

PWI Summer Seminar 2023

Manufacture to Maintain

One Stop Supply

voestalpine, A LEADING STEEL AND TECHNOLOGY GROUP

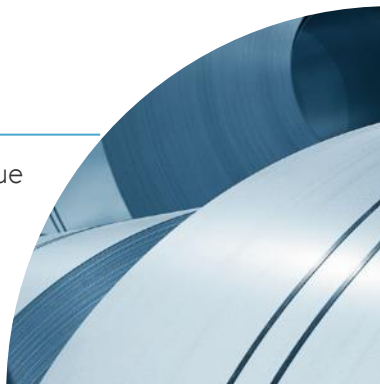


- » Headquarters are in Linz, Austria
- » Employees: 50,225 around the world
- » Turnover: 14.9 Billion EUR per annum



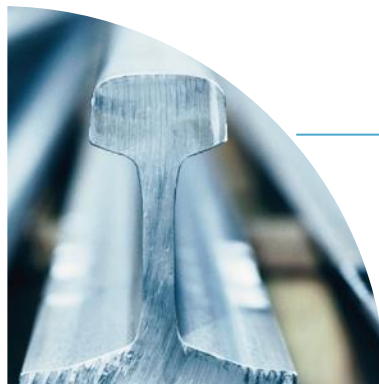
Steel Division

36 % share of consolidated Group value



Metal Engineering Division

22 % share of consolidated Group value



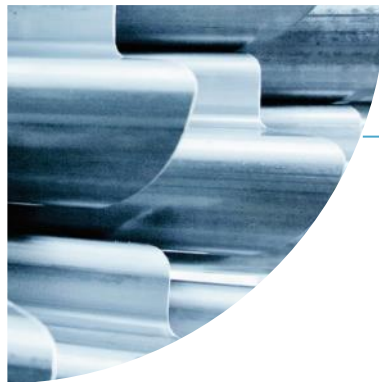
High Performance Metals Division

20 % share of consolidated Group value



Metal Forming Division

22 % share of consolidated Group value



Brief Introduction to voestalpine Railway Systems

66

Production and sales
locations worldwide

4

Strategic Business
Areas

7,000+
Employees



RAILWAY
SYSTEMS
by voestalpine

3

Profit Centers

(Turnouts & Fixations,
Rails, Signaling)

1

Competence Center

(Track Solutions)

Think Global – Act Local

- » 66 Production-, Sales- and Service Locations
- » Maximum understanding and knowledge of local conditions and customer demands
- » “Performance on Track®” The greatest possible availability with the lowest possible life cycle costs
- » The locations to support our customers in the United Kingdom
 - » va Turnout Technology UK
 - » Edinburgh
 - » Harworth, Nottinghamshire
 - » va Signaling UK
 - » Fareham, Southampton
 - » va Rail Technology UK
 - » Harworth, Nottinghamshire



CENTERS AND REGIONAL STRUCTURES

TURNOUT & FIXATIONS



RAIL



SIGNALING



TRACK SOLUTIONS



North America

South America

Europe North

Europe South

Africa

Asia

Australia

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voestalpine

ONE STEP AHEAD.

Performance on Track



We are the **global leader for railway infrastructure system solutions**, offering outstanding products, logistics and services for rails, turnouts & fixations, signaling and monitoring applications.

Creating maximum customer benefit is the driving force behind all activities of the group.

We are **performance on track®**.



RAILWAY
SYSTEMS

High Speed traffic

Burkhard Zillien

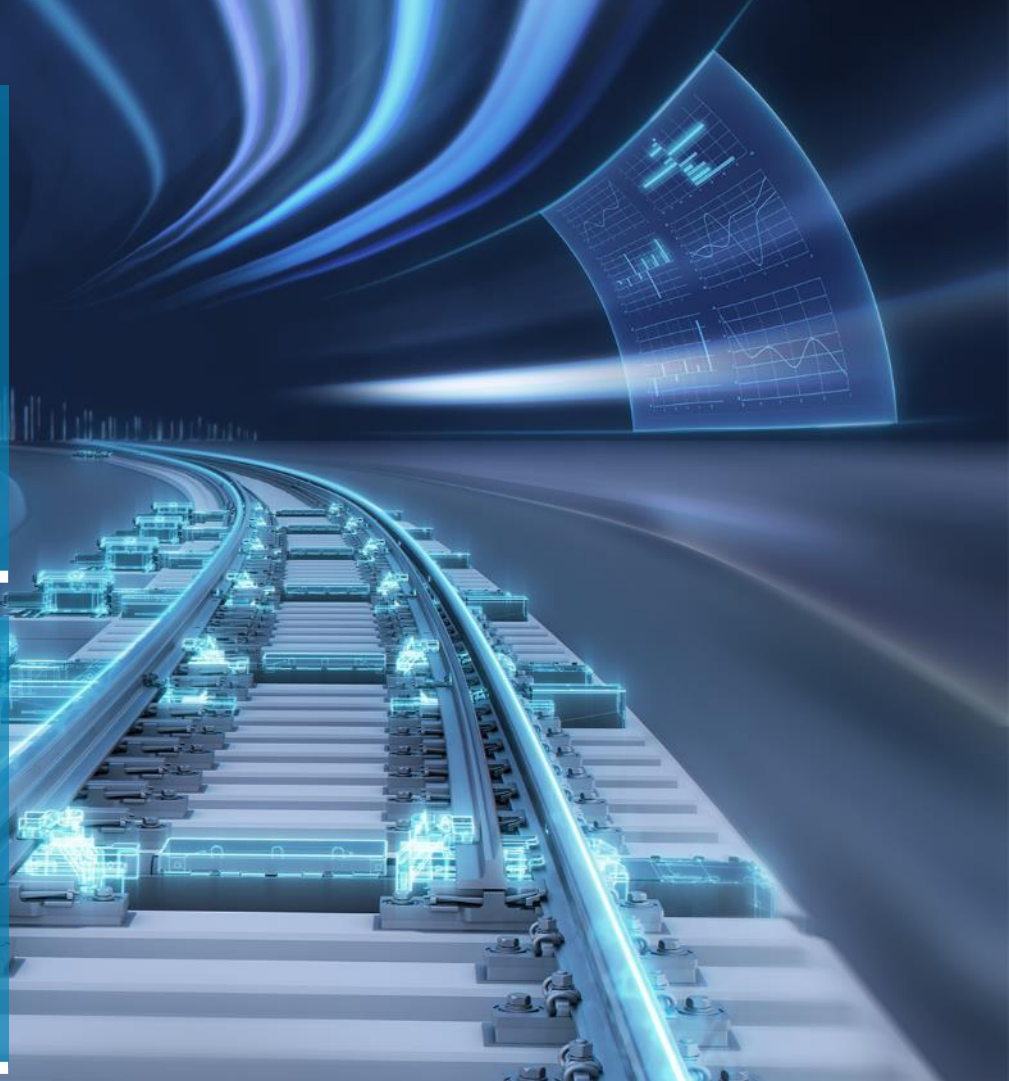
Competence Center – High Speed

ENVIRONMENT & CHALLENGES

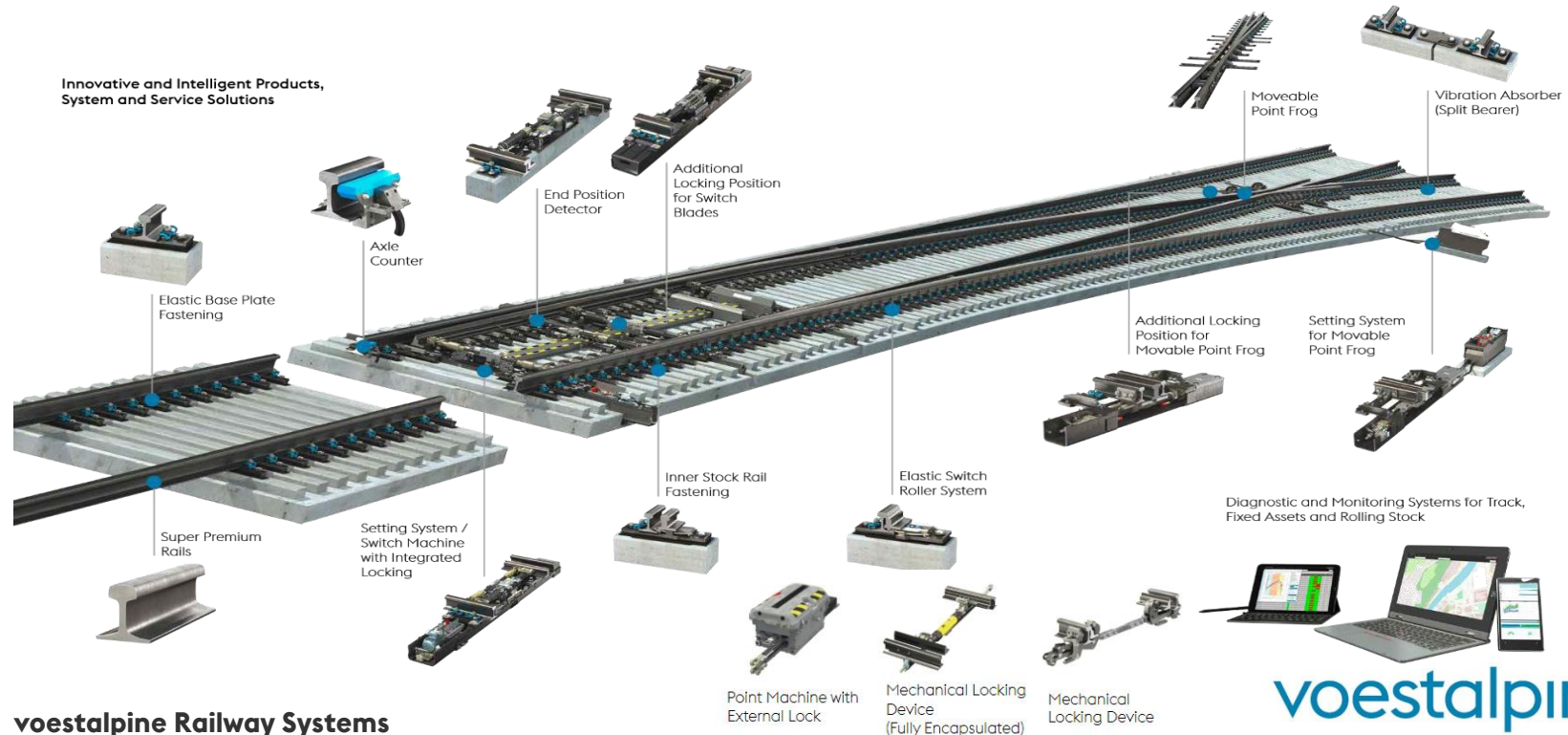
- » Growing global demand for intercity transportation
- » High competition with air travel
- » Rising speeds (350km/h +) and train frequencies
- » Maximum travel comfort and safety

OUR SOLUTIONS

- » Optimized materials and geometries to maximize safety
- » Elastic track supports to optimize elasticity for slab track
- » Integrated signaling solutions
- » Comprehensive monitoring portfolio to identify potential system failures on time



WHAT IS HIGH-SPEED TRAFFIC SYSTEMS?



voestalpine Railway Systems

Main Features

High-Speed Turnout System

Double Clothoid Geometry

Clothoid turnout geometry with minimized jerk and limited lateral acceleration at the turnout beginning

Kinematic Gauge Optimization

Optimize the continuous sinus run of the vehicle through the switching device

Swing-nose Crossing

A Must for train speeds higher than 250 km/h

Rail Expansion Devices

Necessary to compensate longitudinal movement of rails and substructures

Elastic Base Plate System

Elastic base plate system with stiffness adapted to operational condition in high-speed turnouts

R&D, Design, Verification, Validation, Trail Test

Locking Devices

High available, reliable, low maintenance and safe external locking system HRS Locking Device

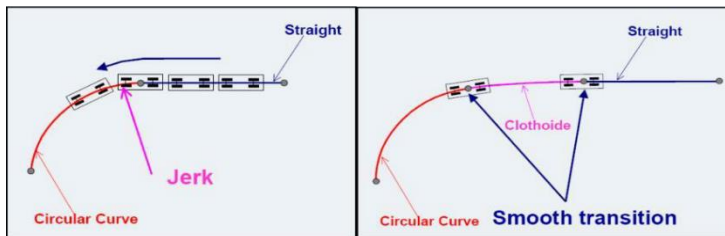
Main Features

High-Speed Turnout System - Double Clothoid Geometry

Pioneering development of high-speed turnouts with double clothoid geometry in the beginning of the 1990's by voestalpine Turnout Technology Germany (formerly known as BWG). Applied in high-speed lines in Europa and in Asia.

- » Clothoid section with its great initial radius
 - » minimizes the lateral jerk of the vehicle when it enters the diverging track,
 - » increases the traveling comfort,
 - » reduces considerably the strain and by consequence the wear of the front switch section,
- » Bend increases linearly by length
 - » linearly increasing lateral acceleration occurs
- » By adapting the clothoid section to the required maximum branch-off speed, the maximum lateral acceleration is limited to a safety-and wear-relevant value.

Circular curved turnout



Clothoid curved turnout

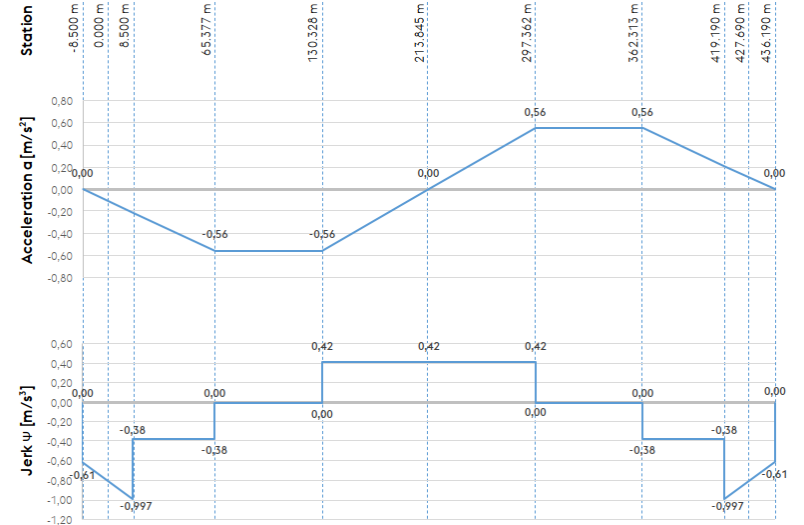
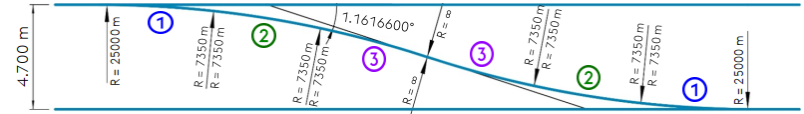
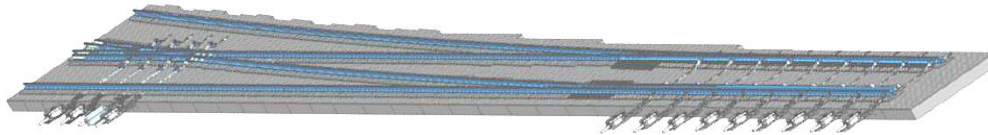
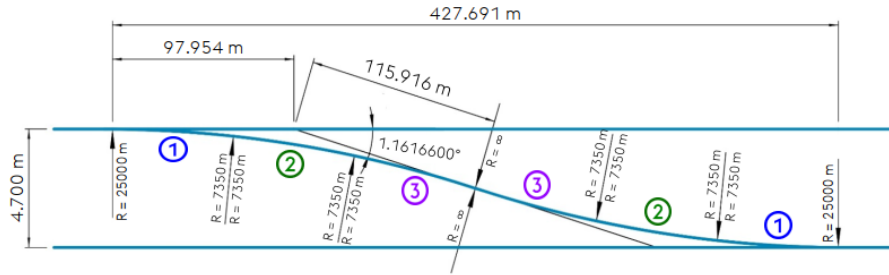


Main Features

High-Speed Turnout System - Double Clothoid Geometry

» Example: turnout geometry for branch speed 230 km/h.

Turnout length:	187.328 m	① Clothoid section	② Circular arc	③ Clothoid
Spread:	1.817 m	A = 825.000 m	A = 783.554 m	A = 783.554 m
Turnout end inclination:	1 : 50.750	L = 65.377 m	L = 64.955 m	L = 83.532 m
		$\alpha = 0.3297348^\circ$	$\alpha = 0.5063388^\circ$	$\alpha = 0.3255789^\circ$
		T1 = 38.634 m	T1 = 32.477 m	T1 = 27.844 m
		T2 = 26743.261 m	T2 = 32.477 m	T2 = 55.688 m

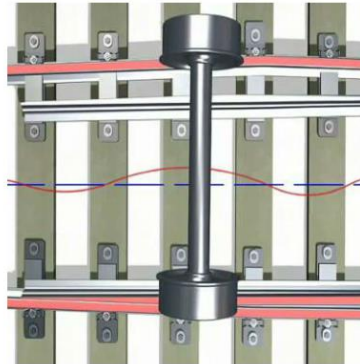
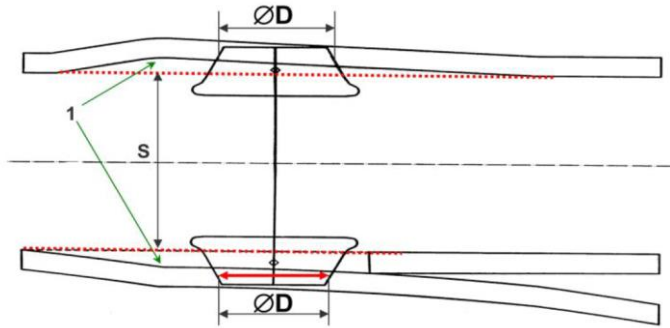


Main Features

High-Speed Turnout System – Kinematic Gauge Optimization

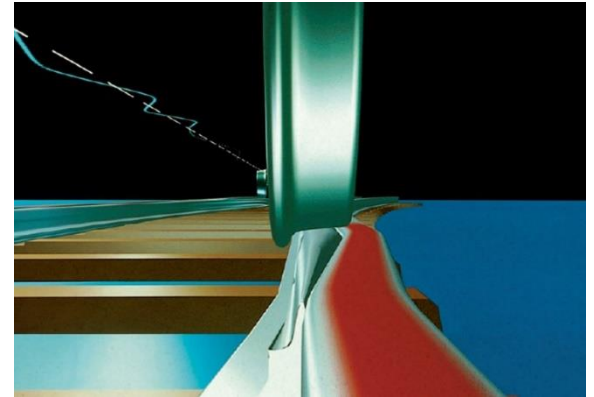
The key features include:

- » Ensure the continuous sinus run
- » Strengthen the switch blade
- » Reduce wear and tear
- » Up to six times longer life cycle compared to conventional switch design
- » Increase passenger comfort



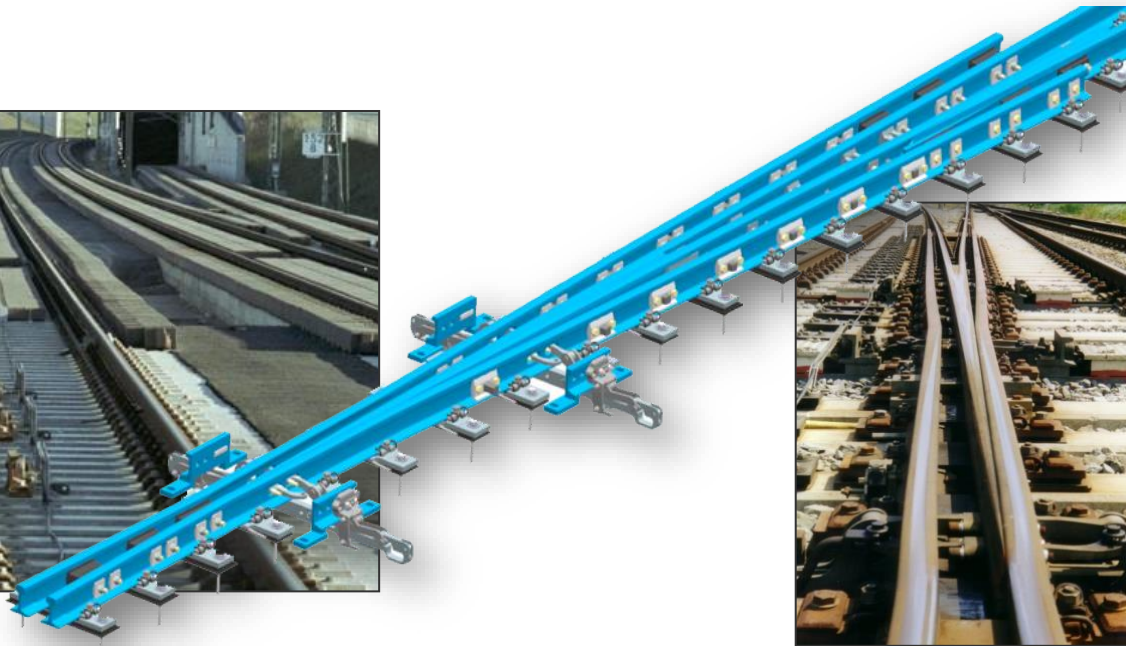
Set of switches with FAKOP

- » Steering of the wheel set caused by the conical wheel profile.
- » No steering through the wheel flange.



Main Features

High-Speed Turnout System – Swing-nose Crossing



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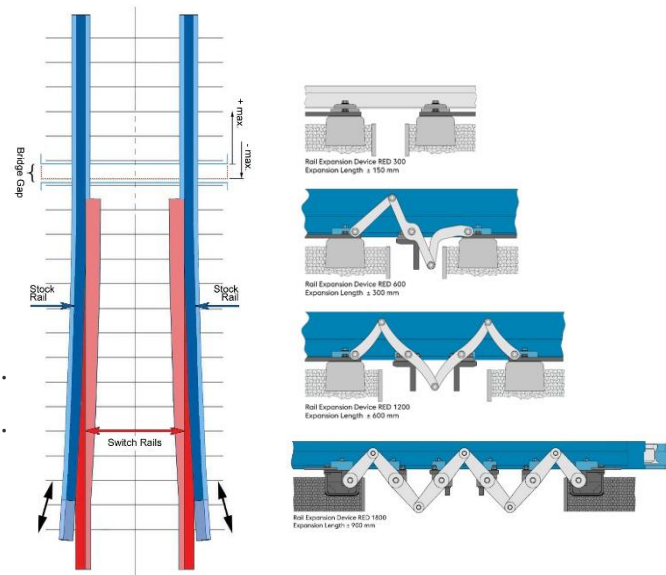
ONE STEP AHEAD.

Main Features

High-Speed Turnout System – Rail Expansion Devices

Rail Expansion Device System

- » Rail Expansion Devices are necessary to:
 - » compensate the longitudinal movement of rails and substructures (influenced by temperature variation, creeping and shrinking of the concrete of the bridge, braking and acceleration of the trains)
 - » bridge the gap of the sub-structures
- » Universal design with expansion lengths between ± 150 mm and ± 900 mm
- » Advanced versions available for heavy haul (30 tons static axle load)
- » The change in length is effected by the stock rails without affecting the track gauge.
- » The bridging of the bridge gap is designed so as to prevent flexibility discontinuities.

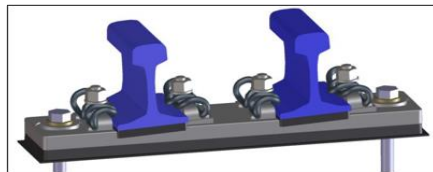
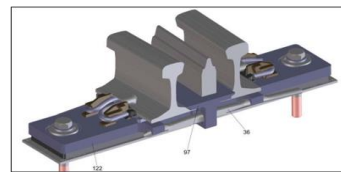
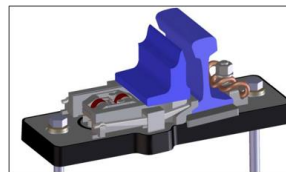
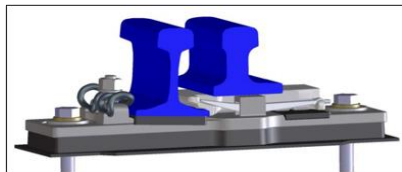
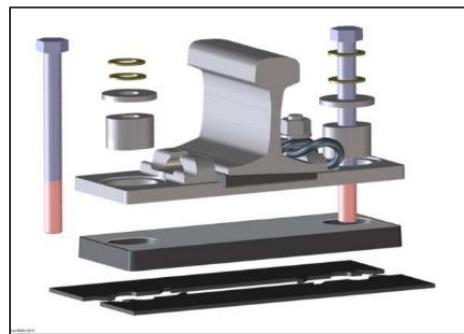


Main Features

High-Speed Turnout System – Elastic Base Plate System

Elastic Base Plate Support (ERL)

- » The ERL system guarantees a uniform deflection of the elastically supported plates independent of the form and position of the plate and the stiffness and number of the supported rail components.
- » Elasticity can be adjusted from 4 kN/mm to 80 kN/mm according required track stiffness
- » Lateral adjustment +/- 8mm
- » Hight adjustment +24 mm, -4 mm
- » Certified according EN standard
- » Applicable for all kind of railway operations and track design
- » Bolt-through fixation M27



Main Features

High-Speed Turnout System – Elastic Couplings

Elastic Couplings (SWT)

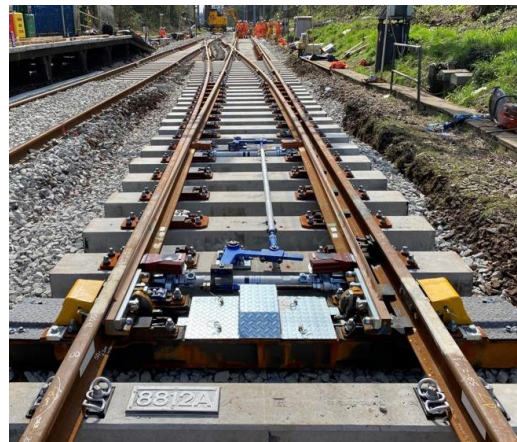
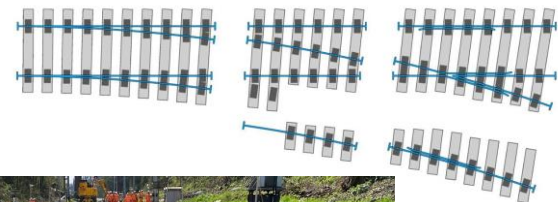
- » Turnout segments, especially in the rear of the turnout, can reach such a width that it is not possible to load and transport them on standard vehicles when assembled.
- » In order to allow a pre-assembly in the turnout factory and transport to the installation site in spite of this width, the sleepers are divided and then reconnected at the installation site with the aid of elastic couplings.
- » In ballasted track turnouts vibration dampers are used as elastic couplings. The elastic properties of the coupling elements also ensure favorable ballast pressure and avoid an one-sided loading of the long



Elastic coupling for concrete sleeper with through bolt connection (Swt 7)



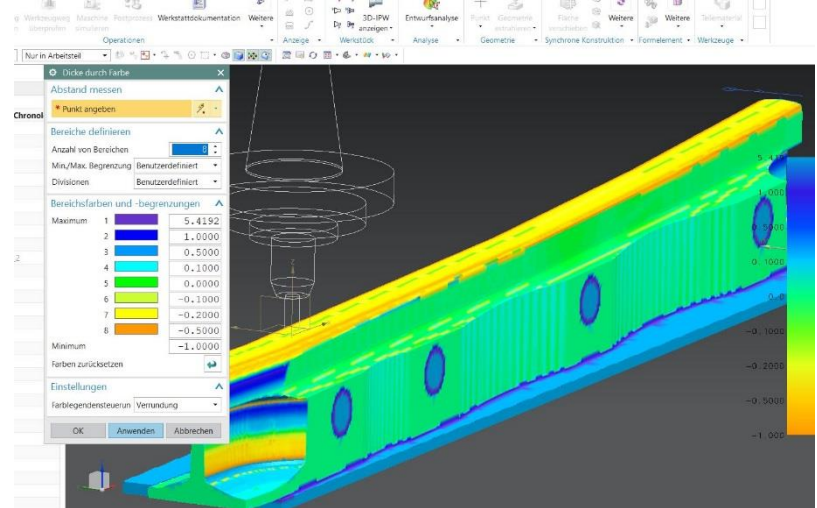
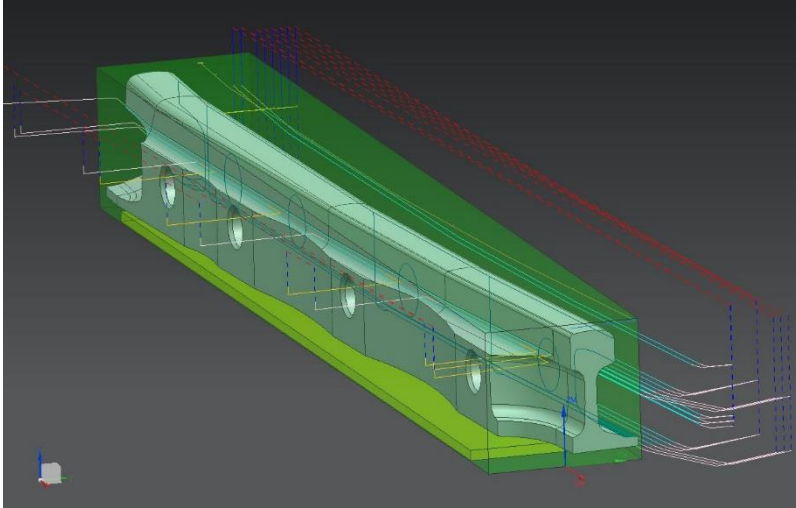
Elastic coupling with adapter plate for concrete sleeper with dowel fastening (Swt 13)



Trail test with Network Rail at Reading West 8812A/B
Installation in April 2023

R&D, Design, Verification, Validation, Trail Test

High-Speed Turnout System

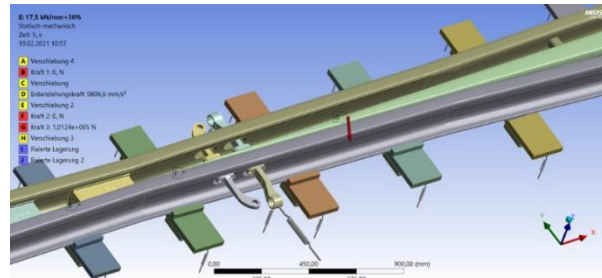


CAD/CAM

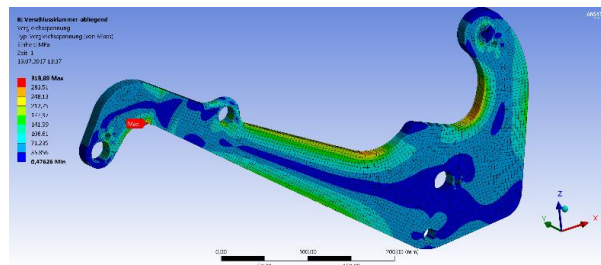
Exact milling geometry with CAM produced components

R&D, Design, Verification, Validation, Trail Test High-Speed Turnout System

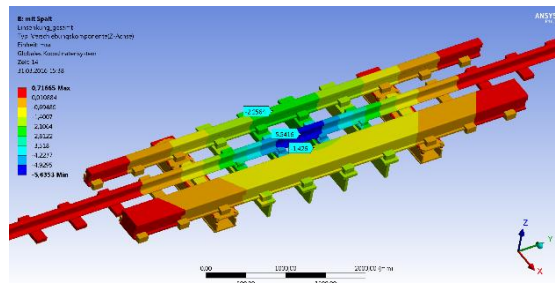
Design verification and validation with advanced software systems



..at the swing-nose crossing



..at HRS-Locking Device



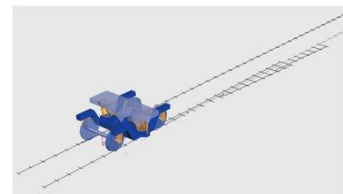
..at the Rail Expansion Device

CHALMERS
UNIVERSITY OF TECHNOLOGY

CHARMEC

Model

- Model
 - Simpack
 - Manchester Benchmarks passenger vehicle, yaw and lateral stiffness in primary suspension adjusted for HS
 - Traffic represented by one bogie
 - 18 tonnes axle load
 - Flextrack model
 - Beam elements for base plates and rails
 - Nominal pad stiffness (17kN/mm)
 - 350 km/h



Multi Body Simulation

voestalpine Railway Systems

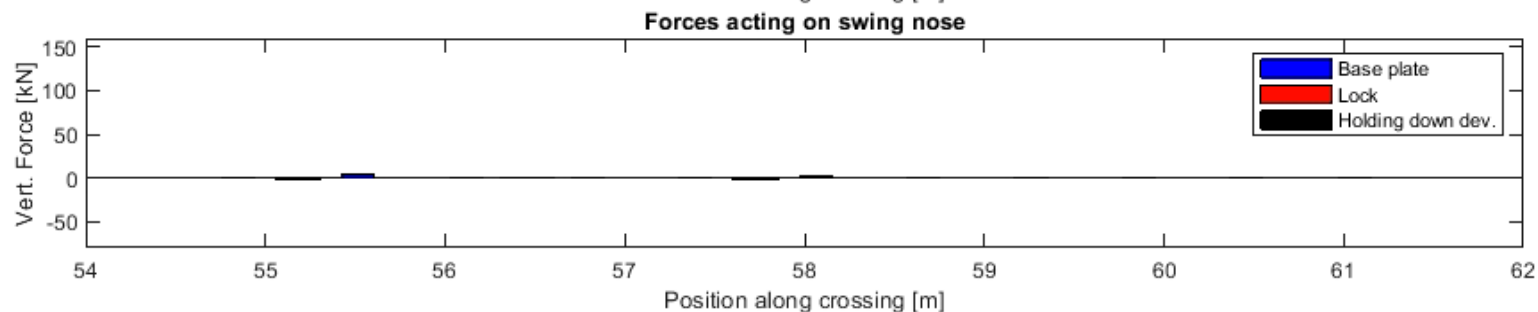
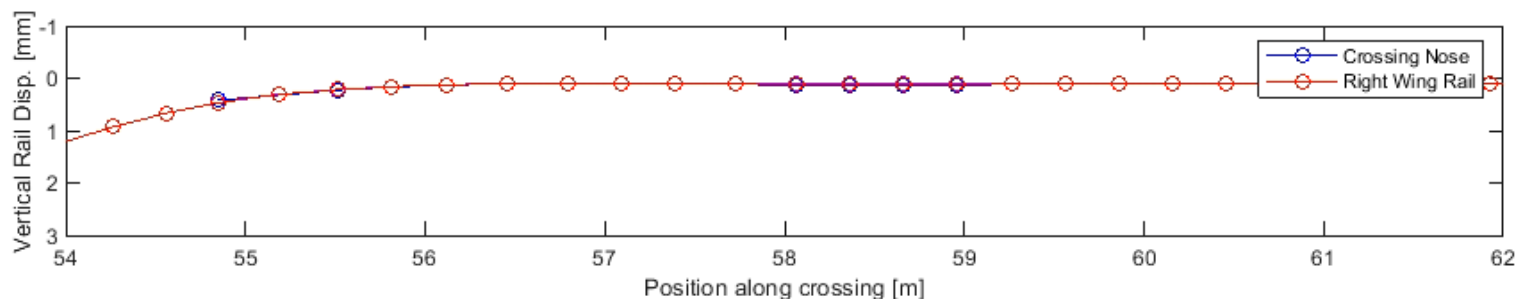
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voestalpine

ONE STEP AHEAD.

Simulation results nominal current design 400 km/h



R&D, Design, Verification, Validation, Trail Test

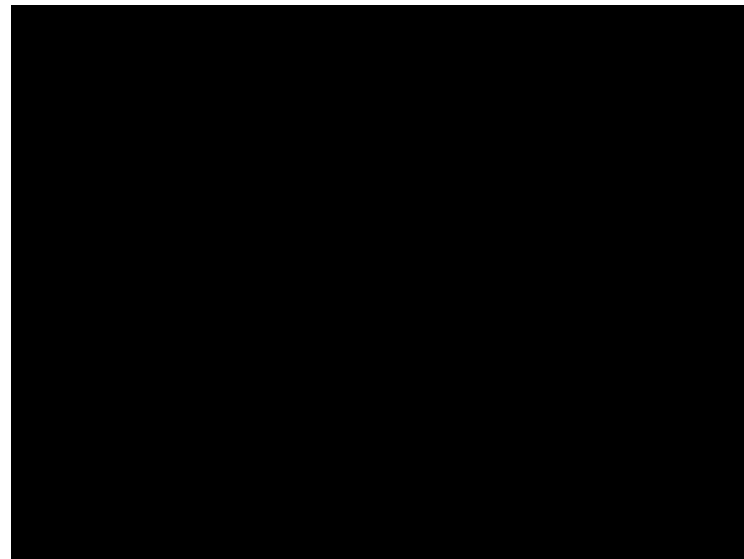
High-Speed Turnout System

Fatigue test of
swing-nose crossing



Fatigue test of fastening system acc. to EN 13481

R&D, Design, Verification, Validation, Trail Test High-Speed Turnout System



R&D, Design, Verification, Validation, Trail Test

High-Speed Turnout System

» Installation Deutsche Bahn:

- » Field test at Deutsche Bahn in Haste
- » 2 x crossings 60E2A1-500-1:12
- » ongoing

» Installation Network Rail

- » Field test with NR in the UK
- » 2 x crossings 56E1-1:13 & 56E-1:9,25
- » date: 04/2023

» Further Industrial customers:

- » since 2020: Hamburg Port Authority – 6 UHPCs
& Evonik – 2 UHPCs
- » in 2022: Bremenports – 6 UHPCs



R&D, Design, Verification, Validation, Trail Test

High-Speed Turnout System

Measurements on a high-speed switch in Spain

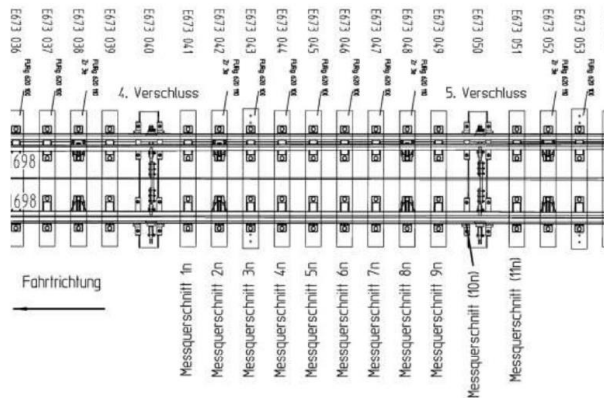
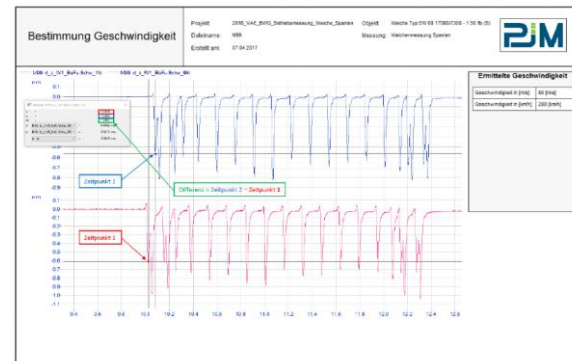
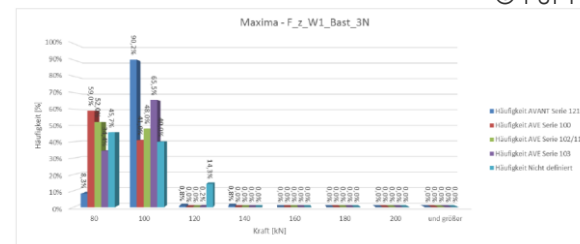


Abbildung 5.2: Übersicht der Messstellen M1N bis M9N



© PJM



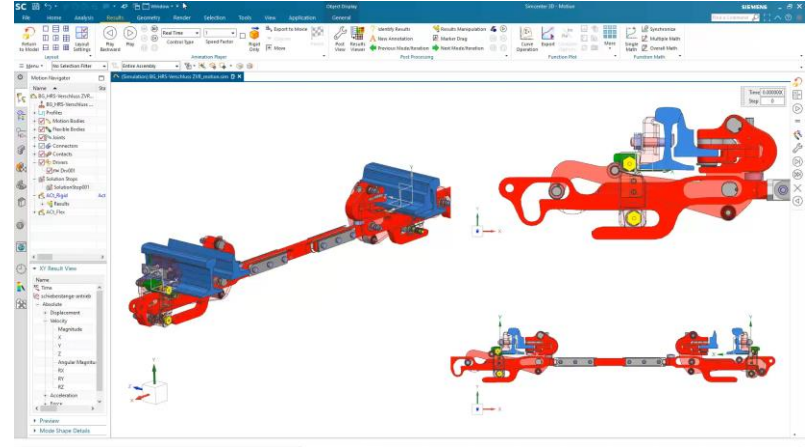
© PJM

Main Features

High-Speed Turnout System – Locking Devices

HRS Locking Device

- » Secures the locked switch in horizontal and in vertical directions
- » HRS applicable for both, the set of switches and swing-nose crossing
- » Suited for ballasted track and slab track
- » Low maintenance due to permanent roll lubrication and BKL 80
- » Substantial extension of maintenance intervals (> 6 months)





RAILWAY
SYSTEMS

Point Operating Equipment

Anna Cornish
Competence unit – signaling (POE)



RAILWAY
SYSTEMS

EcoStar

Drive and detect

ECOSTAR – DRIVE

- » EcoStar is a hydraulic power unit and can offer secondary detection
- » Compliments the HRS locking device and track forms developed by sister companies
- » SIL 4 according to CENELEC EN 50126 and 50129
- » IP67
- » Flexible installation in all signal and switch designs
- » Reduced maintenance (annual lubrication and visual inspections recommended)
- » No planned maintenance interventions required
- » Designed for 1 million cycles or 25yrs
- » Low Whole Life Cycle Costs
- » Enhanced diagnostic capabilities (hydraulic pressure and levels in tank, moisture sensor, current transducers).

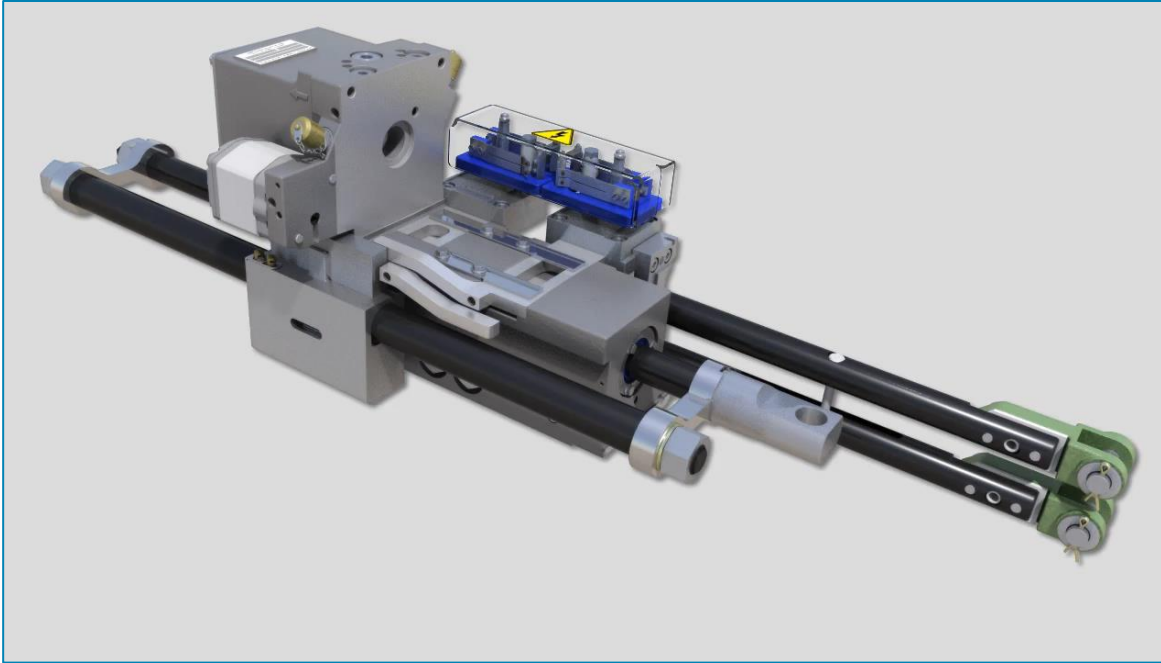


ECOSTAR– TECHNICAL DATA



- » **Setting Unit**
- » Temperature range -40/+80
 - » hydraulic – mechanical system
- » Throw up to 240mm → tongue opening 185mm
- » Throw force up to 9kN
 - » Standard 5kN and 7kN
- » Trailing force 7kN or 9kN
- » Integrated end position detectors
- » Weight < 100 kg

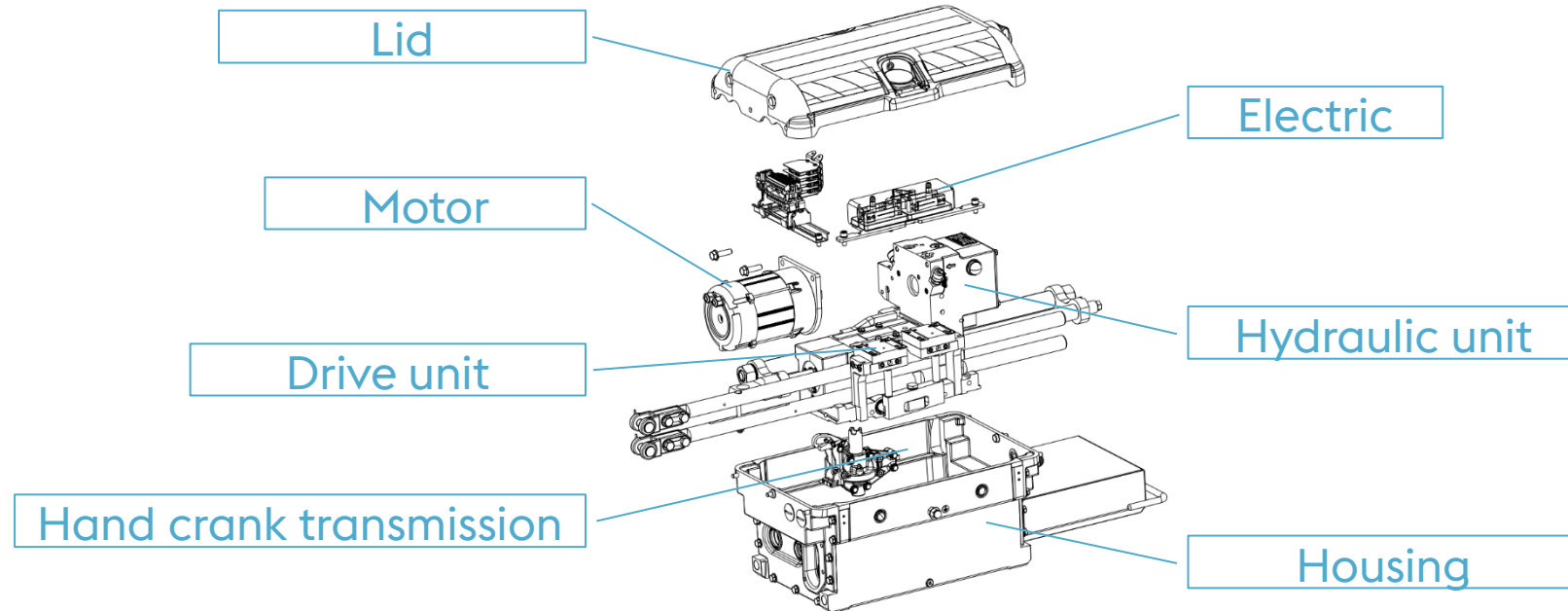
THROW FUNCTION



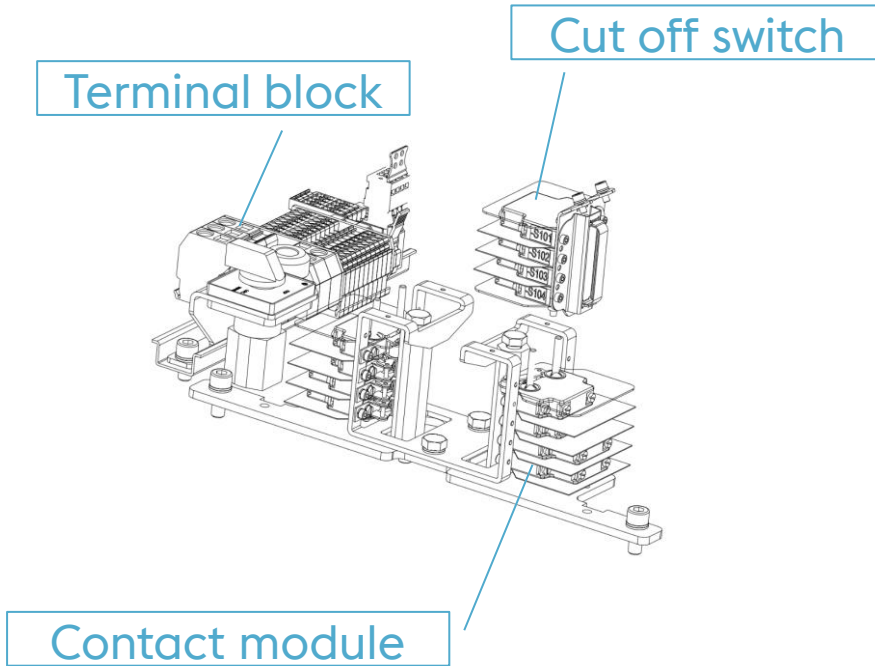
THROW FUNCTION

- » Initialization (control current)
 - » command of the interlocking
 - » Electric motor powers hydraulic pump
- » Unlocking phase
 - » Hydraulic system accomplishes adjustment of the bolts
 - » Bolt releases ramp device
 - » Electrical module is switched via the bolt → conversion
- » Operation phase (system throws over)
- » Locking phase
 - » slide must be in end position
 - » The piston rod must be in the end position
 - » Latch falls and secures the end position
 - » Electrical module is switched via the bolt → control command ended, changeover ended

SYSTEM OVERVIEW

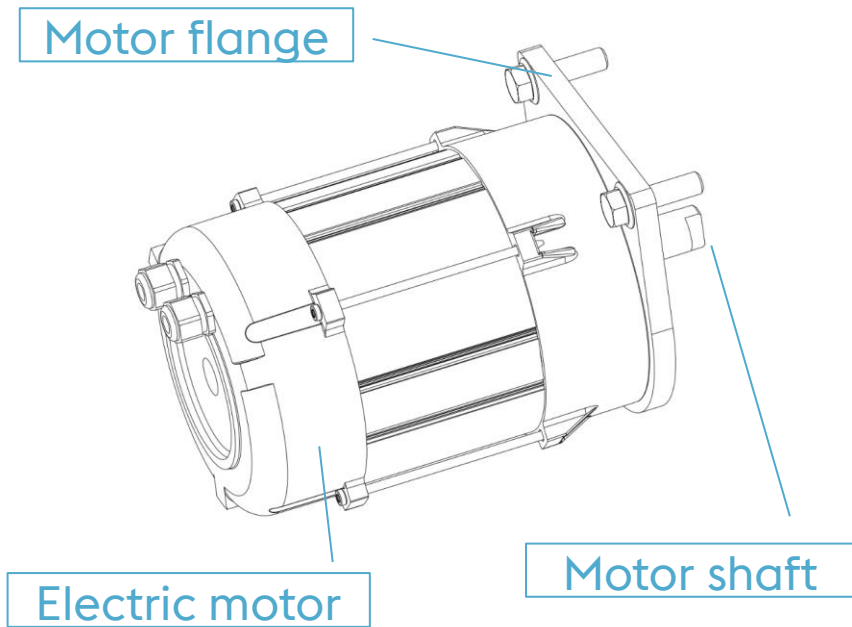


ELECTRIC



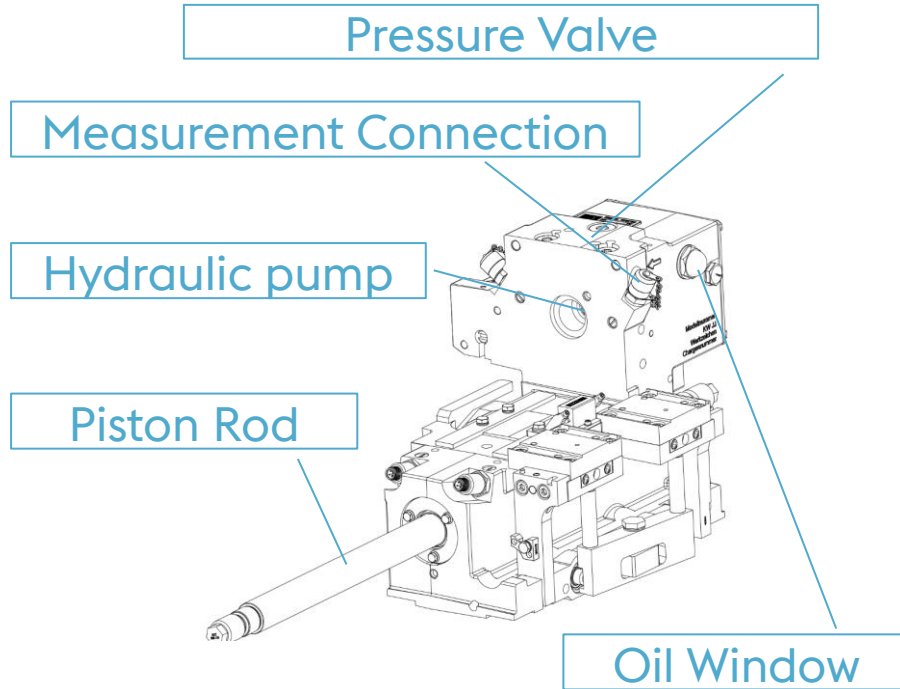
- » Interlocking (4 Wire, 7 Wire, 5 Wire...)
- » Cut off Switch (Hand Crank)
- » Terminal block → according to customer (program plug possible)

MOTOR



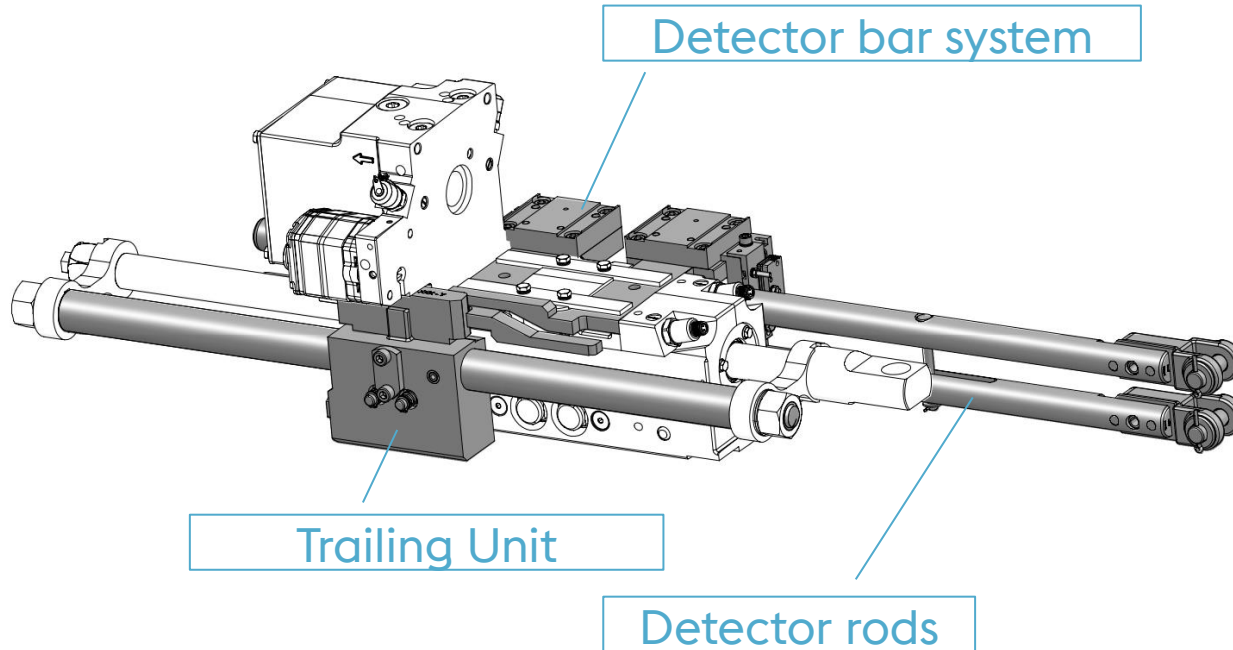
- » Modular system in different variations
 - » 110V AC- 400V AC
 - » 24V DC – 150V DC
- » Motor flange connects Motor with Hydraulic unit
- » Motor shaft transfers torque to hydraulic pump

HYDRAULIC SYSTEM

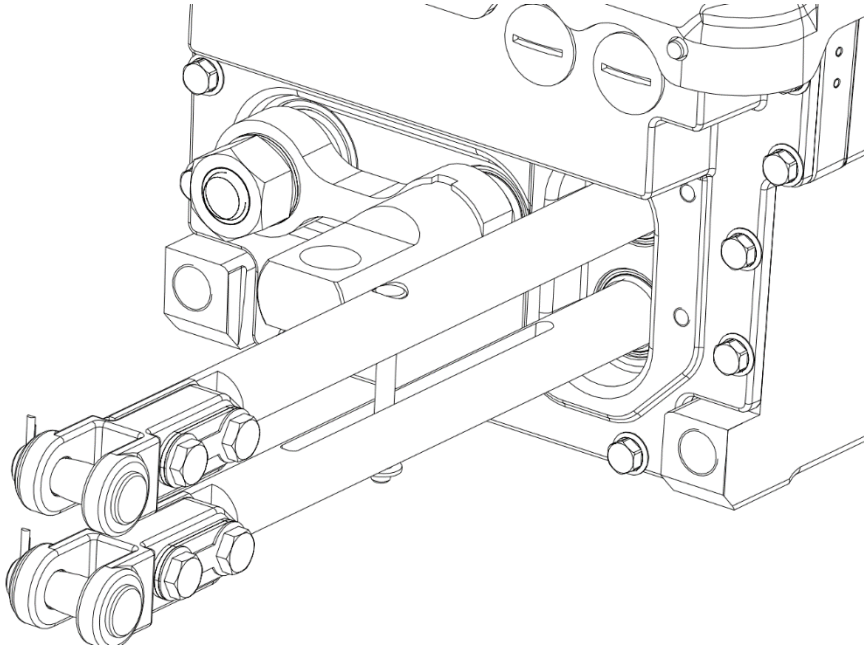


- » Sensors can be added to monitor the performance and function of the hydraulic unit

SETTING UNIT



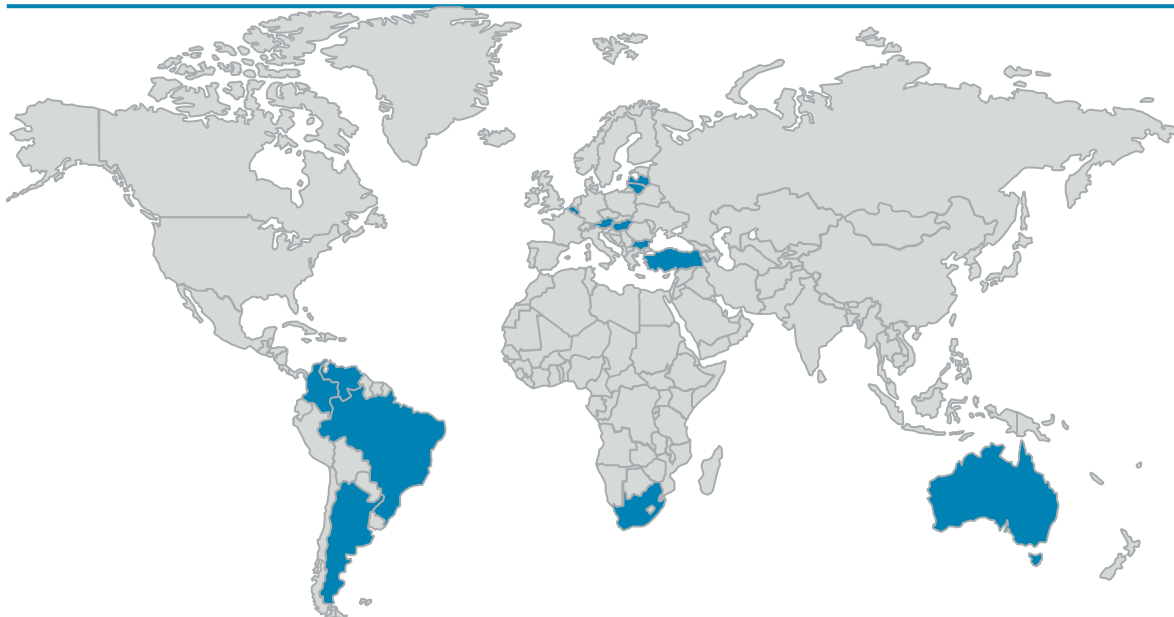
DETECTOR UNIT



- » Checks the position of the switch (open and closed)
- » Can also act as a Secondary lock in case of broken drive rod
- » Connected to switch rails via connecting rods
- » Both detector rods are independent to each other

ECOSTAR

REFERENCES



ÖBB
www.oebb.at
NCA Rosario
www.nca.com.ar
UGOFÉ
www.ugofe.com.ar
Metro Trains Melbourne (MTM)
www.metrotrains.com.au
Vale
www.vale.com
Metro Sao Paulo
www.metro.sp.gov.br
Thales Group
www.thalesgroup.com
Fenoco
www.fenoco.com.co
TCDD
www.tcdd.gov.tr
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www.litrail.lt
Instituto de Ferrocarriles del Estado (IFE)
www.ife.gob.ve
BDZ
www.bdz.bg
LDZ
www.ldz.lv
MAV
www.mavcsoport.hu
INFRABEL
www.infrabel.be



RAILWAY
SYSTEMS

IE2010

Independent detection

IE 2010: System description

» Principle:

The **IE2010** is an integrated end position detector, installed between the rails and is mounted on top of a sleeper for standard or wide gauge applications.

The IE2010 has no drive or lock function

The IE2010 can also be mounted on concrete slab track



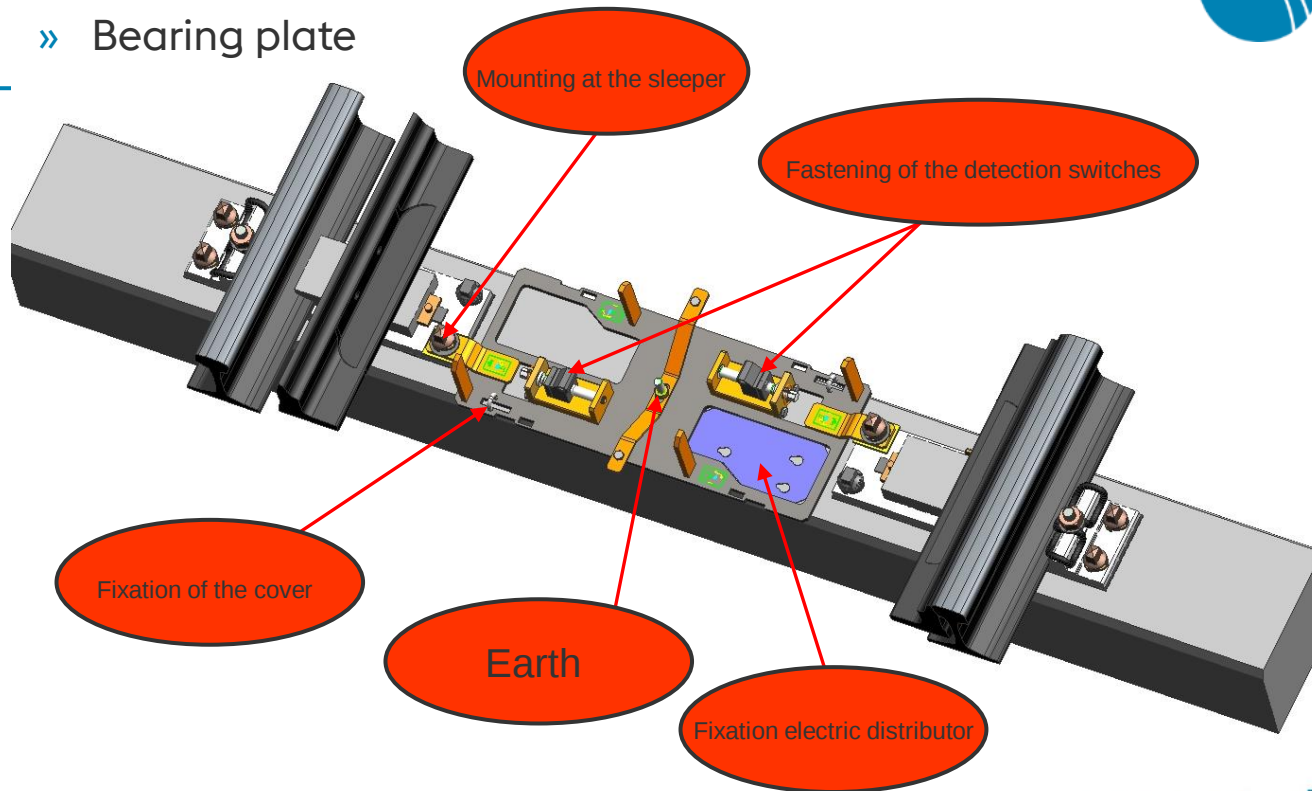
IE 2010: System description

- IE2010 is passive, the rail connections allow the detection halves to follow the switch rail
- Provides open and closed end position switch rail detection
- Adjustability of the IE2010 allows the detection halves to monitor the switch rail has reached the desired position



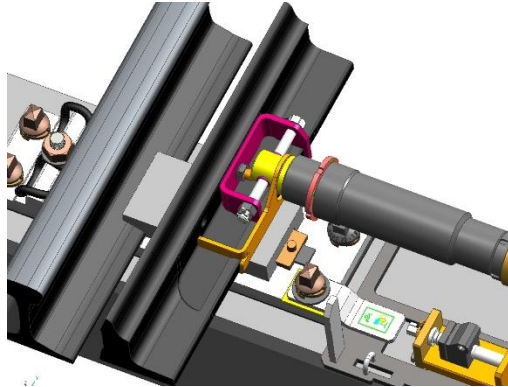
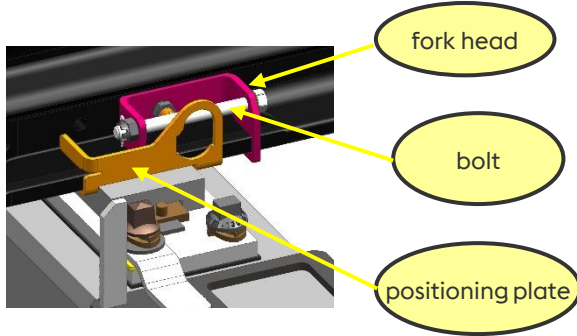
IE 2010 – main parts

» Bearing plate



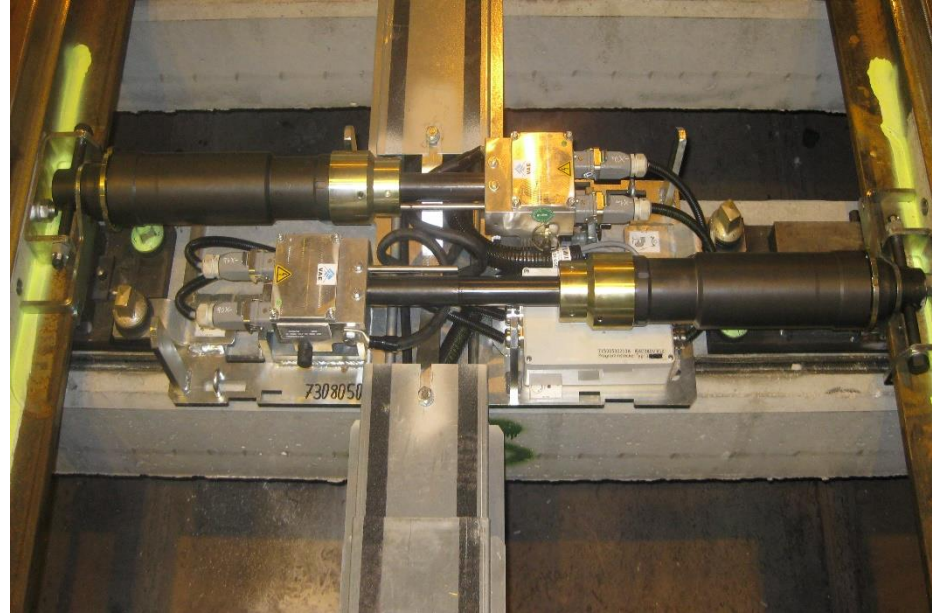
IE 2010 – main parts

- Switch rail connections to allow thermal expansion/contraction of the switch rail, plus lateral movement (roller lift, track voiding)



IE 2010 - main parts

- » Picture shows the detection halves mounted on bearer
- » Fully tampable
- » Power feed can be supplied by drive unit or interlocking
- » Detection feeds can be summed up in drive unit or independently fed to interlocking
- » Annual maintenance (visual checks)



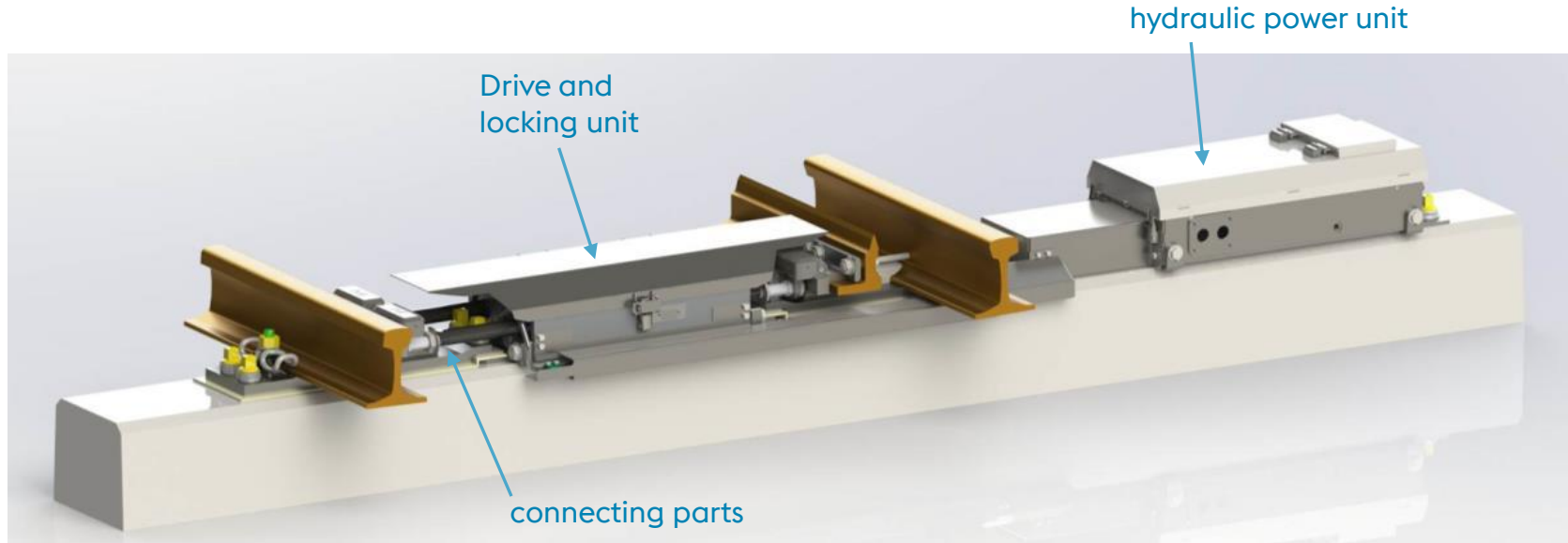


RAILWAY
SYSTEMS

Unistar HR

Integrated lock, drive and detection

UNISTAR HR



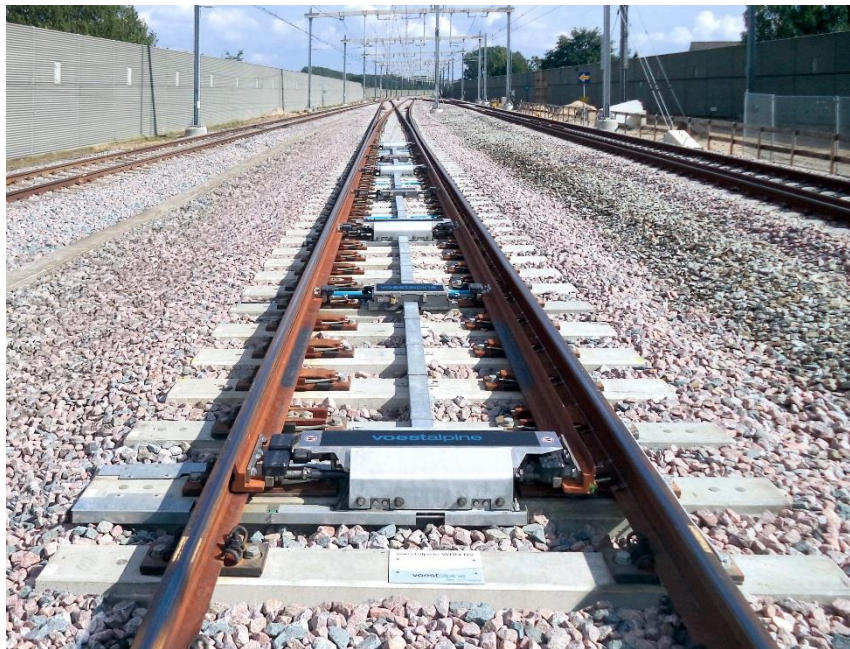
UNISTAR HR

Highlights:

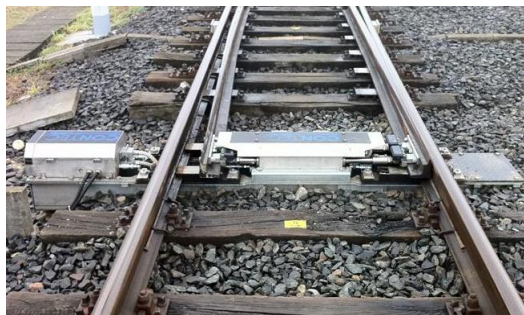
- » Designed for Heavy Rail to Metro applications – SIL4 certified with single or multiple setting levels
- » Industry leading RAMS figures: high MTBF of more than 500 000h, very low MTTR of only 20min
- » Low weight of components - no lifting gear required for installation
- » Space saving, can be on bearer mounted to allow fully tampable in ballast turnouts
- » Supplied with connecting cables, with plug couplers and disconnection box to NR Standards
- » IP67 protection class – watertight, dust tight
- » Trailable machine
- » Designed for 10yrs or 1 million cycles as a minimum. Overhaul programmes allow prolonged use.

UNISTAR HR

Key facts



- » Electro-hydraulic point machine
- » SIL4 certified
- » Point opening: 60-160 mm
- » Throw force: 17 kN
- » Throw time: 2-5 seconds
- » Power supply: 120V DC for UK but can be 24 – 750 V AC and DC
- » Up to 4 setting levels from one hydraulic unit
- » Internal locking device, offering open/ closed switch detection to both sides
- » Hydraulic unit can be positioned up to 20m away from 1st drive unit
- » Hydraulic unit contains local indications for drive position



Type of fixation

- » Sleeper fixation brackets (on bearer)
- » Stock rail fixation (mid bearer)
- » Installation on slab track
- » Installation on hollow sleeper





Installation on bearer:

“Advantage - full automatic tamping is possible”



Increased track bed quality



Place of installation

- » Center gauge installation
- » Outside the running rails
- » One side connections (swing nose applications)
- » Wall mounting of hydraulic unit



Space saving solutions and
flexible to design
requirements

Robust to environmental impacts



- » Hydraulic power unit and drive/locking/detection unit are installed in an IP67 certified enclosure
- » An IP68 machine is currently on trial in New York metro
- » Protection against hard environmental conditions



Low weight of components

Component	Weight in Kg (approx.)
Complete Unit	194
Setting/Locking	75
Drive Unit	52
Connecting Parts (1 Level)	26
Hydraulic Fixation	15

The Unistar in 3D

[UNISTAR HR - Switch Machine electro
hydraulic variant #2 - YouTube](#)

EcoStar, IE2010 and UNISTAR HR

Maintenance protocols



- » All are modular designs
- » Each module can be changed out independently of the overall system
 - » MTTR is typically 20mins
 - » Rail brackets/ ground connections can be easily separated from the drive/ detector unit
 - » Hydraulic quick connects allow quick hydraulic unit change outs
- » We advise lubrication frequencies of 26 – 52 weeks
- » Annual inspection checks and Unistar, FPL
- » More detailed bi annually inspections can be applicable (i.e. EcoStar trailability test)

Training and Maintenance readiness

- » Could the future of training be virtual?
- » As all our drawings and designs are in CAD software systems, transferring the images into 3D models and video is easily achieved
- » At Innotrans 2022, we demonstrated installation and maintenance tasks in virtual reality
- » During the pandemic, we were able to continue supporting customers by offering on line training and technical support, 24/7



Diagnostic & Monitoring Technologies for Infrastructure

Richard Beardmore

Competence unit – Diagnostics and Monitoring

Thinking beyond the retrofit.

```
const stations$ = from(track['station'].stations);  
this.subscriptions.add(stations$.subscribe((station_id) => {  
  const stationUnit = units.find(function(unit) {  
    return unit.id == station_id;  
  }));  
  let stats = {};  
  if(stationUnit != undefined)  
    this.store.dispatch(new GetStats({stationUnit: stationUnit.id});  
  stats = this.store.select(un
```



But first - Installed Base



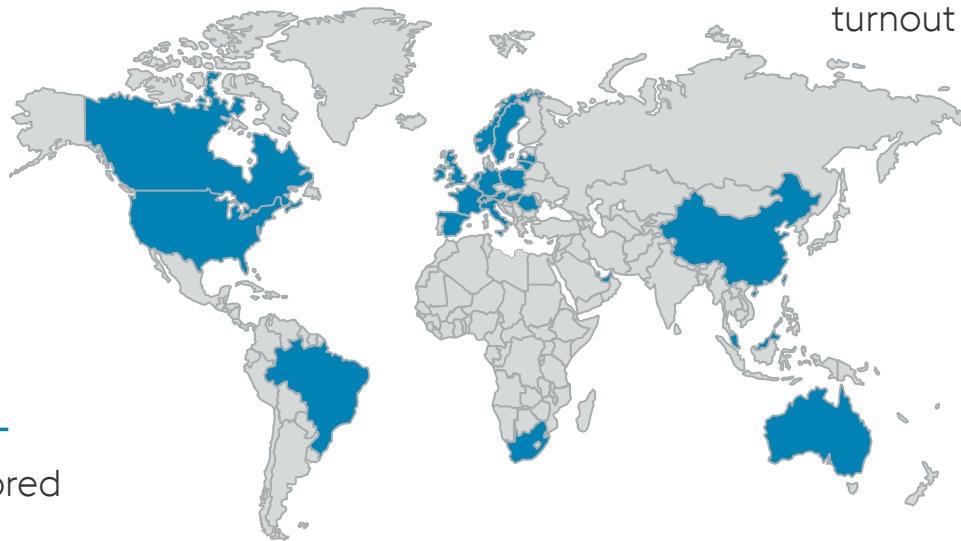
Of course...

Retrofit is possible!

25+
Countries

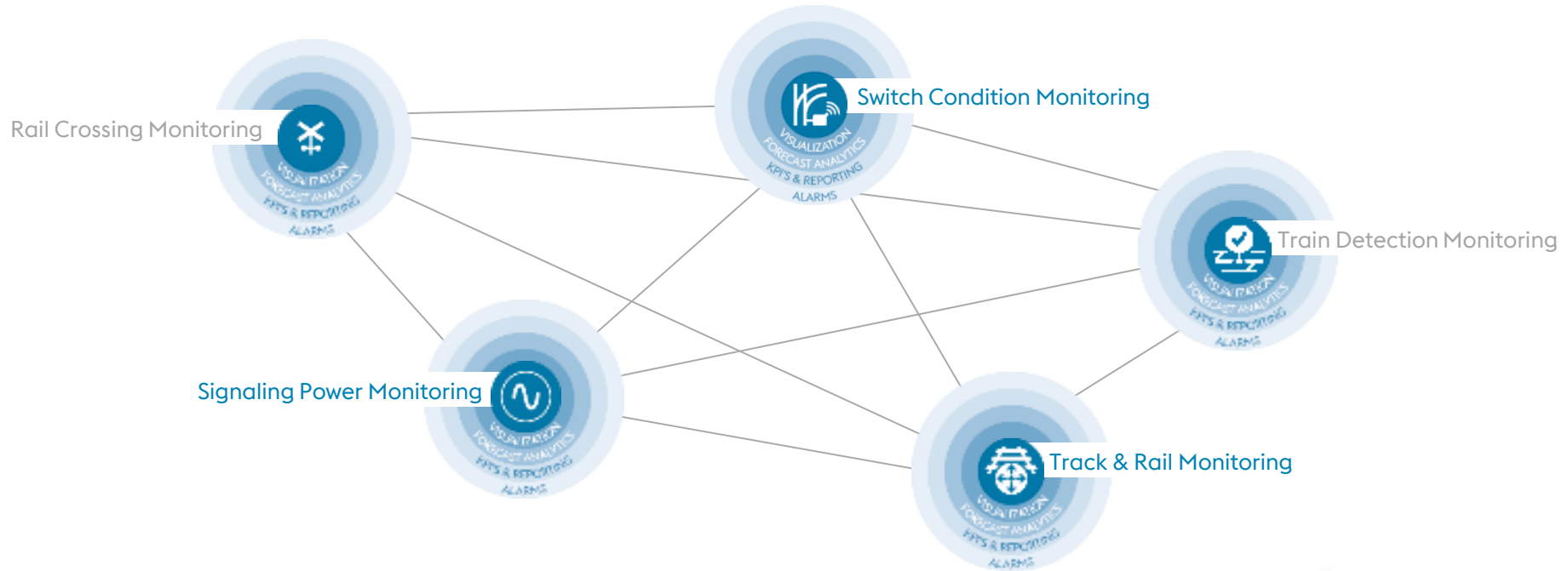
40.000+
Assets monitored

Reduction of as much as 40% in
turnout failures



10,000+
Point machines
monitored

CATEGORIES



SWITCH CONDITION MONITORING

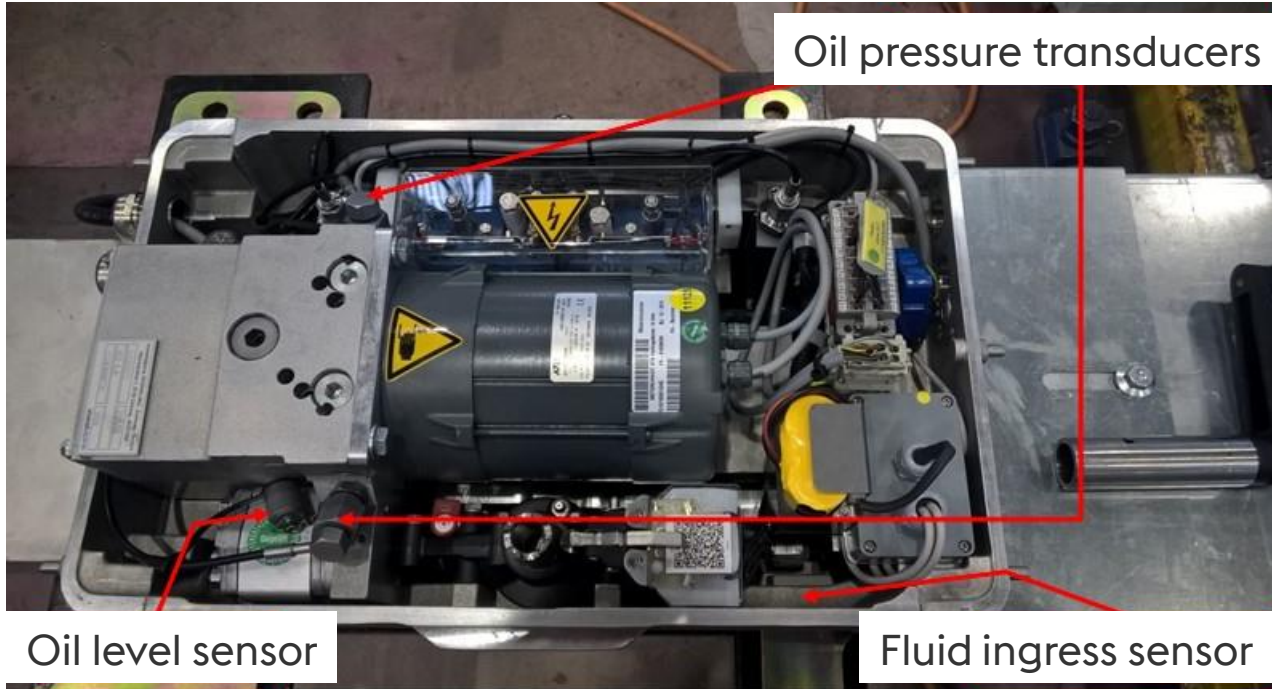
SWITCH CONDITION

Alarm

amp

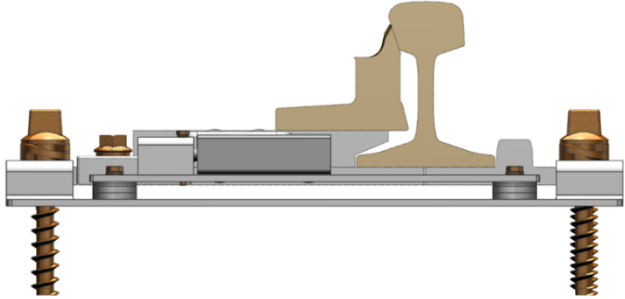


Points Operating Equipment



- » UNISTAR HR® machine shown
- » Sensors incorporated in housing:
 - » Hydraulic pressure
 - » Hydraulic fluid level
 - » Fluid ingress
 - » Structure Borne Acoustic Sensor (not shown)
- » For electric drive machines:
 - » Motor current
- » All sensors are solid state
 - » virtually maintenance free

Rail Position



- » Precise measurement of rail position
- » Used at Toe and Minimum Flange Position
- » Linear sensor range 0-30mm for maximum accuracy
- » Open and closed position possible
- » Solid state output
- » Custom fixation for high-quality installation

Structure-Borne Acoustic Sensor



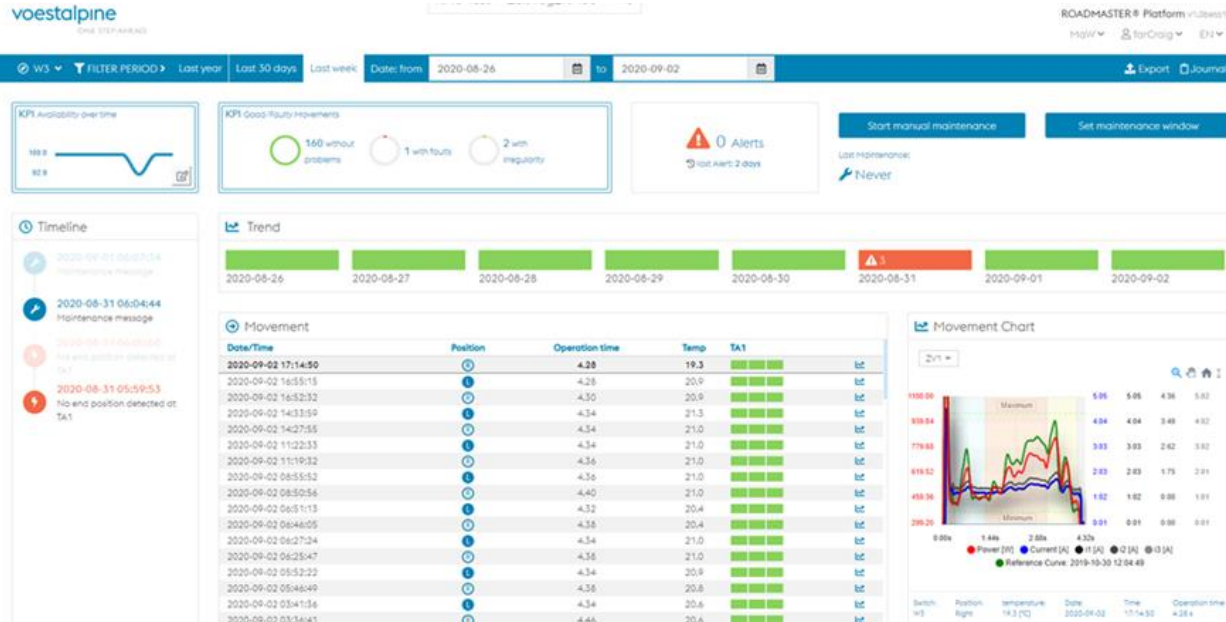
- » Sensors
 - » High-end acoustic emission sensor
 - » Gyroscope (acceleration & inclination)
 - » Temperature sensor
- » Edge processing
- » Installation
 - » Rail web
 - » Crossing area
 - » Bearer
 - » Points Operating Equipment
- » Can detect
 - » Voiding
 - » Crossing nose wear
 - » Rail damage
- » New processes needed (adhesive!)

Data Transmission



- » Advanced dataloggers
- » Communication via mobile data or fixed network
- » Can be coupled with CCS enclosure for drive and detection monitoring
- » Dataloggers require specialist inputs for monitoring drive and detection
- » Sensors provided with assets
- » Edge-computing on sensors
- » Sensor cable lengths 500m+

Turning Data into Information



» ROADMASTER® Diagnostic & Monitoring System

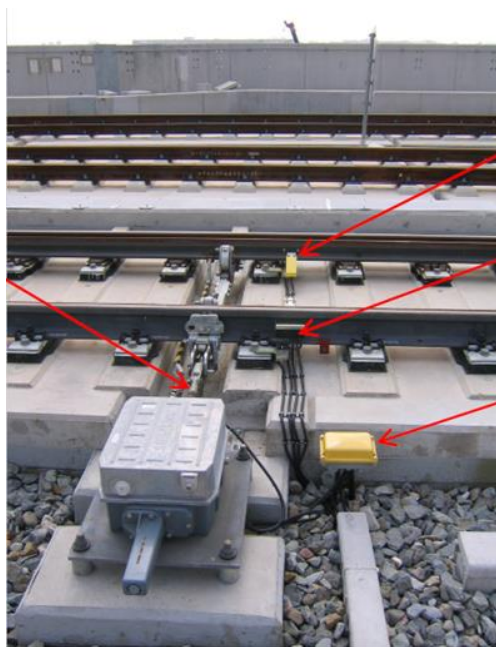
- » Data storage and processing
- » Alarms & alerts
- » API for master dashboards

» Flexibility of server installation is key

- » Hosted (customer or supplier)
- » Cloud

» Historic data, trending and analytics

Turnout Integration



- » Sensors **within** Points Operating Equipment
- » **Pre-routing** and fixing for cables
- » **Perfect-fit** brackets for sensors
- » Installation speed, **quality** and skill level
- » **Tested** as part of turnout
- » Monitoring systems are historically generally **SIL-0**
- » Sensors within **Points Operating Equipment** require additional assurance

Crossing Degradation

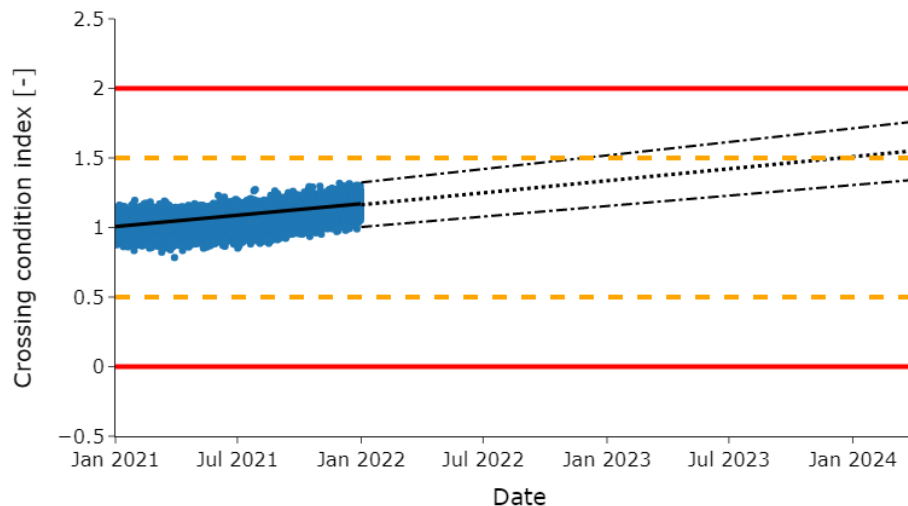
- » Dynamic loads lead to RCF, wear and plastic deformation of frogs and wing rails
- » Crossing condition index monitors and predicts crossing health



Crossing Degradation Data

Parameters

Trains	Total	Percentage
Regional Trains	21,900	40%
International Trains	14,600	27%
Freight Trains	18,250	33%
Direction	Facing	Trailing
[%]	94	6
Route	Through	Diverging
[%]	92	8
Speed	Maximum	Average
[km/h]	163	112
Capacity / Day	Maximum	Average
MGT	0.38	0.12



A modular approach.





RAILWAY
SYSTEMS

Thank you

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ONE STEP AHEAD.