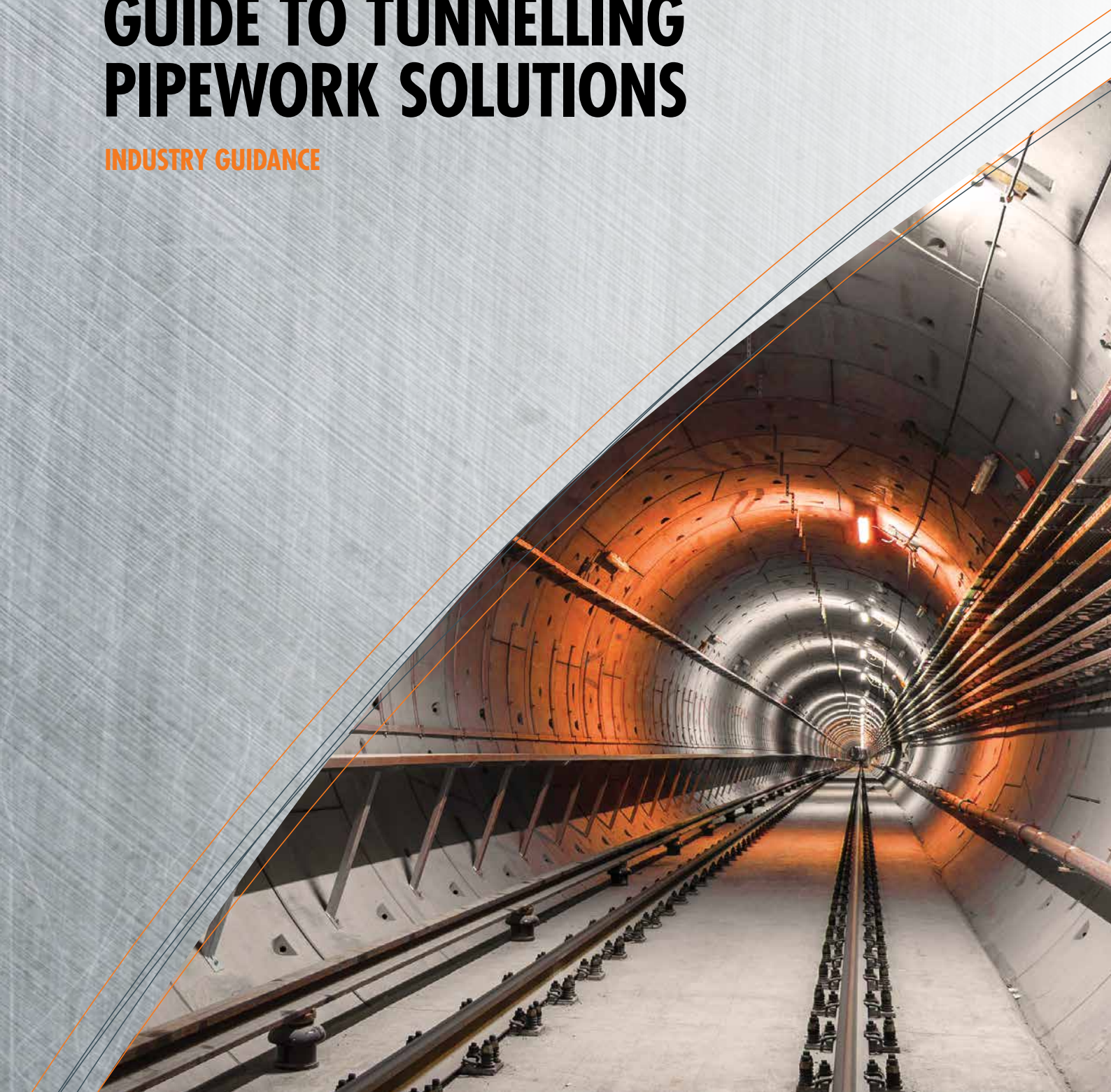
ASHWORTH
PEOPLE - PRODUCTS - SERVICE

GUIDE TO TUNNELLING PIPEWORK SOLUTIONS

INDUSTRY GUIDANCE



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GUIDE TO TUNNELLING PIPEWORK SOLUTIONS

1 OVERVIEW

Founded in 1907, Ashworth is recognised as one of the UK's leading suppliers of pipe and drainage systems, valves, and associated products into both the building services and specialist markets. We provide market-leading products from a network of strategically located branches serving all the major cities and surrounding territories.

Over recent years the UK has seen an increasing number of tunnelling projects. Ashworth has been working closely with Tata Steel UK and its Tubes business to develop our expertise and supply of UK manufactured carbon steel pipework solutions into such tunnelling projects.

Some projects are high profile and well publicised, such as Crossrail, Thames Tideway, HS1 and HS2. Others are not so visible, these include projects for road, utility, services and other underground rail extension tunnels, that equally need pipework solutions.

Below is a summary of projects we have undertaken to date.

- Channel Tunnel Fire Main + Utilities
- Kingsway Tunnel Fire main, Liverpool
- Queensway Tunnel Fire main
- New Tyne Tunnel Fire Main + Drainage
- National Grid - London Power Tunnels - Fire Main
- Crossrail C315 - Connaught Tunnel Refurbishment & Surface Rail Project
- Crossrail C305 - TBM Service Pipelines
- Crossrail C610 - Systemwide Fire Main / Pumped Drainage
- Black Wall Tunnel Fire main
- Hindhead Road Tunnel Fire main
- Baynard House - Replacement Thames Water Cooling Water Line
- Tideway East C338
- Tideway Central C410 - 315

As an emerging market sector, this industry guide has been developed by Ashworth to help answer some common questions and highlight the expertise, products, and services we can provide to ensure your tunnelling projects are a success.

2 CHALLENGES FOR THE INDUSTRY

Tunnelling projects typically have two distinct phases. Phase 1 we refer to as Dig-out and Phase 2 as Fit-out, both requiring particular pipework solutions to ensure project requirements are satisfied.

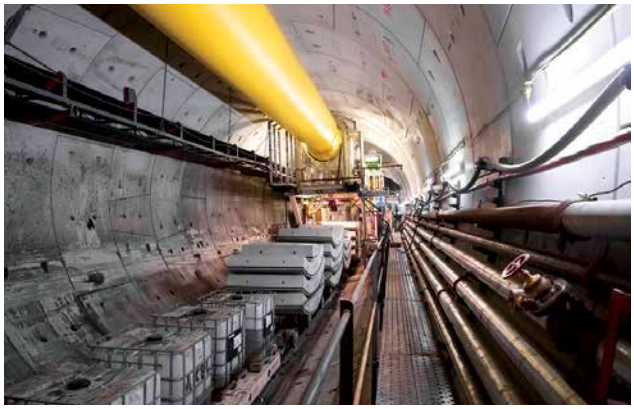


FIGURE 1: EXAMPLE OF DIG-OUT SERVICES.

FIGURE 2: EXAMPLE OF FIT-OUT SERVICES.

2.1 Dig-out: This involves the removal of the soil or rock as part of the tunnel or support shaft operations. Depending on the size of the tunnel this may be achieved by TBM (Tunnel Boring Machine) or an alternative method of mechanical excavation.

As well as being designed to bore through anything from hard rock to sand, TBM's can install precast concrete segments to form the tunnel walls. As the segments are positioned an annular gap remains between these segments and the ground. The filling of this gap is a very important requirement as this ensures continuous contact with the ground, load transfer and deters water ingress.

Pipework solutions are required to provide services to the TBM, remove the soil and rock debris, typically in the form of a slurry, and provide grouting lines to enable the annulus to be filled. The industrial grade pipework for such applications differs from those typically used within building services applications. The lack of an industrial recognised standard and variation in the requirements between different projects only adds to the confusion around the selection of the correct pipework. One of the challenges we aim to address within this guide.

2.2 Fit-out: This phase occurs once the walls are complete and pipework is installed to service or support the intended application of the tunnel. For example, this may include pipework for electrical conduit, fire suppression systems, air lines, wastewater or heating and cooling runs. The pipework specification for these services will typically default to those used within the building services market.

However, not all of the grades of carbon steel tube used for building services are suitable or compliant for some tunnelling applications which have particular temperature, pressure, and legislative requirements, such as operating above 50°C, at pressures exceeding 16bar, or satisfying the CPR (Construction Products Regulation) or the PED (Pressure Equipment Directive).

In addition, the service life requirements and corrosive categories for tunnel fit-out applications are often not considered during product selection, but this something we also aim to address within this guide.

3 METAL SYSTEMS

In most of the dig-out and fit-out applications traditional carbon steel pipework is typically suitable for use. Often referred to as mild steel, plain-carbon steel, or low-carbon steel, such tubes are the most commonly used type of tube, because of their relatively low price, toughness, strength and other material properties that are suitable for a wide range of applications.

Carbon steel is malleable, ductile and easy to work with. It can be prone to corrosion, but, if the system conditions are suitably controlled, carbon steel tube can have a life expectancy of many decades.

Concerns around carbon steel pipework erosion during dig-out can be addressed with thicker walls, but this can add additional weight and costs, alternatively the concern can be addressed by using stronger steel grades.

Service life concerns within fit-out applications can be addressed by using Hot Dipped Galvanised (HDG) carbon steel tubes. Other coating options are available to help improve service life performance.

In addition, depending on which phase the tube is being used in and if it's being buried, or encased within a concrete slab, bitumen wraps may also be utilised to provide improved protection.

4 TYPES OF PIPES

Carbon steel tubes can be supplied either as welded (hot-finished or cold-formed) or seamless (hot-finished), and the technical supply condition can influence how the tube performs in service, as well as its application compliance.

Hot-finished tubes have a range of technical advantages over cold-formed, and seamless tubes may be able to take higher pressures and temperatures compared to welded. Spirally welded tube may also be a possibility, but is not commonly available within the UK building and industrial services market. Therefore, it is imperative that the differences between tube manufacturing types is known and that the correct product is specified and procured to ensure project requirements are satisfied in full.

The summary shown on Page 7 highlights the typical advantages of a Tata Steel's UK manufactured hot-finished tube compared to that of cold-formed.

Because of the pressures involved and the line size of tunnelling tube the PED (Pressure Equipment Directive) may apply or be asked for as part of the clients technical specification. Cold-formed Part 1 TR1 carbon steel tubes are not suitable for applications under the PED (Note 1).

They do not meet the essential safety requirements of the directive. It is also important to note that for a system of connected pipework, it is the largest size within that system which can also dictate if the PED applies or not.

Note 1: On 20th April 2021, the old versions of BS EN10217 Part 1:2002-A1:2006 and BS EN10217 Part 2: 2002-A1:2005 were officially withdrawn, and the new replacement BS EN10217 Part 1: 2019 and BS EN10217 Part 2: 2019 versions became the current standards for the industry to use. The new 2019 versions now clearly state that Part 1 TR1 cold-form tubes are no longer suitable under the PED.

This is because they no longer satisfy the essential requirements of the PED. In addition, they continue to have temperature limitations, as Part 1 only covers a temperature range of +5 to +50°C. Therefore, their application and use must be controlled accordingly to mitigate the risk of incorrect product selection and non-compliance.

Source: BESA (Building Engineering Services Association) Technical Bulleting TB55 - COMPLIANCE OF DUAL CERTIFIED CARBON STEEL TUBES TO BS EN10255 AND 10217 PART 1 OR PART 2 .

Advantages of hot-finished (Part-2 GH grade) tubes

Tata Steel's welded hot-finished tubes have no Heat Affected Zone (HAZ), this is removed during hot-manufacturing, resulting in a superior product having:

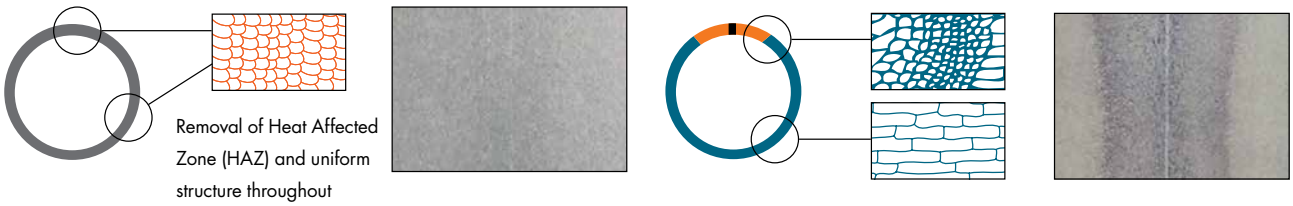
- An ordered and consistent microstructure
- No internal stress that can promote cracking
- Consistent and reliable mechanical properties
- Improved structural integrity and ductility
- Improved and consistent toughness
- Higher pressure integrity
- Greater factor of safety
- No loss of strength during additional welding or heating
- Improved performance against corrosion
- Ability to be bent to tighter radii without splitting, creasing or collapsing

Disadvantages of cold-formed (Part-1 TR1 grade) tubes

Cold-formed tubes contain a Heat Affected Zone (HAZ) around the weld-seam, this is an area of weakness, in addition cold-formed tubes also have:

- An inconsistent microstructure
- Pockets of stress that can promote cracking
- Inconsistencies in mechanical properties and strength
- Poorer toughness than the tube body
- Increased risk of splitting
- Poorer pressure integrity
- Reduced performance against corrosion
- Poorer bending abilities
- A maximum application temperature of 50°C
- No compliance with the PED (cold Part-1-TR1 tubes do not meet the essential technical requirements of the Directive)

FIGURE 3: HOT VS COLD CARBON STEEL TUBES



5 TATA STEEL'S HOT MANUFACTURING PROCESS

Although initially following a similar manufacturing process to that of imported cold-formed products, Tata Steel's traditional walled hot-finished Part 2 GH grade tubes undergo a crucial additional step. This involves removing the internal production stresses and the coarse grain structure of the Heat Affected Zone (HAZ), an area of weakness around the weld seam region.

This is achieved by heating the tubes to a high temperature (normalising temperature, i.e. greater than +950°C) using an induction or furnace process. Removal of the HAZ can be used to confirm a hot product during product investigations.

The Part 2 standard also defines different steel grades, technical delivery conditions as well as additional and more stringent post manufacturing testing, which demonstrates product suitability for both low (down to -10°C) and elevated temperatures (such products may be supplied with elevated temperature properties, as validated by the manufacturer, up to a maximum of +400°C for welded products).

Whilst such high temperatures may not be required for dig-out applications, there may be requirements for PED compliance. In addition to PED compliance, the Part 2 products are suitable for low, medium, or high temperature hot water services for fit-out applications.

Therefore, Part 2 (hot-finished GH) tubes ensure the correct steel chemistry composition, ductility and toughness to satisfy the essential technical requirements of the PED, as well as being technically validated for a wider operating temperature range.

In addition, welded tubes also have better ovality and end consistency than seamless alternatives (Figure 4). Providing improved end-matching for pipework and jointing, a key advantage in tunnelling projects, when alignment of products for jointing is required.

FIGURE 4: SCHEMATIC OF HOT-FINISHED WELDED TUBE ADVANTAGES COMPARED TO SEAMLESS

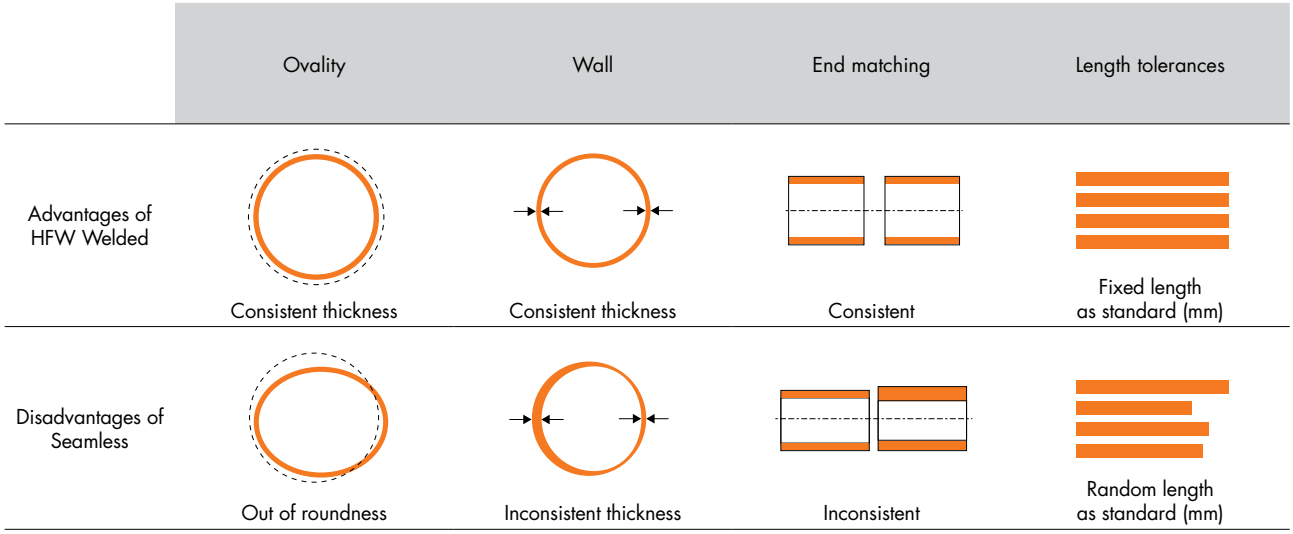
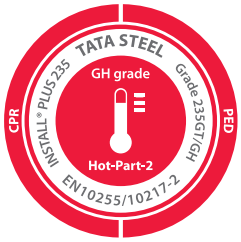
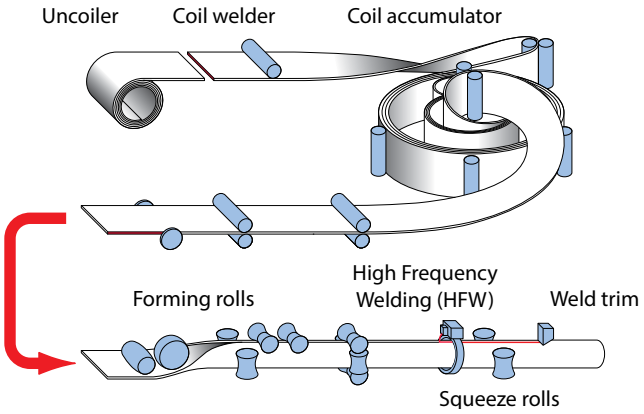
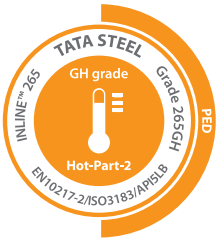


FIGURE 5: SCHEMATIC OF TATA STEEL'S HOT-FINISHED TUBE MANUFACTURING



For sizes:
15nb (1/2") OD21.3mm
to 150nb (6")
OD165.1mm
Design temp -20 to 300°C

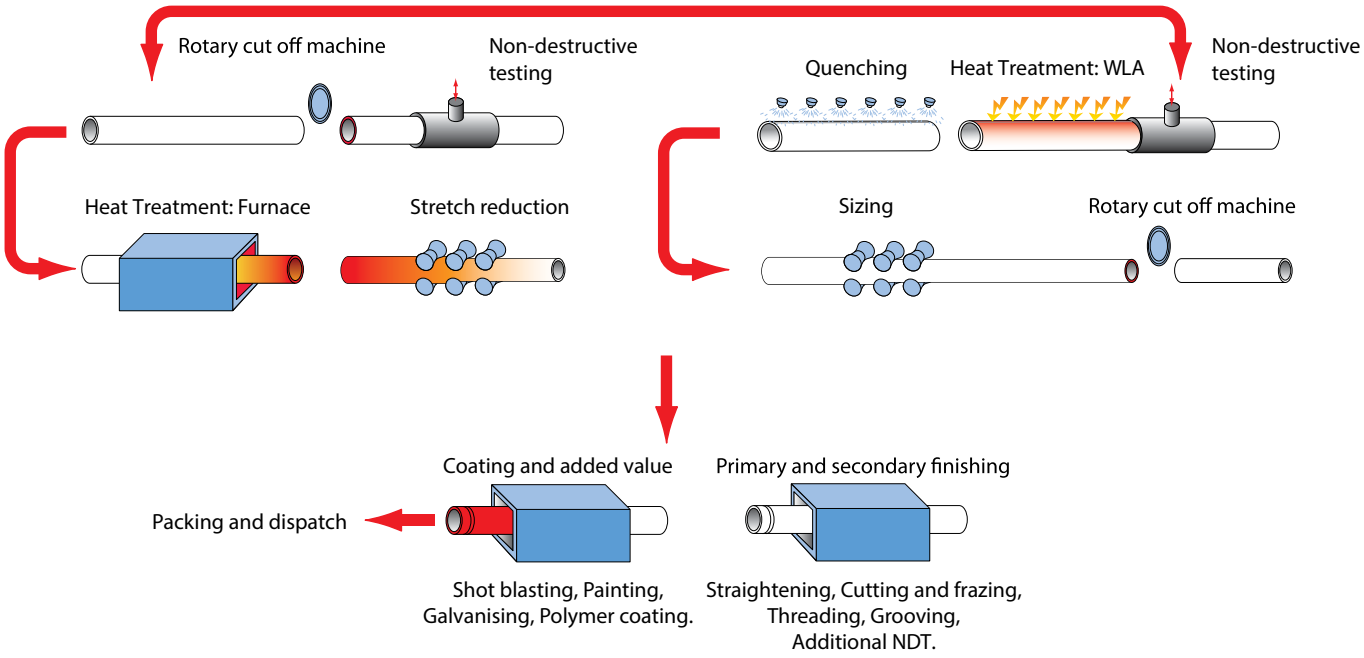




For sizes:
Up to and including
500nb (20") OD508mm
Design temp -20 to 400°C

Corby route Install® Plus 235

Hartlepool route Inline™ 265



6 SIZE OF PIPES

6.1 Dig-out: Due to the nature of the dig-out activities, tubes may need to have thicker walls to address erosion concerns, or be thick enough to undergo cut grooving and still ensure there is enough material to maintain structural and pressure integrity. Thicker walls may be required due to the higher pressures that may be seen within grouting lines etc. Figure 6 shows the typical size range and wall thicknesses as per BS EN10217-2 that falls within Tata Steel's hot-finished welded tube capability.

FIGURE 6: BS EN10217 OFFERING FROM TATA STEEL

OD	Thickness (mm)																		
(mm)	2.0	2.3	2.6	2.9	3.2	3.6	4.0	4.5	5.0	5.6	6.3	7.1	8.0	8.8	10.0	11.0	12.5	14.2	16.0
17.2	■	■	■	■	■														
21.3	■	■	■	■	■	■	■												
26.9	■	■	■	■	■	■	■												
31.8		■	■	■	■	■	■	■											
33.7		■	■	■	■	■	■	■											
38.0		■	■	■	■	■	■	■											
42.4		■	■	■	■	■	■	■	■										
48.3		■	■	■	■	■	■	■	■	■	■								
51.0		■	■	■	■	■	■	■	■	■	■								
57.0			■	■	■	■	■	■	■	■	■								
60.3			■	■	■	■	■	■	■	■	■	■							
70.0			■	■	■	■	■	■	■	■	■								
76.1				■	■	■	■	■	■	■	■	■							
82.5				■	■	■	■	■	■	■	■	■	■						
88.9					■	■	■	■	■	■	■	■	■						
114.3					■	■	■	■	■	■	■	■	■						
139.7					■	■	■	■	■	■	■	■	■	■	■				
159.0								■	■	■	■	■	■	■	■	■	■		
168.3							■	■	■	■	■	■	■	■	■	■	■		
193.7							■	■	■	■	■	■	■	■	■	■	■		
219.1								■	■	■	■	■	■	■	■	■	■	■	■
244.5									■	■	■	■	■	■	■	■	■	■	■
273.0									■	■	■	■	■	■	■	■	■	■	■
323.9									■	■	■	■	■	■	■	■	■	■	■
355.6									■	■	■	■	■	■	■	■	■	■	■
406.4										■	■	■	■	■	■	■	■	■	■
457.0										■	■	■	■	■	■	■	■	■	■
508.0										■	■	■	■	■	■	■	■	■	■

The table above is for guidance only, some sizes may not be standard or covered by regular manufacturing cycles. Other sizes may be available upon request. Please refer to the relevant technical literature or contact one of our account managers for confirmation of product specifications, sizes, lengths and finishing options available.

BS EN10217 pressure pipe standard allows a far greater range of product options. However, in some cases high steel grades and strengths may satisfy erosion and pressure requirements, whilst allowing a wall and mass reduction. For very high strength steels, BS EN10217-3 and P355 grades can be considered.

Figure 7 shows the suggested maximum design pressure (in Bar) for generic sizes at ambient temperature with a P235GH strength of carbon steel – the pressures are for the tube and final system pressure will be a function of the jointing system and type employed. Please contact us for additional information covering P355N or other grade/technical delivery condition options, contact details can be found at the back of this guide.

FIGURE 7A: SUGGESTED MAXIMUM DESIGN PRESSURE (BAR) FOR TATA STEEL'S BS EN10217-2 P235GH TUBES UP TO AND INCLUDING WALL THICKNESSES OF 7.10MM, AT AMBIENT TEMPERATURE

OD (mm)			Wall thickness (mm)																						
Series 1	Series 2	Series 3	2.00	2.30	2.60	2.90	3.00	3.20	3.60	3.90	4.00	4.25	4.50	4.78	5.00	5.40	5.50	5.60	6.00	6.02	6.30	6.35	6.40	7.00	7.10
17.2			260	299	338	377	390																		
21.3			210	242	273	305	315	336																	
26.9			166	191	216	241	250	266	299																
	31.8			162	183	204	211	225	253	274															
33.7				153	173	193	199	212	239	259															
	38.0			135	153	171	177	188	212	230															
42.4				121	137	153	158	169	190	206	211														
		44.5		116	131	146	151	161	181	196	201	214	226												
48.3				107	120	134	139	148	167	181	185	197	208												
	51.0				114	127	132	140	158	171	176	186	197												
	57.0				102	114	118	126	141	153	157	167	177	188											
60.3					96	108	111	119	134	145	148	158	167												
	63.5					102	106	113	127	137	141	150	159	168											
	70.0					93	96	102	115	125	128	136	144	153	160										
76.1							88	94	106	115	118	125	132	141	147										
		82.5						87	98	106	108	115	122	130	136										
88.9								81	91	98	101	107	113	120	126	136	138								
	101.6									86	88	94	99	105	110	119	121	123	132						
		108.0							75	81	83	88	93	99	104	112	114	116	124						
114.3									70	76	78	83	88	94	98	106	108	110	117						
	127.0									69	70	75	79	84	88	95	97	99	106	106	111	112	113	123	125
	133.0										67	72	76	80	84	91	93	94	101	101	106	107	108	118	119
139.7											64	68	72	77	80	86	88	90	96	96	101	102	103	112	114
		141.3									63	67	71	76	79	86	87	89	95	95	100	101	101	111	112
		152.4									59	62	66	70	73	79	81	82	88	88	93	93	94	103	104
		159.0										60	63	67	70	76	77	79	84	85	89	89	90	99	100
168.3												57	60	64	66	72	73	74	80	80	84	84	85	93	94
		177.8											57	60	63	68	69	70	76	76	79	80	81	88	89
		193.7											52	55	58	62	64	65	69	70	73	73	74	81	82
219.1													46	49	51	55	56	57	61	61	64	65	65	71	73
		244.5													46	49	50	51	55	55	58	58	59	64	65
273.0															41	44	45	46	49	49	52	52	52	57	58
323.9															35	37	38	39	41	42	44	44	44	48	49
355.6															31	34	35	35	38	38	40	40	40	44	45
406.4															28	30	30	31	33	33	35	35	35	39	39
457.0															24	26	27	27	29	29	31	31	31	34	35
508.0																		25	26	27	28	28	28	31	31

FIGURE 7B: SUGGESTED MAXIMUM DESIGN PRESSURE (BAR) FOR TATA STEEL'S BS EN10217-2 P235GH TUBES UP TO AND INCLUDING WALL THICKNESSES OF 16.00MM, AT AMBIENT TEMPERATURE

OD (mm)			Wall thickness (mm)																			
Series 1	Series 2	Series 3	7.50	7.80	7.90	7.92	8.00	8.20	8.40	8.80	9.00	9.30	9.50	9.52	10.00	10.30	11.00	12.50	12.70	14.20	14.30	15.10	16.00
17.2																							
21.3																							
26.9																							
	31.8																						
33.7																							
	38.0																						
42.4																							
		44.5																					
48.3																							
	51.0																						
	57.0																						
60.3																							
	63.5																						
	70.0																						
76.1																							
		82.5																					
88.9			189	196	199	199	201																
	101.6		165	172	174	174	176	181	185	194													
		108.0	155	162	164	164	166	170	174	182	186	193	197	197	207								
114.3			147	153	155	155	157	161	164	172	176	182	186	186	196	202	215	245					
	127.0		132	137	139	140	141	144	148	155	159	164	167	168	176	181	194	220					
	133.0		126	131	133	133	135	138	141	148	151	156	160	160	168	173	185	210					
139.7			120	125	127	127	128	131	135	141	144	149	152	152	160	165	176	200					
		141.3	119	124	125	125	127	130	133	139	143	147	150	151	158	163	174	198					
		152.4	110	115	116	116	117	120	123	129	132	137	139	140	147	151	162	184					
		159.0	106	110	111	111	113	115	118	124	127	131	134	134	141	145	155	176					
168.3			100	104	105	105	106	109	112	117	120	124	126	127	133	137	146	166	169				
		177.8	94	98	99	100	101	103	106	111	113	117	120	120	126	130	138	157	160				
		193.7	87	90	91	91	92	95	97	102	104	107	110	110	116	119	127	144	147				
219.1			77	80	81	81	82	84	86	90	92	95	97	97	102	105	112	128	130	145	146	154	163
		244.5	69	71	72	72	73	75	77	81	82	85	87	87	92	94	101	114	116	130	131	138	146
273.0			61	64	65	65	66	67	69	72	74	76	78	78	82	84	90	102	104	116	117	124	131
323.9			52	54	55	55	55	57	58	61	62	64	66	66	69	71	76	86	88	98	99	104	111
355.6			47	49	50	50	50	52	53	55	57	59	60	60	63	65	69	79	80	89	90	95	101
406.4			41	43	43	44	44	45	46	48	50	51	52	52	55	57	61	69	70	78	79	83	88
457.0			37	38	39	39	39	40	41	43	44	46	47	47	49	50	54	61	62	70	70	74	78
508.0			33	34	35	35	35	36	37	39	40	41	42	42	44	45	48	55	56	63	63	67	70

6.2 Fit-out: Such applications are more aligned with those typical of building and industrial services, and as such the carbon steel tubes tend to be supplied in traditional wall thicknesses, typically referred to as Medium (MED) or Heavy (HVY) weight or Schedule (Sch) sizes. The MED and HVY weights are associated with BS EN10255 tubes and cover the size range up to and including 150nb / 6" / OD165.1mm.

Sch is associated with API5L (American Petroleum Institute), typical sizes are show below. In both cases, use of a single certified product may leave you exposed to compliance issues, particularly if the PED applies. API is an American specification, typically for linepipe use, but as it has been available in the UK market over many decades, it is typically referred to for larger diameter applications.

To ensure both UK/European legislative alignment or compliance, dual standard products to appropriate parts of BS EN10217 or 10216 not only ensure harmonisation with the PED but provide the correct quality designations to confirm exactly what the pipework is, in terms of its technical delivery conditions, as well as highlight other OD and wall thickness opportunities.

FIGURE 8: TYPICAL BS EN10255/10217-2 SIZE RANGE FOR SIZES UP TO AND INCLUDING 150NB/6"/OD165.1

Thread size	Specified Outside Diameter		Thickness (mm)									
R (inch)	OD (mm)	NB	2.0	2.3	2.6	2.9	3.2	3.6	4.0	4.5	5.0	5.4
½	21.3	15			Medium		Heavy					
¾	26.9	20			Medium		Heavy					
1	33.7	25					Medium		Heavy			
1 ¼	42.4	32					Medium		Heavy			
1 ½	48.3	40					Medium		Heavy			
2	60.3	50						Medium		Heavy		
2 ½	76.1	65						Medium		Heavy		
3	88.9	80							Medium		Heavy	
4	114.3	100								Medium		Heavy
5	139.7	125									Medium	Heavy
6	165.1	150									Medium	Heavy

FIGURE 9: SUGGESTED MAXIMUM DESIGN PRESSURE (BAR) FOR TATA STEEL'S BS EN10255/10217-2 TUBES FOR SIZES UP TO AND INCLUDING 150NB/6"/OD165.1

Tube size			(A) Suggested maximum design (bar) for screwed and socketed joints. Correctly made-up using suitable appropriate jointing compounds						(B) Suggested maximum design pressure (bar) for tube or full penetration butt-welded joints. Butt-welded joints prepared in accordance with current best practice (based on S235GT/P235GH mechanical properties)							
			Water -20 up to 100°C		Compressed air		Steam to 220°C		-20 to 60°C		100°C max		150°C max		300°C max	
OD	Nominal bore (NB)		Tube weight (M = Medium, H = Heavy)						Tube weight (M = Medium, H = Heavy)							
mm	mm	inch	M	H	M	H	M	H	M	H	M	H	M	H	M	H
21.3	15	½	80	100	70	90	20	22	233	270	190	234	182	225	128	158
26.9	20	¾	75	90	65	80	20	22	186	215	152	187	146	179	103	126
33.7	25	1	70	85	60	75	20	22	172	215	149	186	143	179	101	126
42.4	32	1¼	55	70	50	65	19	21	137	171	119	148	114	143	80	100
48.3	40	1½	45	60	40	55	19	21	120	150	104	130	100	125	71	88
60.3	50	2	40	55	35	50	17	19	109	136	94	118	91	113	64	80
76.1	65	2½	35	45	30	40	17	19	86	108	75	93	72	90	51	63
88.9	80	3	30	40	25	35	17	19	82	103	71	89	68	85	48	60
114.3	100	4	25	35	20	30	15	17	72	86	62	75	60	72	42	51
139.7	125	5	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*	65	70	57	61	54	59	38	41
165.1	150	6	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*	55	60	48	52	46	50	32	35

**Pressure data for guidance only - and will be a function of the jointing system used. S&S joints may be restricted for some applications. We do not offer 5 and 6" S&S.*

FIGURE 10: TYPICAL API5L/BS EN10217-2 SIZE RANGE

Thread size	Specified Outside Diameter		Thickness (mm)								
R (inch)	OD (mm)	NB	3.9	5.5	6.0	6.4	7.1	7.9	8.2	9.3	9.5
2	60.3	50.0	STD Sch40								
3	88.9	80.0		STD Sch40							
4	114.3	100.0			STD Sch40						
6	168.3	150.0					STD Sch40				
8	219.1	200.0				Sch20			Sch40		
10	273.0	250.0				Sch20				STD Sch40	
12	323.9	300.0				Sch20					STD
14	355.6	350.0						Sch20			STD Sch30
16	406.4	400.0						Sch20			STD Sch30
18	457.0	450.0						Sch20			STD
20	508.0	500.0									STD Sch20

STD = Standard Weight, Sch = Schedule, Other sizes may be available unpon request.

FIGURE 11: SUGGESTED MAXIMUM DESIGN PRESSURE (BAR) FOR TATA STEEL'S BS EN10217-2/API5L GRADE B TUBES FOR SIZES UP TO AND INCLUDING 500NB/20"/OD508.0.

OD (mm) (NB) (inches)	Thickness (mm)	Designation		Mass (kg/m)	Mass (kg/m)	Recommended Maximum Design Pressure (bar)	
		Strength	Schedule	(DRY)	(WET)	Ambient Temp	Elevated Temp 400°C
60.3 (50) (2")	3.9	STD	40	5.4	184.5	148	69
88.9 (80) (3")	5.5	STD	40	11.3	88.4	142	66
114.3 (100) (4")	6.0	STD	40	16.0	62.4	121	56
168.3 (150) (6")	7.1	STD	40	28.2	35.4	97	45
219.1 (200) (8")	6.4		20	33.6	29.8	65	32
	8.2	STD	40	42.7	23.5	85	40
273.0 (250) (10")	6.4		20	42.1	23.8	52	25
	9.3	STD	40	60.5	16.5	77	37
323.9 (300) (12")	6.4		20	50.1	20.0	44	21
	9.5	STD		73.7	13.6	66	32
355.6 (350) (14")	7.9		20	67.7	14.8	50	24
	9.5	STD	30	81.1	12.3	60	29
406.4 (400) (16")	7.9		20	77.6	12.9	44	21
	9.5	STD	30	93.0	10.8	53	25
457.1 (450) (18")	7.9		20	87.5	11.4	39	19
	9.5	STD		104.8	9.5	47	23
508.0 (500) (20")	9.5	STD	20	116.8	8.6	42	20

Only key sizes shown – other sizes are available, please refer to the main Inline™ technical brochure, or contact the us for full details.

The sizes shown above are well recognised within the UK building and industrial services market and are readily available through Ashworth. However, other options are available, as shown for example in Figure 12, so please discuss any additional requirements with us.

Again, it is important to note that pipe wall thickness selection may also be dictated by the pressure integrity required (both operating and test pressures) or by the jointing system used. This is especially true if roll grooved or cut-grooved jointing is being used, as particular wall thicknesses are required to correctly make up such joints.

FIGURE 12: OTHER API5L/BS EN10217-2 PRODUCT OPTIONS

OD (mm) (DN) (Inches)	Thickness (mm)	Designation		Typical Mass (kg/m)	Typical Length/ Weight (m/tonne)	Inline™ 245 Recommended Maximum Design Pressure (bar)		Inline™ 265 Recommended Maximum Design Pressure (bar)		Inline™ Plus 360 Recommended Maximum Design Pressure (bar)	
		Strength	Schedule			Ambient Temp.	Elevated Temp. 400°C	Ambient Temp.	Elevated Temp. 400°C	Ambient Temp.	Elevated Temp. 400°C
60.3 (50) (2″)	3.91	STD	40	5.42	184.5	133	62	148	69	219	103
	5.54	XS	80	7.43	134.6	188	88	209	98	307	145
88.9 (80) (3″)	5.49	STD	40	11.31	88.4	128	59	142	66	210	99
	7.62	XS	80	15.24	65.6	177	83	197	92	290	136
114.3 (100) (4″)	6.02	STD	40	16.02	62.4	109	50	121	56	179	84
	8.56	XS	80	22.42	44.6	157	73	174	81	256	120
168.3 (150) (6″)	7.11	STD	40	28.22	35.4	87	41	97	45	144	68
	10.97	XS	80	42.67	23.4	136	63	151	70	223	105
219.1 (200) (8″)	6.35		20	33.57	29.8	59	29	65	32	100	47
	7.04		30	36.61	27.3	66	32	73	35	109	51
	8.18	STD	40	42.65	23.5	77	36	85	40	128	60
	10.31		60	53.03	18.1	96	46	107	51	161	76
	12.7	XS	80	64.64	15.5	120	57	133	63	198	93
	15.1		100	75.96	13.2	144	67	160	74	236	111
273 (250) (10″)	6.35		20	42.09	23.8	47	23	52	25	80	38
	7.8		30	51.03	19.6	58	28	64	31	98	46
	9.27	STD	40	60.5	16.5	69	33	77	37	117	55
	12.7	XS	60	81.55	12.3	95	45	106	50	159	75
	15.09		80	96.07	10.4	114	54	127	60	189	89
323.9 (300) (12″)	6.35		20	50.11	20	40	19	44	21	68	32
	8.38		30	65.35	15.3	52	25	58	28	89	42
	9.53	STD		73.65	13.6	59	29	66	32	101	47
	10.31		40	79.65	12.6	65	31	72	34	109	51
	12.7	XS		97.46	10.3	80	38	89	42	134	63
	14.27		60	109.18	9.2	90	43	100	48	151	71
355.6 (350) (14″)	6.35		10	55.11	18.2	36	17	40	19	62	29
	7.92		20	67.74	14.8	45	22	50	24	76	36
	9.53	STD	30	81.08	12.3	54	26	60	29	92	43
	11.13		40	94.3	10.6	64	31	71	34	107	50
	12.7	XS		107.39	9.3	73	35	81	39	122	58
	15.09		60	126.79	7.9	87	41	97	46	146	68
406.4 (400) (16″)	6.35		10	63.1	15.8	32	15	35	17	54	25
	7.92		20	77.63	12.9	40	19	44	21	67	31
	9.53	STD	30	92.98	10.8	48	23	53	25	80	38
	12.7	XS	40	123.3	8.1	64	31	71	34	107	50
457.1 (450) (18″)	6.35		10	71.12	14.1	28	14	31	15	48	23
	7.92		20	87.49	11.4	35	17	39	19	59	28
	9.53	STD		104.84	9.5	42	21	47	23	71	34
	11.3		30	22.05	8.2	50	23	55	26	83	39
	12.7	XS		139.15	7.2	57	27	63	30	95	45
	14.27		40	156.11	6.4	63	31	70	34	107	50
508 (500) (20″)	6.35		10	79.16	12.6	25	13	28	14	43	20
	9.35	STD	20	116.78	8.6	38	18	42	20	64	30
	12.7	XS	30	155.12	6.5	50	24	56	27	86	40
	15.09		40	183.54	5.5	60	29	67	32	102	48

7 TUBE END FINISHES

Typically, within building and industrial services carbon steel pipework can be welded together (directly or using flanges), or joined using a range of demountable (screwed, grooved or mechanical couplings etc.) or non-demountable (press-fit) fittings, each one having their own range of features and benefits, as well as limitations in certain applications.

However, for dig-out the tubes are typically joined by cut-grooved couplings or using weld rings and the appropriate clamping coupling. Roll grooved or mechanical couplings can be used in dig-out, but are extensively used within fit-out applications. The different tube end and jointing options are discussed below:

Roll-grooved: A roll-grooving machine is used to deform the tube ends to product the characteristic profile for the grooved coupling to engage with. Roll grooving changes the internal diameter at the point of the profile, resulting in a localised raised surface. The key dimensions for the tooling and profiles will be available from the grooving manufacturer. In addition, tapes and gauges are also available to check profiles after forming to ensure the grooved coupling sits correctly.

The grooved coupling consists of either a hinged body or two separate upper and lower body parts with an elastomer seal ring sitting inside. The joint is made when the coupling body and seal engages with groove profiles on the two sections of tubes being joined together. Bolts on the coupling are then tightened so that the body and seal compress into the groove recess and the seal mating face.

The combined force of the bolts, body and the seal rings being compressed around the tube makes the joint. Typically, the coupling bodies are manufactured from ductile iron or stainless steel and are supplied with a galvanised or painted finish dependent upon the application. Grooved couplings are easy to fit and provide a quick and easy, heat-free, and demountable joining system. Different elastomer seal materials may be needed for different applications, so it's always best to check with the manufacture or with their appropriate datasheets for confirmation.

PROS

- Quick, clean jointing solution.
- Elastomer seal integrated into coupling design.
- Good pressure integrity.
- Demountable.
- Mechanical joint – resists tube pull out.
- Ability to adjust tube for curvatures in pipework runs.

CONS

- Elastomer seal may be prone to damage if tube ends are not correctly prepared.
- Specialist grooving kit required to produce the grooved profile.
- Rolled profile changes internal diameter at the groove – may cause erosion or flow issues.
- Fittings can be bulky depending on size.

Cut-grooved: Rather than roll grooving the profile, the required profile is machined into the tube ends. This can be done on a lathe (tube size permitting) or a special cut grooving machine. A cut groove has the advantage of producing a cleaner more defined profile, with the internal diameter of the tube remaining unchanged. However, a much thicker tube is required to ensure there is enough wall thickness for both the profile to be cut and to maintain structural and pressure integrity.

As the wall thickness increases, so does the tube weight and more than likely its cost. Again, the key dimensions for the profiles will be available from the groove coupling manufacturer. As with roll grooving, tapes and gauges can be used to check profiles after machining or during installation.

PROS

- Cleaner more defined grooving profile.
- No localised change to the internal diameter as a result of the grooved profile.
- Effective mechanical joint – resists tube pull out.
- Quick, clean jointing solution.
- Demountable Elastomer seal integrated into coupling design.
- Good pressure integrity.

CONS

- Requires a much thicker and heavier tube compared to roll grooved.
- Specialist machining is required to cut the joint profile.
- Elastomer seal may be prone to damage if tube ends are not correctly prepared.
- Fittings can be bulky depending on size.

Weld-rings: Rather than a profile within the tube to secure the clamp, weld rings provide an anchorage on the outside of the tube. This allows for no change to the internal diameters, unlike roll-grooved, and no need for thick-walled tubes, unlike cut-grooved. However, the welding of the rings is a hot work activity, so typically will be done offsite. This joint system also requires the use of positioning jigs to ensure the rings are correctly located and aligned for the couplings to clamp onto.

In addition, weld procedures, welder qualifications and post weld tests and checks will also be required - a set up example is shown below. The weld ring type of jointing is typically considered for the dig-out phase, where unobstructive bores and good joint pressure integrity is required for the slurry lines.

FIGURE 13: EXAMPLE OF WELD RING AND TUBE END PREPARATION

PROS

- Strong anchorage for couplings.
- No localised change to the internal diameter as a result of the grooved profile.
- Unlike cut-grooving, thinner tubes can be used
- Quick, clean jointing solution.
- Elastomer seal integrated into coupling design.
- Good pressure integrity.
- Demountable.

CONS

- Requires the use of specially supplied rings.
- Specialist set up and welding is required to attach the rings to the pipe ends.
- Adds additional mass to the tubes weight.
- Fittings can be bulky depending on size.

Mechanical Body Grip Ring Couplings: also referred to as Gasketed Mechanical Couplings are used to join plain ended pipes together. The fitting comprises a steel coupling casing, which houses an elastomer seal with integrated pipe gripping rings which bite into the pipe wall and resist axial movement of the pipe ends. Gasketed mechanical couplings can be uninstalled and re-used again, providing a quick and easy, heat-free and demountable joining system.Additional anchor points may also be required with use on very large diameter tubes. Different elastomer seal materials may also be needed for different applications.

In all cases, the joints described are demountable, allowing for tube sections to be readily installed and removed as required.

PROS

- Quick, clean jointing solution.
- No change to ID profile.
- No need or any tube profile or machining for joint to work.
- Elastomer seal integrated into coupling design.
- Good pressure integrity.
- Demountable.
- Mechanical joint – teeth bit into tube for anchorage whilst body tightens and grips tube.
- Compact design.

CONS

- Correct selection of coupling type required – as different types for different applications.
- Risk of tube slippage at very high pressures.
- Larger coupling sizes may need anchorage points welded to the tube surface.

FIGURE 14: EXAMPLE OF GROOVED COUPLINGS BEING USED ON 150NB FIT-OUT WATER SERVICES

FIGURE 15: EXAMPLE OF 350NB MECHANICAL BODY GRIP RING COUPLINGS ON SLURRY PUMPING LINES

8 LIFE SPAN OF PRODUCTS

The environment found within tunnels, both during dig-out and fit-out operations, will often prompt requests for additional corrosion protection. The application of a zinc coating provides an effective method of impeding or preventing corrosion of ferrous materials.

Such coatings are used because they protect both by barrier action and by galvanic action, thereby providing improved service life.

The first consideration is to use a carbon steel tube with an appropriate chemical composition as certain elements, in particular silicon (Si) and phosphorus (P) in the steel can affect the galvanising by prolonging the reaction between the steel surface and the molten zinc.

Therefore, particular steel compositions offer more consistent coatings with regard to appearance, thickness and smoothness. Tata Steel's carbon steel tubes have a Si content of 0.03% max. so will provide a more consistent coating with regard to appearance, thickness and smoothness etc.

8.1 Galvanising process: Whilst carbon steel tubes can be galvanised either by an Automated process (Auto-galv) in accordance with BS EN10240 or Hot-dipped Galvanised (HDG) to BS EN ISO1461, we only recommend HDG is used for tunnel applications. This is because for auto-galvy tube the typical coating thickness is 55-75 microns.

For HDG tube the coating can be significantly thicker, typically greater than 80 microns, which provides improved service life/ product life span through better corrosion protection.

Typically, HDG tube is NOT passivated after the galvanising process. Under damp storage conditions, prior to or post-delivery, white discolouration can form on galvanised coatings, but this has no effect on the corrosion protection of the product, and if required, can easily be removed, but poses no risk if left in place, in fact it's an indication that the corrosion protection is occurring.

TABLE SHOWING THE MEAN/AVERAGE ZINC COATING THICKNESS AS A FUNCTION OF COATING PROCESS

Coating Process	Typical zinc thickness
Auto-galvanised	55 – 75 µm
Hot-dipped Galvanised	>80 µm

8.2 Atmospheric exposure: The next consideration regards the service life of a galvanised tube is the actual corrosion rate of the zinc coating. This is influenced by the time it is exposed to wetness, air pollution and any surface contamination. However, the corrosion rate is significantly slower than that seen for unprotected steel, hence why galvanised steel pipework has greater service life/product life span.

General information on the atmospheric corrosion rate for zinc is given in ISO9224. The table below, summarises and gives examples of the typical environment classifications (related to ISO9223), these are also referred to as Corrosivity or Corrosion Categories, and can be used to provide an indication of the likely corrosion rate applicable to a zinc coating when exposed to each of the Corrosion Categories.

Based on previous project specifications that Ashworth and Tata Steel have worked to, C3 is typically the Corrosion Category identified for tunnelling projects, as a maximum.

Although, it must be recognised that this is an indication, as the corrosion application examples covered do not specifically include modern tunnel environments.

TABLE SHOWING THE DESCRIPTIONS OF TYPICAL ATMOSPHERIC ENVIRONMENTS RELATED TO THE ESTIMATION OF CORROSIVITY CATEGORIES (ISO 9224) – WITH C3 TYPICALLY BEING APPLIED TO TUNNELS AS A MAXIMUM

Category	Indoor	Outdoor
C1 ≤ 0.1µm per year	Heated spaces with low relative humidity and insignificant pollution. e.g., offices, schools, museums etc.	Dry or cold zone, atmospheric environment with very low pollution and time of wetness. e.g., certain deserts, central arctic/Antarctica.
C2 0.1-0.7µm per year	Unheated spaces with varying temperature and relative humidity. Low frequency of condensation and low pollution. e.g., storage, sport halls.	Temperate zone, atmospheric environment with low pollution (SO_2< 5 µg/m^3) e.g., rural, small towns, Dry or cold zone, atmospheric environment with short time of wetness e.g., deserts, sub-arctic areas
C3 0.7-2µm per year	Spaces with moderate frequency of condensation and moderate pollution from production process e.g., food processing, plants, laundries, breweries, dairies	Temperate zone, atmospheric environment with medium pollution (SO_2 5-30 µg/m^3) or some effect of chlorides e.g., urban areas, coastal areas with low deposition of chlorides, subtropical and tropical zones with atmosphere with low pollution
C4 2-4µm per year	Spaces with high frequency of condensation and high pollution from production process e.g., industrial processing plants, swimming pools	Temperate zone, atmospheric environment with high pollution (SO_2 30-90 µg/m^3) or substantial effect of chlorides e.g., polluted urban areas, industrial areas, coastal areas without spray of sea water, exposure to strong effects of de-icing salts, subtropical and tropical zones with atmosphere with medium pollution
C5 4-8µm per year	Spaces with very high frequency of condensation and/or with high pollution from production process e.g., mines, caverns for industrial purposes, unventilated sheds in subtropical and tropical zones	Temperate and subtropical zones, atmospheric environment with very high pollution (SO_2 90-250 µg/m^3) and/or important effect of chlorides e.g., industrial areas, coastal areas, sheltered positions on coastline
CX 8-25µm per year	Spaces with almost permanent condensation or extensive periods of exposure to extreme humidity effects and/or with high pollution from production process e.g., unventilated sheds in humid tropical zones with penetration of outdoor pollution including airborne chlorides and corrosion stimulating particulate matter	Subtropical and tropical zones (very high time of wetness), atmospheric environment with very high pollution (SO_2 > 250 µg/m^3) including accompanying and production pollution and/or strong effect of chlorides e.g., extreme industrial areas, coastal and off shore areas with occasional contact with sea spray

TABLE SHOWING LIFE TO FIRST MAINTENANCE FOR A SELECTION OF ZINC COATINGS

System	Reference standard	Minimum thickness µm	Selected corrosivity category (ISO 9223) life min./max. (years) and durability class (VL, L, M, H, VH)							
			C3		C4		C5		CX	
Hot-dipped Galvanised (HDG) tubes	ISO1461	85	40/>100	VH	20/40	VH	10/20	H	3/10	M
		140	67/>100	VH	33/67	VH	17/33	VH	6/17	H
		200	95/>100	VH	48/95	VH	24/48	VH	8/24	H
Auto-galvanised tube	EN10240	55	26/79	VH	13/26	H	7/13	H	2/7	L

The table above now shows the 'life to first maintenance' for a selection of zinc coatings exposed to the range of the Corrosion Categories. The minimum and maximum life expectancies are indicated for each chosen system and the durability class.

Therefore, a hot-dipped galvanised tube to BS EN ISO1461 with a mean minimum thickness of 85µm in a C3 corrosion environment can have a service life between 40 to over 100 years. Durability classes (VH) = Very high, so a properly specified, procured, installed and commissioned tube could go greater than 20 years before first maintenance.

Requesting even thicker coatings may actually be detrimental, whilst in some cases the service life could increase, the excessive zinc, which is extremely soft compared to the steel, is more prone to damage and disbonding, and can also cause issues with the jointing, securing the tubes within bracketry and to some degree, the tube weight.

8.3 Contact with concrete: Unprotected steel products in contact with concrete can corrode as moisture penetrates into the concrete through cracks and pores. The oxidation products from the reaction between the steel and the oxygen/moisture present can create sufficient pressure to cause damage to the concrete (spalling). Zinc coatings can be used to prevent this type of deterioration for long periods of time, dependent upon the specific exposure environment.

The corrosion protection afforded by galvanized steel in concrete is due to a combination of beneficial effects. Of primary importance is the substantially higher chloride threshold (2 to 4 times higher) enabling zinc coatings to resist corroding compared to uncoated steel. In addition, zinc has a much greater pH passivation range than uncoated steel (11,5 versus 9,5) making galvanised steel far less susceptible to corrosion due to carbonation of the concrete.

Zinc also reacts with the wet concrete to form calcium hydroxyzincate accompanied by the evolution of hydrogen. This corrosion product is insoluble and protects the underlying zinc (provided that the surrounding concrete mixture is below a pH of about 13,3). During this initial reaction period until coating passivation and concrete hardening occurs, some of the pure zinc layer of the coating is dissolved. However, this initial reaction ceases once the concrete hardens and the hydroxyzincate coating has formed. The zinc coating can remain in a passive state for extended periods of time, even when exposed to high chloride levels in the surrounding concrete.

Therefore, we see no issues with Tata Steel's galvanised hot-finished tubes being embedded within a concrete slab during tunnelling applications. However, further protection and service life improvements can be realised by using additional tube protection such as protective bitumen tapes or wrappings.

9 HOW TO CHOOSE THE CORRECT PRODUCT – CONSIDERATIONS

Phase	Application	Tube	Jointing
Dig-out	**Slurry line**	Thick walled tube may be required to deal with high pressures, pressure pulses and/or erosion. Thickness will also be dictated if cut-grooved is used. Cut-grooving will also require specialist machining, so typically an offsite operation. If weld-ring couplings are used the rings will need to be welded to the tube ends – so will require pre-fabrication before getting to site. Self-colour tube can be used as the slurry line will be a temporary installation.	Demountable system required. Due to the tendency of having smooth bores (no internal ID disruption due to a roll grooved profile) cut grooved or mechanical grip ring coupling. Depending on the size of tube used, anchorage points on the tube may be required for mechanical grip ring couplings, alternatively the pipe supports may be suitable enough to act as the anchor. Alternatively weld rings couplings can be used – but will require end preparation and welding of the support rings.
	Grouting line	Grouting lines tend to be smaller diameters than the slurry lines. A thick walled tube may still be required to deal with high pressures, pressure pulses and/or erosion. Thicker tubes could be required if cut-grooved is used. If weld-ring couplings are used the rings will need to be welded to the tube ends. However, rolled grooved may be considered if a higher stronger grade of steel is used. This may allow thinner lighter walls to be considered. Self-colour tube can be used as the slurry line will be a temporary installation. As any internal coatings may get eroded away, so any protection is very temporary.	Demountable system required. Due to the tendency of having smooth bores (no internal ID disruption due to a roll grooved profile) cut grooved or mechanical grip ring couplings. Alternatively weld rings couplings can be used – but will require end preparation and welding of the support rings. Rolled grooved may be considered if a higher stronger grade of steel is used. This may allow thinner lighter walls to be considered.
	Waste water	Typically lower pressures than slurry or grouting lines, so self-coloured tube of a thickness to withstand the application pressure can be considered. Higher steel grades may allow thinner walls for weight savings whilst still maintaining the required pressure integrity.	Demountable system required. Roll grooved can be considered along with cut grooved or mechanical grip ring couplings.

Phase	Application	Tube	Jointing
Fit-out	**Fire suppression**	Pipework can be in accordance with standard building services offering and wall thickness. Typically HDG (Hot Dipped Galvanised) for extended service life. Note: increasing galvy thickness may result in handling and issues with applying the fittings. A minimum mean coating thickness of 85µm is typically specified/ suitable for such applications. For plant rooms etc, red painted tube may be suitable. Tube ends typically roll-grooved or plain-end for mechanical grip ring couplings.	Demountable system required. Roll grooved can be considered along with mechanical grip ring couplings. For small diameters screwed and socketed may be an option. For very large diameter tubes mechanical grip ring couplings may need anchorage points on the tube (however, these would assist in lifting tubes during galvanising and installation on site). Alternatively, the pipe supports may be suitable enough to act as the anchor.
	Water services	Pipework can be in accordance with standard building services offering and wall thickness. Typically galvanised for extended service life. Note: increasing galvy thickness may result in handling and issues with applying the fittings. A minimum mean coating thickness of 85µm is typically specified/suitable for such applications. Tube ends typically roll-grooved or plain-end for mechanical grip ring couplings.	Demountable system required. Roll grooved can be considered along with mechanical grip ring couplings. For small diameters screwed and socketed may be an option. For very large diameter tubes mechanical grip ring couplings may need anchorage points on the tube (however, these would assist in lifting tubes during galvanising and installation on site). Alternatively, the pipe supports may be suitable enough to act as the anchor.
	Conduit	Pipework can be in accordance with standard building services offering and wall thickness. Thinner walls can be considered as such systems are not pressurised. Typically galvanised for extended service life. Note: increasing galvy thickness may result in handling and issues with applying the fittings. A minimum mean coating thickness of 85µm is typically specified/suitable for such applications. Tube ends typically Screwed and Socketed or plain-end for mechanical grip ring couplings. Tubes needs to have internal weld bead removed and no profile disruption that may impact the running of cables.	Demountable system required. For small diameters screwed and socketed may be an option. For larger sizes mechanical grip ring couplings may be used.

10 SPECIFICATIONS OF PRODUCTS

Phase	Application	Specification – Tube	Specification - Jointing
Dig-out	Slurry tube Grouting line Waste water	**Tube:** To Ashworth/Tata Steel **BS EN10217 Part 2 Grade P235GH** – Special focus on OD and Wall thickness tolerances to provide improved end matching. *Note: Other stronger Grades such as P265 and P355 are also possible if high pressure integrity/mechanical properties are required. Alternatively, higher grades may allow thinner walls to be considered.* **OD:** To suit application requirements. **Wall thickness:** To suit application and jointing requirements. **Lengths:** 3.2's, 6m, 6.4m, 9m, 12m options available. **Length tolerance: EXACTS -0/+5mm IMPORTANT – Exact lengths required due to how TBM's operate.** **Surface finish:** Self-coloured. **Ends:** To suit jointing.	Please contact us to discus your jointing requirements in full. Contact details can be found at the back of this guide.
Fit-out	Fire suppression	**For sizes up to and including 150nb/6"/OD165.1mm** **Tata Steel INSTALL PLUS 235 to BS EN10255/10217-2 P235GH** **OD:** To suit application requirements **Wall thickness:** To suit application requirements. **Lengths:** 3.2's, 6m, 6.4m, 9m, 12m options available. **Length tolerance:** -0/+50mm. **Surface finish:** HDG (Hot Dipped Galvanised) minimum mean 85µm, other options include red painted. **Ends:** To suit jointing. **For sizes greater than 150nb/6"/OD165.1mm up to and including 500nb/20"/OD508.0mm** **Tata Steel INLINE 265 to BS EN10217-2/API5L Grade P235GH/5B** **OD:** To suit application requirements **Wall thickness:** To suit application requirements. **Lengths:** 3.2's, 6m, 6.4m, 9m, 12m options available. **Length tolerance:** -0/+50mm. **Surface finish:** HDG (Hot Dipped Galvanised) minimum mean 85µm, other options include self-coloured. **Ends:** To suit jointing.	Please contact us to discus your jointing requirements in full. Contact details can be found at the back of this guide.
	Water services	As above.	
	Conduit	**For sizes up to and including 150nb/6"/OD165.1mm** **Tata Steel INSTALL PLUS 235 to BS EN10255/10217-2 P235GH** Technical delivery conditions: As above	

Note: The above is for guidance only – other options may be available. Please contact us to discuss any further requirements so we can ensure your application requirements are satisfied in full.

11 TUNNELLING TUBE PRODUCTS FOR CARBON SAVINGS

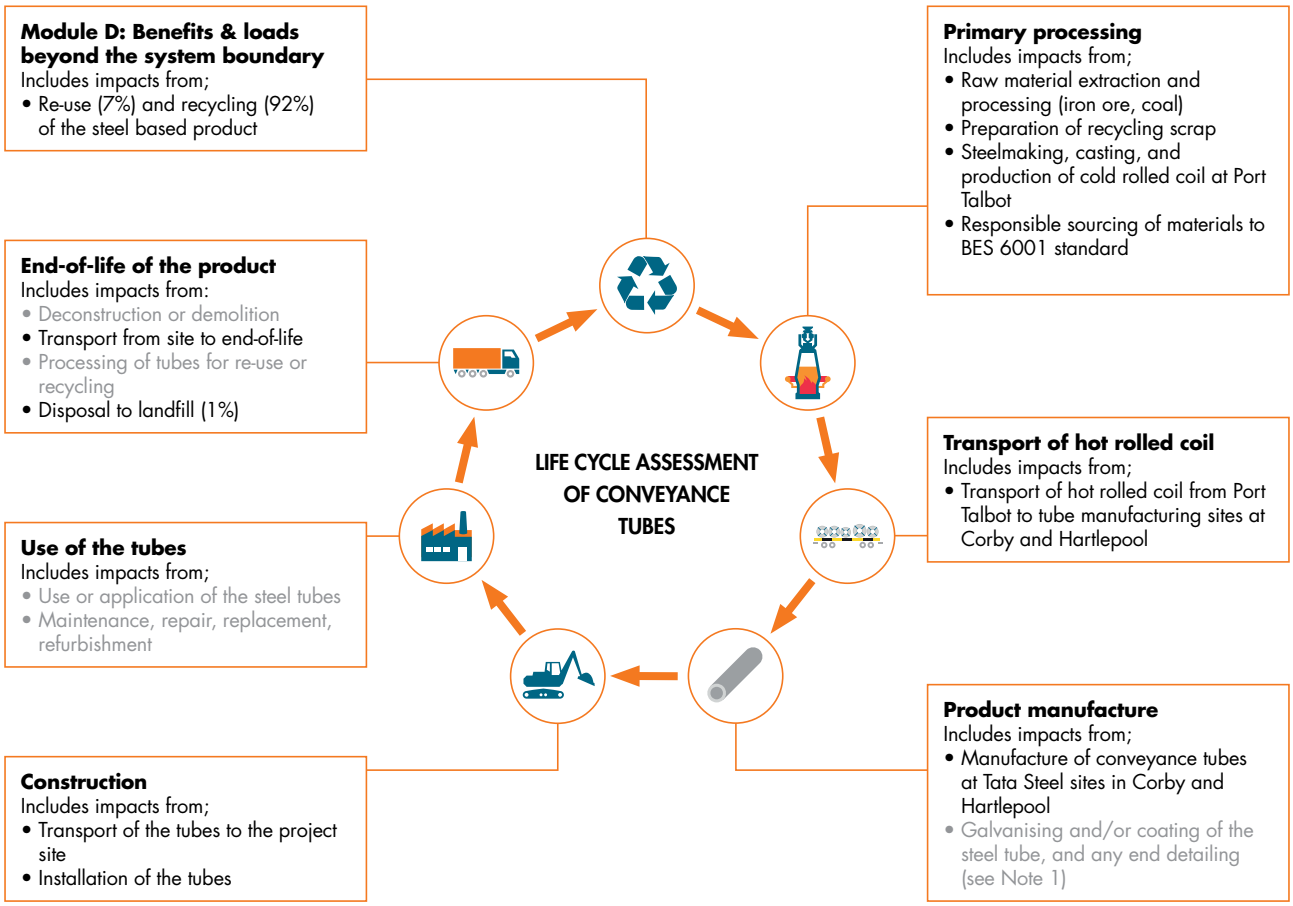
Ashworth and Tata Steel recognises the importance of identifying risk in the supply chain and in taking a due diligence approach. In line with this, Tata Steel's tube products are BES 6001 certified, which demonstrates through 3rd party assurance, that the constituent materials have been responsibly sourced.

Furthermore, Tata Steel has been identified as a global leader for engaging with its suppliers on climate change and has been awarded a position in the top 3% of organisations assessed by CDP (Carbon Disclosure Project - **www.cdp.net/en**) on their Supplier Engagement Leader board.

Tata Steel's responsible sourcing certification also enables them to help the construction supply chains accrue points, under building certification schemes such as BREEAM, on their construction projects. Further details can be found at: **www.tatasteeleurope.com/construction/sustainability/responsible-sourcing**

In addition, with steel made by Tata Steel in Port Talbot, Wales and transported by rail for tube production at Corby and Hartlepool, Tata Steel and Ashworth by working together also provide a reduced leg UK supply chain solution.

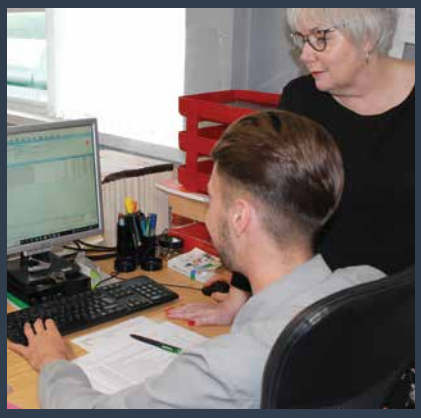
FIGURE 16 LIFE CYCLE ASSESSMENT OF STEEL CLADDING SYSTEM



Note 1: Galvanised conveyance products HDG process add approx. 0.2kg CO_2 per kg of steel - this is based on internal HDG process data.

12.1 ASHWORTH

12 YOUR SUPPLY CHAIN PARTNERS



DELIVERY

- National coverage
- Fleet operates to FORS Silver
- HIAB off-loading facilities
- Euro 6 engines
- Extensive delivery fleet options

STORAGE AND ADDED VALUE

- Vast product ranges
- Specialists in pipe and fittings handling & protection
- Experienced warehouse and operational teams
- In-house pipe cutting and grooving facilities up to 24"

POLICIES

- Environmental Management & Waste Policy ISO 14001:2015
- Lloyds Registered Quality Policy ISO 9001:2015 QMS Certificate
- Employers, Public & Product Liability Insurance (TWIMC)

12.2 TATA STEEL

TUBES

- Robust UK manufacturing, ability to supply key sizes and added value finishes
- Hot-finished welded carbon steel tubes for a wide range of applications
- Integrated UK supply chain providing fine grain steel, with traceability and consistent mechanical properties
- Technical understanding of our tube products (EN10217, ISO3183, API, EN10255) and where and how they can be used
- Extended range of product approvals and service life guarantees
- Supporting technical literature and specification expertise
- Experience in Tunnelling products, specifications, and client requirements

For more information please visit Tata Steel's dedicated website landing page:
www.tatasteeleurope.com/hotvscold

Or contact us on our technical Helpline if you have any additional product questions, or wish to learn more about our free Specification Review Service or any of our CPD's.
Technical Support: 01536 404561

13 CASE STUDY EXAMPLES

Our experience includes delivering major multi-million pound capital projects where solutions are required to meet complicated logistics plans which can include managing multiple site locations and contractors in a safe and environmentally conscious manner.

In addition to supplying material we also offer in-house pipe cutting and grooving facilities up to 24". Within the industrial market we also understand the importance of test certifications and are experienced in procuring products where source of origin and traceability is crucial within the specification.

Some of our recent projects have included requirements for:

- The storage and delivery of vested products.
- Specialised pipe and fittings protection during transit.
- Management of large call off orders including liaising with third party fabrication sub-contractors.
- Packaging of export orders including heat treated pallets to ISPM-15.

THAMESLINK

FIRE SUPPRESSION/ WATER SERVICES

PRODUCT USED
Tata Steel INSTALL PLUS 235 to BS EN10255/10217-2 P235GH

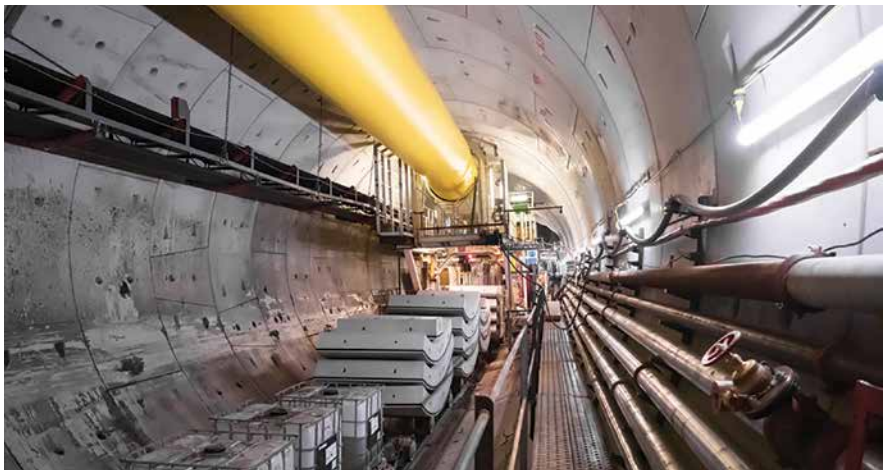
SIZE
150nb HVY

ENDS
Roll-grooved

Project Engineers had specified a galvanised coating thickness of over 100µm. However, with Tata Steel's experience of galvanising, and with the expert help of the Galvanisers Association, the Tubes Technical Managers were able to challenge this requirement, showing that a thinner coating of minimum mean of 85µm not only provided adequate protection for the service life of the tube but also delivered benefits in terms of reduced risk of disbondment of the coating during installation.

THAMES TIDEWAY

WASTE WATER SERVICES



PRODUCT USED
Tata Steel INLINE 265 to BS EN10217-2 P265GH

SIZE
200nb Sch40

ENDS
Weld rings

We were asked to provide the pipework solution for this important London infrastructure project. Project Value approx. £4 million with goods supplied to CVB Joint Venture on the eastern section of the Thames Tideway Tunnel project. We supplied the steel pipework and associated products for the feed and return lines to slurry tunnel boring machines on Tideway. The project also included piping products for slurry treatment plant and pumping stations. Both pipework packages were supplied to the agreed client's schedule. Provision of additional trailers improved logistics options and reduced time for loading and offloading, Provision of bespoke timber chocks to ensure health and safety requirements were met and to ensure loading plans were adhered too. Project production planning & management was offered to eliminate delays in the programme due to COVID and other factors. Customer regularly used our Rochester warehouse facility to collect critical and additional items.

We have supported the development of new pipework selection tools through our Trade Association membership

BMTFA

BESA Pipe Plus App – download from the App Store or visit WWW.BMTFA.ORG

Through Tata Steel we have access to UK Universities as part of the BISPA initiative – training, CPD's etc

BISPA

Building & Industrial Services Pipework Academy

www.bispa.org

ASHWORTH

PEOPLE - PRODUCTS - SERVICE

ASHWORTH

Suppliers of Pipe & Drainage Systems, Valves, Bracketry & Associated Products – including Tunnelling Pipework Solutions

WWW.ASHWORTH.UK.COM

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