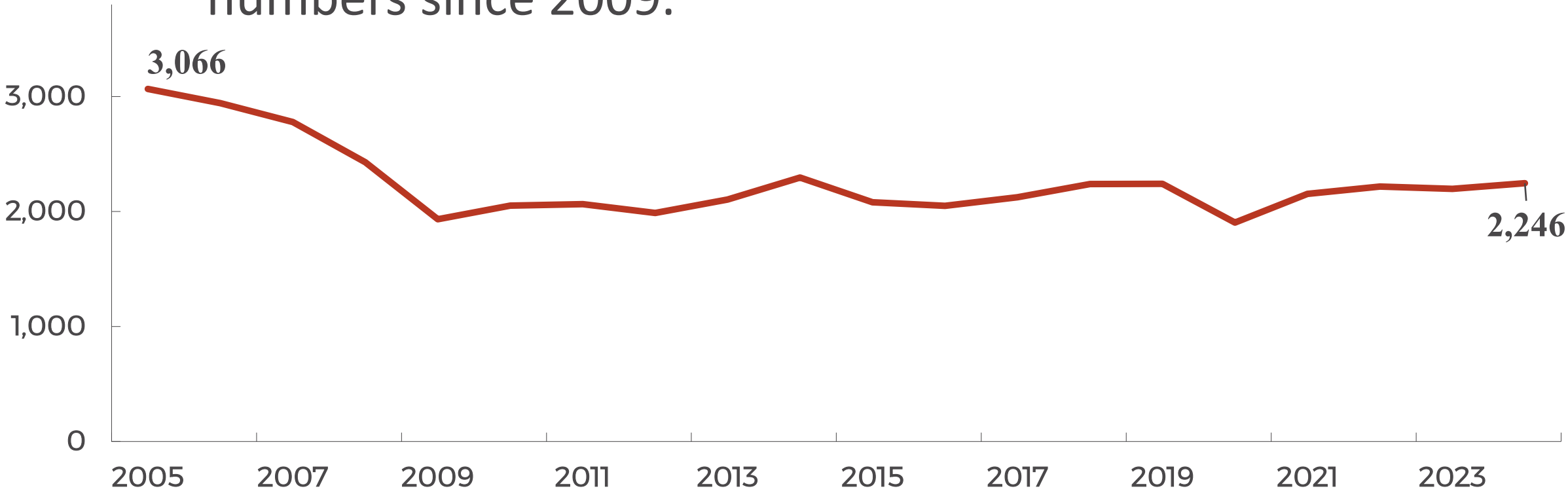
U.S. Railroad Safety Statistics

- The last decade was the safest on record for railroads.
- Railroads compare favorably with other industries and modes of transportation.
- The most troubling railroad safety problems arise from factors largely outside of railroad control.
- Railroads have implemented numerous technological improvements and safety programs.

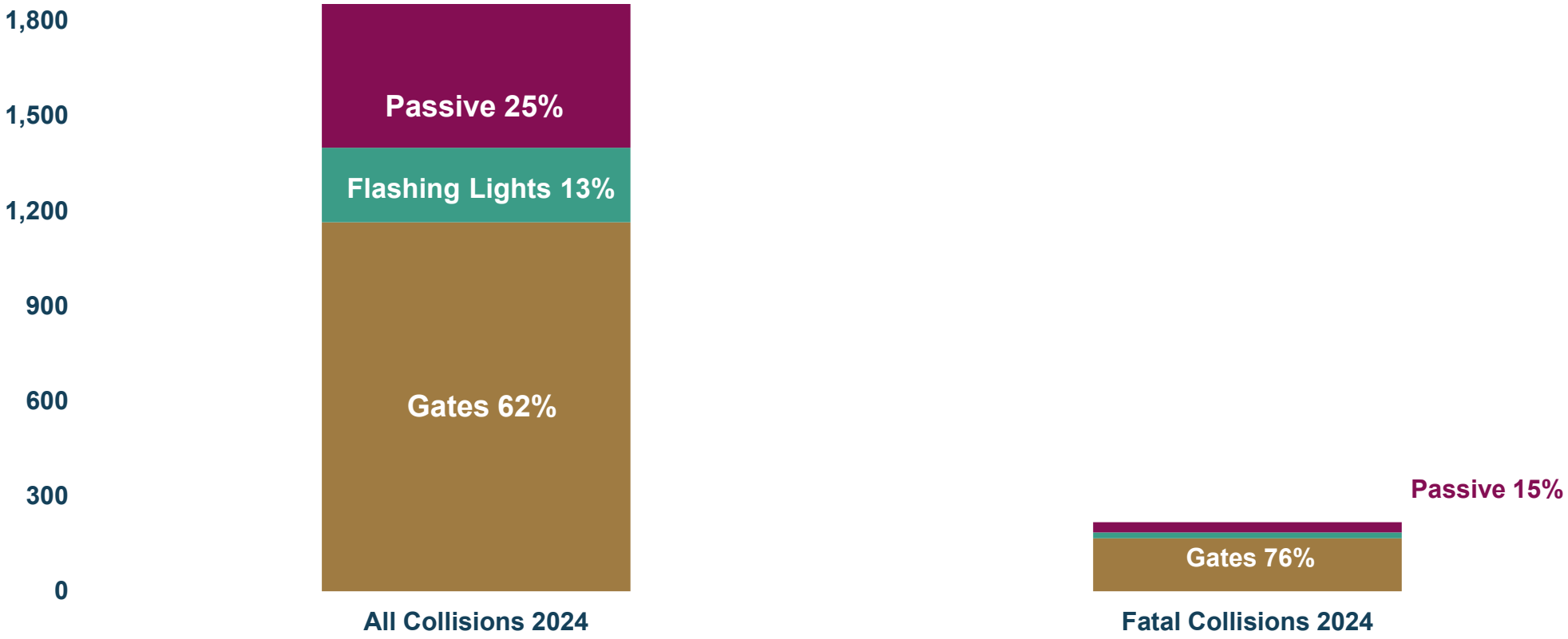
In 2024, over 96% of rail-related fatalities were grade crossing users or trespassers.



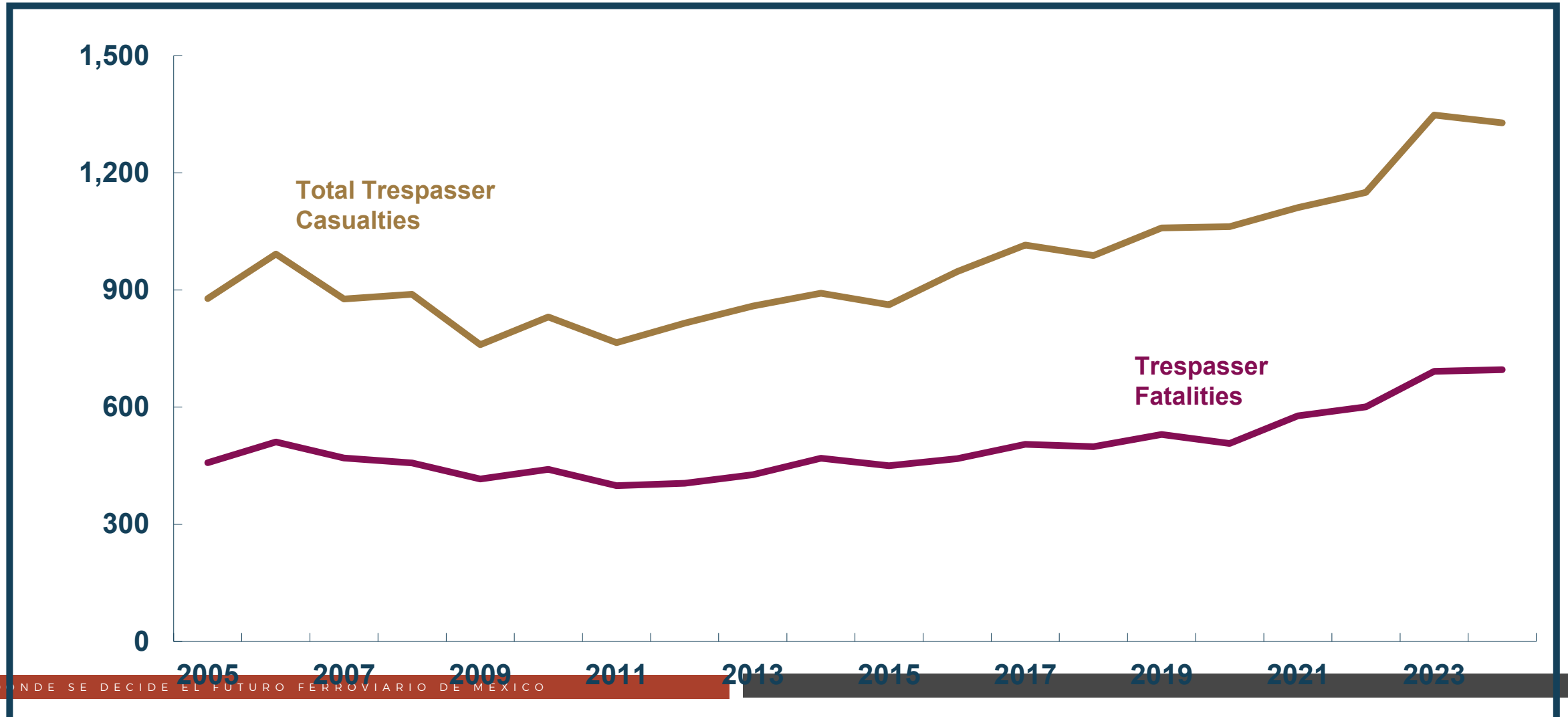
Grade crossing are a challenge. Grade crossing collisions have declined 27% since 2005 and but have remained at similar numbers since 2009.



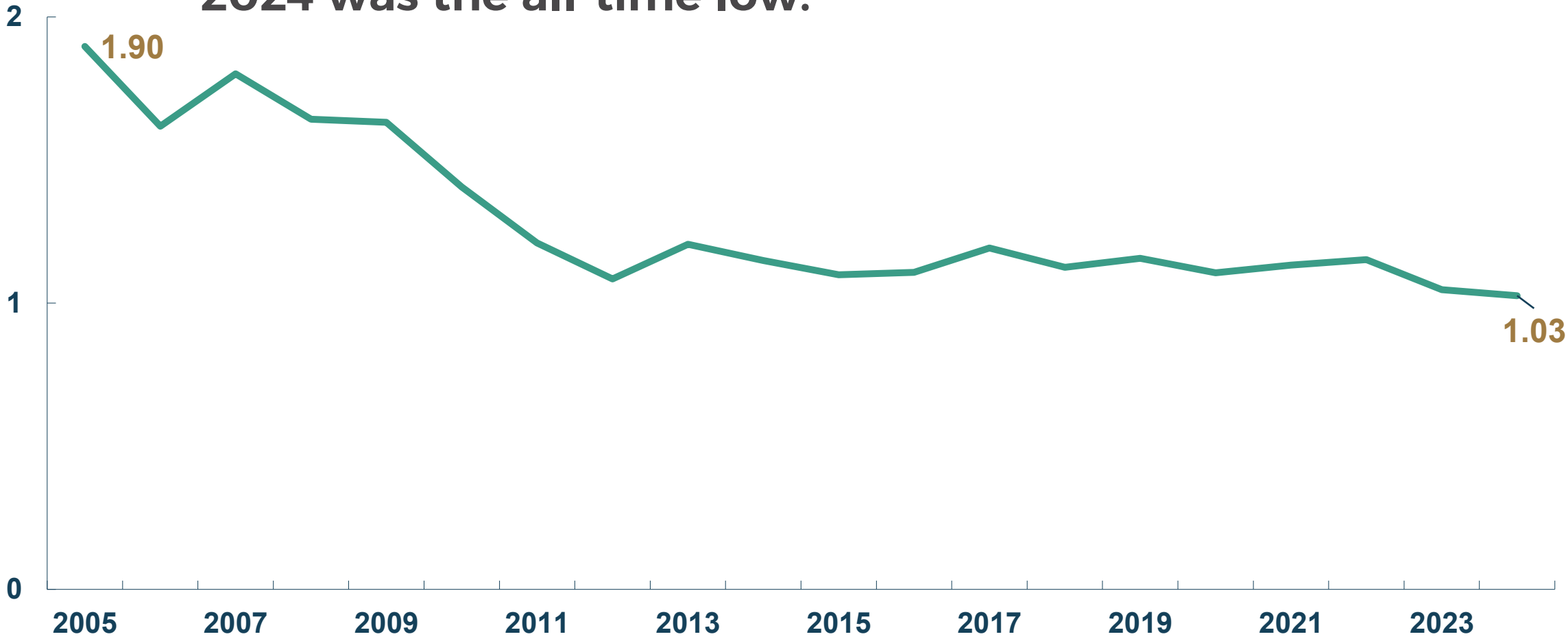
In 2024, 62% of all grade crossing collisions and 76% of all fatal grade crossing collisions occurred at gated crossings.



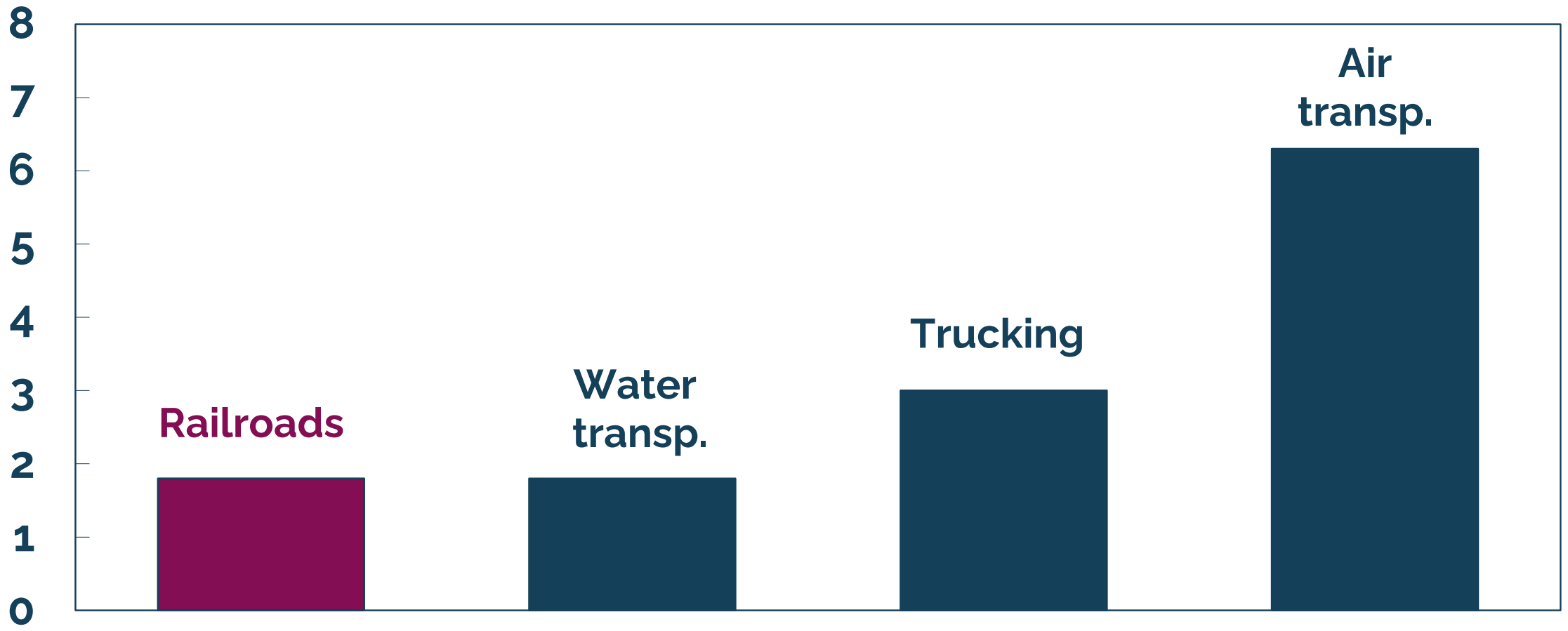
Trespasser casualties are a significant safety problem.



Class I Railroads have reduced employee injury rates by 46% since 2005.
2024 was the all-time low.



Injuries and Illnesses Per 200,000 Employee Hours



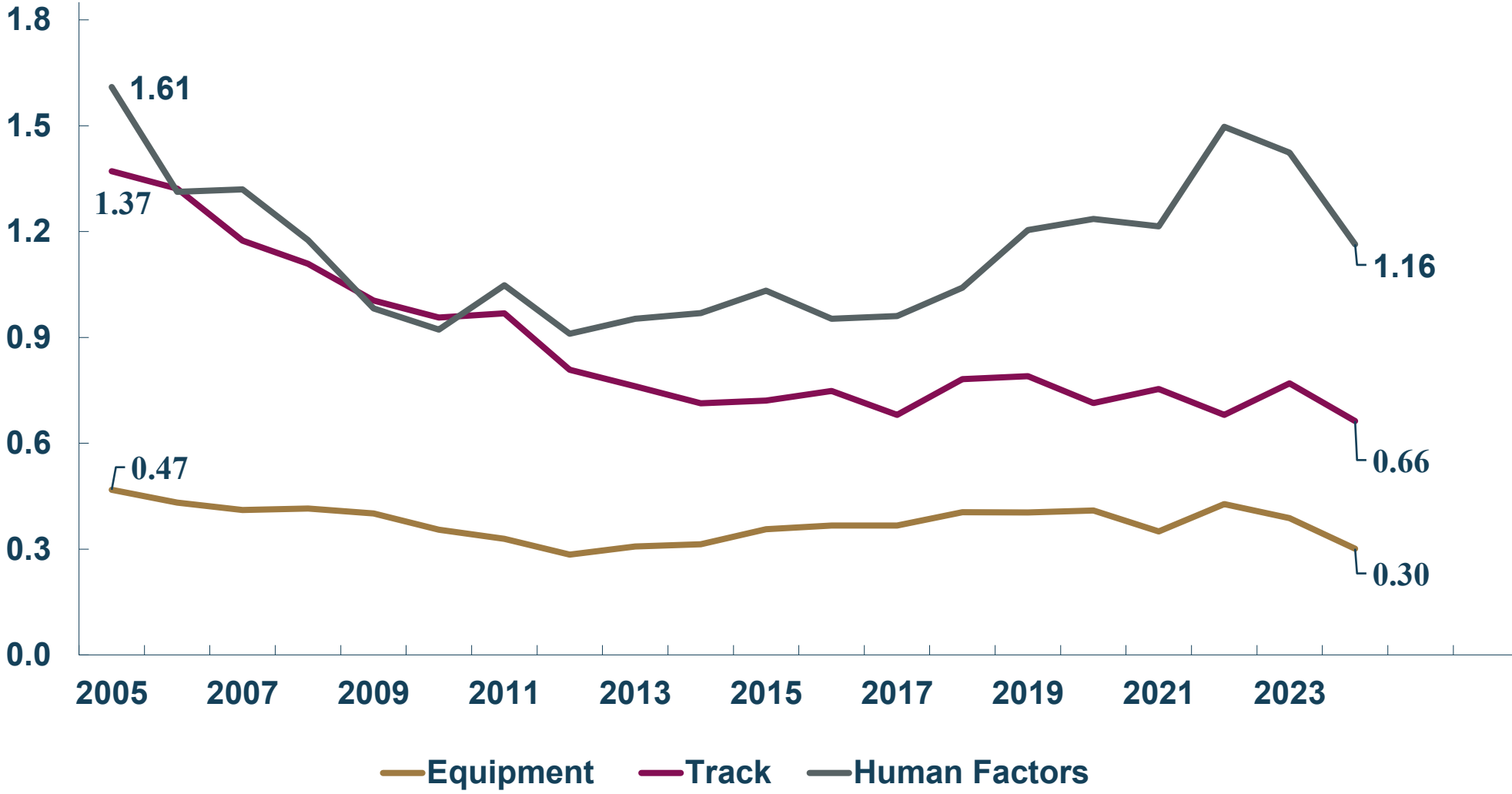
Train accidents per million train-miles

Since 2005.

Human factors-caused accident rate down 28%.

Track-caused accident rate down 52%.

Equipment-caused accident rate down 36%.



2nd Topic

Federal Railroad Administration Safety Regulations

U.S. Government Request for Information For Regulatory Change

The AAR filed three major requests:

- Automated Track Inspection
- Reform of Signal Regulations
- eABS Rule

In addition, AAR filed about 80 requests for additional regulatory changes in nearly every aspect of 49 CFR regulation

Needed: Regulations for the 21st Century

Part 215: “At each location where a freight car is placed in a train” a mechanical inspection is required. (Part 215 has its origins in the 1950’s)

However, a train today is not the same as a train in the 1950’s.

Today, in 2025, cars with individual health information travel in blocks, and trains/blocks can be combined or separated, picked-up or set-off. Cars, not trains, are monitored as they travel.

Needed: Regulations for the 21st Century

Part 215: “At each location where a freight car is placed in a train” a mechanical inspection is required. (Part 215 has its origins in the 1950’s)

An inspection today is not the same as an inspection in the 1950’s.

In 2025 we have wayside technologies, asset health strategies, vision systems, AI, and more coming online.

Needed: Regulations for the 21st Century

Part 215: “At each location where a freight car is placed in a train” a mechanical inspection is required. (Part 215 has its origins in the 1950’s)

A defect today may not be the same as a defect in the 1950’s.

In 2025, we have EHMS, Railinc Data, predictive maintenance, defect trending, combination causes, more precise measurements, and more.

Needed: Regulations for the 21st Century

Many rail regulations stem from decades ago when wayside inspection technologies, data collection, system comparisons, and safety strategies did not exist.

- Trains had to be stopped to be inspected.
- Track inspectors had to get out of the vehicle to take track measurements.
- Signal maintainers had to visit the site to check batteries and bulbs.

We are thankful there was never a regulation to require the use of a caboose.

3rd Topic

Machine Vision Systems

Machine Vision Systems

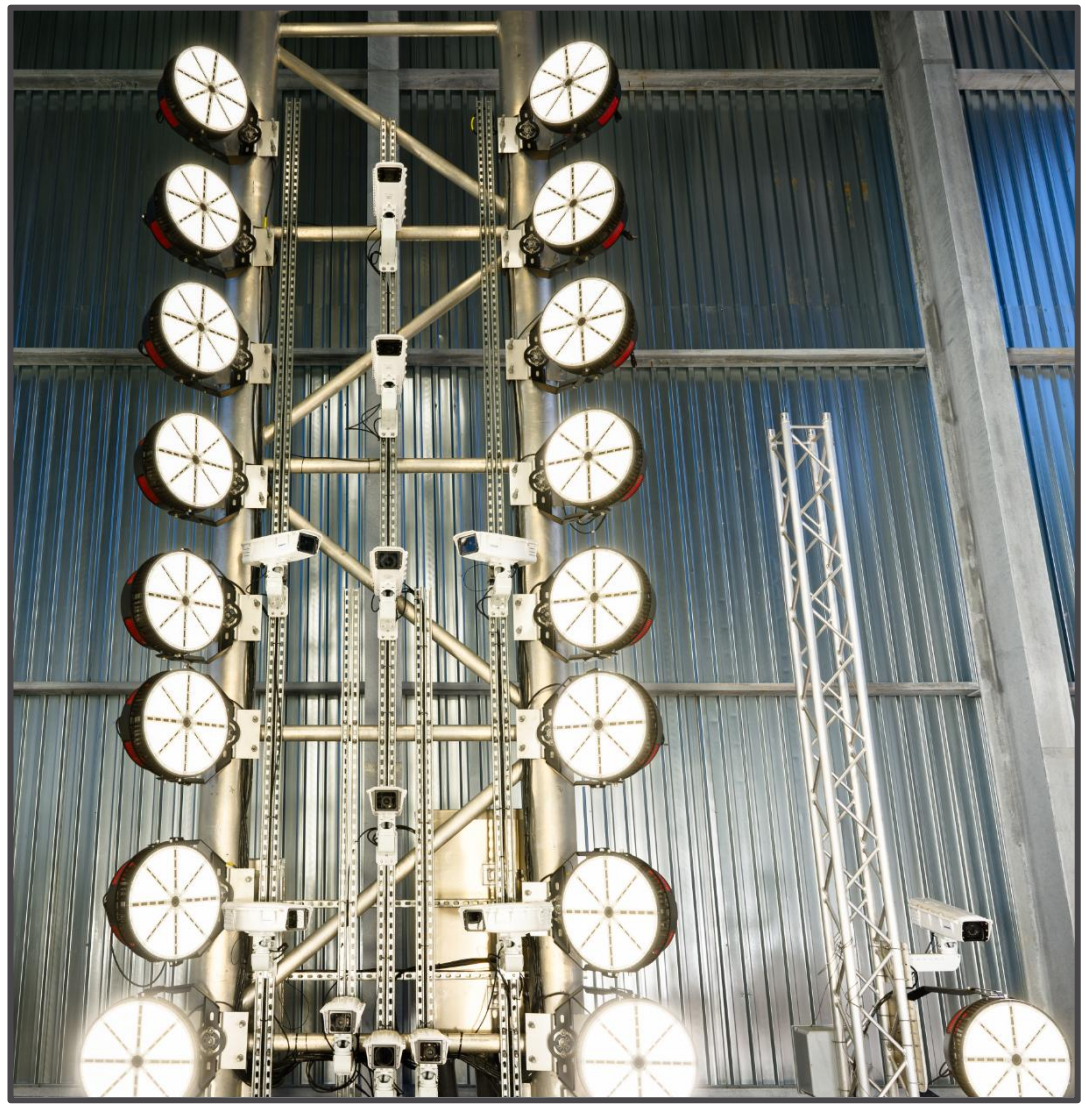
- Machine Vision Systems find anomalies in freight cars as trains pass at track speed through an inspection portal.
- There are various types of Machine Vision Systems.
- Most, but not all, large U.S. Railroads are using Machine Vision systems.
- Machine Vision Systems work together with other types of defect detectors.
- Importantly, Machine Vision systems can “learn” and perform better with time.
- New technologies and strategies can be adopted as they are developed.

Machine Vision Systems

At an inspection portal, a protective structure provides constant light conditions, and protects images from rain, sleet, or blowing snow.

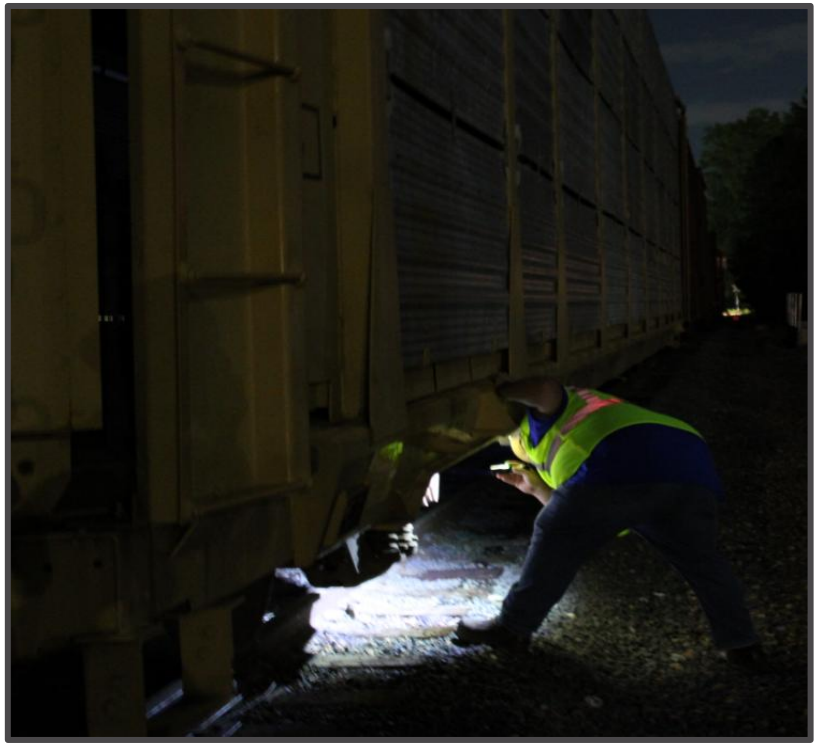
Digital imaging devices are arranged to view freight cars from every angle, and underneath, and on top, and the ends of cars.

About 1,000 images are taken for each freight car. This happens at 100 KPH or more.



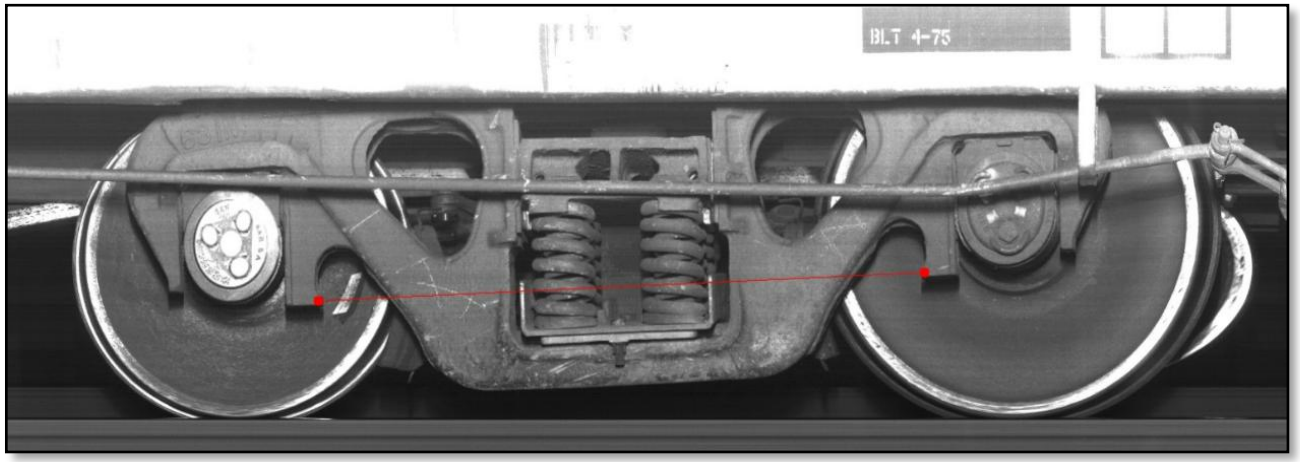
Meanwhile, a train inspection by a human is a repetitive process that demands consistent focus at any time of day in all conditions.

For an inspection by a human, is the 150th car inspected the same as the 1st?



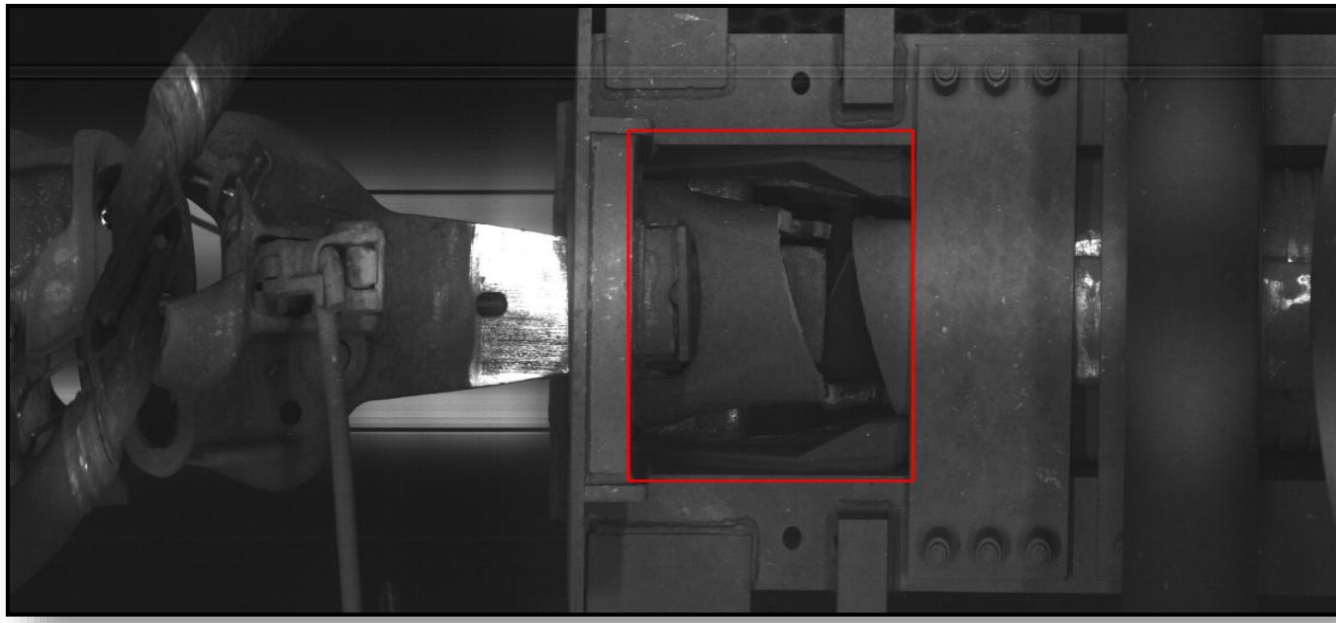
Machine Vision Systems

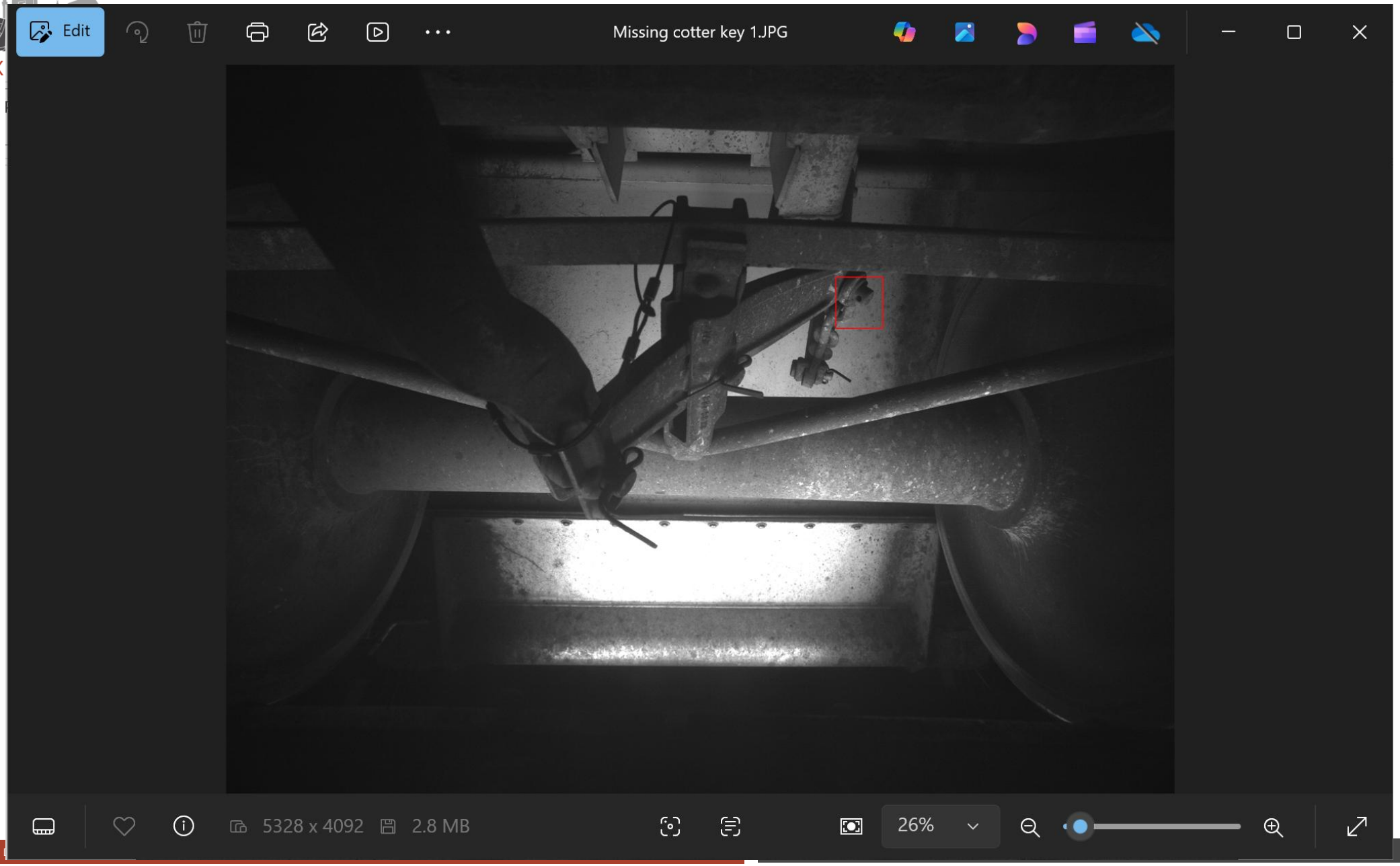
- Consistent and precise condition monitoring in different operating environments, at any time of day in all conditions.
- Inspects trains passing at track speed to measure and evaluates cars in their dynamic state.
- Uses AI that “learns” and improves over time. Produces a visual representation that can be reviewed and monitored for accuracy.



Machine Vision Systems

- MV systems look underneath the equipment, something not done during manual inspections of stopped trains.
- Allows inspectors to view the alert on paper before physically inspecting the equipment.
- All defects found by Machine Vision systems were missed by humans during predeparture inspections.

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Missing cotter key 1.JPG
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Brake beam defect 1.JPG

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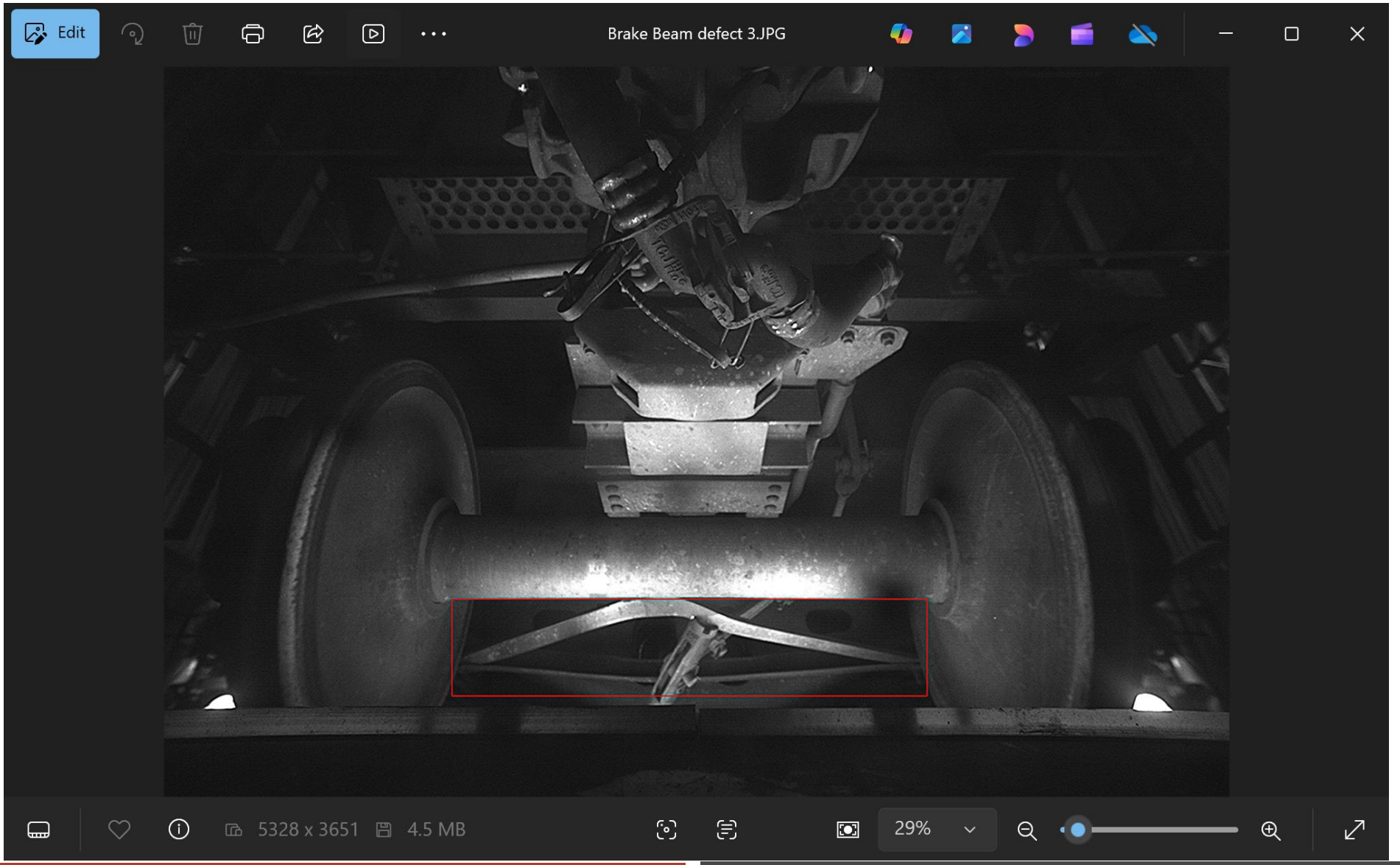
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Other Considerations of Machine Vision Systems

Individual wayside detectors may add a small machine vision system for a particular purpose. An image can be very helpful to allow a human to make a decision.

Other Considerations of Machine Vision Systems

The rail industry is constantly learning from what we see on images.

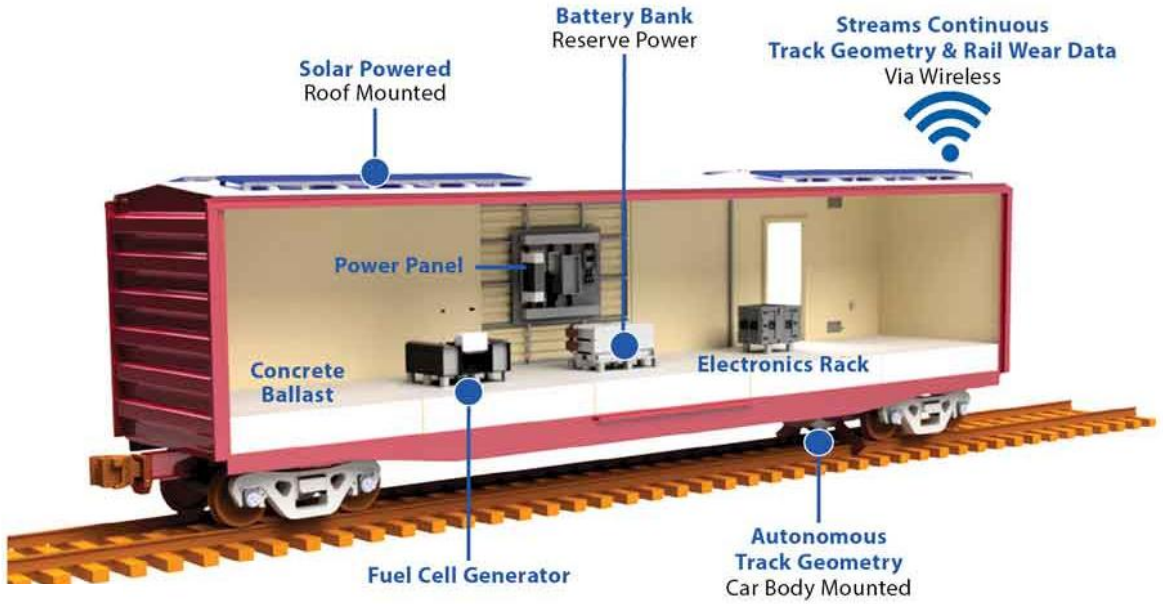
A record is kept of the images that were obtained. If there is a derailment, a review of the defective component can be viewed to see how it appeared before the derailment.

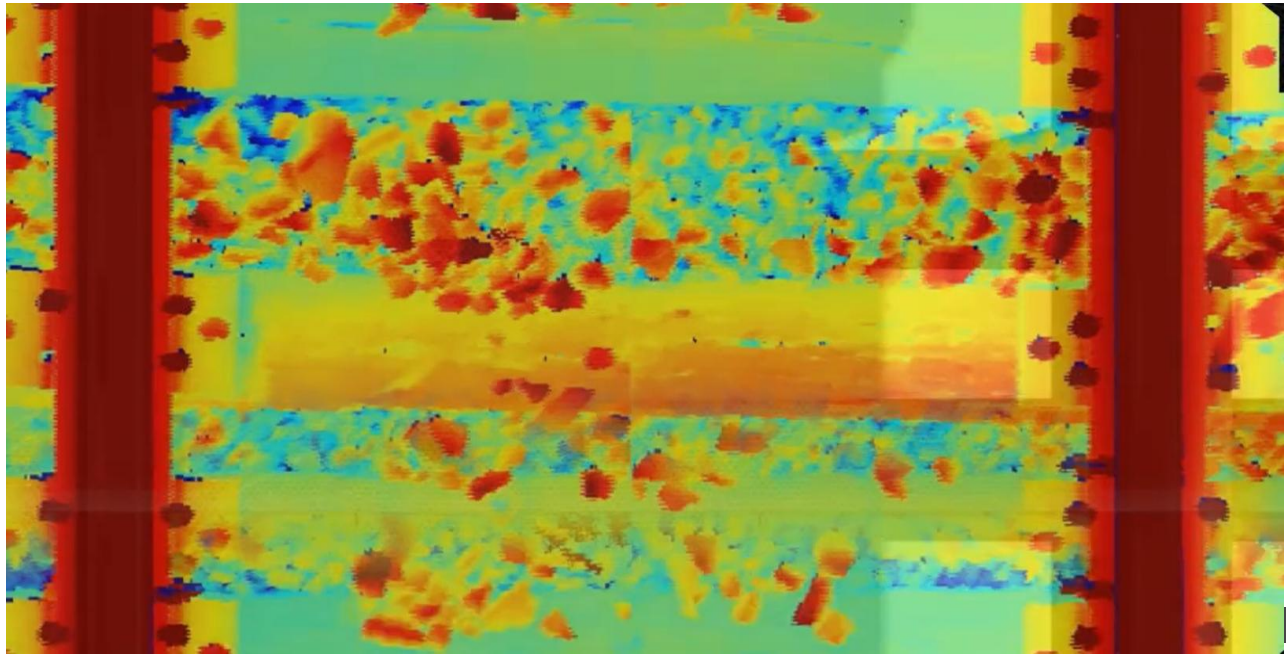
Machine Vision systems can locate other items, such as:

- Tank car valve securement and missing placards.
- Air hose connections and stress factors
- Doors open on freight cars or containers
- Products leaking from railcars

Machine Vision is also used to inspect track

Similar to a machine vision systems in a stationary structure next to the track examining passing freight cars, a freight car can be equipped with machine vision to examine the track as the machine vision system travels over the track.





Geometry cars are placed in a train like any other freight car.

4th Topic

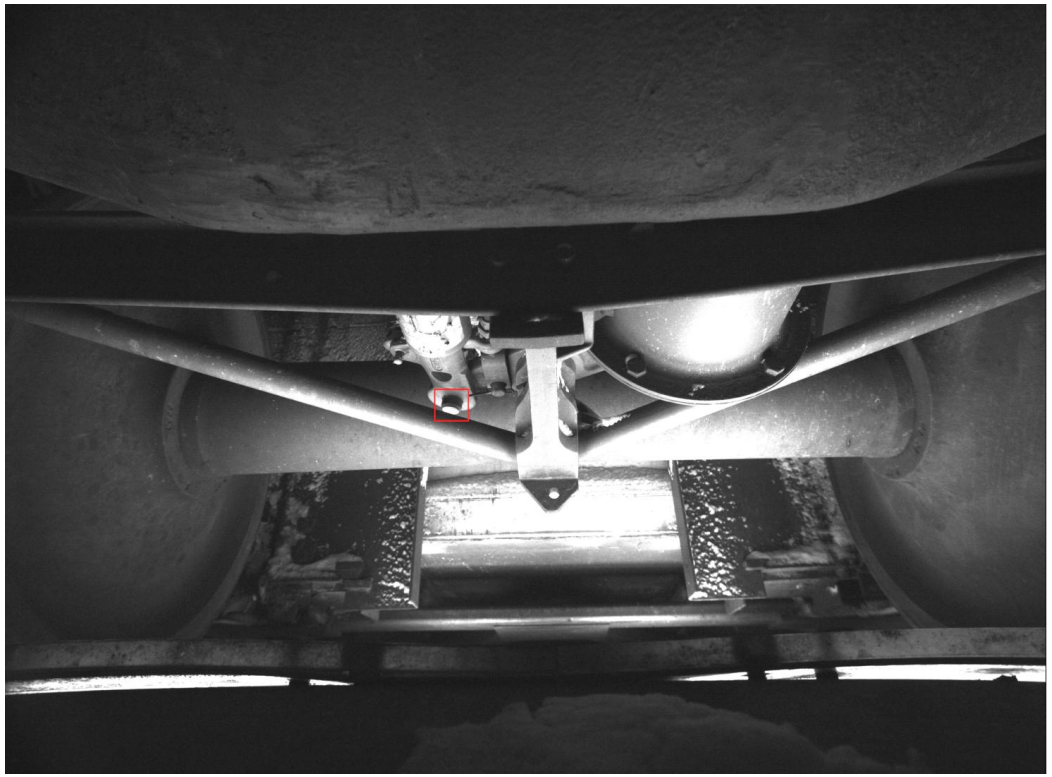
Artificial Intelligence

Artificial Intelligence

We'll look at just three ways in which artificial Intelligence, or AI, is being used in the freight rail industry.

- Identify defects in freight cars
- Identify defects in track
- Improve the operations of freight trains

Machine vision provides the pixels, and Artificial Intelligence finds the pixels that are of concern. Machine learning is a subset of AI that allows the system to improve with use.



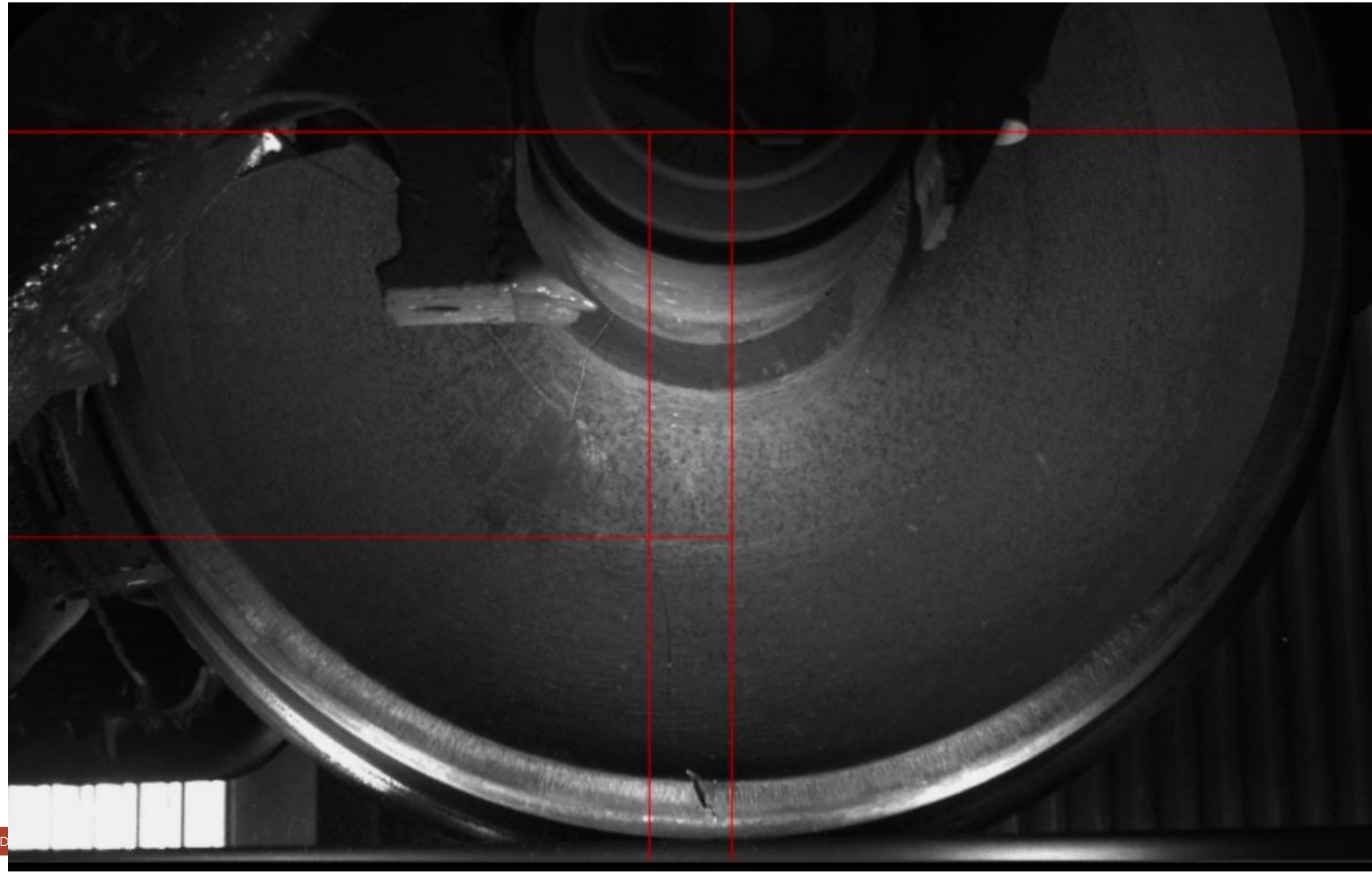
Machine Vision + Artificial Intelligence + Machine Learning

Machine Vision Systems can provide millions of pixels in an image.

AI can identify the difference in pixels of an image.

Machine learning can make practical use of this technology.

A human being would not be expected to find this defect for many reasons.



Machine Vision and Artificial Intelligence

- Must be focused on the correct location.
- Cannot use reasoning to look for something. (not yet)
- Cannot look at everything. (not yet)
- Vision of a component on one rail car may be hidden on another type of rail car
- Legacy car designs may have components that are not visible and remain in service for many years.
- Some types of Machine Vision can identify railcar owner and numbers.
- Machine Vision often identifies a federal defect.
- Machine Vision may present new methods of component tracking.

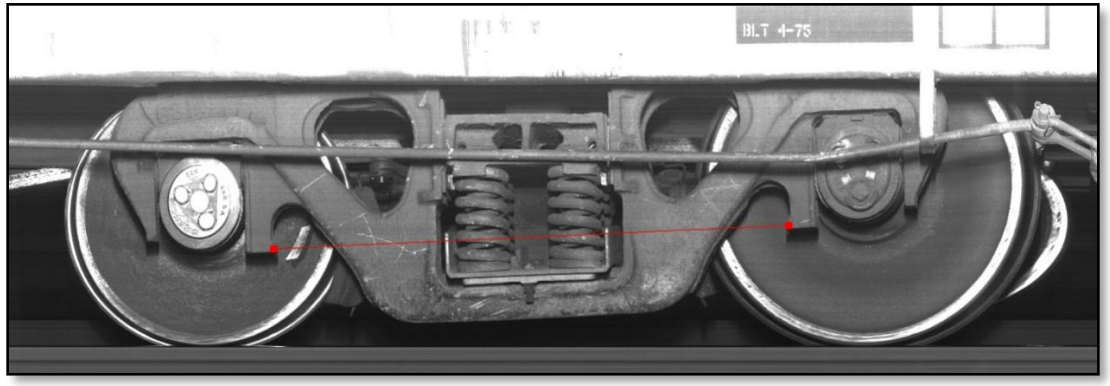
Checking up on the work of Humans

Rember this image from earlier?

This was not a defect that happened as the car traveled. This was a defect caused by the installation of the wrong size wheels.

Similarly with all the images of missing carter keys. They are not simply falling out – they were not being placed by the mechanics who made the repair.

Technology is finding new areas of possible improvement.



AI and Machine Learning makes better train operation possible

Locomotive energy management systems can control the locomotives in a manner that would be extremely difficult for a human operator.

The head-end of the train with two locomotives locomotives may be going up hill, while 2 kilometers behind in the train two locomotives are going down hill.

Machine learning also takes place with this technology.

Numerous tests have shown that long trains are handled more smoothly by energy management systems.

Any human operator will get tired after a long time of running a train. Different times of night and day, with different types of trains. It is not easy.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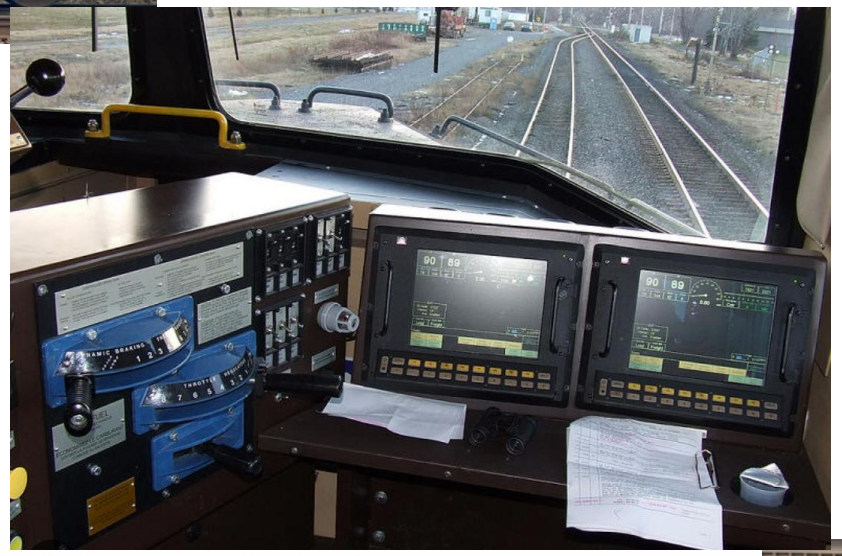
RETAINING VALVE

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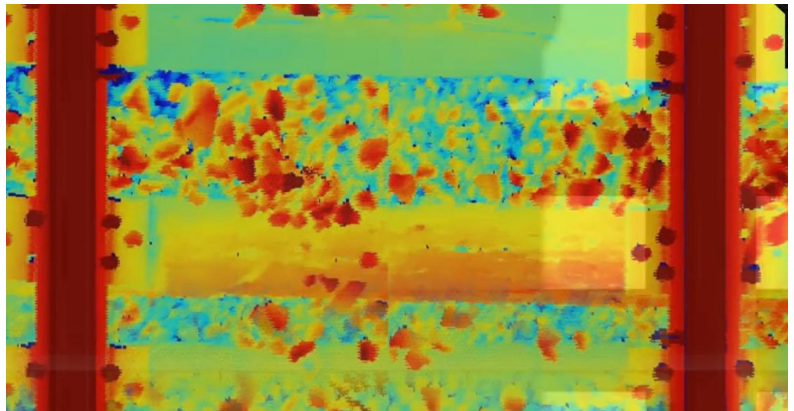

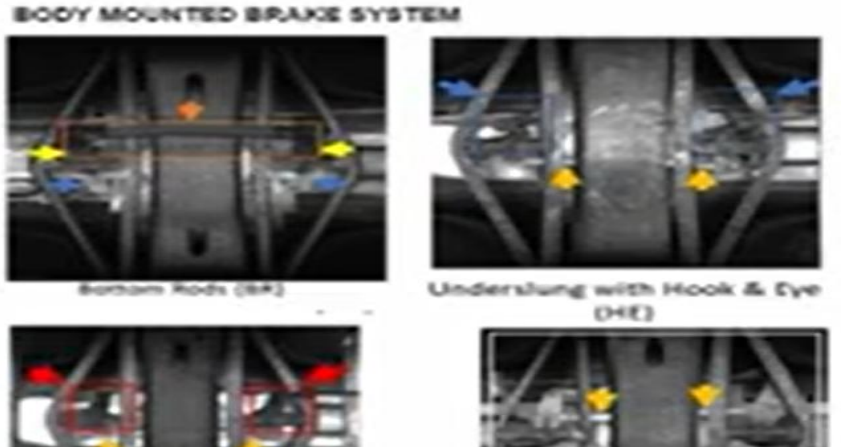
BODY MOUNTED BRAKE SYSTEM
Bolster Rods (BR)
Underslung with Hook & Eye (HE)