

# Rail Stress Management VERSE and VSR

Craig Mulvay  
2024

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# Hello and Welcome



**Craig Mulvay**

**BEng (Hon) Mechanical, UK Chartered Engineer, EMBA**

**Head of Business Development – Pandrol Vortok Product Line**

**2014 – 2018 – Head of Engineering**

**2018 – 2022 – Technical and Commercial Manager – APAC**

**2022 – Current – Head of Business Development**

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# Rail Stress Management - Theory

# What is Rail Stress Management (RSM)?



Rail Stress Management is the active management of rail thermal forces to prevent buckling in high temperatures or rail break in low temperatures.

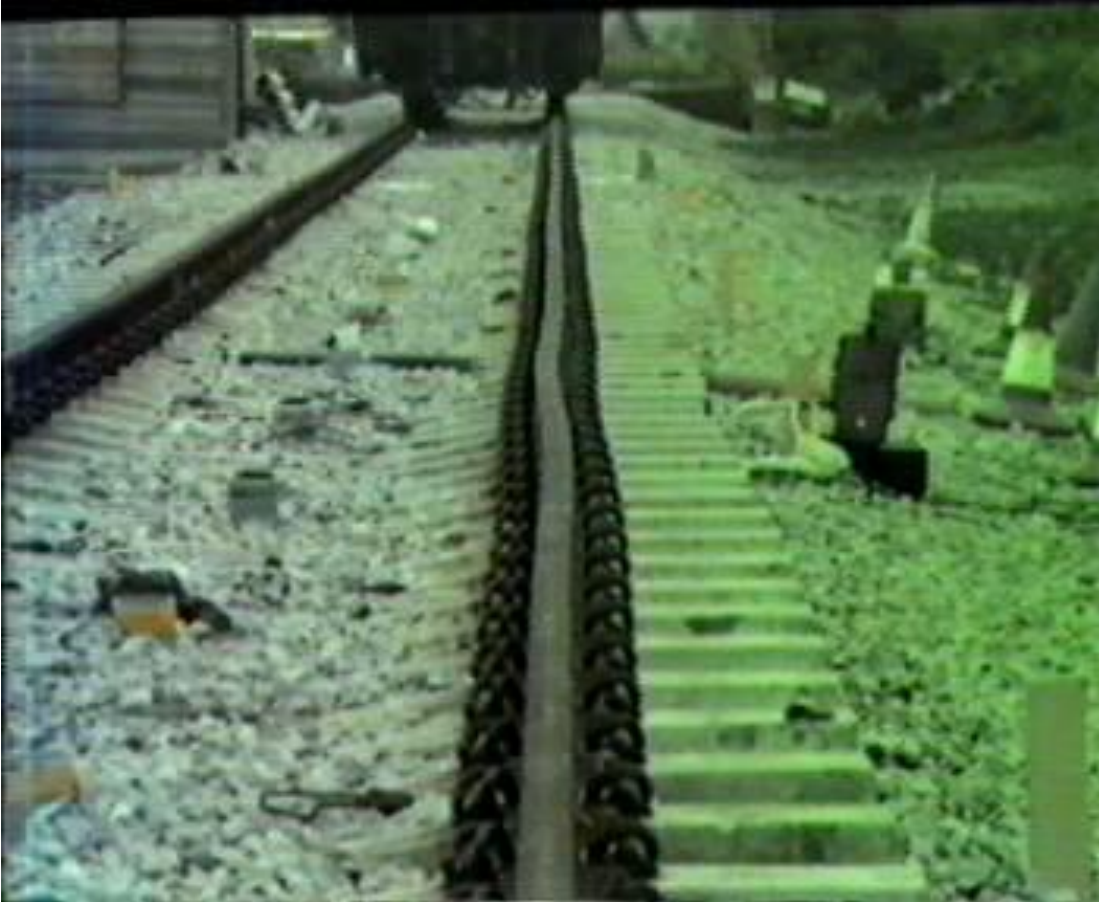
One of the foundations of managing the risk is by maintaining the Stress Free Temperature (SFT) of the rail.

Stress Free Temperature (SFT) = Neutral Rail Temperature (NRT)

# Buckle vs Break



Buckle



Break

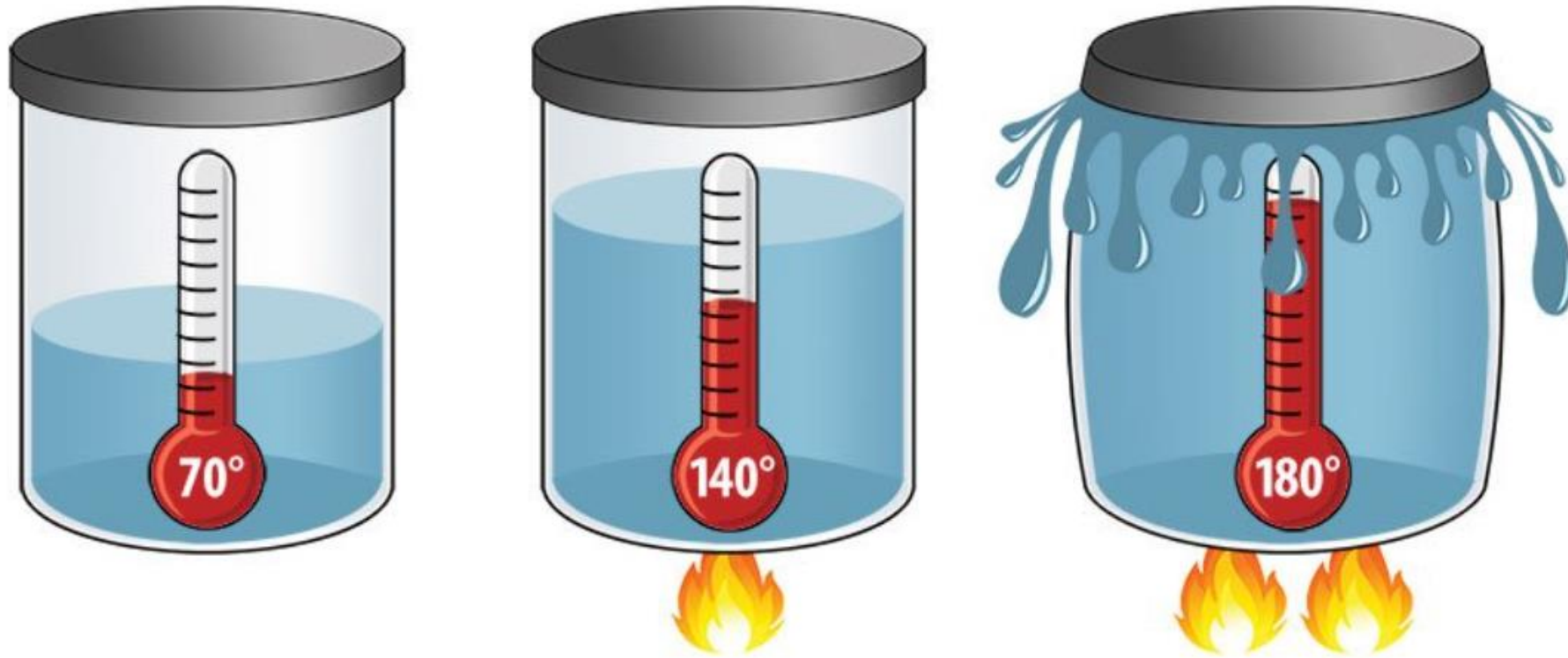


# Buckle vs Break

## Buckle



# What is SFT: Thermal Expansions



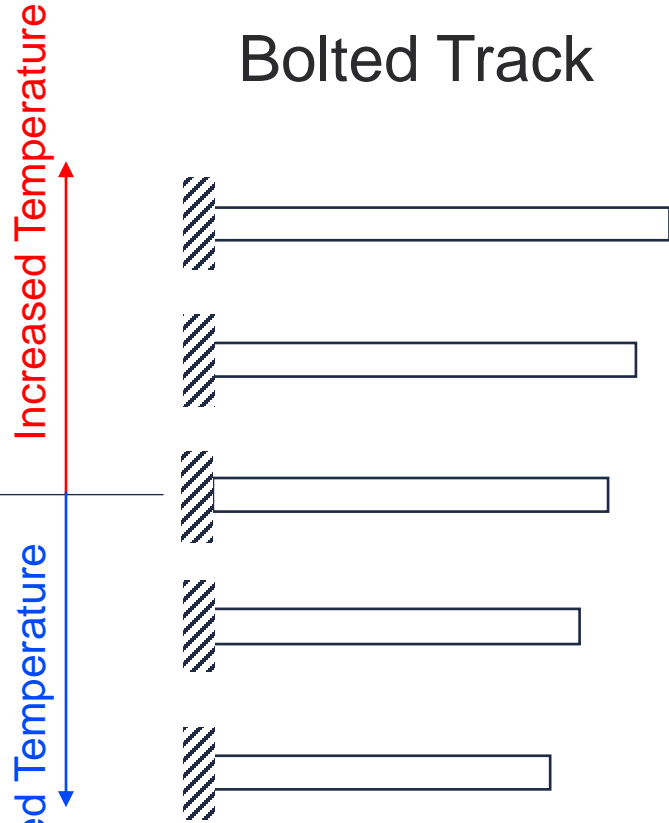
As temperatures increase, most materials expand in volume - **thermal expansion**.



# What is SFT:



Bolted Track



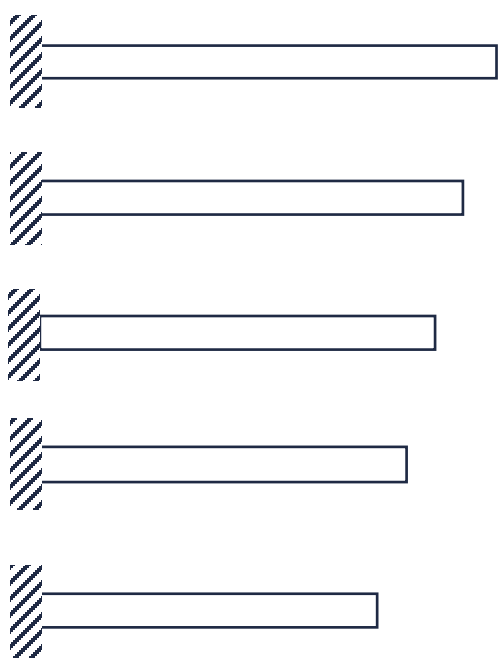


# What is SFT:

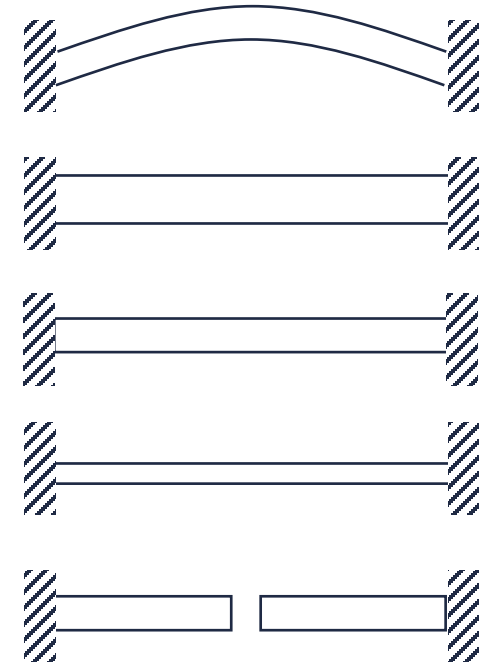


Increased Temperature ↑  
Decreased Temperature ↓

## Bolted Track



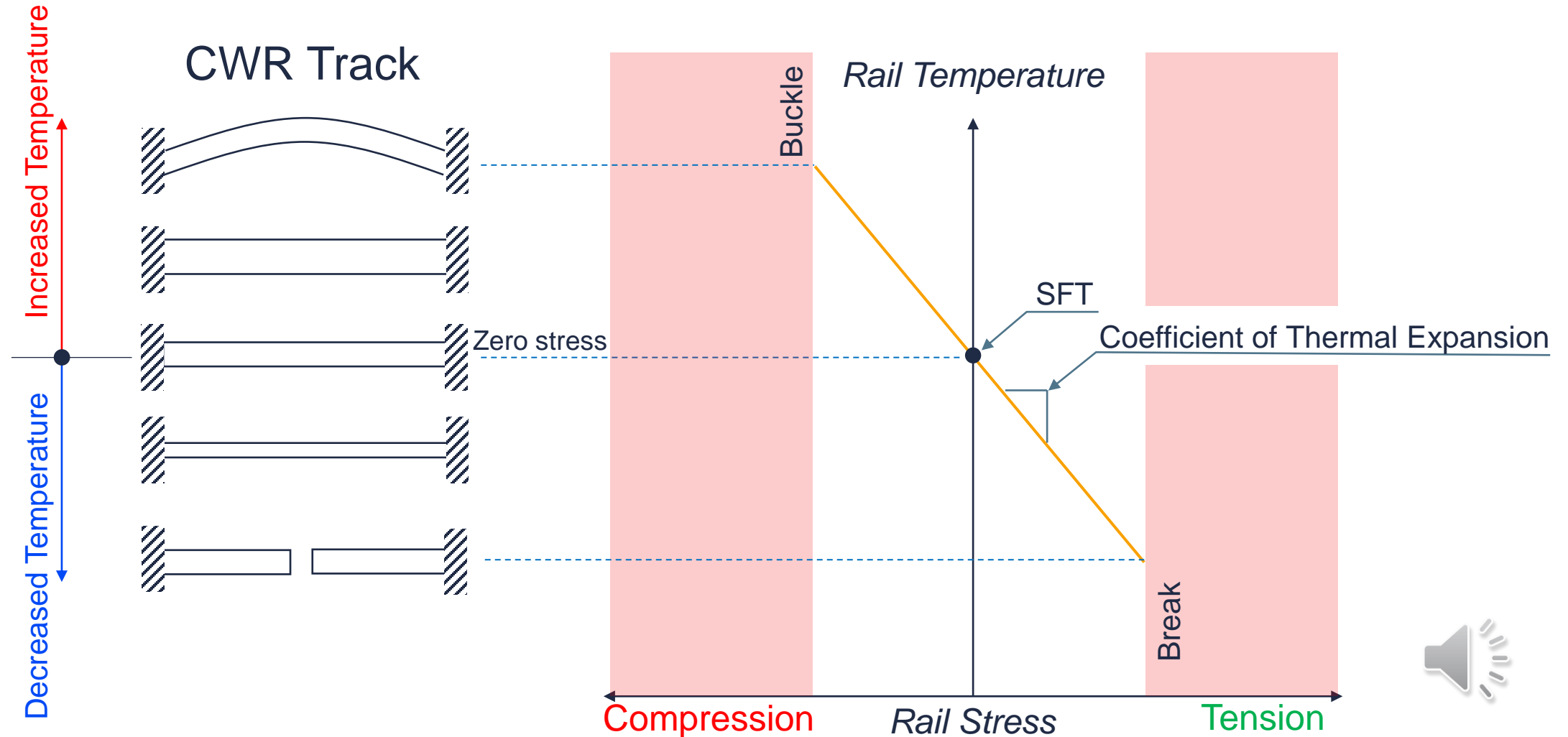
## CWR Track



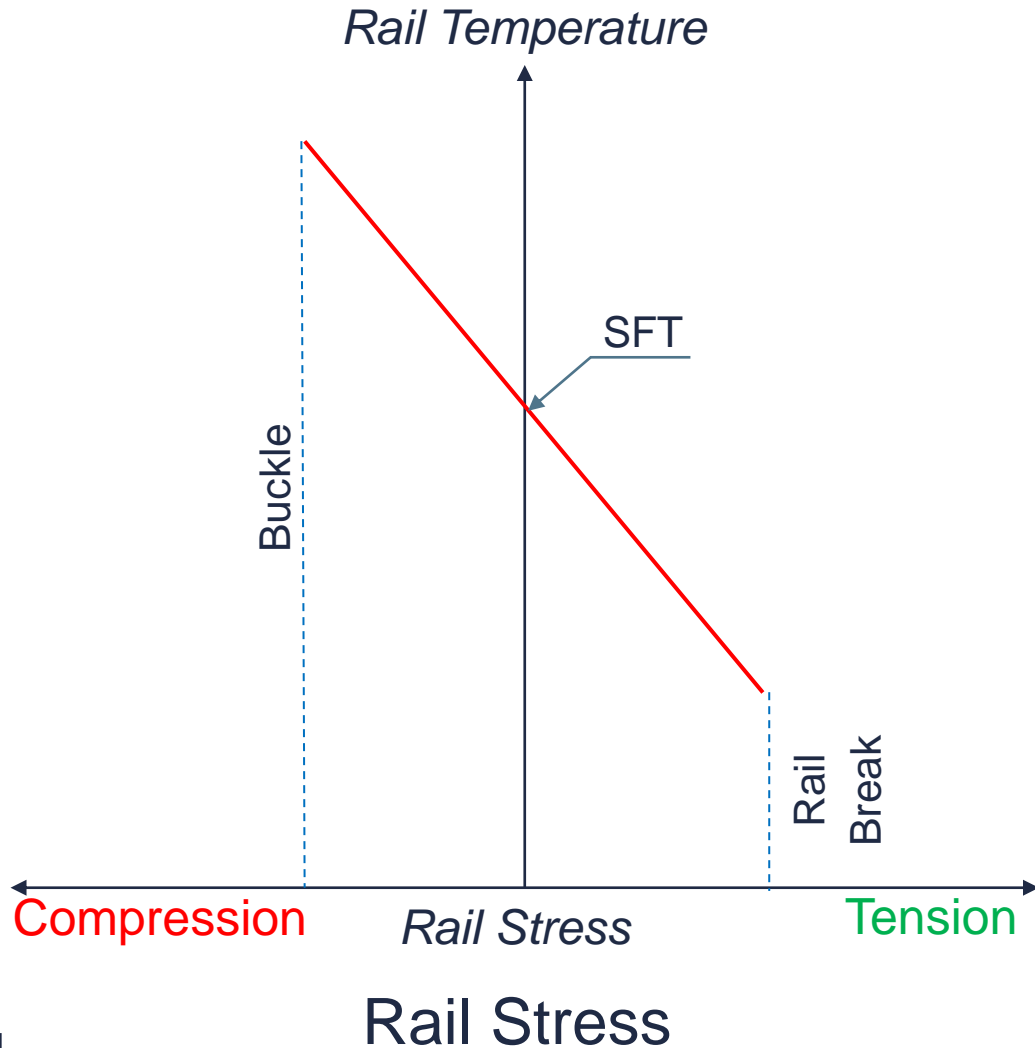
Compressive stress buckles track  
Compressive stress  
Zero stress  
Tensile stress  
Tensile stress breaks track



# What is Stress Free Temperature (SFT)



# What is Stress Free Temperature (SFT)



Stress Free Temperature (SFT) is the temperature at which the rail is at zero axial thermal loading.

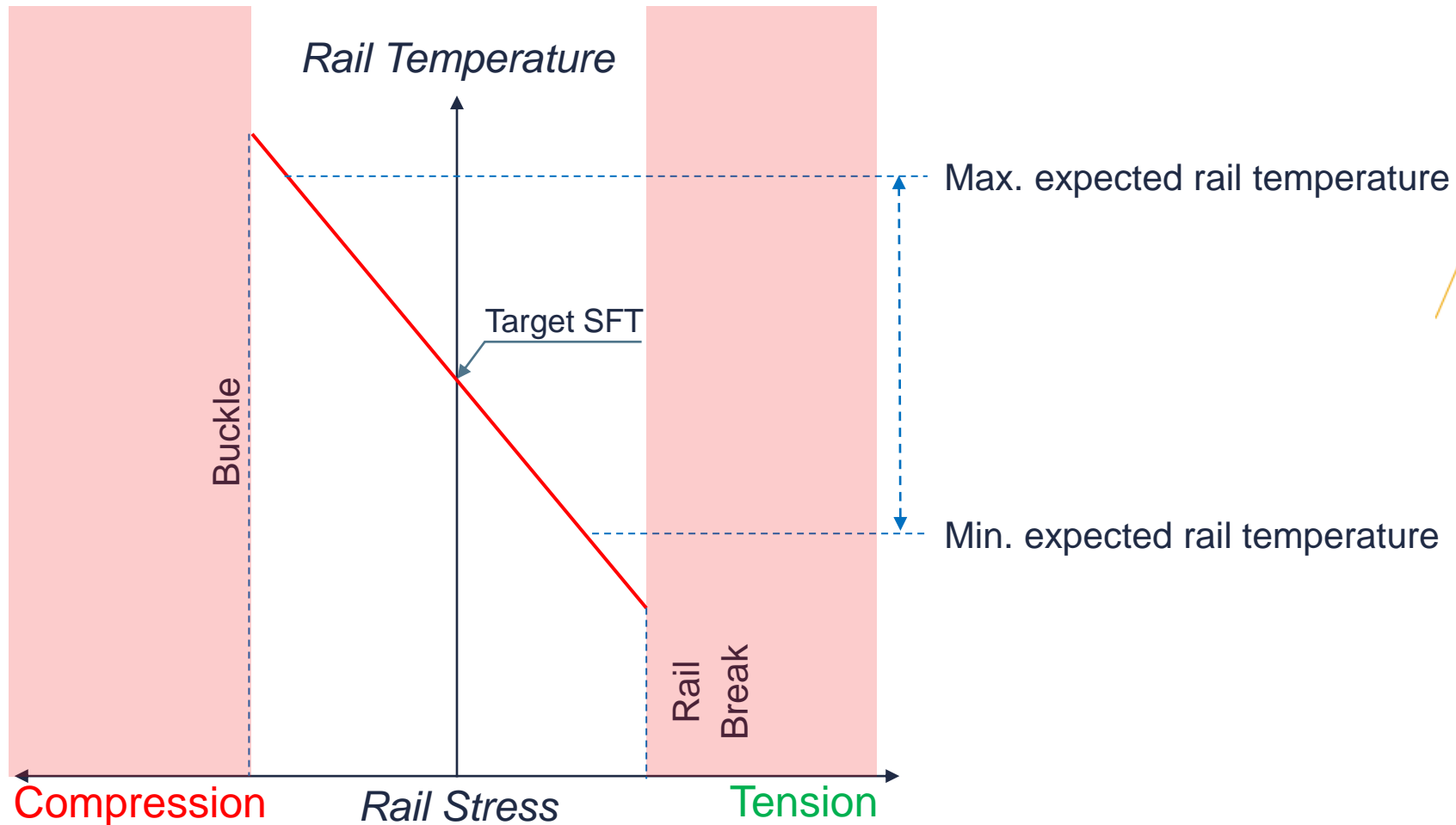
That is; not in tension and not in compression.

SFT = Neutral Temperature

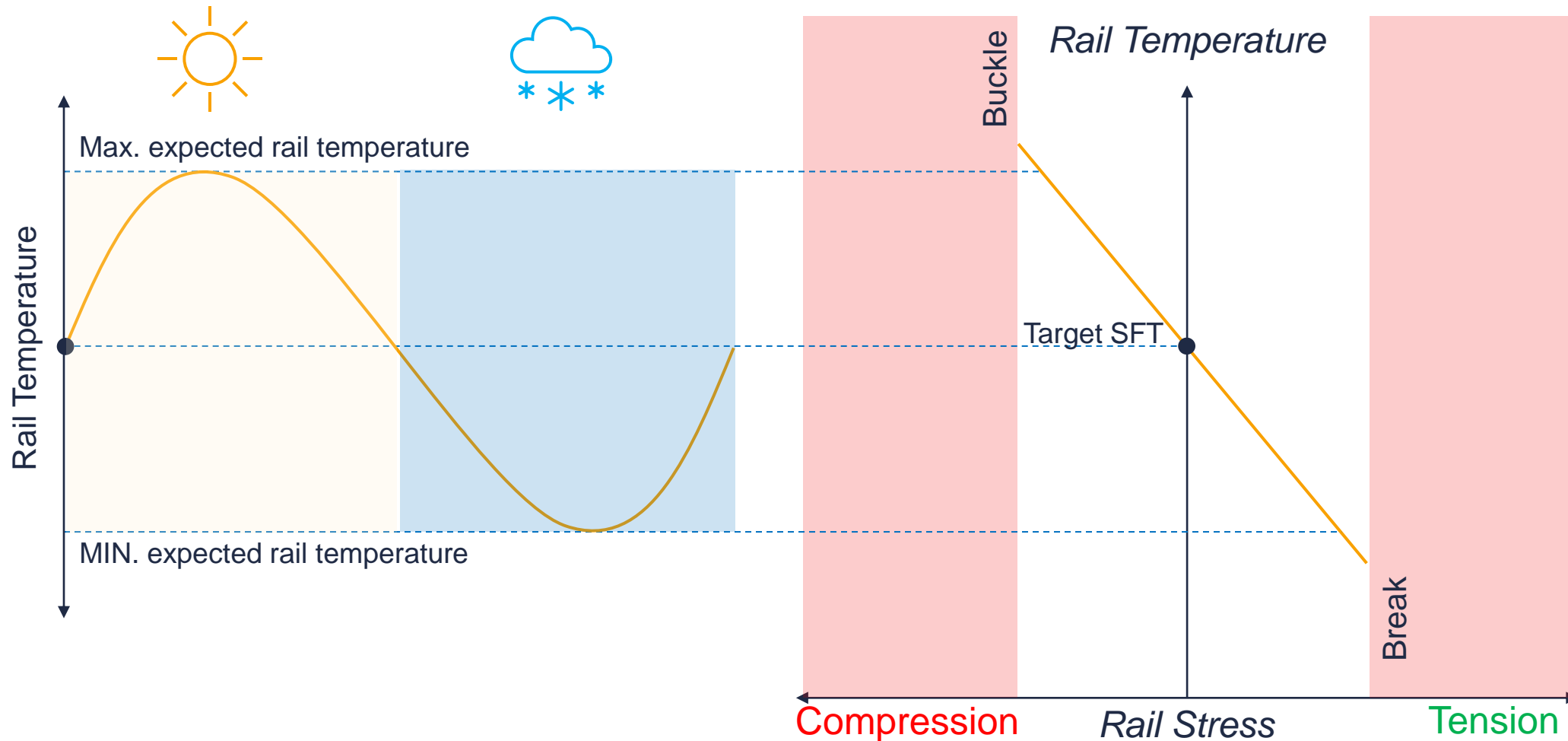


# Target SFT

Target SFT is set by the Track Owner



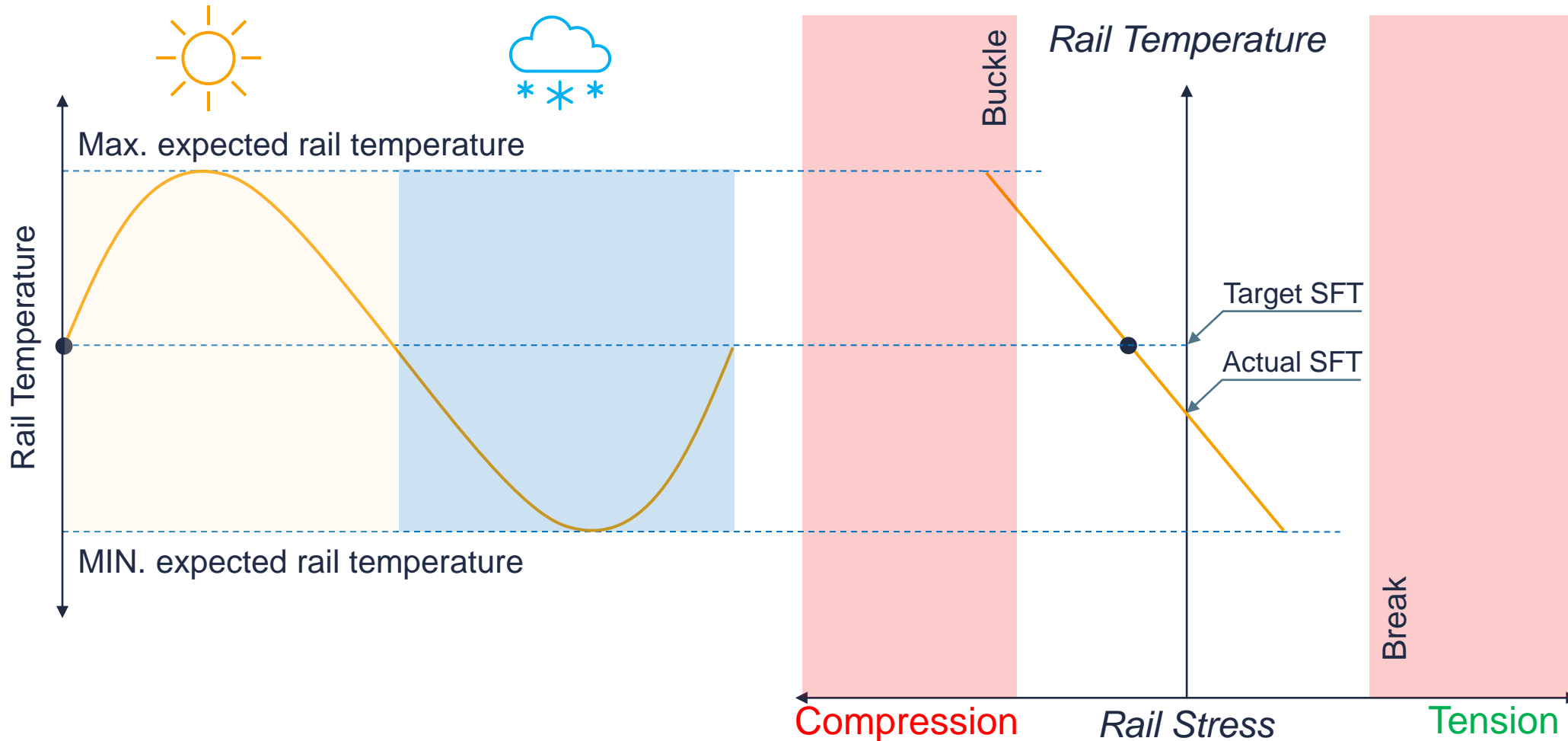
# Well Maintained SFT



# SFT Below Target

**Buckle Risk!**

*Solution: Increase SFT back to target by adding tension to rail (removing steel)*

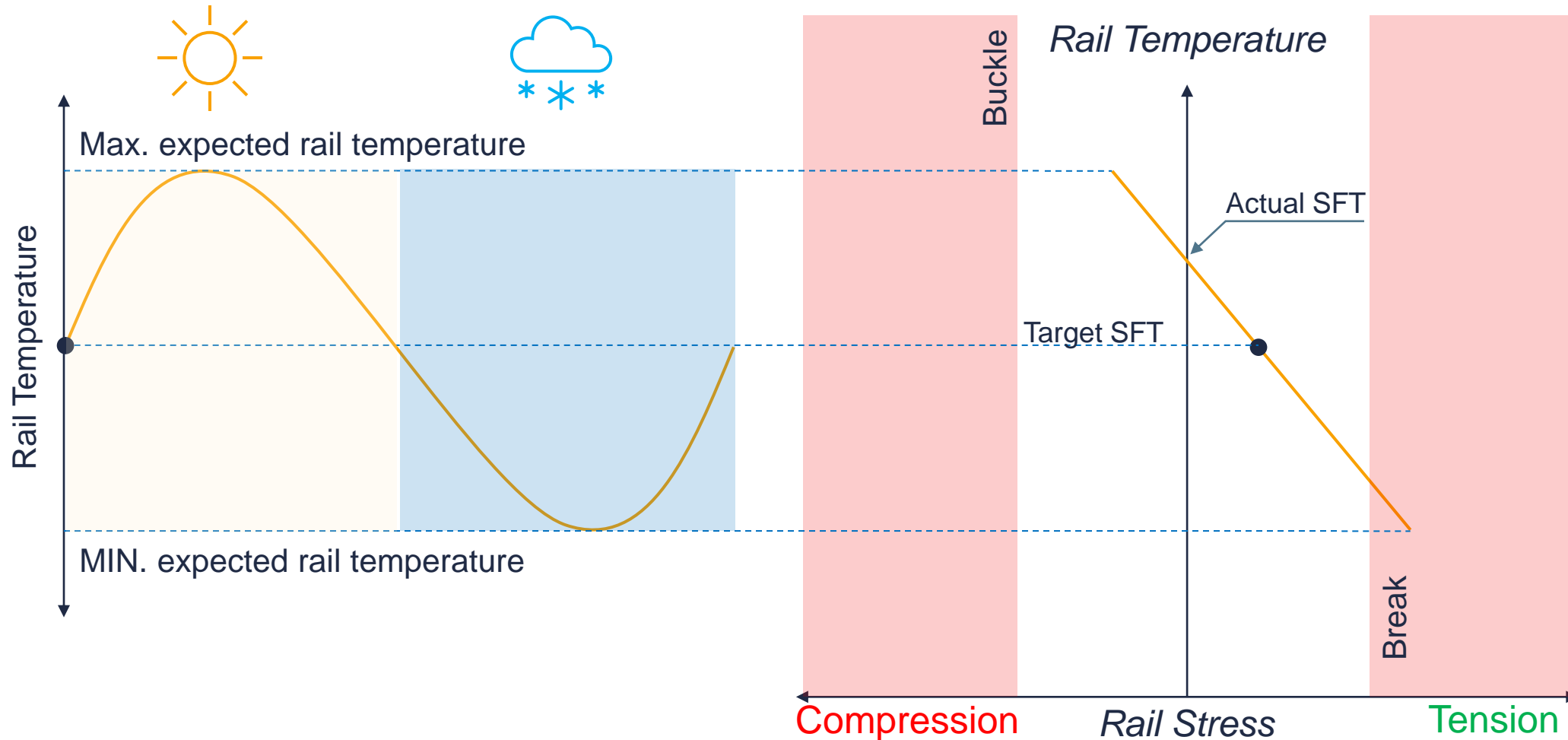


# SFT Above Target

## Rail Break Risk!



*Solution: Decrease SFT back to target by releasing tension to rail (adding closure rail)*



# Destress / Stressing Operation

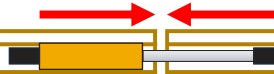


## Clipping Machines

VERSE SFT Tester



Vortok Stressing Rollers



Track Tools



Aluminothermic Welding



Non-destructive Testing







# VERSE

# Product Description Overview - VERSE



- VERSE – **V**ertical Rail **S**tiffness **E**quipment
- Non-destructive method of measuring Stress Free Temperature (SFT) of Continuously Welded Rail (CWR)
- Recognised standard for reducing risk of track buckles and rail breaks

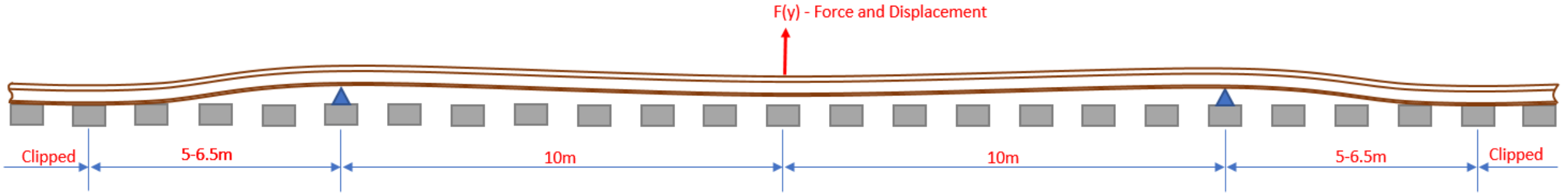


# How is VERSE Used?

- As a routine Survey Tool
- As a spot check
- As a quality control tool
- To check mechanised maintenance impact
- As a research tool



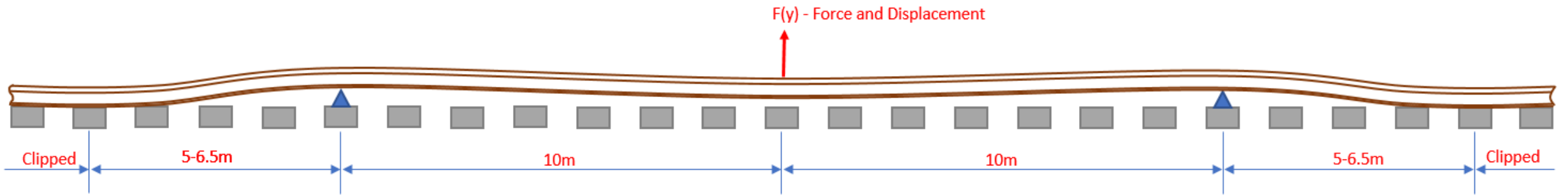
# Theory – Overview



- Rail is raised to bridge across two support points
- Rail is deflected in the centre of the beam and Force and Displacement is measured
- Force vs Displacement result is a function of the Rail Tension which is in turn a function of the SFT
- $F(y) \rightarrow$  Rail Tension  $\rightarrow$  SFT



# Theory – Overview



SFT  $\rightarrow$   $F(y)$

Inputs:

Force and Displacement Data

Rail Temperature

Rail Section Stiffness

- Rail Section Type

- Rail Wear

- Elastic Modulus (constant)

Beam Geometry

- Inner Spans

- Outer Spans

Curve Versine (before and after unclipping)

Outputs:

**SFT of the Rail**

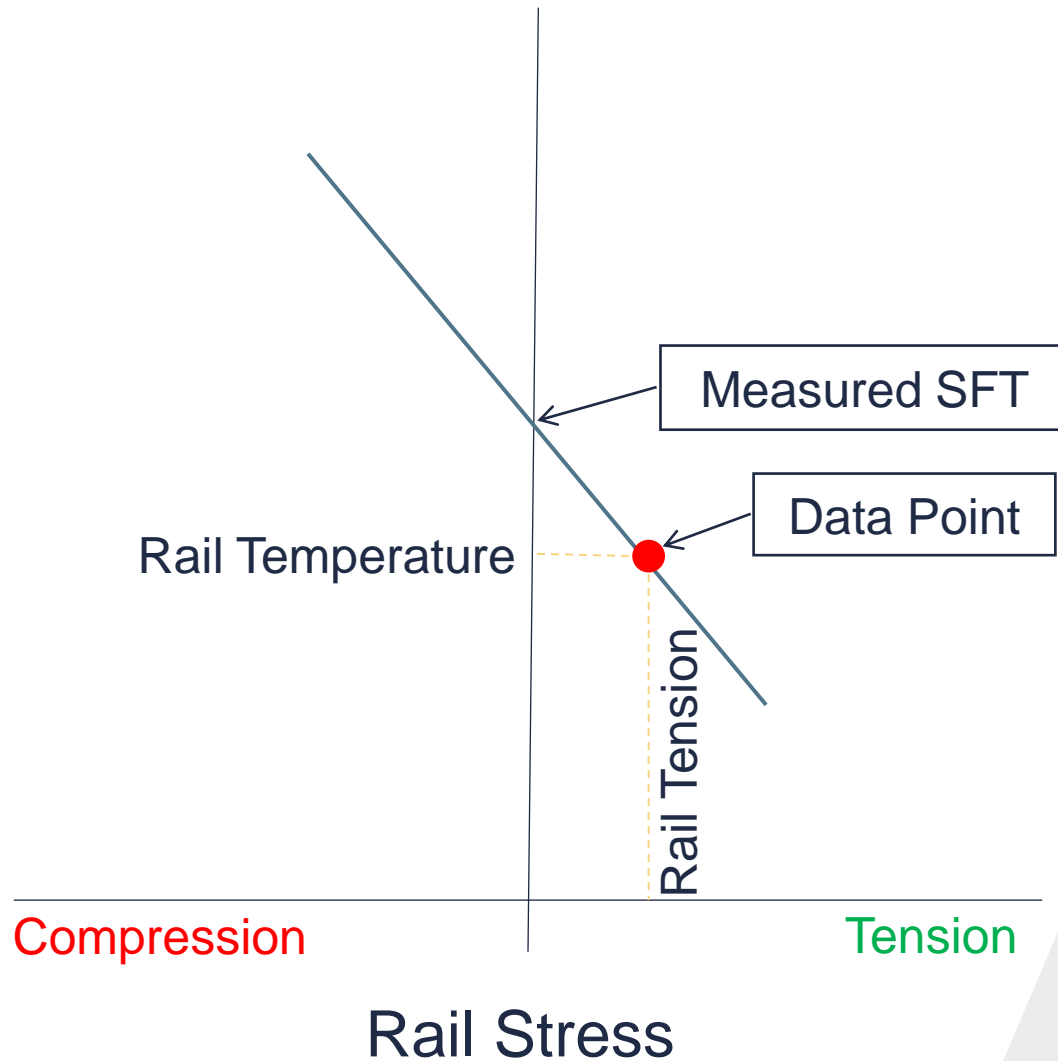


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# Theory – Overview



Rail Temperature



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# Handheld Computer



09 Mar 2017 100% 15:51:47

**Rail** Left

Span Total 1	Span Inner 1	Span Inner 2	Span Total 2
15	10	10	15

**Save** **Cancel**

Left

**Rail Section**  
UIC50

**Rail Height (mm) 1**  
152

**Rail Height (mm) 2**  
152

**Save** **Cancel**

09 Mar 2017 100% 15:57:15

**Measurement Run: 1**

Load (kN)	Disp (mm)
4.530	36.48

**Part Lift** **Abort**

09 Mar 2017 100% 16:00:06

**Run 1**  
SFT

28.0C

*Details*  
Lift Status: Ok  
Curve Compensation Factor: 2.6C  
Calculated SFT: 25.4C

**OK**



# Equipment Overview – PC Software



VERSE - 0380\_94.BIN - wl wl - (12/06/2021 9:45:29 am) - Handheld V 5.0.4

**File Details**

Name:	0380_94.BIN [v3]	Lifts:	3	Operator ID:	
Date:	12/06/2021 9:45:29 am	Source:	Calculated	Kit ID:	0380
UID/Ref No:	3237343537370000	Run:	94	Handheld Rail Section:	NZ50

**Graph Details**  
Max Load 10      Max Disp 72

**Site Details**

ELR	wl	m	57	yds	199
TID	wl	Curve Radius	0		
Location	featherston				
Cant	0				

**Rail Details**

Rail	Left	Rail Section	NZ50	Notes				
Start Temperature	11.9		(1.0.0)					
End Temperature	11.9	Rail Depth	153.7					
Span Inner 1	9.8	Span Inner 2	9.8	Span End 1		15.44	Span End 2	16.04

**Lift Details** (1 of 3)  
30.6°C (87.1°F) CR: 92%

**Handheld SFT**  
Average of 3  
30.8°C (87.4°F)

**Calc'd SFT**  
Average of 3  
30.8°C (87.4°F)  
Overall CR: 90%

**Curve Compensation**  
Clipped versine: 0  
Unclipped versine: 0  
Curve Comp Factor: 0

**Messages**

**Buttons:** Load, Save to DB, ReCalculate, Unlock, Create Certificate, Close





# Equipment Overview – PC Software



## PANDROL VERSE SFT Measurement Report

Date and Time		Site Details	
Recording date	12/06/2021	ELR	wl
Recording time	09:45:29	TID	wl
		Miles	57
		Yards	199
		Location	featherston
		Cart	0
		Curve	0
		Rail	Left
		Rail Section (PC)	NZ50 (1.0.0)
		Rail Section (Handheld)	NZ50
		Rail Height	153.7mm
		Start Temp.	11.9°C (53.4°F)
		End Temp.	11.9°C (53.4°F)

Equipment Details	
Verse Kit ID	0380
Handheld Serial Number	3237343537370000
Handheld S/W Version	V 5.0.4
PC Software Version	V 6.0.0.0
Load Cal.	412.03
Displacement Cal.	-33.16

Individual Run Results					
Run	Time	Raw SFT (No CC)	Confidence Ratio	Error	User Selected
1	09:39	30.6°C (87.1°F)	92%	No	Yes
2	09:41	30.8°C (87.4°F)	87%	No	Yes
3	09:42	30.9°C (87.6°F)	91%	No	Yes
4	-	-	-	-	-
5	-	-	-	-	-
6	-	-	-	-	-
7	-	-	-	-	-
8	-	-	-	-	-
9	-	-	-	-	-
10	-	-	-	-	-

Results Summary	
File Name	0380_94.BIN
Operator ID	
Runs Recorded	3
Curve Compensation	0.0°C (0.0°F)
<b>Average SFT</b>	<b>30.8°C (87.4°F)</b>
<b>Confidence Ratio</b>	<b>90%</b>

**Notes**

Name: \_\_\_\_\_ Signed: \_\_\_\_\_ Date: \_\_\_\_\_





# VSR



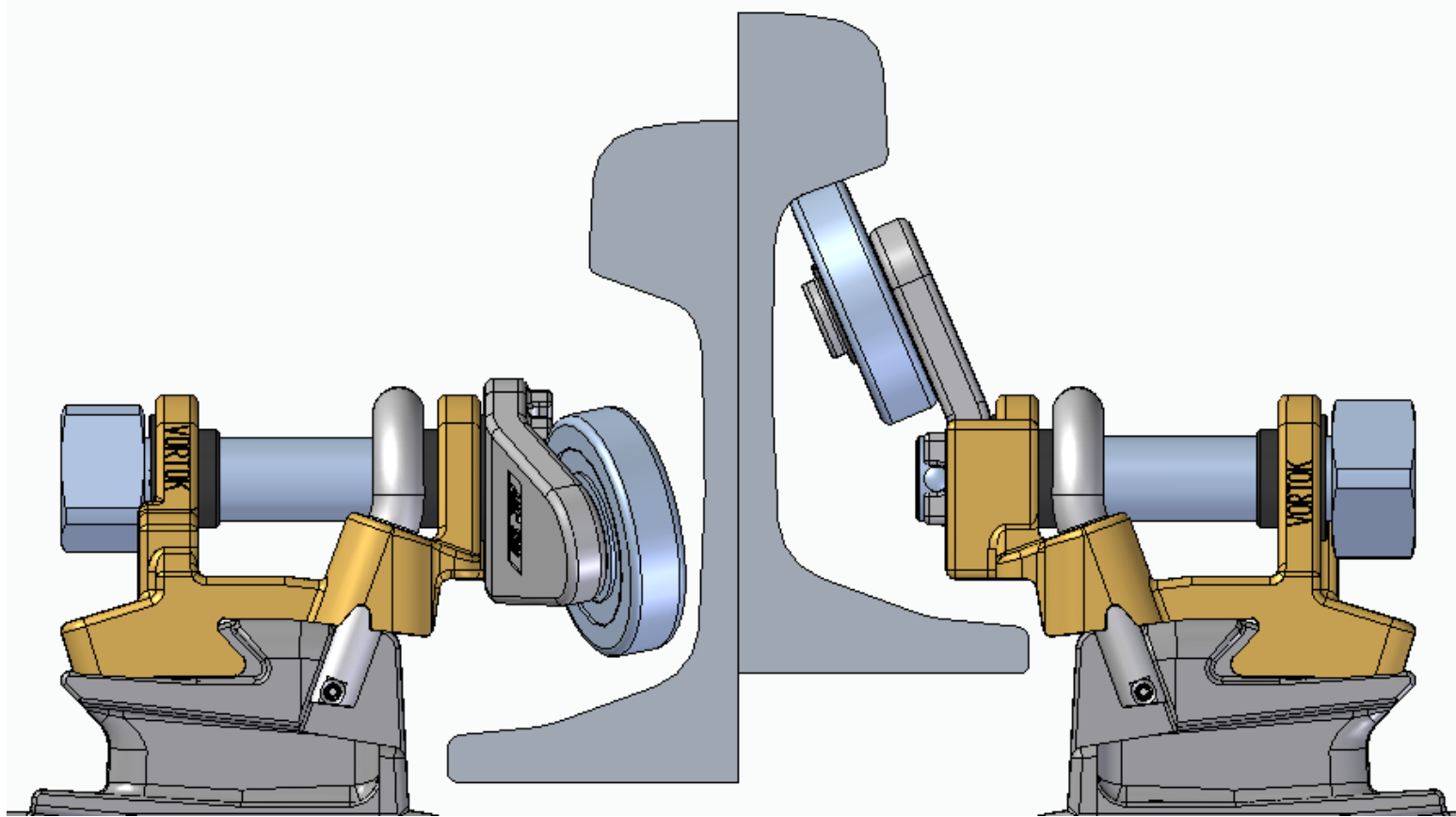
# Product Description Overview - VSR



- VSR – Vortok Stressing Roller
- Roller to support Stressing/Destressing operations
- Lifts the rail onto a roller bearing to provide low friction contact to rail
- Utilises Rail Fastening Shoulder as load reaction point

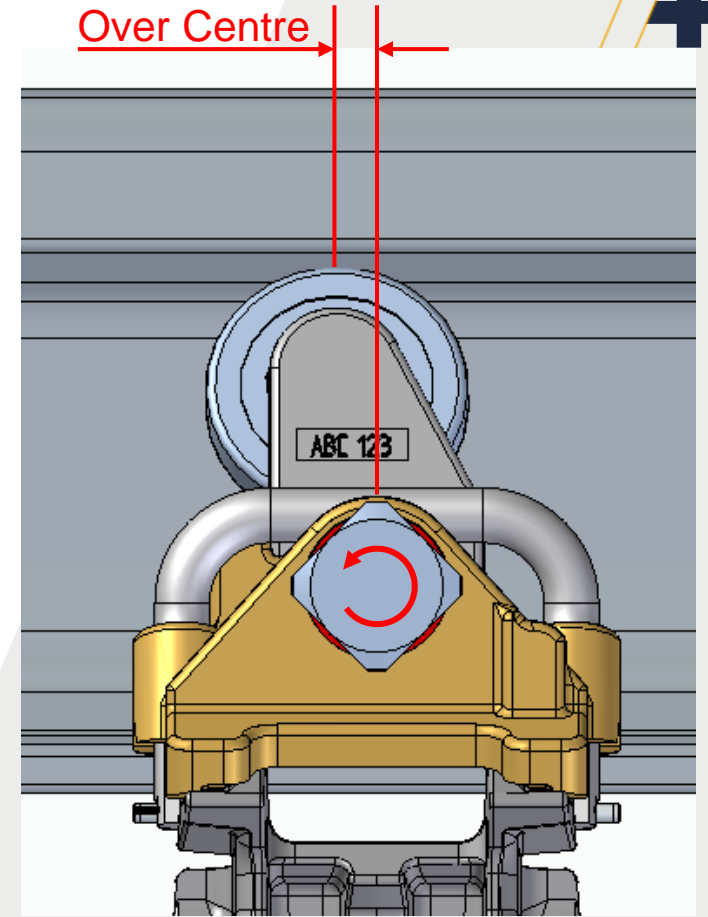


# How It Works



Lowered

Raised

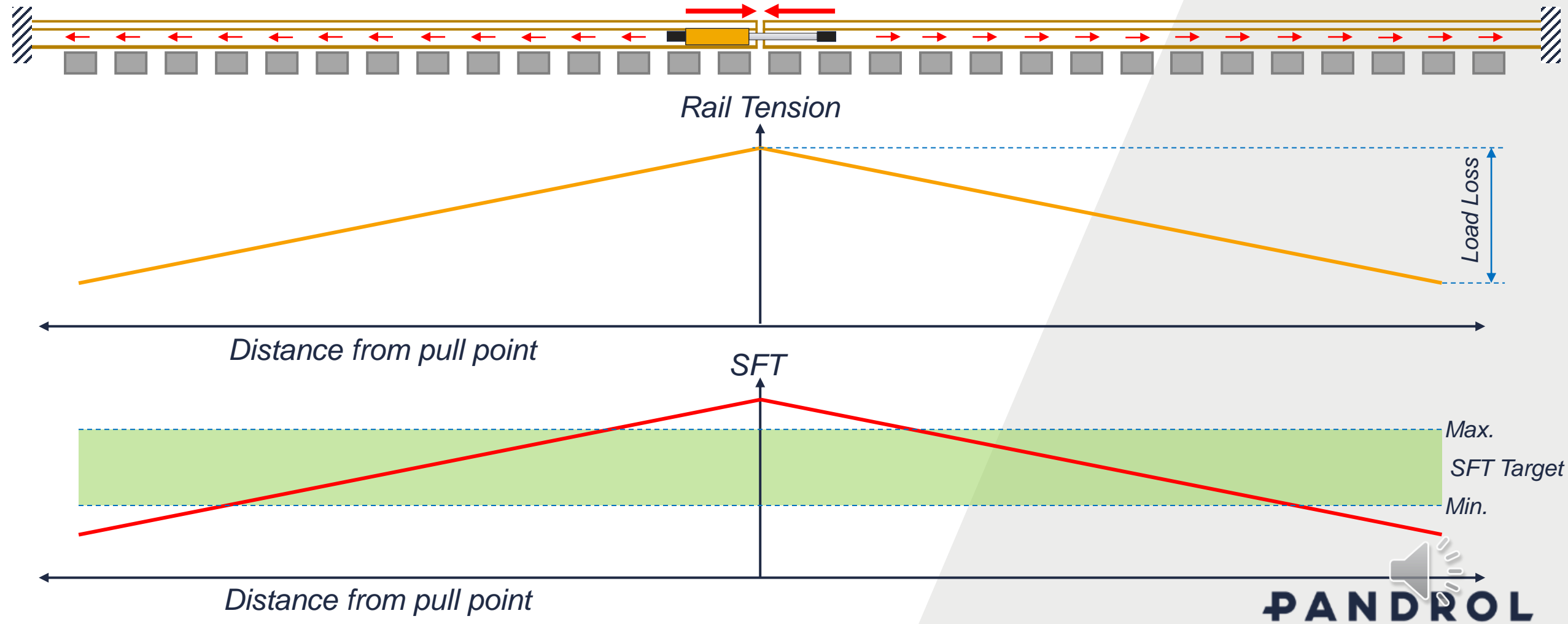


# How It Works

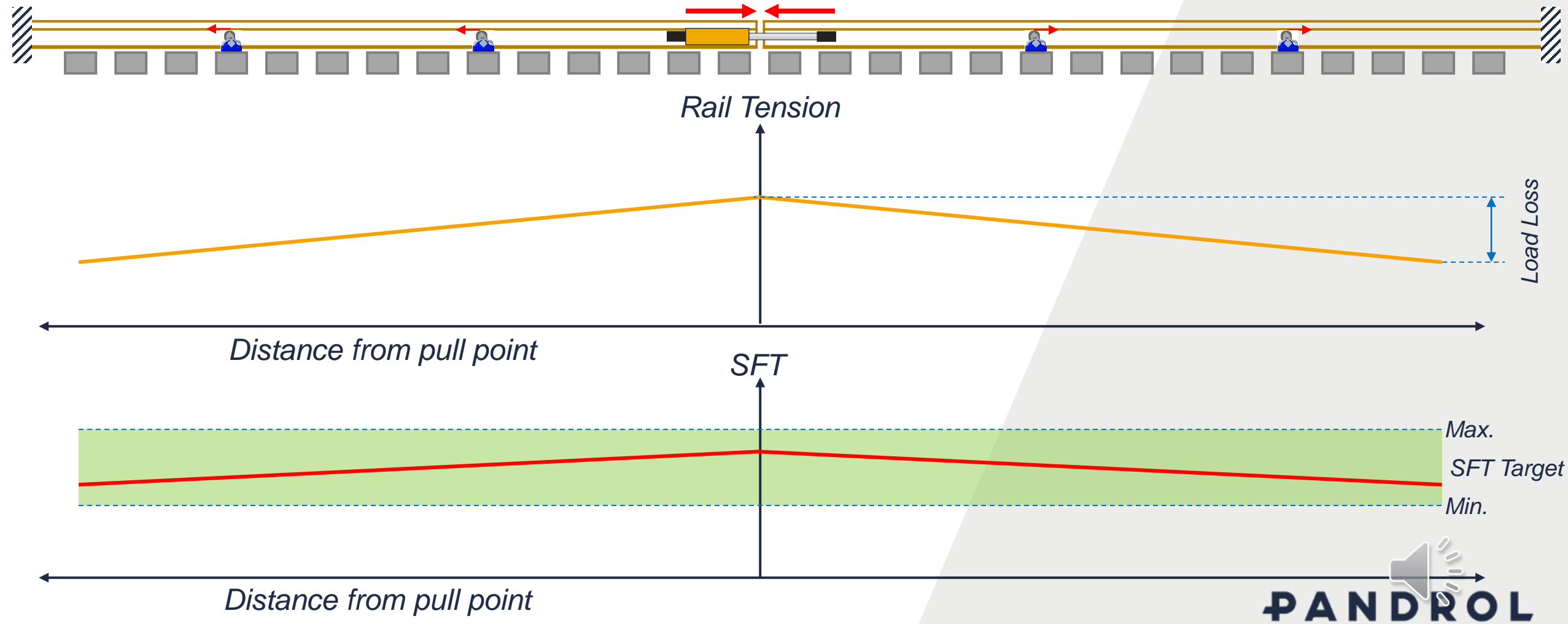


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# How It Works – Reason for using VSR



# How It Works – Reason for using VSR



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# Application – VSR Spacing

## VSR Spacing Guide

- Note that some rail authorities have their own guidance.

Radius [m]	VSR Frequency
$R < 250$	Do not use
$250 < R < 350$	Every 2nd Sleeper
$350 < R < 450$	Every 3rd Sleeper
$450 < R < 550$	Every 4th Sleeper
$550 < R < 650$	Every 5th Sleeper
$650 < R < 750$	Every 6th Sleeper
$750 < R < 850$	Every 7th Sleeper
$850 < R < 950$	Every 8th Sleeper
$950 < R < 1050$	Every 9th Sleeper
$1050 < R$	Every 10th Sleeper

Note: guidance based on 700mm sleeper centres

## VSR

- VSR packed into plastic storage tubs which are used to manage parts onsite
- VSR Spanners







# Our Experience



# Our Experience - VSR

- 225,000+ VSR units sold globally.
- Countries VSR used:
  - UK
  - France
  - Denmark
  - Norway
  - Sweden
  - Brazil
  - Australia
  - South Africa
  - USA



**Network Rail**

Acceptance National Specialist Team  
Network Rail,  
Floor 4, 40 Melton Street  
London,  
NW1 2EE

From: Steve Rennolds

Tel: 085 78944 (0207 557 8944)  
Fax: 085 79013 (0207 557 9013)  
Email: [Steven.Rennolds@networkrail.co.uk](mailto:Steven.Rennolds@networkrail.co.uk)

Date: 28 Nov 2006

**Acceptance Advice Note  
(for Network Rail use only)**

THE ADVICE NOTE IS ONLY APPLICABLE TO THE ACCOMPANYING CERTIFICATE OF ACCEPTANCE. THE CERTIFICATE MUST BE READ IN ORDER TO UNDERSTAND ANY RESTRICTIONS OR CONDITIONS THAT APPLY TO USE OF THE PRODUCT.

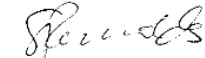
This advice note provides appropriate background information and any specific action that may be required in accordance with the **attached certificate**. It will enable you to meet your obligations in meeting the requirements of the Network Rail procedure NR/CS/ACC/029 (formerly RT/LS/P/029).

Certificate Ref.	Issue	Product
PA05/02578	1	Stressing Roller (for Fastclip applications)

**Manufacturer**  
Vortok International  
Unit 7, Haxter Close, Belliver Industrial Estate, Roborough, Plymouth, Devon, PL6 7DD  
Telephone: 01752 700601 Fax: Email: [Richard@vortok.co.uk](mailto:Richard@vortok.co.uk)

**Background/Reason for Issue**  
Vortok's stressing roller (VSR) system is a very fast fit and removable roller system, to reduce friction during stressing operations, and has gained acceptance for use with Pandrol Fastclip systems only.

**Network Rail action**  
None required

  
Acceptance Specialist

# Our Experience - VERSE



- 280+ VERSE units sold globally
- Approved in the UK (NR (PA05/00901))
- In Use in these countries
  - UK
  - France
  - Germany
  - Ireland
  - Italy
  - Sweden
  - Norway
  - Finland
  - Bosnia
  - China
  - Australia
  - Canada
  - USA
  - Mexico
  - Singapore
  - New Zealand

Certificate of Acceptance PA05/00901

**Manufacturer:**  
Vortok International

**Issue:** 3  
**Valid From:** 20.08.2018

VERSE (Vertical Rail Stiffness Equipment) incorporating DCCR bridge

**Product Description**

The Vortok VERSE (Vertical Rail Stiffness Equipment) (incorporating Direct Current Conductor Rail (DCCR) bridge) is a non-destructive method that can measure stress free temperature (SFT) of continuous welded rail (CWR). The VERSE kit is a combined mechanical/software system that can measure SFT on trackside.

The equipment consists of a portable loading frame, which is positioned over the rail to be measured. An upward vertical force is applied to the rail via the system hydraulics.

Transducers are used to measure the applied force with respect to the vertical displacement of the rail. This data is stored in a small robust handheld computer, which, along with a signal conditioning system, powers the transducers, captures their output signals and calculates the SFT.

**Product Image**

**Scope of Acceptance**

**Full Acceptance**

1) Accepted to measure and to indicate the stress state within continuous welded rail complying with NR/L2/TRK/001/mod3, issue 8, Clause 8.5 'Stress unknown' sites.

Safety, Technical and Engineering (STE) hereby authorise the product above for use and trial use on railway infrastructure for which Network Rail is the Infrastructure Manager on the ROGS regulations.

Reviewed by:

Lana Trnadi  
Product Acceptance Coordinator

Authorised by:

Gareth Evans  
Professional Head of Track

**TRACK ENGINEERING  
TYPE APPROVAL CERTIFICATE**

**Certificate Number:**

T-TA-01-2019

**MANUFACTURER:**

Vortok International

**SUPPLIER:**

**Pandrol**  
Vortok House, 3 Western Wood Way, Lingsae Science Park, Plymouth, PL7 5BG, UNITED KINGDOM

**PRODUCT DESCRIPTION:**

Vortok International's VERSE is a non-destructive system for measuring the Stress Free Temperature (SFT) of Continuous Welded Rails (CWR). The system is based on the principle that the vertical force required to lift a rail varies with the axial force contained within. Conventional SFT measurement techniques involve cutting the rail. Such destructive measurements are expensive, disruptive and slow. VERSE fulfils the need for a simple non-destructive SFT measurement technique.

**Limitations And Conditions of Use:**

Measurements shall not be carried out at rail temperatures above the minimum SFT tolerance. Site track configuration will need to be confirmed before conducting a test at the location. Equipment must be set with NZR rail profile data before use.

At all times the manufacturer's operating and maintenance manuals shall be adhered to. Operators shall be trained and certified competent in its use by the manufacturer. The manufacturer is to remain accredited to ISO 9001 for this product.

Any changes to the design, materials or manufacturing process from this date are to be notified to KiwiRail for subsequent type approval amendment.

**APPROVED FOR:**

**Pandrol**  
Vortok's VERSE Stress Measurement Equipment

**ISSUE DATE:**

30th October 2019

**ISSUED BY:**

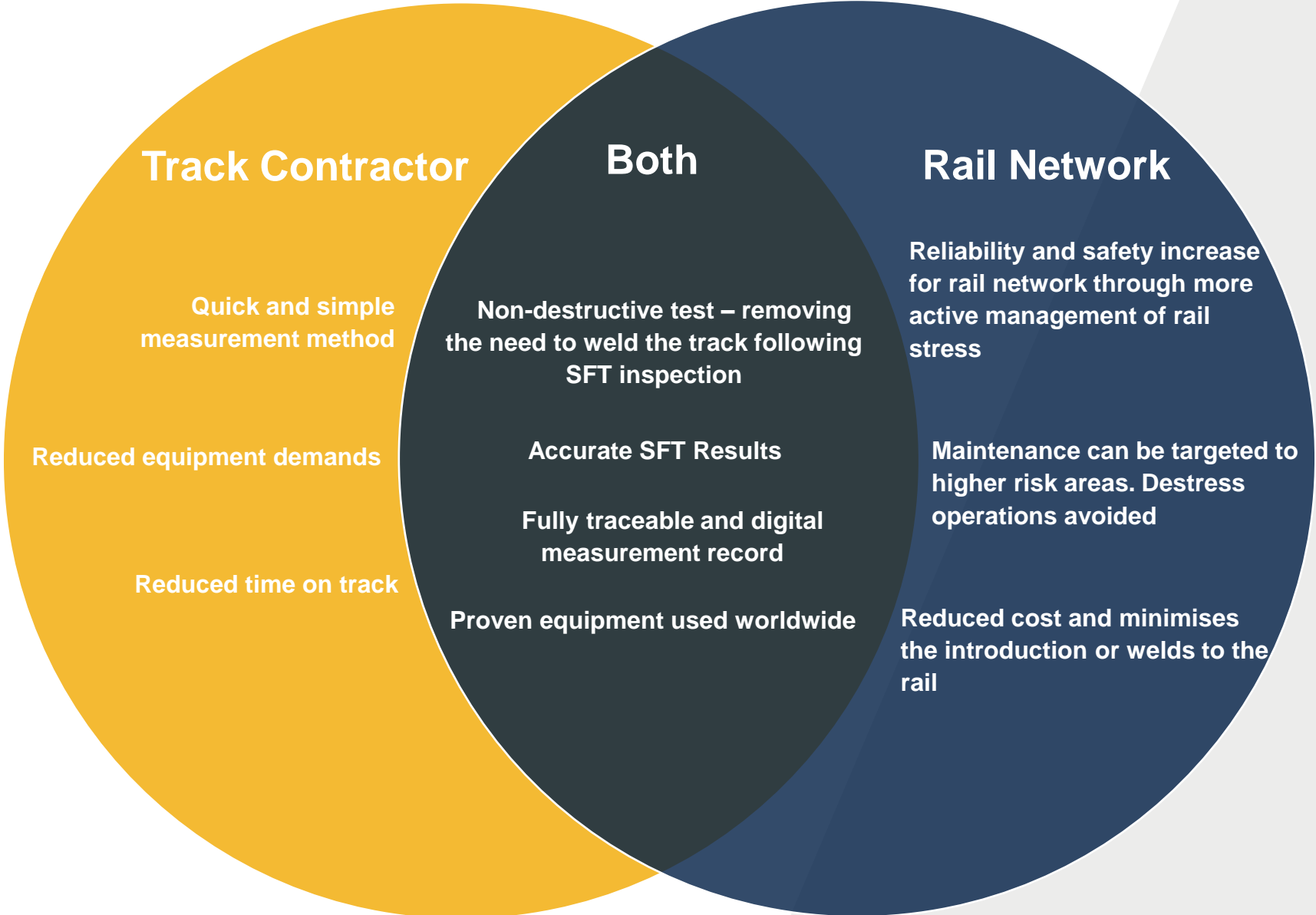
**NAME:** Mark Fleet  
**POSITION:** Professional Head of Track

**SIGNATURE:**

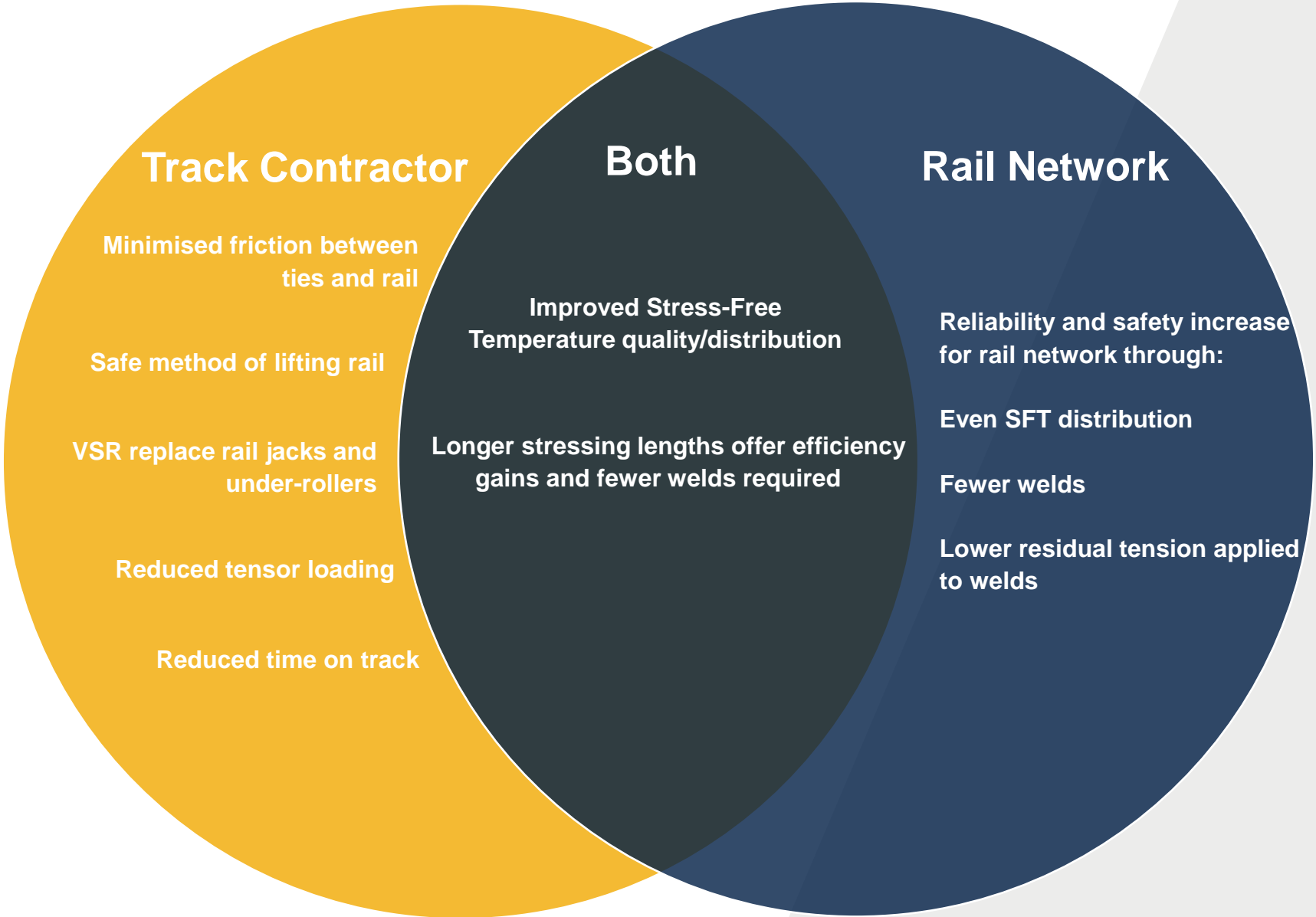
T-ST-MA-5737 FO Type Approval Certificate



# Product Value - VERSE



# Product Value - VSR



# More Information

## Following Webinar




→ PRODUCT DATA SHEET

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### Vortok Stressing Roller

Track Equipment



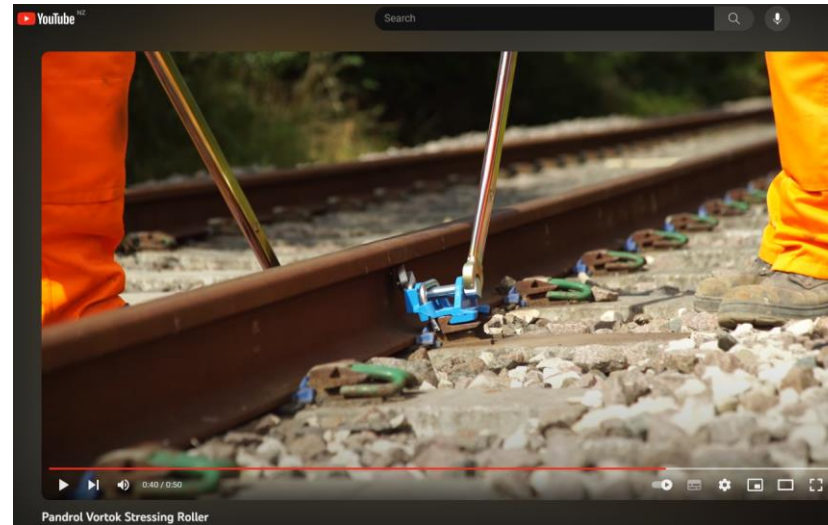
The VSR is designed to attach to the rail fastening and by means of a rotating lift arm and bearing, contact the underside of the rail head and lift the unclipped rail from the sleeper (tie). This product replaces under rollers and side rollers.

Once lifted, the rail can be moved with very low friction for the purposes of rail stressing. The resultant stress distribution is, therefore, optimised. The VSR can also be used for changing rail pads. The product range is designed for the majority of rail fastenings and common rails irrespective of sleeper material.

→ TECHNICAL FEATURES

- Life expectancy 10x longer than that of conventional under rollers.
- A third of the installation cost.
- After 10 operations the costs have balanced.
- There are savings made in possession (blockade) costs, which are worldwide as well as country related, and are usually the greater saving - as much as 75% on some jobs.
- Stress distribution significantly improved.
- Rail breaks at the weld reduced, as the localised tension is optimised.
- Significant safety improvements.
- The smooth lift and drop action eliminates insulator and pad damage.

Services / Mainline Light Rail & Tram Ports & Industrial Heavy Haul High Speed Metro & Depot →



**Contact Us!**

[usa\\_quotes\\_pus@pandrol.com](mailto:usa_quotes_pus@pandrol.com)



**Thank You!**

