



LIMITS COMPLIANCE & COLLISION AVOIDANCE

Piper Helix™ is an advanced, multi-sensor Limits Compliance and Collision Avoidance System (LCCAS) that integrates LiDAR, UWB, GPS-RTK and other technologies.

Advanced Maintenance of Way Safety

The Helix™ Maintenance of Way (MoW) safety solution allows for fleets of rail-bound and hi-rail equipment to be accurately detected and tracked on the railroad in real-time, thereby reducing the potential for worker injury, equipment damage, and operational disruptions resulting from accidents or major rule violations.

The system addresses several challenges that transit agencies and freight railroad's face today, including: Limits Compliance, Collision Avoidance, Object and Worker Detection, and Collision Detection. In addition to providing this vast array of operational information to MOW vehicle operators, Piper also consolidates information for foremen and employees-in-charge who are assigned multiple vehicles from the work gang. Foreman tablets provide interfaces to monitor vehicle locations and onboard telemetry in real-time.

Multi-Sensor, Multi-Solution

Piper Helix™ LCCAS incorporates multiple sensors to provide railroads with a modular vehicle-centric safety system:

- **Collision Avoidance** - Ultra-Wideband (UWB) radios for collision avoidance between equipped vehicles and localization in complex junctions, yards, and/or areas where GPS is unavailable.
- **Obstacle Detection** - Piper's patented TrackSight™ LiDAR uses Piper's proprietary Virtual Tunnel algorithms for reliable obstacle detection.
- **Limits Compliance** - GPS-RTK provides a high precision position & speed calculation for limits compliance and time synchronization.
- **Collision Detection** - Onboard Inertial Measurement Unit (IMU) for collision detection.
- **Event Recorder** - HD Cameras capture outward and inward video purely for forensic purposes.



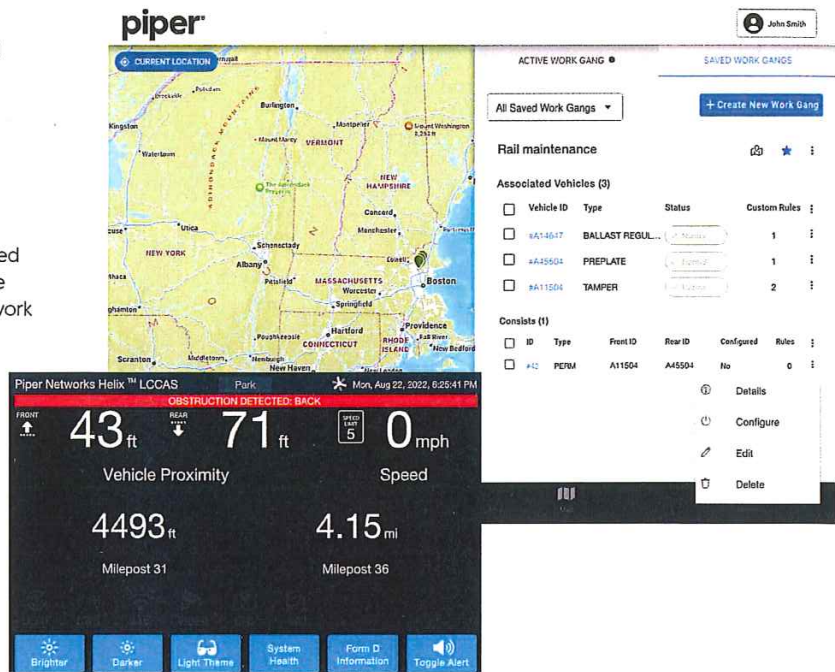
How Piper's Helix™ LCCAS Works

Dynamic Work Zone Creation

Piper has also developed an interface for Rail Control Center (RCC) personnel to remotely set protection limits for work zones. The system was designed in accordance with industry standard flagging rules.

The fleet manager app (FMA) shows all the equipment operating within the work zone and displays all the same information that the selected equipment is showing its operator, as well as live telemetry and alerts. Foremen can also create work gangs, couplings and work zone parameters.

An intuitive Operator Dashboard displays feedback from the sensors locally to generate operator alerts. Operators can be notified of overspeeding, distance to and from established work zones for limits compliance, proximity to nearby vehicles and obstacles, and approaching grade crossings.

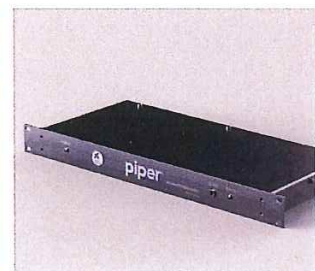
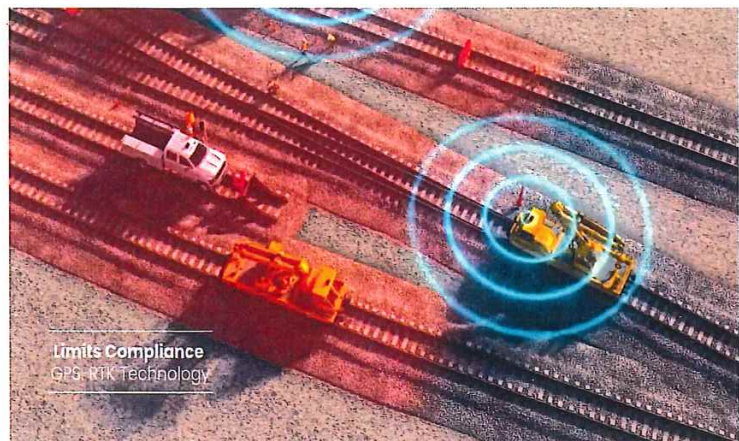


Limits Compliance

Limits compliance functionality relies on Piper's GPS RTK technology to position MOW vehicles in the territory with centimeter-level accuracy.

This accuracy is critical for determining the track the vehicle is operating on and calculating the distance to the ends of the work zone. To accomplish this, Piper deploys redundant, broad coverage GPS-RTK base stations along the right of way.

Piper recently deployed a comprehensive database of the entire Northeast Corridor track geometry and required only 32 base stations. In addition to determining precise track and location, this network provides fine resolution for the proximity of vehicles to various points of interest, including: interlockings, platforms, grade crossings and signals.



Piper's UWB technology became the world's first SIL 4 safety certified UWB positioning system.

Collision Avoidance and Detection

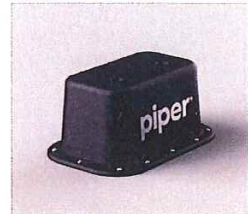
Work zones often include multiple MoW vehicles operating in close proximity to each other with bi-directional movements. It's imperative to monitor the front and rear of each of these vehicles to prevent collisions and damage. For this function Piper deploys its field-tested UWB solution. The Helix CPU uses its knowledge of which track the vehicle is localized to and communicates with other Helix-equipped vehicles on the same track using UWB in a localized fashion. The ranging data collected from the UWB sensors allows the Helix CPU to accurately track the distance between the two vehicles and warn both operators if they begin to encroach on their safety envelopes. Operators are able to view this proximity information through the in-cab display alerts that follow the rules for safe separation of vehicles in both work and travel modes.

Inertial Measurement Units (IMU) detect collisions in real-time and HD Cameras store outward and inward recordings for forensic review following hazardous events. The IMU will enable Helix to immediately alert the EIC and dispatcher when a collision occurs.



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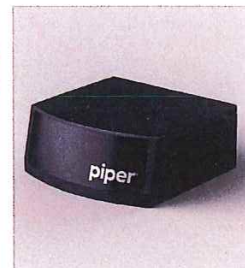
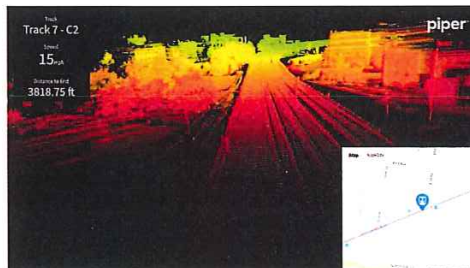
According to the FRA, there were over 3,200 train-related injuries for on-duty railway workers in 2021.



Object and Worker Detection

Operators are also alerted to the presence of workers that inadvertently cross the track fouling area as well as objects that may be left in the path of the vehicles.

Piper's TrackSight™ LiDAR system is calibrated to focus its field of view towards the direction of the track for the purpose of detecting any obstacles which could result in a collision with the operating vehicle. The sensor is configured to ignore any observed objects which don't meet the minimum threshold for size as to avoid false positives caused by common debris. Additionally, TrackSight™ can determine its distance to observed objects and notify the equipment operator of when they should prepare to stop based on their current speed.



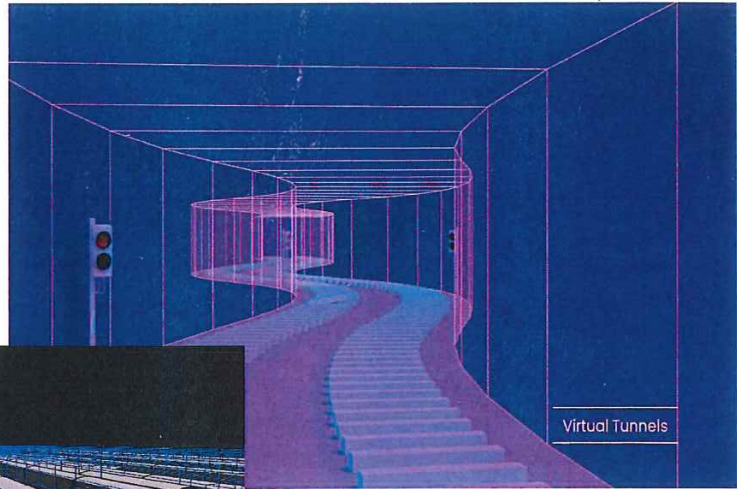
Advanced Tools for Maintenance of Way Protection

Virtual Tunnels

In order to reduce alert fatigue, Piper uses advanced algorithms that create Virtual Tunnels.

Using the database created from the Virtual Tunnels, Piper distinguishes between objects that are breaching the fouling area or creating a hazard, from necessary and existing wayside infrastructure such as signal heads or gantrys.

To eliminate false positives, the TrackSight™ sensor takes into account the database residing on the local CPU to then dynamically focus its field of view when the vehicle is approaching a curve or the track is changing elevations.



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In the last 5 years, there have been more than 10,525 railroad crossing incidents resulting in 1,279 deaths.

US FEDERAL RAILROAD ADMINISTRATION (FRA)



Benefits of Piper Helix™ LCCAS

- High Precision - Reliable System provides accurate navigation for rail vehicles.
- Works in extreme conditions & above or underground rail environments.
- Advanced protection for MOW equipment and track workers.
- Suite of sensor technologies includes UWB, LiDAR, IMU and GPS-RTK.
- Consistent two-way communication with local MoW system using LTE Modem.
- SIL 4 Safety Certified Equipment tested against AREMA C&S 11.5.1 and IEEE 1478

Piper Networks is an innovative rail engineering solutions provider and systems integrator specializing in the development of transportation technologies. Founded in 2011, Piper has five primary product lines that serve the industry, including: Vital Train Positioning, Maintenance of Way (MOW) Protection, Automatic Train Protection (ATP), Grade Crossing Safety, and Passenger Information Display Systems (PIDS). Piper's proprietary Ultra Wideband (UWB), GPS-RTK, and patented TrackSight™ LiDAR image positioning technology are designed to operate in some of the most challenging transportation environments while maintaining pinpoint accuracy that improves performance for train operators and train control suppliers.

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