OHL Renewals on Metro & Nexus Overhead Line Renewals Design Works

NEXUS

Introductions

Christopher Wilson
Engineer E&M
Nexus

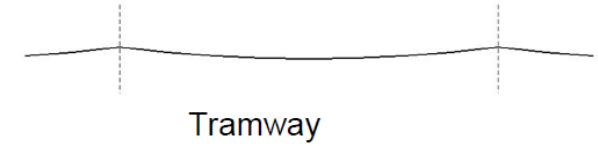
Rob Daffern
Principal Engineer
Furrer & Frey

What is overhead line equipment?

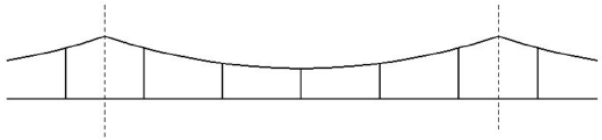
Overhead Line Equipment (OLE) is a means to deliver continuous electrical energy to a moving train, by means of a sliding contact between train bourne current collection equipment (Pantograph) and a fixed overhead supply conductor.

Overhead Line Equipment on Tyne & Wear Metro

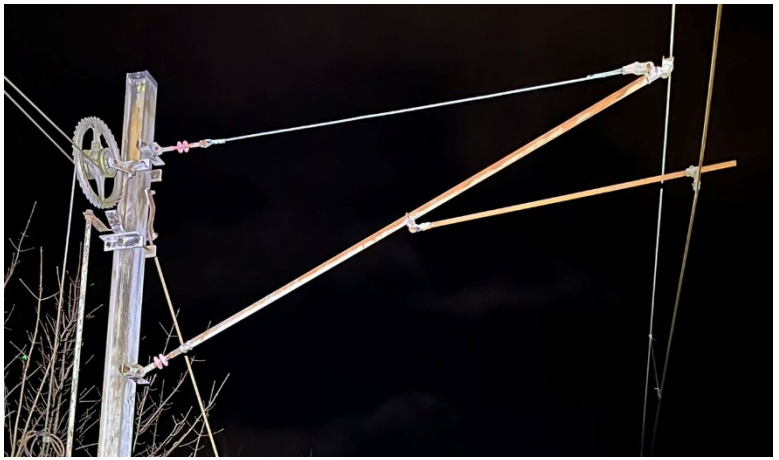
- Predominantly a simple catenary system, with sections of simple Tramway equipment.
- Network Length – 77.5km
- Energised at 1500V DC.
- Multiple conductor configurations based upon electrical demand
  - Single Contact (Tramway equipment)
  - Open Route / Twin Contact
  - Twin Catenary Single Contact
  - Double Open Route
- Conductors generally supported by cantilevers and spanwires via Masts
- System tensions
  - Automatically tensioned nominally 11kN.
  - Fixed termination equipment
    - Tensioned at 14.5kN at 10°C.
    - Tunnel equipment tensioned at 11kN at 15°C.
    - Depots & non-passenger lines tensioned at 8kN at 10°C



Tramway



Simple



Overhead Line Renewals Project Scope

8 Main works streams.

1. Tension Length conductor renewal
2. Support and registration componentry replacement
3. Fixed Termination (F.T.) OLE – Automatically Tensioned (A.T.) OLE conversions
4. Automatic tensioning devices upgrades
5. DC isolator switchbox replacement and relocations
6. Section insulator replacement and relocations
7. Northumberland Park Spanwire removal from Network Rail infrastructure.
8. Conversion of single contact wire only crossovers to open route

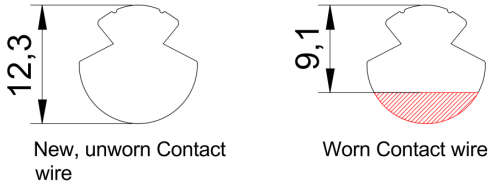
Why are Nexus renewing the overhead line?

45-year-old infrastructure

- Worn wires
- Corroded cantilevers and spanwires
- Failures & “end of life wear out” i.e. Bathtub effect

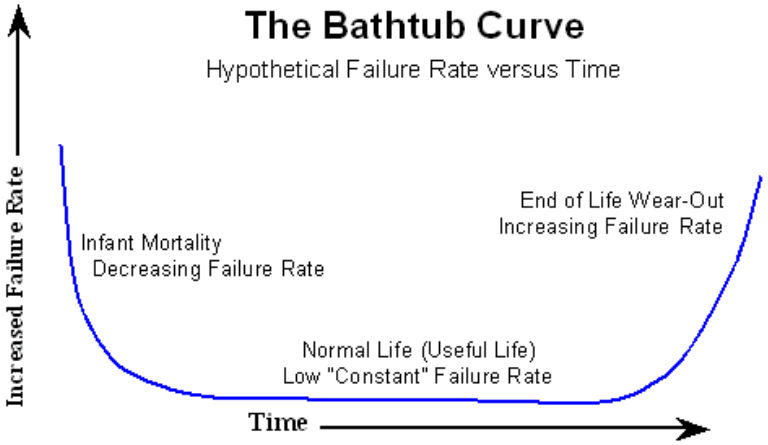
Component obsolescence

- Copper Cadmium contact & catenary wires
- Unique light weight section insulators
- Hydraulic Tensioners



New, unworn Contact wire

Worn Contact wire



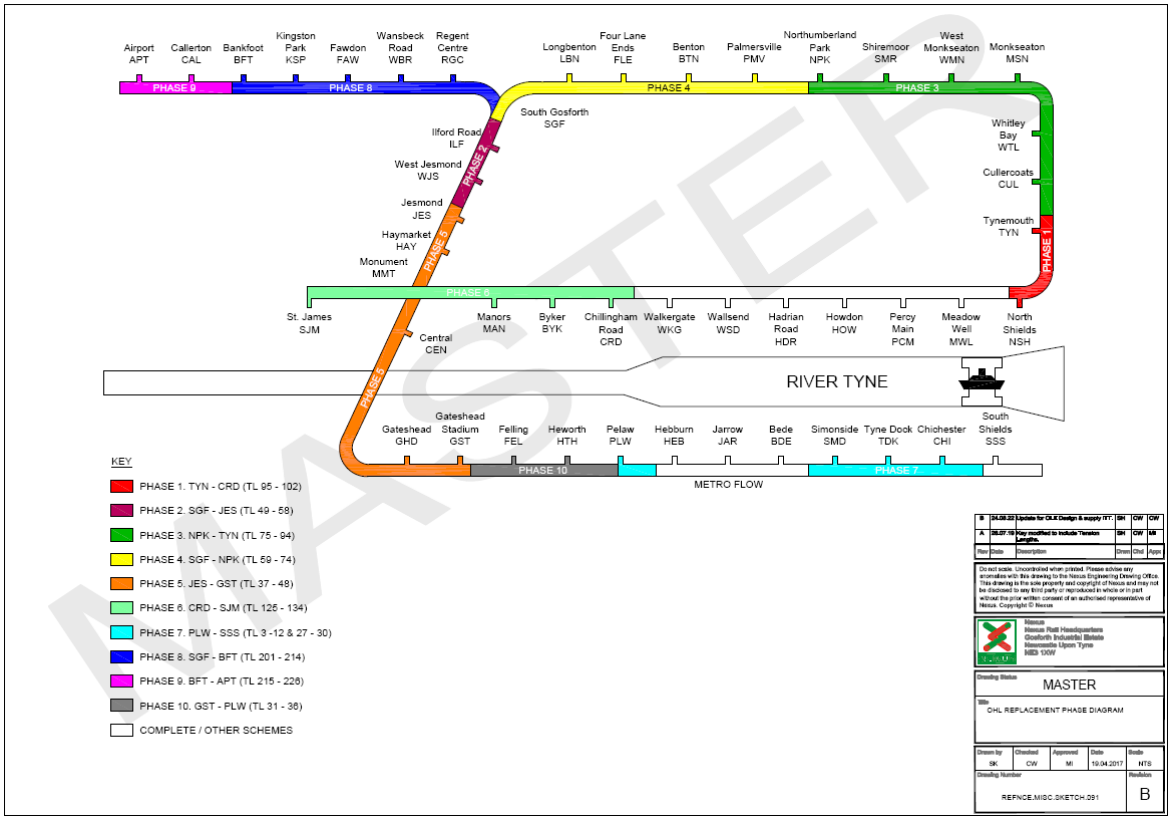
Why are Nexus renewing the overhead line?

System improvements

- Removing outdated legacy equipment
- Improved performance
- Modern technologies (i.e. Tensorex Spring tensioners)

Support and registration componentry renewals

Furrer and Frey appointed in 2022 for the design and supply of a new componentry range for the Nexus owned portion of the Tyne and Wear Metro.



Rob Daffern

Principal Engineer / Engineering Director GB

- 25 yr in rail
- 4 yr Balfour Beatty maintenance
- 5 yr Network Rail Anglia OLE Maintenance Engineer

- 4 yr Network Rail Anglia OLE Senior Project Engineer

- 12 yr Furrer+Frey GB Engineering Director
- MEng Mechanical Engineering
- CEng MIMechE MRailEI

Furrer+Frey

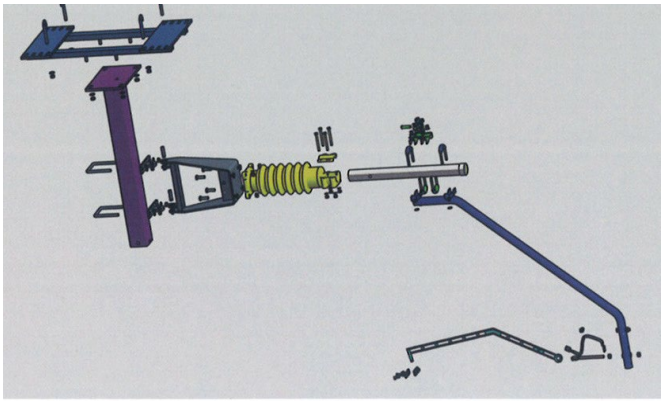
Family Owned Electrification Specialists

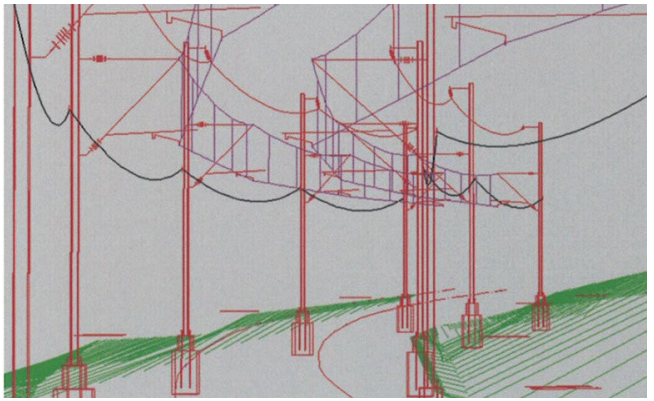
- Founded in 1923 in Switzerland
- 400+ Staff worldwide
- Swiss HQ, offices in:
  - UK
  - China
  - Germany
  - Italy
  - India.

Furrer+Frey

Family Owned Electrification Specialists

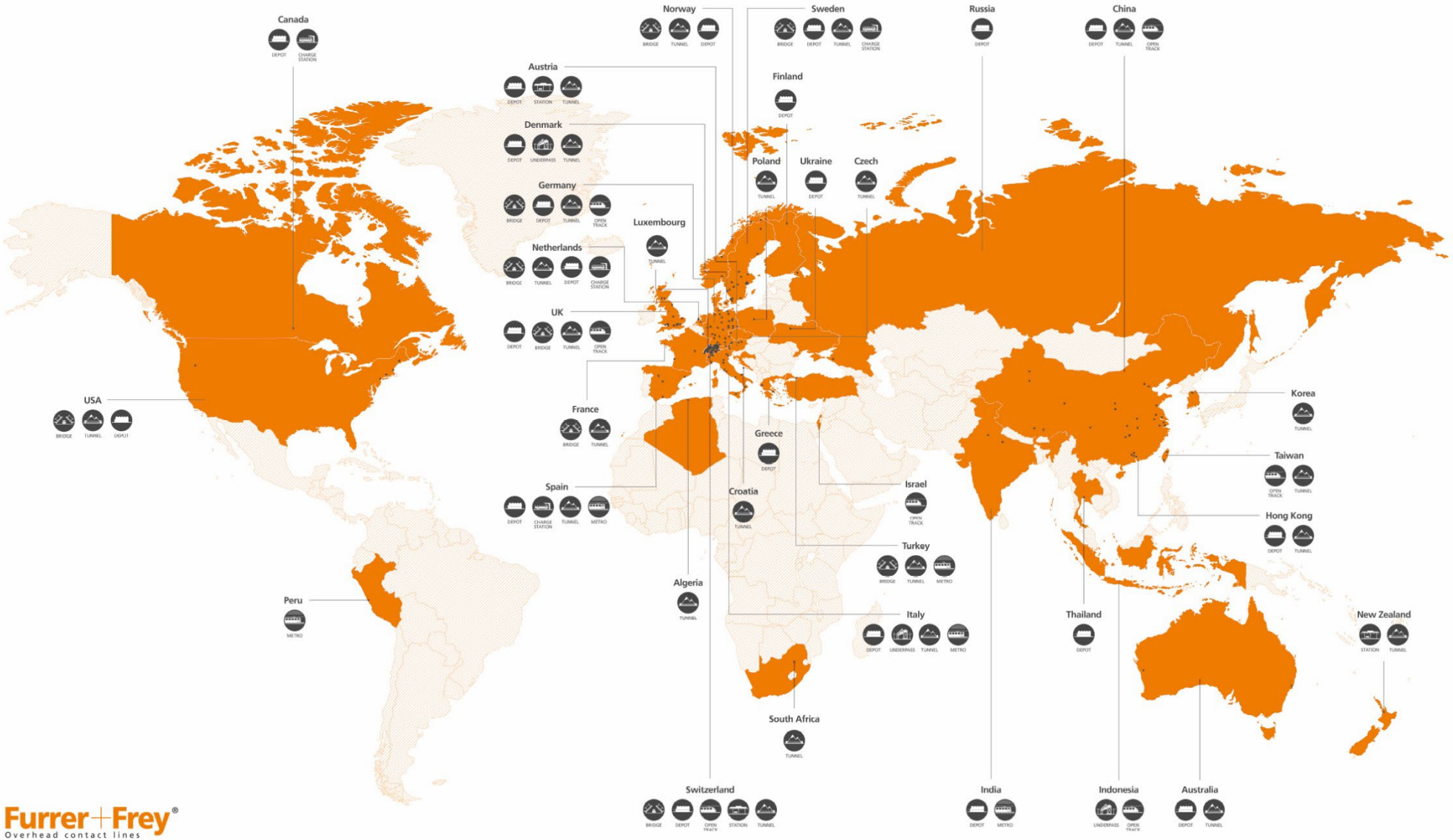
+ System and Component Design, Allocation Design, Consultancy
+ Installation, Commissioning, Maintenance





Worldwide Installations

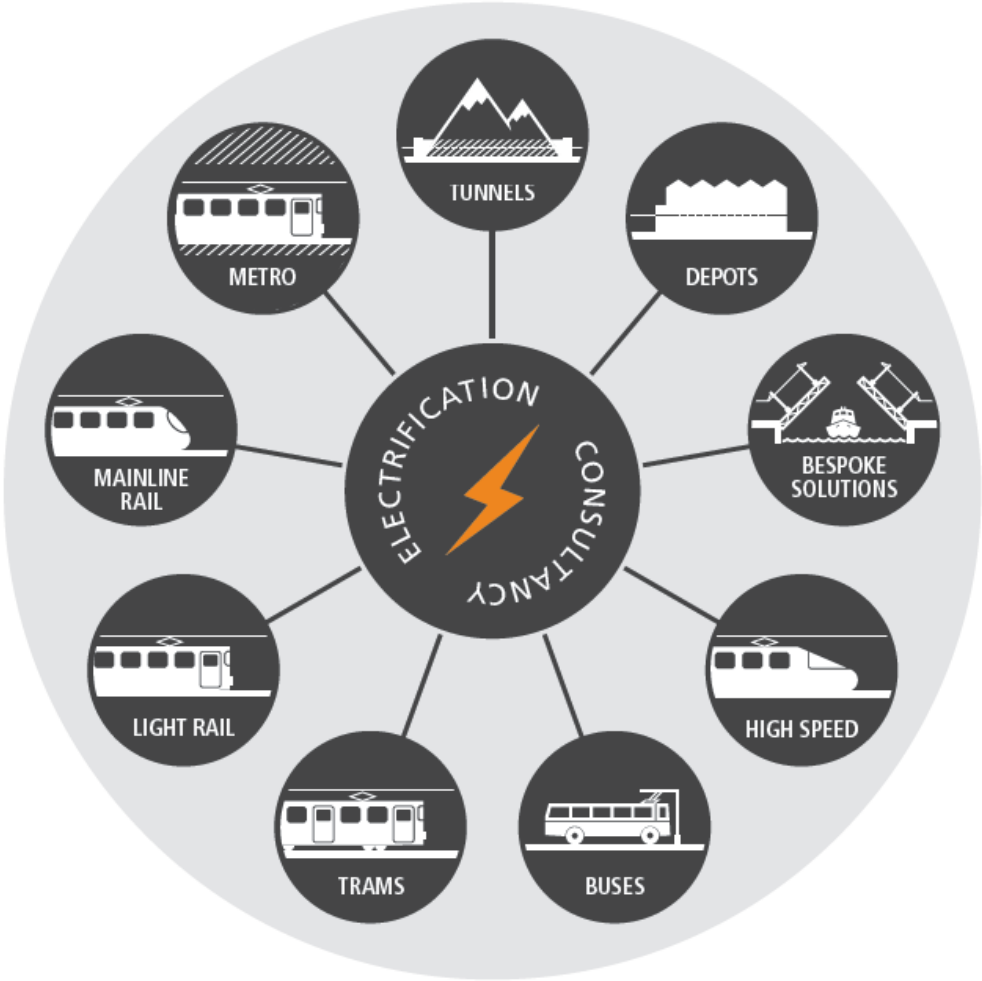
30+ countries | **300+** projects | **300** kmph



Furrer+Frey®
Overhead contact lines

Furrer+Frey

Family Owned Electrification Specialists



Why Renew Nexus?

+ Was very low-cost system in the 1980s
+ Galvanised mild steel tubes: OK *now…*

Why Renew Nexus?

FL200-Light: Remit

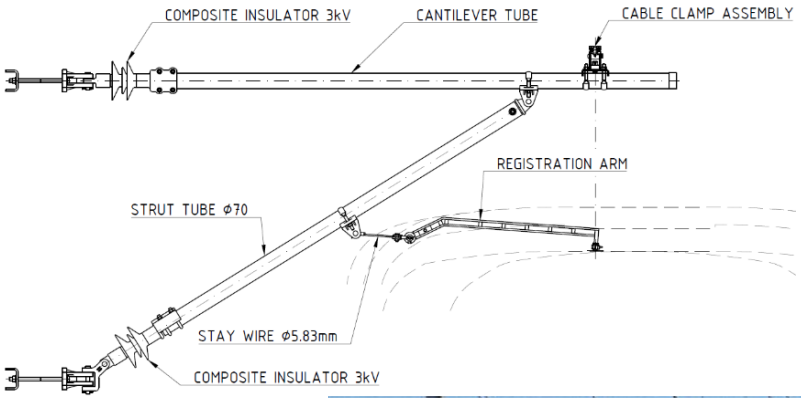
Nexus Remit:

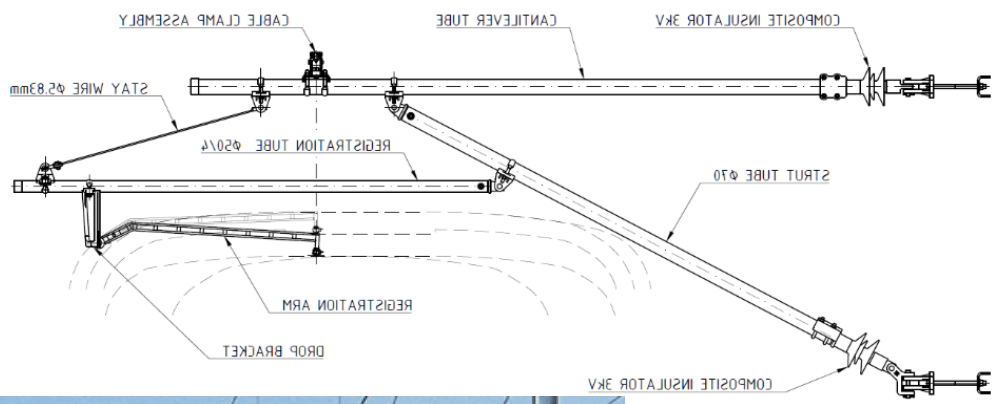
1. Retain existing masts/structures
2. Replace all the cantilevers / supports
3. Geometry/clearances up to modern standards
4. Match the original approved geometry

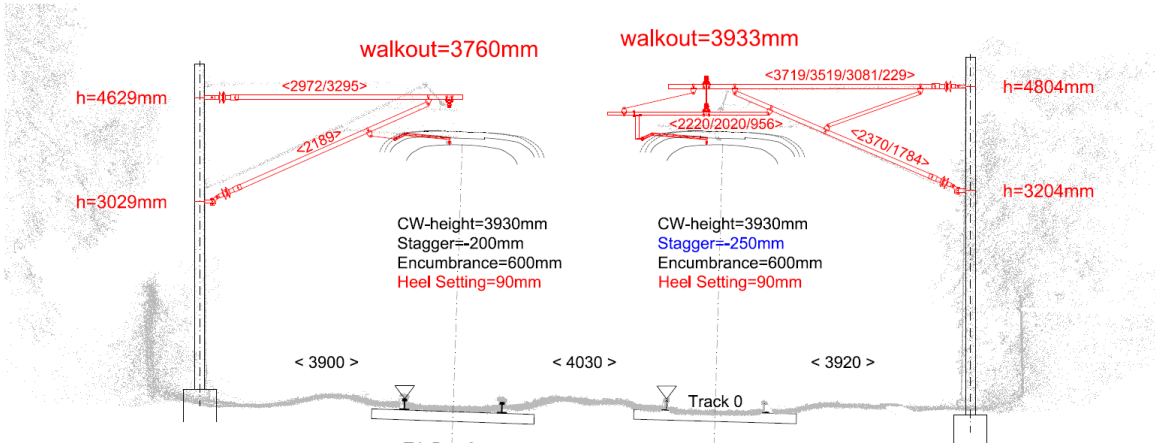
Effect on a new system:

1. Weight of cantilevers is critical: Aluminium
2. Variety / adjustability of fixings
3. Compromise
4. Compromise

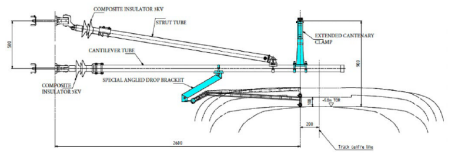
FL200 Light Overview: Aspirational Assemblies

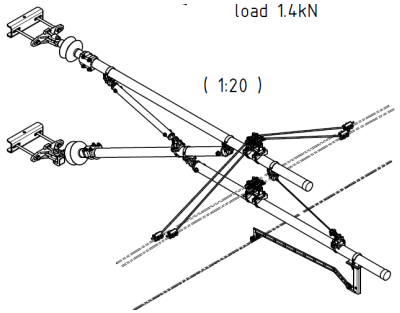


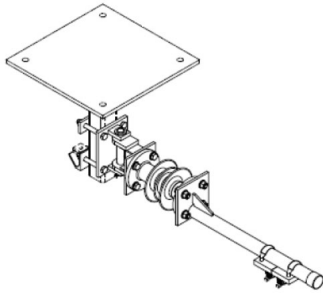


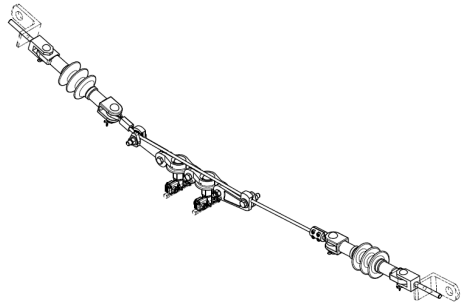


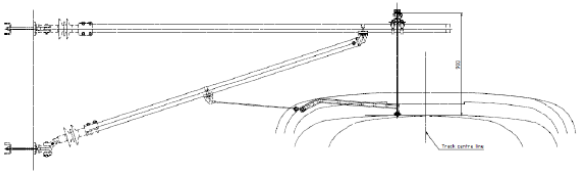
FL200 Light Overview: Actual Assemblies

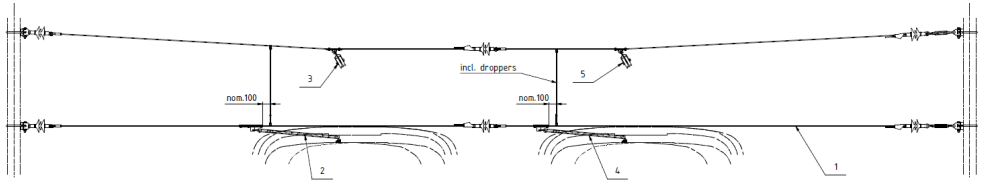


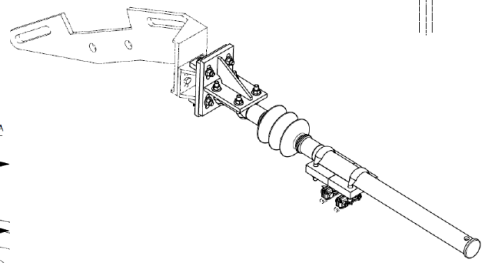


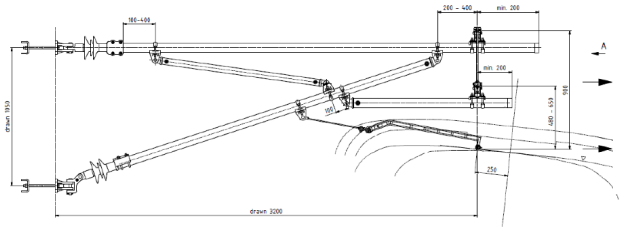


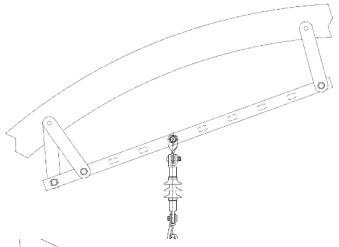


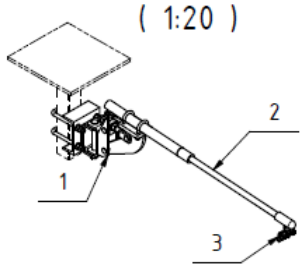


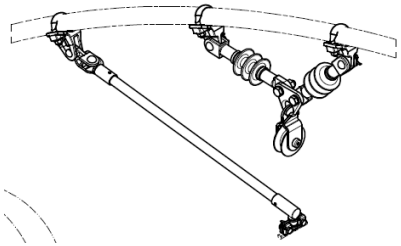


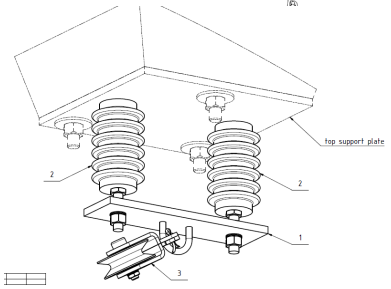


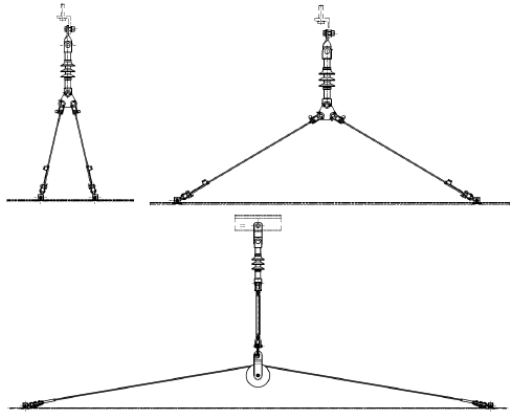












FL200 Light Overview: Actual Assemblies

FL200 Light Overview: Manuals

System and Design Manual

+ Specification, gauge and compatibility
+ Design rules
+ Load limits

Installation Manual

+ Torques, tolerances, weights
+ Handling, storage
+ Commissioning
+ IKEA

Maintenance Manual

+ Inspection periods
+ Defect priorities
+ De-commissioning & recycling

Nexus Specific Interesting Challenges

+ Modifications for high current flow
+ Incredibly value engineered
+ Low wires
+ Tunnels and specials
+ Remit vs physics

Interesting Challenges

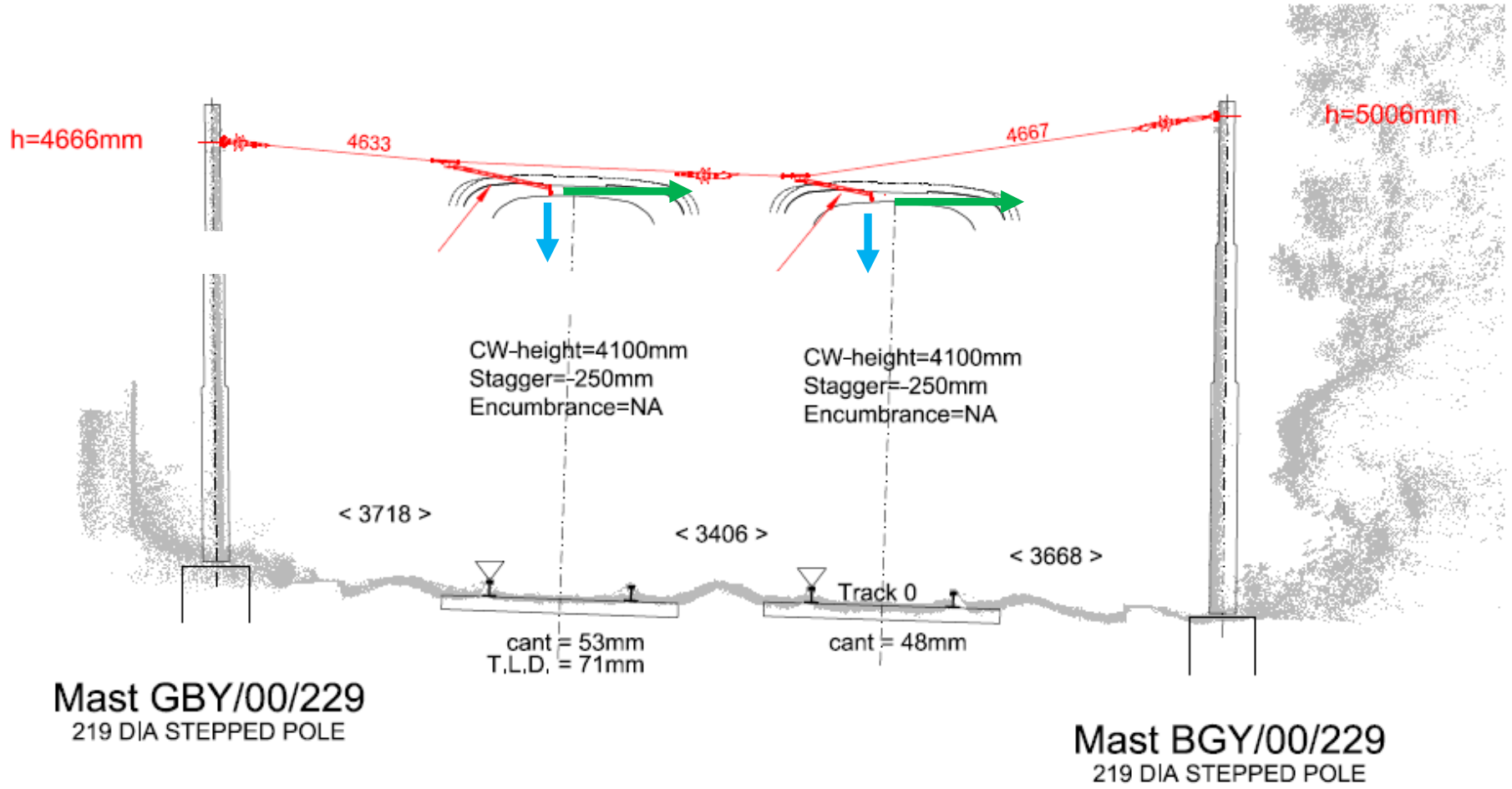
+ Current Flow Modifications. Catenary tension = 11 kN / 2 = 5.5 kN
+ More sag / difficult droppers / twin clamps / increased weights & wind loads

Interesting Challenges

+ 1980’s Value Engineered: Flying Tramwire

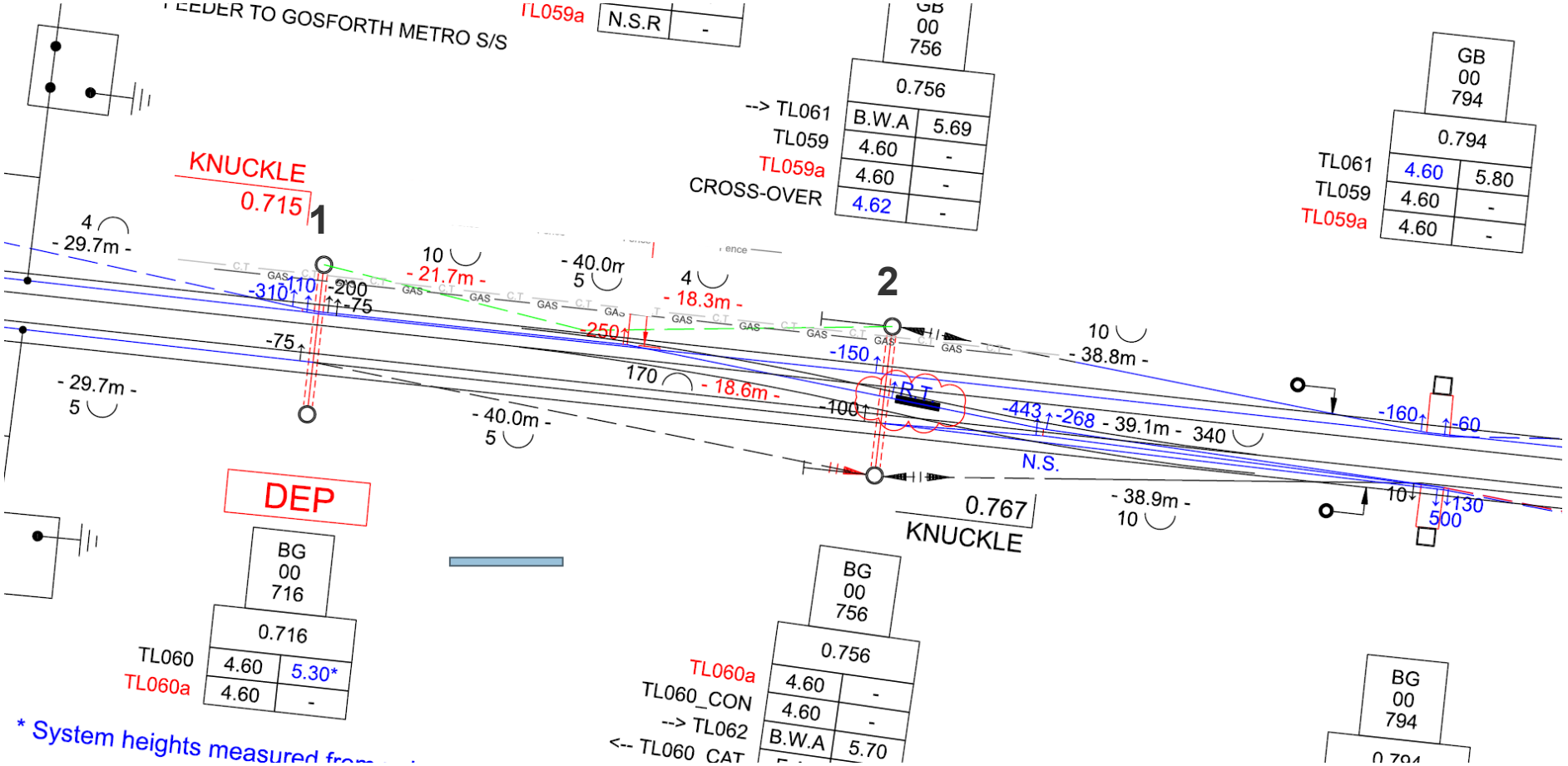
Interesting Challenges

+ 1980's Value Engineered: Flying Tramwire **PRACTICAL**



Interesting Challenges

+ 1980's Value Engineered: Bridle wires vs masts



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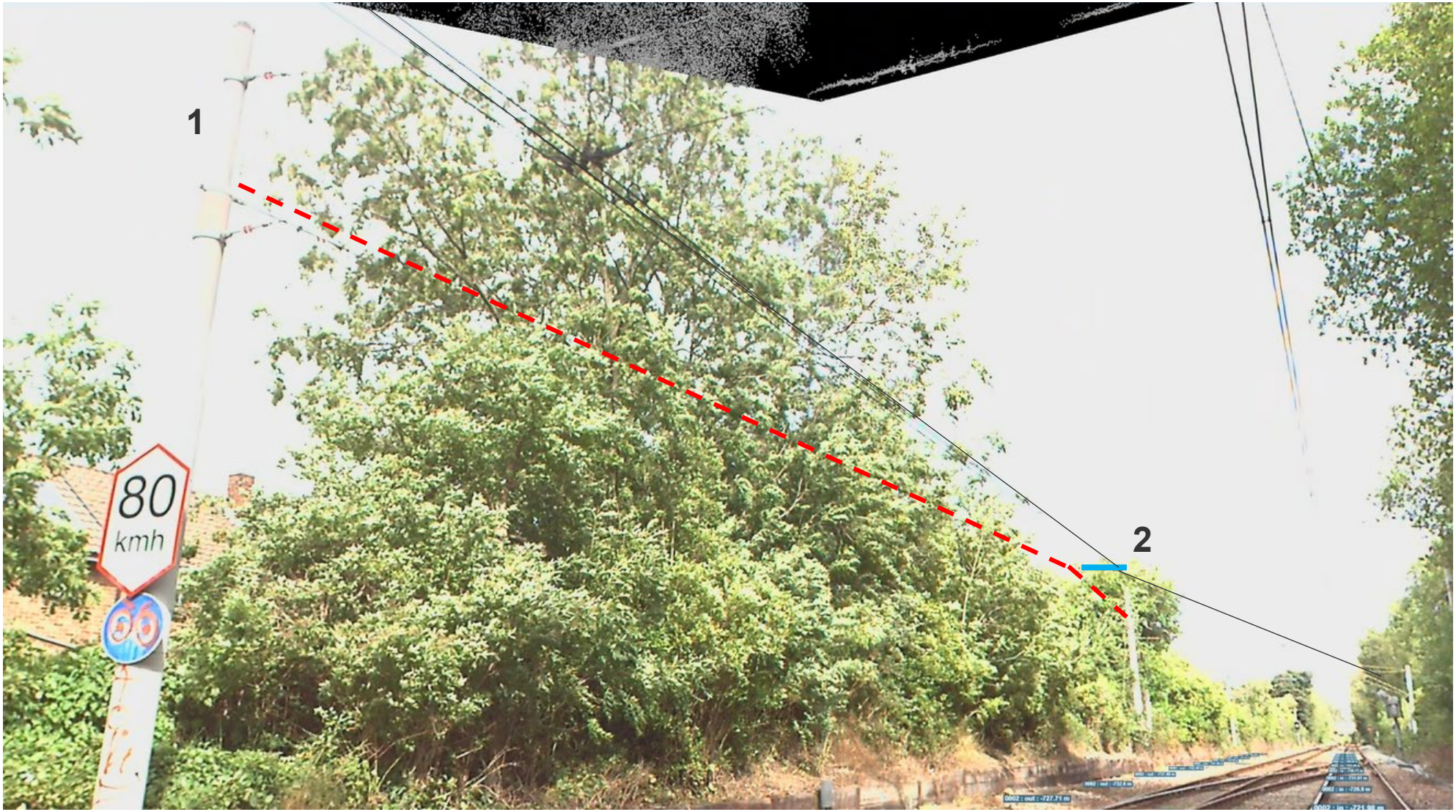

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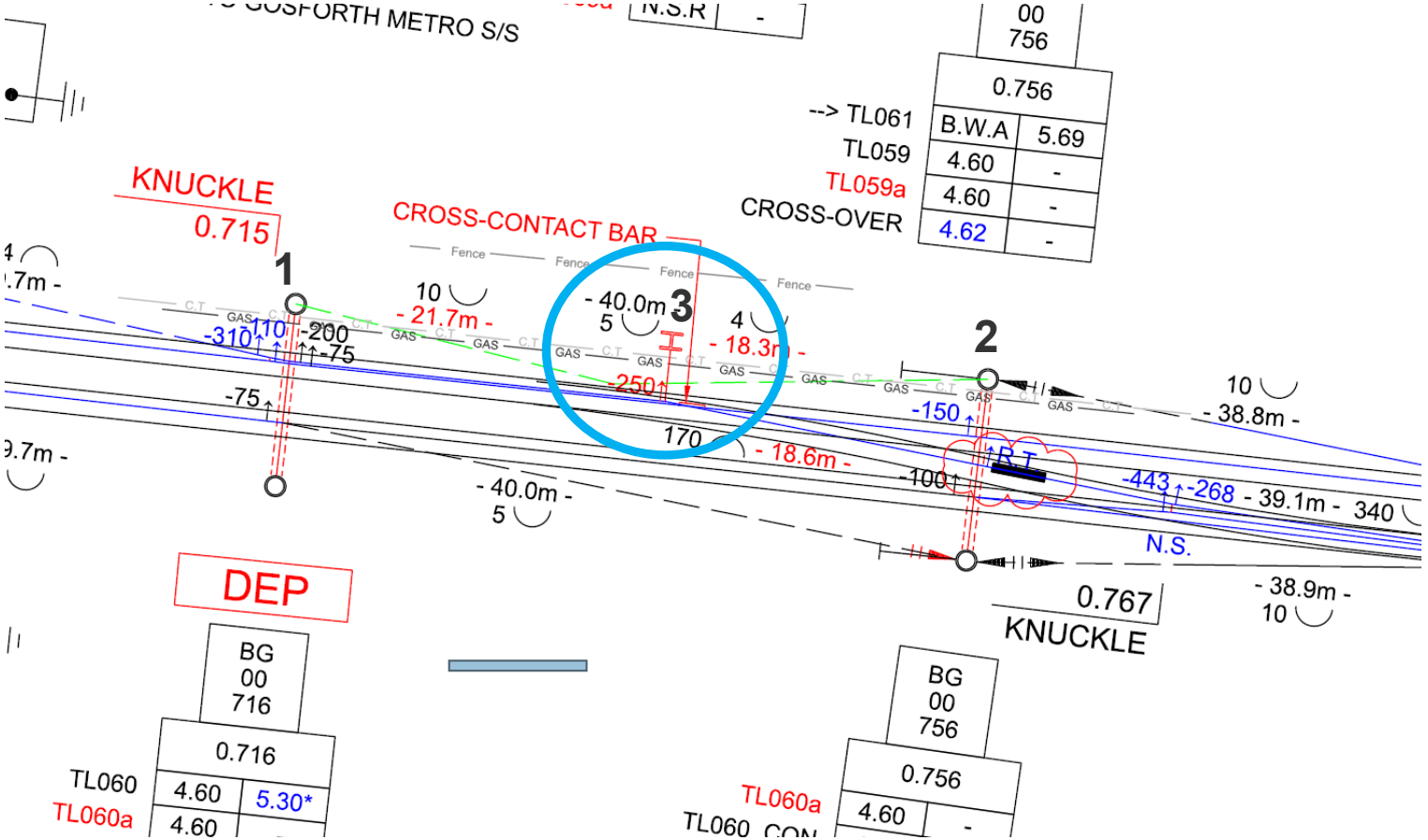

Interesting Challenges

+ Modern remit vs physics

4.12. Electrical Clearance

The normal static air clearances between electrically energised parts and earth shall be at least 150mm. The corresponding passing clearance shall be at least 100mm.

The clearances may be reduced to 100mm and 50mm respectively in cases where normal clearances cannot reasonably be obtained with the agreement of Nexus' Principal Engineer (E&M).

4.16.1. The overhead equipment for the City Centre running tunnels shall generally consist of two fixed termination copper contact wires supported at intervals of nominally 12 metres, by a support unit utilising a resin bonded glass fibre insulator of 200mm minimum creepage length

4.7. Contact Wire Height

		For joint user and T&W Metro Tracks	For Exclusive T&W Metro Tracks
i)	Normal contact wire height	4500mm	4000mm
ii)	Minimum contact wire height	4150mm	3700mm
iii)	Minimum contact wire height at level crossings	5500mm*	5500mm*
iv)	Maximum contact wire height	5600mm*	5600mm*

Note (*) – Prior to renewals work contact wire height at level crossings shall be 5480mm, with a maximum contact height of 5480mm, in accordance with the systems original design

Interesting Challenges

+ Modern remit vs physics

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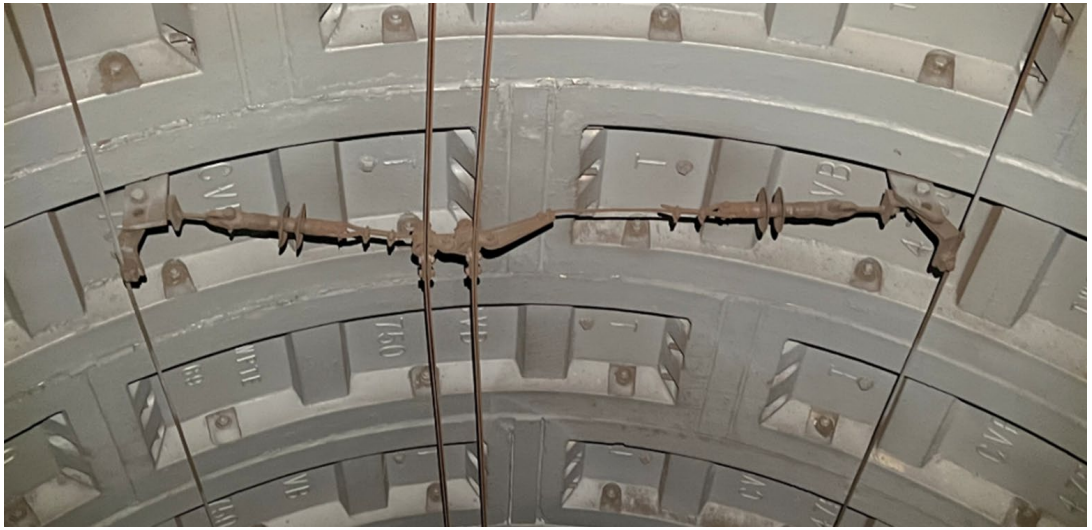
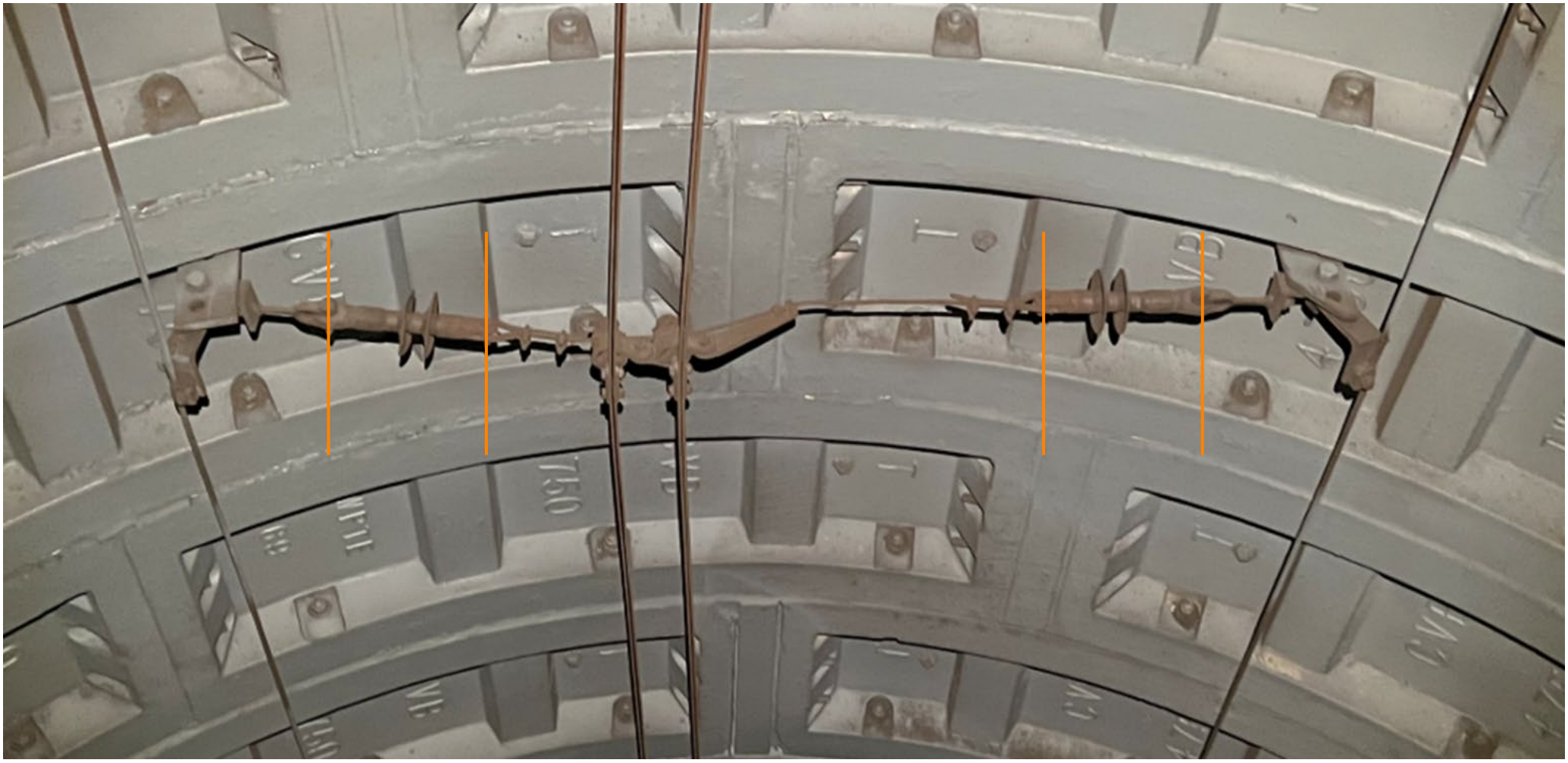


Interesting Challenges

+ Define “live” part of an insulator?

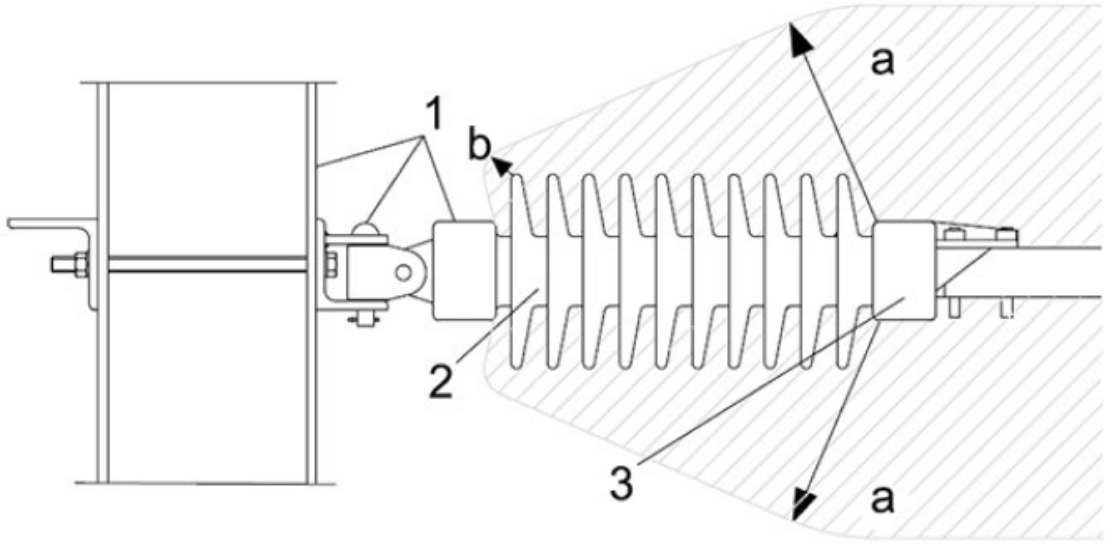


Interesting Challenges

Table 2 — Typical electrical clearances

Nominal Voltage	Typical clearances mm	
	Static (EC_s)	Dynamic (EC_d)
DC 600 V (720 V)[a]	100	50
DC 750 V (900 V)	100	50
DC1,5 kV (1,8 kV)	100	50
DC 3,0 kV (3,6 kV)	150	50
AC 15 kV (17,25 kV)	150	100
AC 25 kV (27,5 kV)	270	150

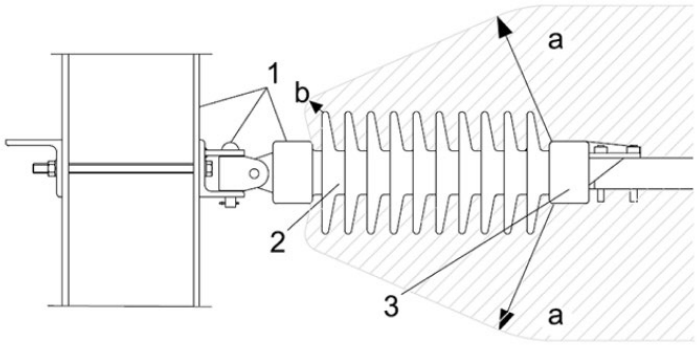
[a] Only for existing systems.
Values into brackets are highest permanent voltage in accordance with EN 50163.

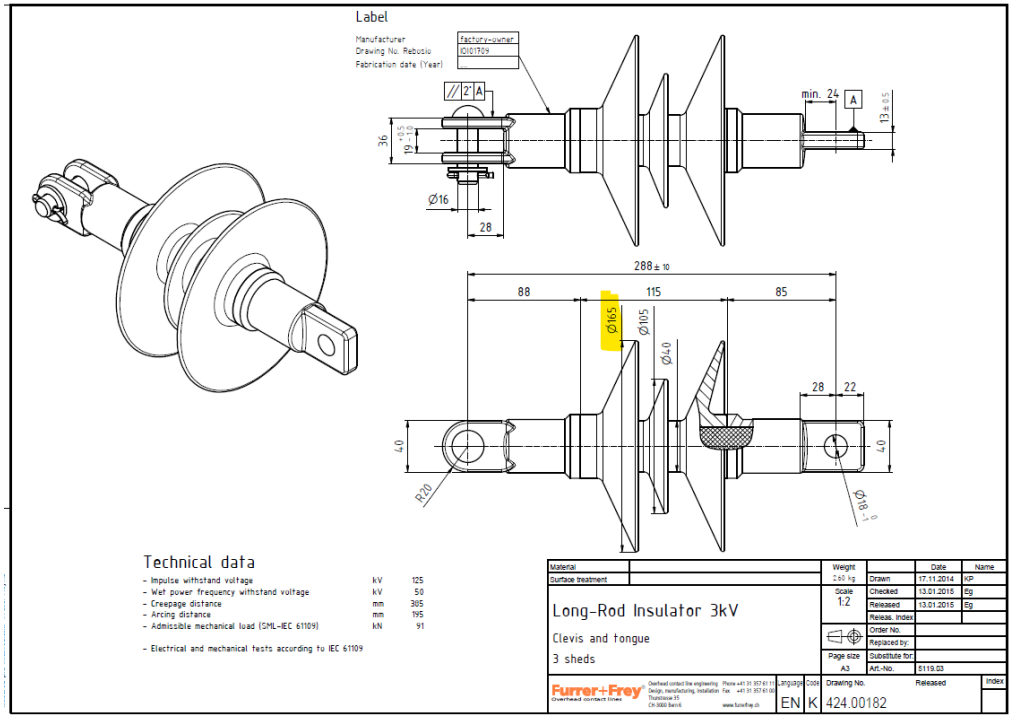


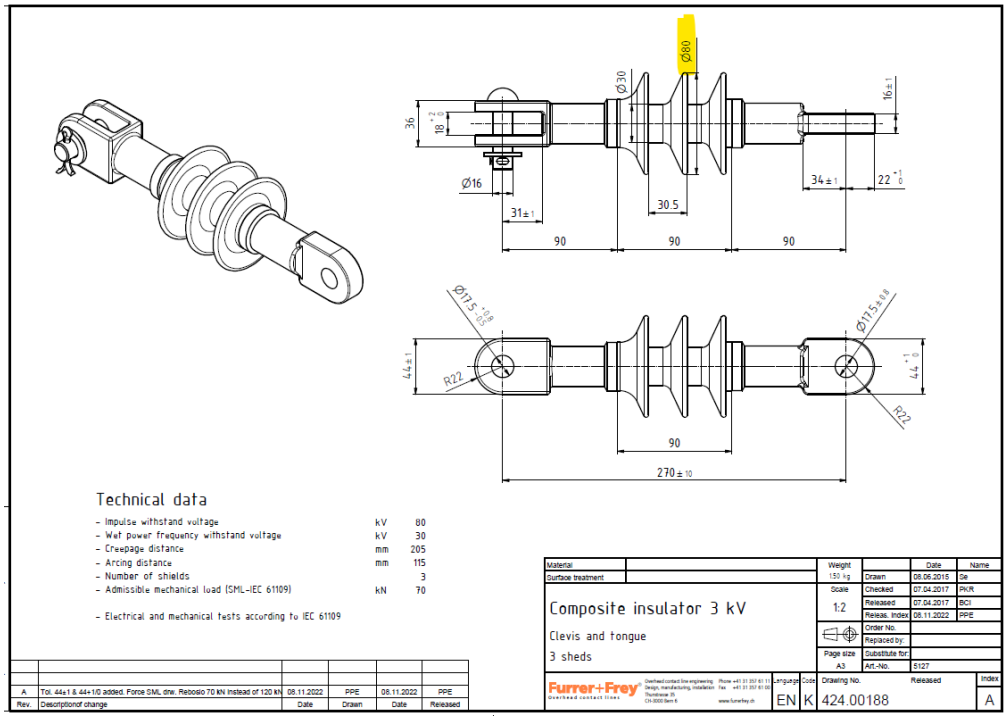
Key

1 earthed equipment
2 insulator sheds
3 Live equipment
a value of static clearance (EC_s) given in Table 2
b 10mm

Interesting Challenges





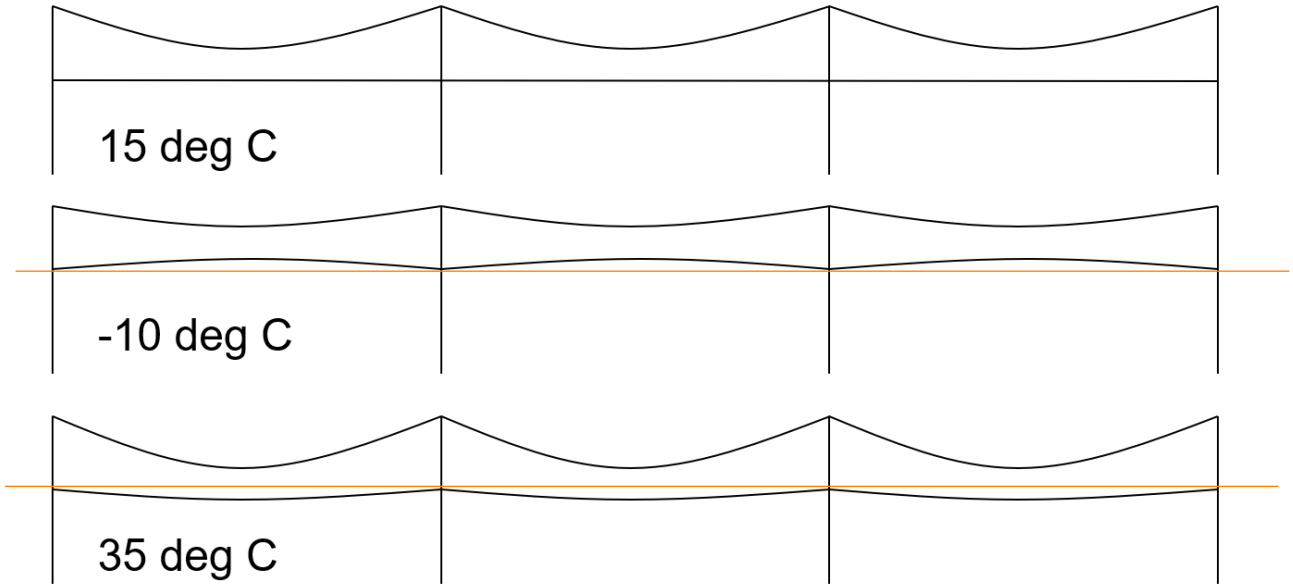


Case Study 1: FT to AT

+ **F**ixed **T**ermination rises with cold sags with heat.
+ **A**uto **T**ension. Stays level (except with ice). Lots of along track movement.
+ Approx 300 spans of FT (of 3,000)

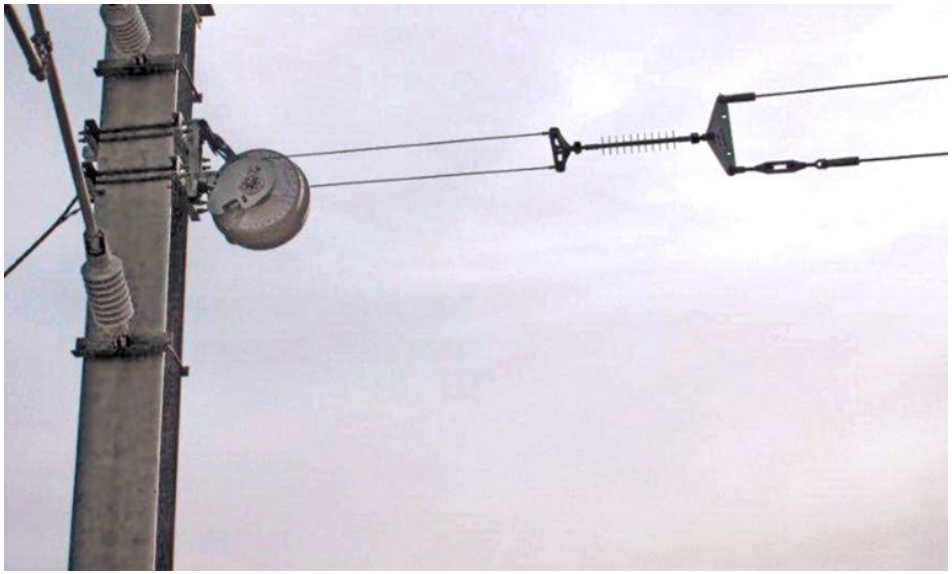
Extra calculations:

+ Assess elec/mech clearances
+ Bridges/stations/level crossings
+ May need wires raising for ice
+ Along track movement
+ Structure loading changes



FT to AT: Tensioners

- Structural assessment (extra weight and wind)
- Find physical space



FT to AT: Along Track Movement

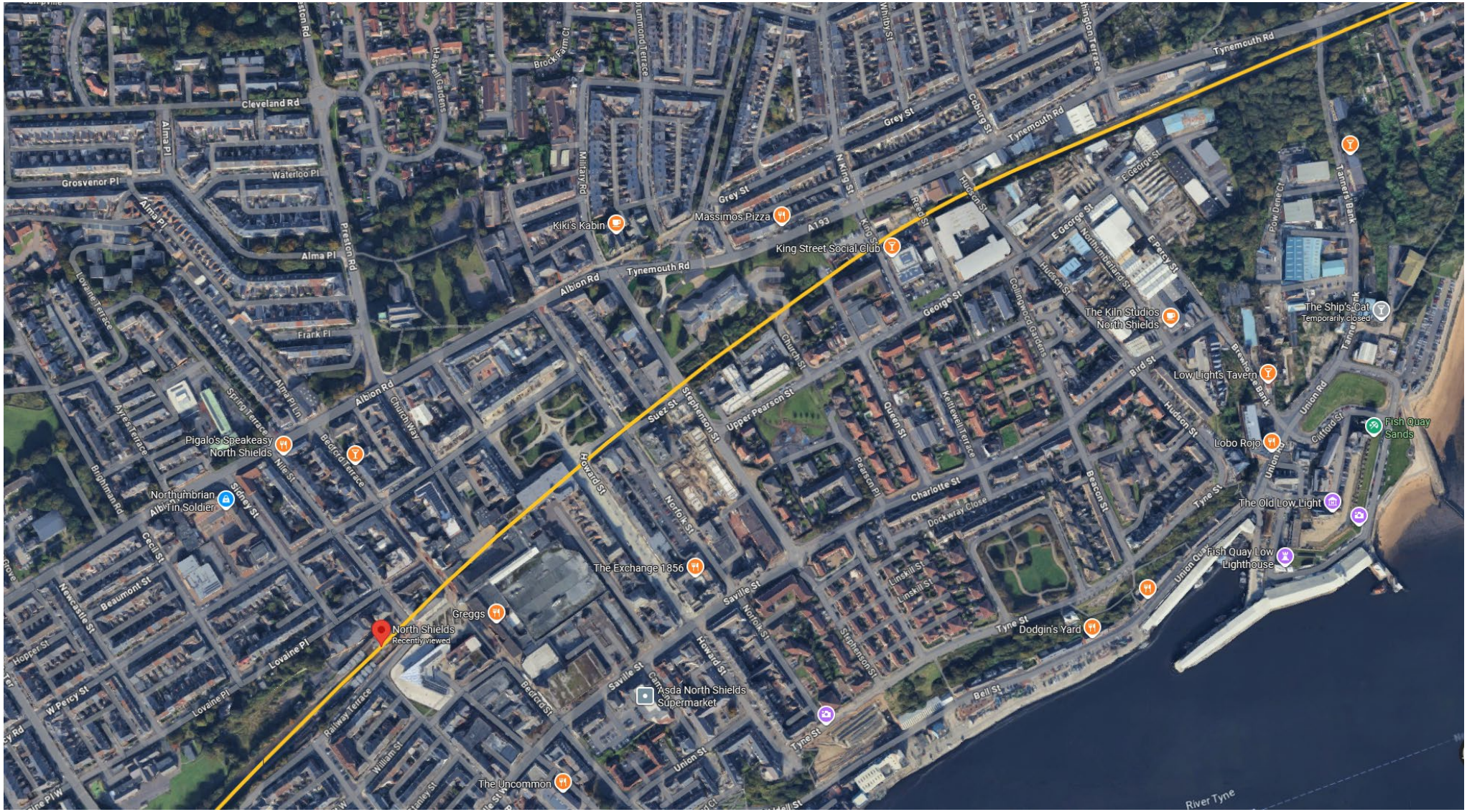
+ FT: Allows 2 wires per cantilever

FT to AT: Along Track Movement

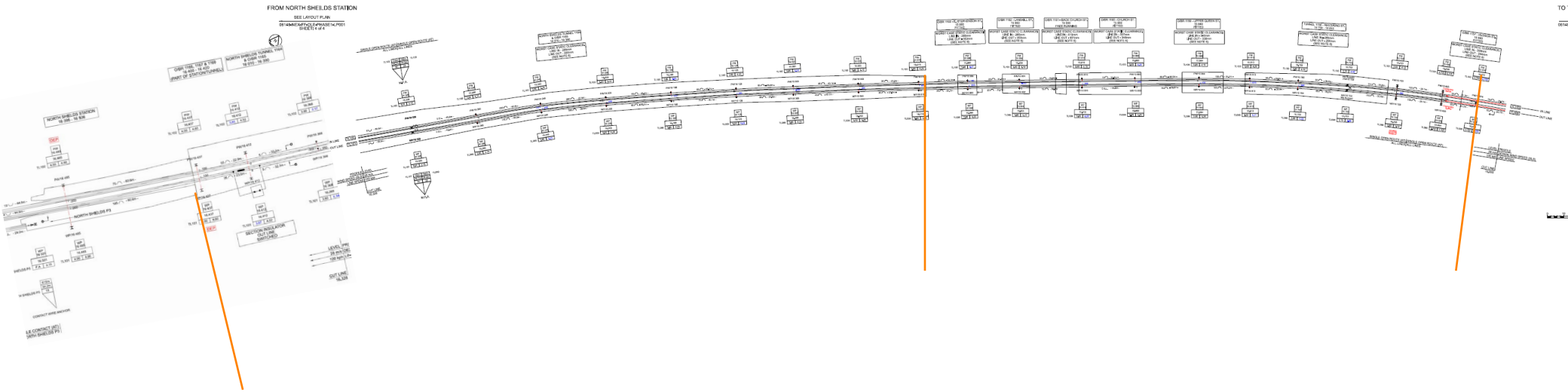
- AT: Twin cantilevers
- Load assessment for 2x cantilevers plus spreaders (usually fail)
- New structures

Case Study 2: North Shields tunnel; Compromise

North Shields tunnel



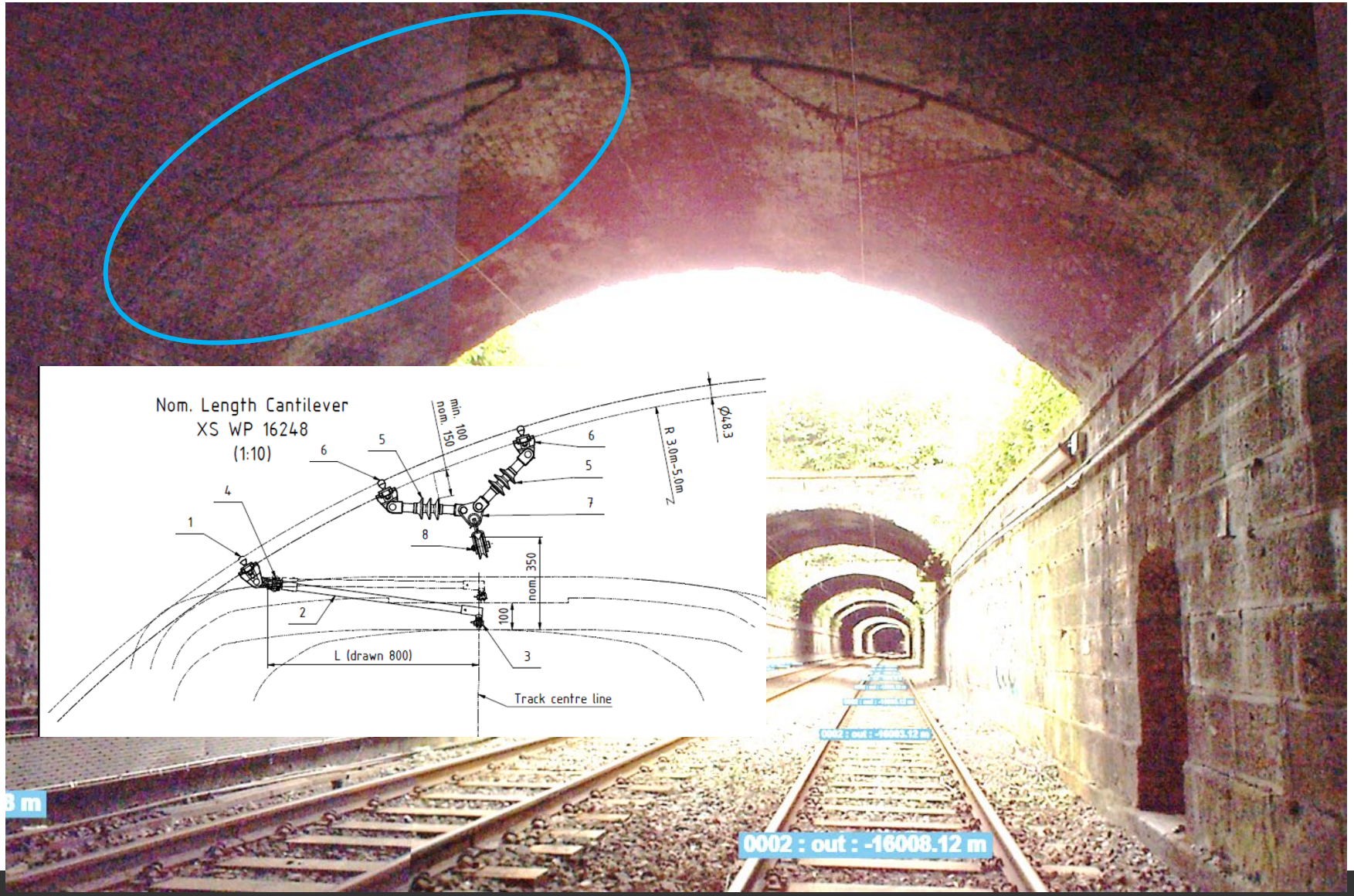
North Shields tunnel



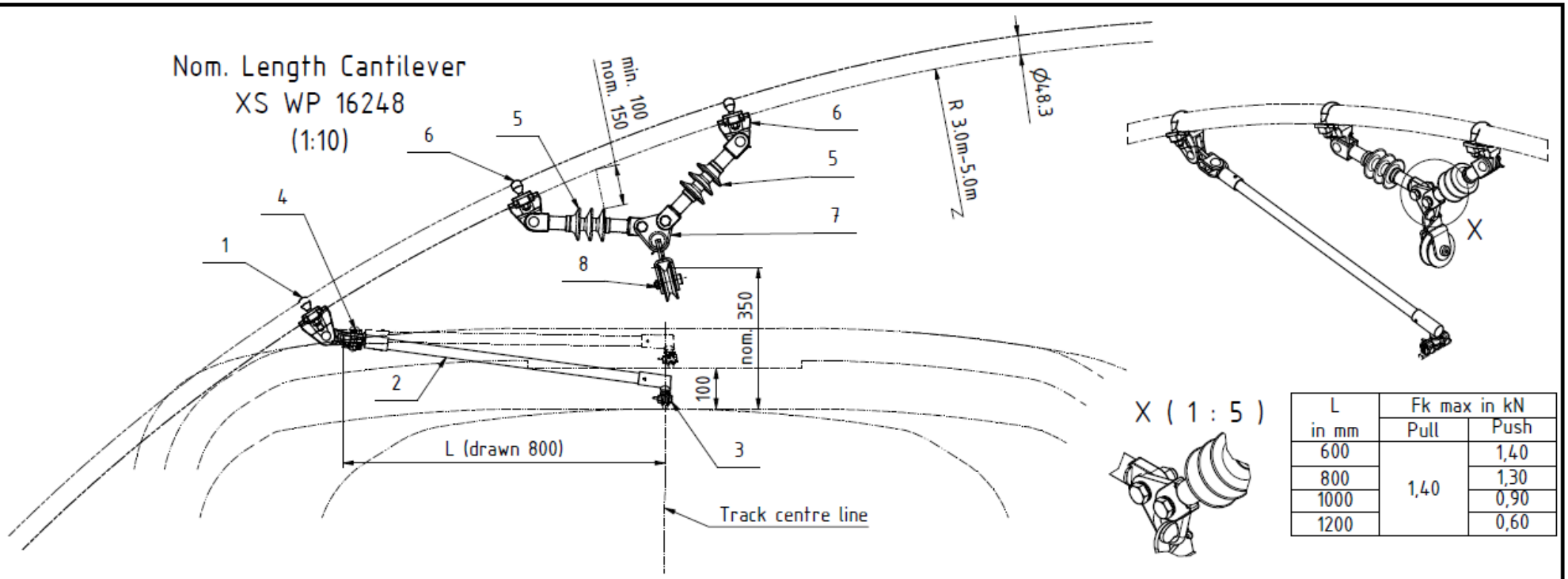
Target:

+ Wire height: 3800mm
+ Pantograph mechanical clearance 80mm
+ Pantograph electrical clearance 100mm
+ Insulator/Static equipment clearance 150mm (100min)

North Shields tunnel



Nom. Length Cantilever
XS WP 16248
(1:10)



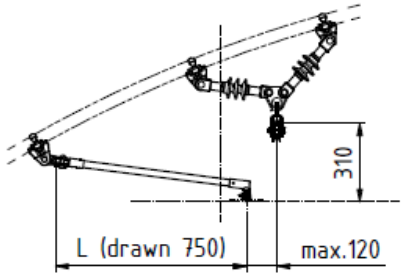
X (1 : 5)

L in mm	Fk max in kN	
	Pull	Push
600	1,40	1,40
800		1,30
1000		0,90
1200		0,60

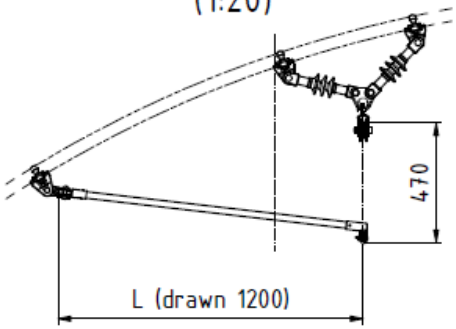
Tunnel SPS arrangements are highly dependent on track and OLE position.
This is an example cross section only. For detailed heights,
lengths, types, clearances etc. please refer to the relevant OLE cross section.

For torque settings please refer to the installation manual.

Min. Length Cantilever
XS WP 16208
(1:20)



Max. Length Cantilever
XS WP 16128
(1:20)



Qty.	Description	Pos.	Drawing / Norm	Art-No.
1	Catenary Suspension Pulley Ø90	8	431.00284-1	
1	Three Pin Triangular Plate	7	431.00314	
2	Tongue clamp	6	353.01085	2159.1.48
2	Composite insulator 3 kV	5	424.00188	5127
1	Clevis strap crossed	4	417.00322	3316
1	Contact wire swivel clip	3	444.00055	5557
1	Steady arm, synthetic	2	356.00086 Typ ...	5583.26. ...
1	Clevis clamp	1	353.01087	2159.48

Material		Weight		Date	Name
Surface treatment		N/V	Drawn	18.01.2024	HRS
		Scale	Checked	02.04.2024	RDN
Tunnel arrangement (NSH)		1:10	Released	02.04.2024	SLR
			Releas. Index	26.06.2025	SLR
			Order No.	06148	
on profiled tube Ø48.3, radius = 3.0–5.0m		Page size	Replaced by:		
		A3	Substitute for:		
			Art.-No.		

Rev.	Description of change	Date	Drawn	Date	Released
B	Insulator position changed to front/rear. Detail "X" added.	19.06.2025	HRS	26.06.2025	SLR
A	new "Tightening Torque Note"	02.05.2024	HRS	02.05.2024	SLR

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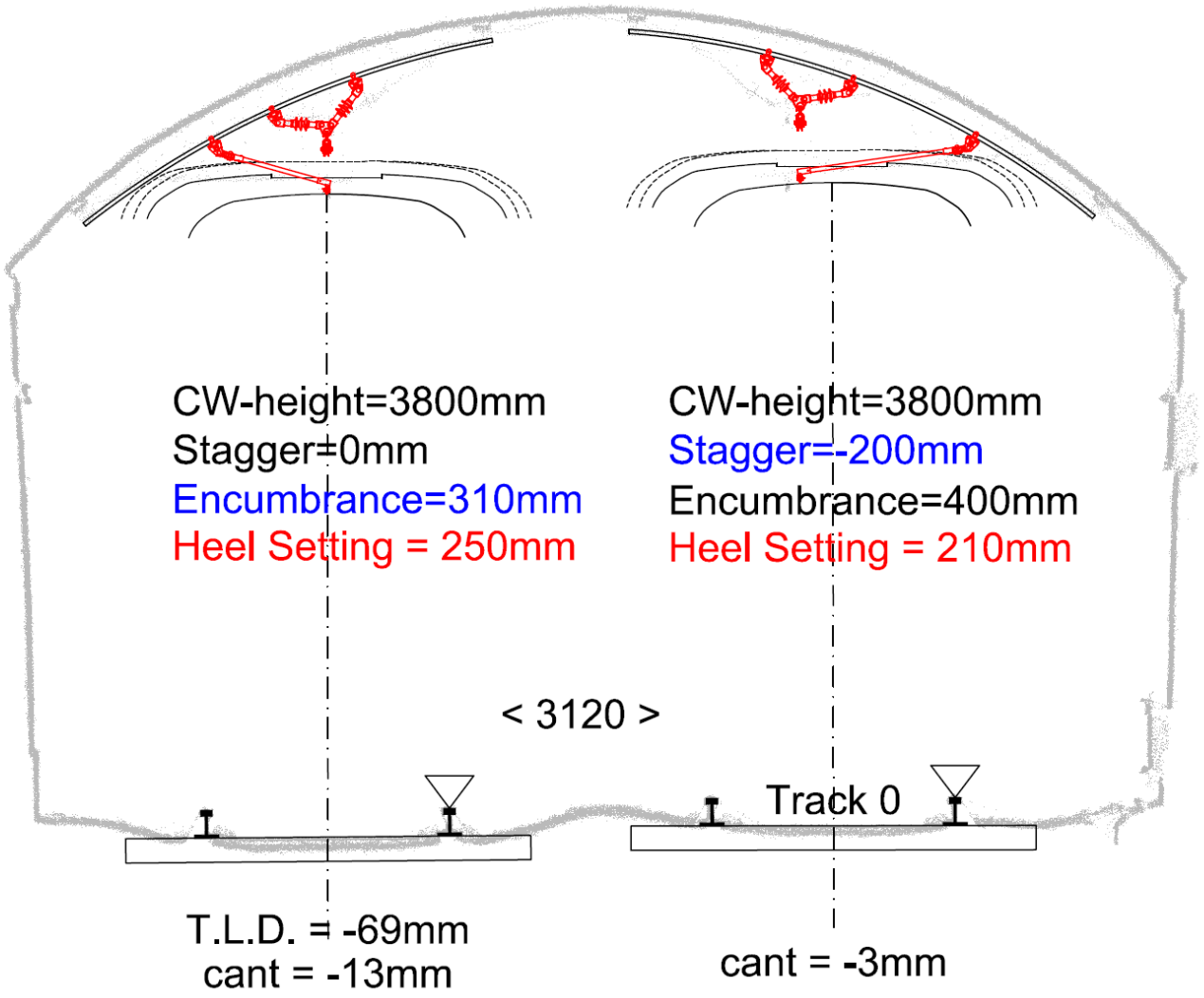
CH-3000 Bern 6
Phone +41 31 357 61 11
Fax +41 31 357 61 00
www.furrerfrey.ch

Language	Code	Drawing No.	Released	Index
EN	K	06148-5.0001		B

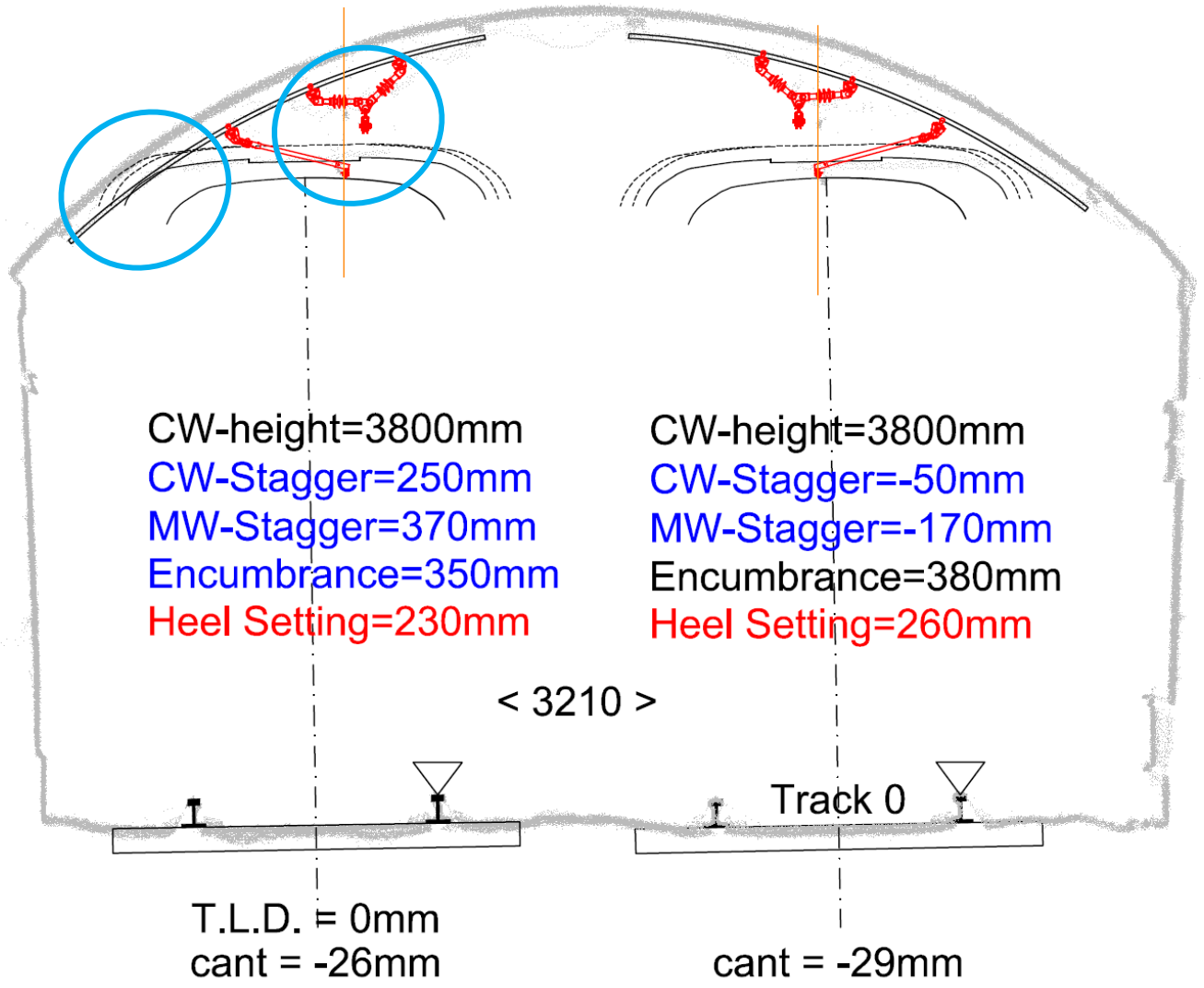
North Shields tunnel



Target:

+ Wire height: 3800mm
+ Mechanical clearance 80mm
+ Electrical clearance 100mm
+ Insulator / equipment static equipment 150mm (100min)

North Shields tunnel



Target:

+ Wire height: 3800mm
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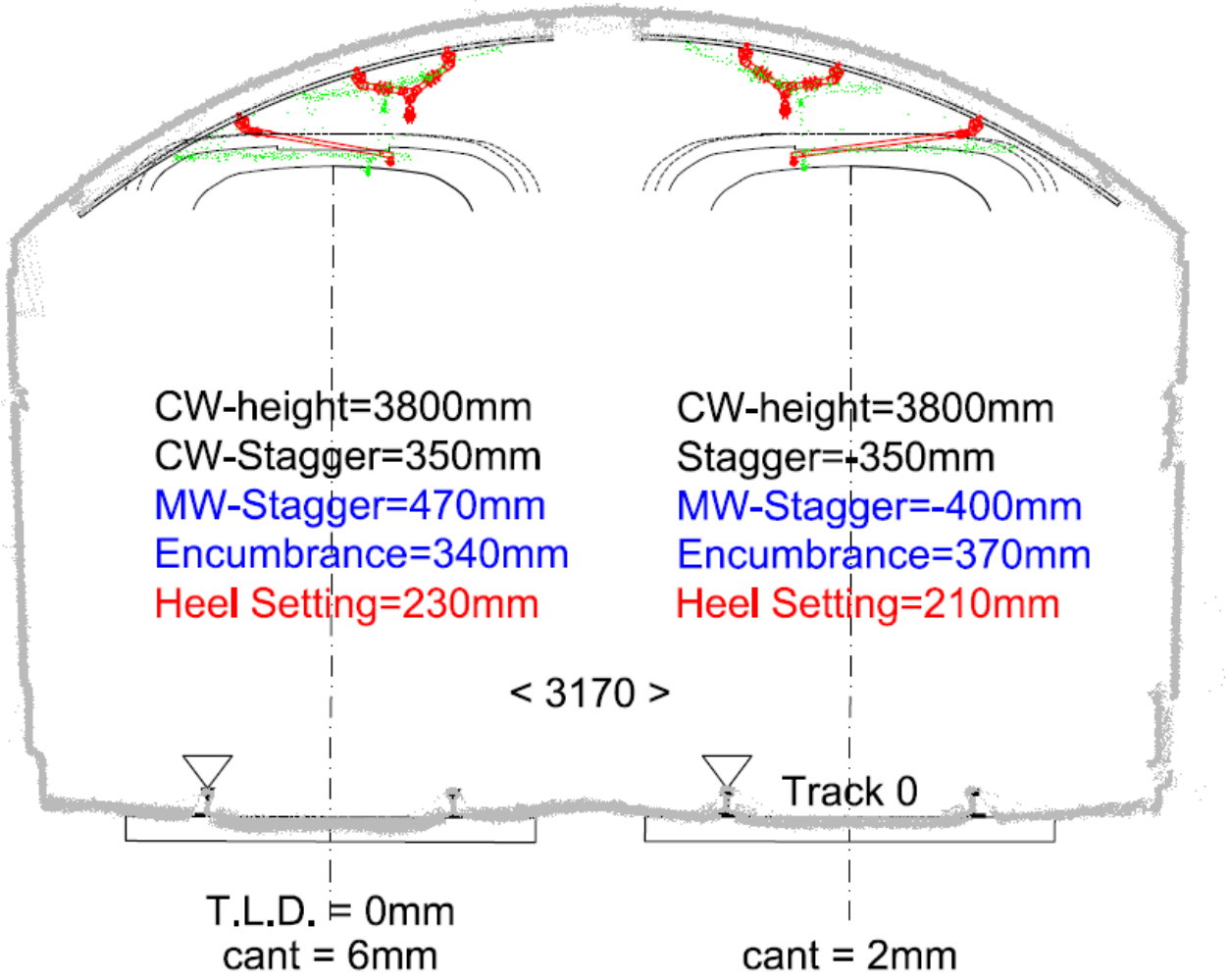
North Shields tunnel



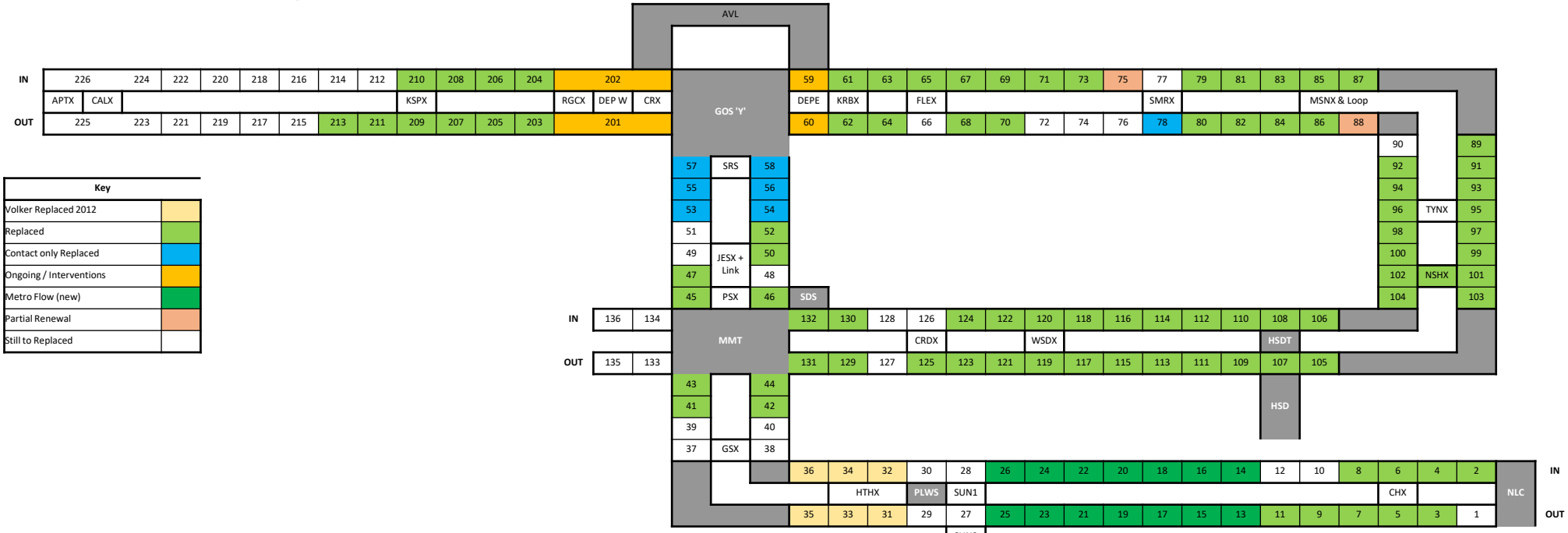
Target:

+ Wire height: 3800mm
+ Mechanical clearance 80mm
+ Electrical clearance 100mm
+ Insulator / equipment static equipment 150mm (100min)

Progress to Date: Componentry Replacement

- Approximately 50% designs system wide have been complete.
  - 1759 locations allocated.
- Approximately 15% of those allocated installed to date
  - 297 Cantilevers replaced to date by Nexus internal Infrastructure Works Delivery OHL Team.

Tension length renewals



Key	
Volker Replaced 2012	
Replaced	
Contact only Replaced	
Ongoing / Interventions	
Metro Flow (new)	
Partial Renewal	
Still to Replaced	

Contact wire completed: 85.5 route km (66%)

Catenary wire completed: 75.7 route km (59%)

Stoddart Strret sidings (SDS)

TSTD01 Bay 1

TSTD02 Bay 2

TSTD03 Bay 3

TSTD04 Bay 4 & Throat

Pelaw Sidings (PLW)

TPLW1 Bay 1

TPLW2 Bay 2

TPLW3 Bay 3

TPLW4 Refuge

TPLW12 Bay 1/2 crossover

TPLW23 Bay 2/3 crossover

Other renewals works

Any questions?