

Lawton Engineering Data Sheet

Precision copper, cupronickel and aluminium brass tube, made to order. The skills and facilities of our two manufacturing plants, Coventry and Dorset, combine into a single engineering offering: straight cut lengths from 6 mm to 10 m, level wound and pancake coils, and profile tube cold drawn to shape. Average manufacturing time is 4 weeks.



Standards	BS EN 12449:2023, BS EN 13600:2021, BS EN 12451:2012 and ASTM B111 / ASME SB-111
Forms	Straight lengths, level wound coils, pancake coils, profile tubes (square, rectangular and oval), cupronickel condenser tube and brake line tube
Materials	Cu-DHP (C106); high conductivity Cu-ETP (C101) and Cu-OF (C103); cupronickel 90/10 (CN102) and 70/30 (CN107); aluminium brass CZ110

Product families and governing standards

Product family	BS EN 12449:2023 General purposes	BS EN 13600:2021 Electrical purposes	BS EN 12451:2012 Heat exchangers	ASTM B111 / ASME SB-111 Condenser tube	Agreed specification
Straight Lengths	Round	Round, HC	Round	Round	-
Level Wound Coils	Round	Round, HC	-	Round	Inner groove
Pancake Coils	Round	-	-	-	-
Profile Tubes	Square ¹ , oval ¹	Square, rectangular, oval ²	-	-	Oval
CuproNickel	Round	-	Round	Round	-

HC denotes the high conductivity grades Cu-ETP (C101) and Cu-OF (C103).
EN 13600 covers round, square and rectangular cross-sections only. It does not cover oval.
Where no product standard applies, tube is supplied to drawing or agreed dimensions and tolerances, with material composition conforming to the ordered grade.
¹ Custom product shape with applicable mechanical properties of BS EN 12449.
² Custom product shape with applicable mechanical and electrical properties of BS EN 13600.

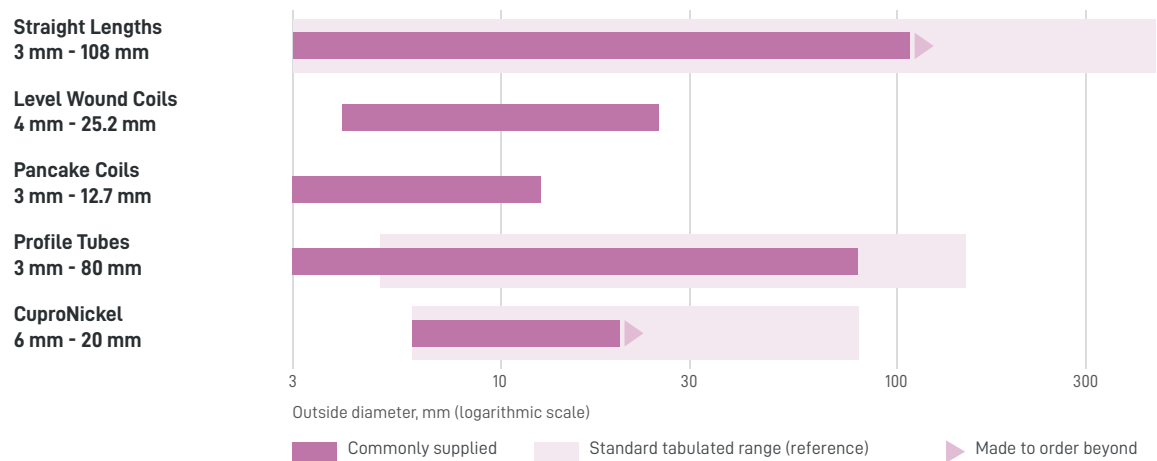
Made to order

Every line is made to order. The sizes in this sheet are commonly supplied ranges, not limits: custom dies, bespoke dimensions, non-standard lengths and small batches are quoted on enquiry, and coil lengths run well beyond any tabulated figure. Other specifications, including further ASTM grades, can be offered. Contact the Sales department with full enquiry details.

- Manufactured under an ISO 9001 certified quality management system
- Eddy current testing: standard on condenser and heat exchanger tube, on request elsewhere
- Hand inspected at several stages of production
- Deburring, degreasing and packing to detail on request
- EN 10204 3.1 inspection certificates on request

Commonly supplied sizes

Reference to standard and common sizes already supplied. Any size and length can be accomodated on quote.



Straight lengths

Forms	Straight lengths and bespoke cut lengths to 10 000 mm; deburred, degreased and packed to detail on request
Materials	Cu-DHP (C106); high conductivity Cu-ETP (C101) and Cu-OF (C103); cupronickel CN102 / CN107; aluminium brass CZ110 (CW702R)
Standards	BS EN 12449:2023; BS EN 13600:2021 for high conductivity grades; BS EN 12451:2012 and ASTM B111 for heat exchanger alloys
Commonly supplied	OD 3 mm - 108 mm, wall 0.3 mm - 8 mm; custom dies and longer lengths to order
Tempers	Soft, half hard, skin hard and hard; supplied to order



Level wound coils

Forms	Level wound coils, plain or inner grooved bore; with or without cardboard core; decoil orientation and inside or outside decoil to order
Materials	Cu-DHP, Cu-ETP, Cu-OF; cupronickel 90/10 CW352H (CN102)
Standards	BS EN 12449:2023; BS EN 13600:2021 (LWC OD 3 mm - 30 mm); ASTM B111 / ASME SB-111 for cupronickel
Commonly supplied	OD 4 mm - 25.2 mm, wall 0.3 mm - 1.6 mm. Coil length or weight to order: typical coils run 150 kg - 300 kg and longer coils are supplied to order
Tempers	Soft, light annealed and hard. Inner groove sizes on application



Pancake coils

Forms	Coils, not level wound; inkjet marking, individual bagging and customer-specific marking on request
Materials	Cu-DHP; cupronickel 90/10 CW352H
Standards	BS EN 12449:2023 (coil tolerances, Table 20)
Commonly supplied	OD 3 mm - 12.7 mm; coil lengths to order, typically 1 m - 30 m and beyond
Markets	ACR, automotive and medical assemblies; supplied annealed



Profile tubes

Forms	Square, rectangular and oval straight lengths, random or exact cut; corners of square and rectangular tube may be rounded along their whole length
Materials	Cu-ETP (C101), Cu-OF (C103), Cu-DHP (C106)
Standards	Square and rectangular: BS EN 13600:2021 (across flats 5 mm - 150 mm, wall 0.5 mm - 10 mm); oval: agreed specification (page 7); BS EN 12449:2023 - as custom product shape with mechanical properties of the standard
Commonly supplied	Cold drawn to the required shape and size, OD 3 mm - 80 mm, wall 1 mm - 8 mm, lengths to 10 000 mm; custom dies to order
Tempers	Soft, half hard and hard; small batch capability



CuproNickel

Forms	Straight lengths, level wound coils and pancake coils
Materials	CuNi10Fe1Mn CW352H (CN102, 90/10, C70600); CuNi30Mn1Fe CW354H (CN107, 70/30, C71500)
Standards	BS EN 12451:2012; ASTM B111 / ASME SB-111; BS EN 12449:2023 for general purpose duty
Commonly supplied	OD 6 mm - 20 mm, wall 0.5 mm - 1.6 mm, within EN 12451 scope; to 20 mm OD under ASTM B111
Testing	100 % eddy current testing and EN 10204 3.1 certification are the norm on condenser lines



Sizes, shapes and finishes beyond these panels are quoted on enquiry; the ranges shown are commonly supplied, not manufacturing limits.

Standards on this sheet

Designation	Title	Governs
BS EN 12449:2023	Copper and copper alloys - Seamless, round tubes for general purposes	General purpose round tube: composition, mechanical properties and dimensional tolerances
BS EN 13600:2021	Copper and copper alloys - Seamless copper tubes for electrical purposes	High conductivity tube: round, square and rectangular cross-sections
BS EN 12451:2012	Copper and copper alloys - Seamless, round tubes for heat exchangers	Heat exchanger and condenser duty, including cupronickel
ASTM B111/B111M-18a	Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock	Cupronickel condenser tube; adopted as SB-111 in ASME BPVC Section II
Material conditions are designated to EN 1173 (R and H conditions) and materials to EN 1412 (CW numbers). The edition cited on the order governs.		

General purpose round tube: BS EN 12449:2023

Composition (% mass fraction)

Legacy grade	Symbol	Number	Cu min % ^a	Bi max %	O max %	P %	Pb max %	Others total max %	Excluding
C106	Cu-DHP	CW024A	99.90	-	- ^c	0.015 - 0.040	-	- ^d	-
C101	Cu-ETP	CW004A	99.90	0.0005	0.040 ^b	-	0.005	0.03	Ag, O
C103	Cu-OF	CW008A	99.95	0.0005	- ^c	-	0.005	0.03	Ag

a Including silver, up to a maximum of 0.015 %.

b Oxygen content up to 0.060 % is permitted, subject to agreement between the purchaser and the supplier.

c The oxygen content shall be such that the material conforms to the hydrogen embrittlement requirements of EN 1976.

d If required, the permitted total of elements other than silver and phosphorus to be agreed between the purchaser and the supplier.

The total of other elements is the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, less the exclusions listed. Source: BS EN 12449:2023 Table 1.

Mechanical properties

Material	Condition	Wall max mm	Rm min N/mm ²	Rp _{0.2} min N/mm ²	Rp _{0.2} max N/mm ²	A min %	HV min	HV max	Temper
Cu-DHP (C106)	M	20	-	-	-	-	-	-	As manufactured
	R200	20	200	-	110	40	-	-	Annealed (soft)
	H040	20	-	-	-	-	40	65	Annealed (soft)
	R250	10	250	150	-	15 - 30 ^e	-	-	Half hard
	H070	10	-	-	-	-	70	100	Half hard
	R290	5	290	250	-	3	-	-	Hard
	H095	5	-	-	-	-	95	120	Hard
	R360	3	360	320	-	-	-	-	Extra hard
	H110	3	-	-	-	-	110	-	Extra hard
	H035	20	-	-	-	-	35	65	Annealed (soft)
Cu-ETP / Cu-OF (C101 / C103)	R200	20	200	-	120	35	-	-	Annealed (soft)
	H065	10	-	-	-	-	65	95	Half hard
	R250	10	250	150	-	15	-	-	Half hard
	H090	5	-	-	-	-	90	110	Hard
	R290	5	290	250	-	5	-	-	Hard
	H100	3	-	-	-	-	100	-	Extra hard
	R360	3	360	320	-	(3)	-	-	Extra hard

e Cu-DHP R250 elongation depends on tube dimensions (Table 16): OD 3 mm - 66.7 mm at wall 0.3 mm - 3 mm: 30 %; OD 3 mm - 66.7 mm at wall 3 mm - 10 mm: 20 %; OD 66.7 mm - 450 mm at wall 0.3 mm - 3 mm: 20 %; OD 66.7 mm - 450 mm at wall 3 mm - 10 mm: 15 %.

1 N/mm2 is equivalent to 1 MPa. Figures in parentheses are for information only. Condition M is as manufactured, with no specified properties. Brinell (HBW) limits are also specified in the standard; Vickers shown here. Source: BS EN 12449:2023 Tables 9 and 16.

High conductivity tube for electrical purposes: BS EN 13600:2021

Composition (% mass fraction)

Legacy grade	Symbol	Number	Copper type	Cu min % ^a	Bi max %	O max %	Pb max %	Others total max %	Excluding
HC C101	Cu-ETP	CW004A	Electrolytic tough pitch copper (oxygen-containing), high electrical conductivity	99.90	0.0005	0.040 ^b	0.005	0.03	Ag, O
HC C103	Cu-OF	CW008A	Oxygen-free copper, produced without deoxidisers, high electrical conductivity	99.95	0.0005	– ^c	0.005	0.03	Ag

^a Including silver, up to a maximum of 0.015 %.

^b Oxygen content up to 0.060 % is permitted, subject to agreement between the purchaser and the supplier.

^c The oxygen content shall be such that the material conforms to the hydrogen embrittlement requirements of EN 1976.

Special precautions are necessary when heat treating, welding or brazing Cu-ETP in atmospheres containing hydrogen. Cu-OF needs no such precautions; tubes in Cu-OF shall show no evidence of cracking when tested to EN ISO 2626. Source: BS EN 13600:2021 Table 2 and Annex A.

Mechanical properties

Condition	Wall max mm	HBW min	HBW max	HV min	HV max	Rm min N/mm ²	Rm max N/mm ²	Rp _{0.2} min N/mm ²	Rp _{0.2} max N/mm ²	A min %
D	–	–	–	–	–	–	–	–	–	–
H035	40	35	60	35	65	–	–	–	–	–
R200	40	–	–	–	–	200	250	–	120	35
H065	20	60	90	65	95	–	–	–	–	–
R250	20	–	–	–	–	250	300	150	–	15
H090	10	85	105	90	110	–	–	–	–	–
R290	10	–	–	–	–	290	360	250	–	5
H100	5	95	–	100	–	–	–	–	–	–
R360	5	–	–	–	–	360	–	320	–	(3)

Applies to all copper grades of the standard, including Cu-ETP (C101) and Cu-OF (C103). 1 N/mm² is equivalent to 1 MPa. Figures in parentheses are for information only. Condition D is as cold drawn, with no specified properties. Source: BS EN 13600:2021 Table 3.

Electrical properties

Condition	Volume resistivity max ohm mm ² /m	Mass resistivity max ohm g/m ²	Conductivity min MS/m	Conductivity min % IACS
D	0.01786	0.1588	56.0	96.6
H035 / R200	0.01724	0.1533	58.0	100.0
H065 / R250	0.01754	0.1559	57.0	98.3
H090 / R290	0.01786	0.1588	56.0	96.6
H100 / R360	0.01818	0.1616	55.0	94.8

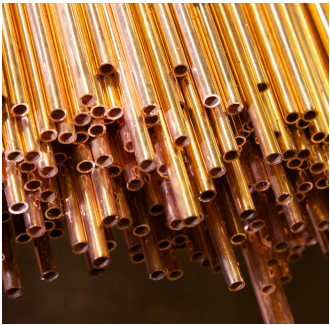
At 20 °C, product in the as delivered condition. Values for Cu-ETP (C101) and Cu-OF (C103); mass resistivity calculated with a copper density of 8.89 g/cm³. Source: BS EN 13600:2021 Table 4.

Heat exchanger tube: BS EN 12451:2012

Cu-DHP (C106, CW024A) heat exchanger tube. Standard scope OD 6 mm - 76 mm, wall 0.5 mm - 3 mm; commonly supplied OD 6 mm - 20 mm. Composition limits are identical to BS EN 12449:2023 Table 1 (page 4).

Condition	Rm min N/mm ²	Rp _{0.2} min N/mm ²	A min %	Drift expansion min %	HV min	HV max
R220	220	-	40	20	-	-
R250	250	150	30	20	-	-
H075	-	-	-	20	75	100
R290	290	250	3	-	-	-
H100	-	-	-	-	100	-

Average grain size in the annealed condition 0.010 mm - 0.050 mm. Drift expanding test to EN ISO 8493, 45 degree mandrel. Freedom from defects testing (eddy current to EN 1771-1 / EN 1771-2, or hydrostatic or pneumatic) when requested. Source: BS EN 12451:2012 Table 2, 6.3 and 6.5.



CuproNickel alloys

Alloy	Designation	Source standard
90/10	CuNi10Fe1Mn CW352H	EN 12449:2023 Table 3 / EN 12451:2012 Table 1
90/10	C70600	ASTM B111/B111M-18a Table 1
70/30	CuNi30Mn1Fe CW354H	EN 12449:2023 Table 3 / EN 12451:2012 Table 1
70/30	C71500	ASTM B111/B111M-18a Table 1

Composition (% mass fraction)

Alloy	Designation	Cu	Ni	Fe	Mn	C max	Co max	P max	Pb max	S max	Sn max	Zn max	Others total max
90/10	CuNi10Fe1Mn CW352H	Rem.	9.0 - 11.0	1.0 - 2.0 ^b	0.5 - 1.0	0.05	0.1 ^a	0.02	0.02	0.05	0.03	0.5	0.2
90/10	C70600	Rem. ^c	9.0 - 11.0 (incl Co)	1.0 - 1.8	1.0 max	0.05	-	0.02	0.05	0.02	-	1.0	-
70/30	CuNi30Mn1Fe CW354H	Rem.	30.0 - 32.0	0.4 - 1.0	0.5 - 1.5	0.05	0.1 ^a	0.02	0.02	0.05	0.05	0.5	0.2
70/30	C71500	Rem. ^c	29.0 - 33.0 (incl Co)	0.40 - 1.0	1.0 max	-	-	0.02	0.05	-	-	1.0	-

^a Co max 0.1 % is counted as Ni.
^b For sea water applications the composition limits shall be agreed between the purchaser and the supplier.
^c Copper is the difference between the sum of all elements determined and 100 %; copper plus named elements 99.5 % min.
The EN and ASTM limits differ in detail; the standard cited on the order governs.

Mechanical properties, EN specifications

Alloy	Condition	Rm min N/mm ²	Rp _{0.2} min N/mm ²	A min %	Drift expansion min %	HV min	HV max
90/10 CW352H	R290	290	90	30	30	-	-
	H075	-	-	-	30	75	105
	R310	310	220	12	20	-	-
	H105	-	-	-	-	105	150
	R480	480	400	8	8	-	-
	H150	-	-	-	-	150	-
	R370	370	120	35	30	-	-
70/30 CW354H	H090	-	-	-	30	90	120
	R480	480	300	12	20	-	-
	H120	-	-	-	-	120	-

R290 / H075 (90/10) and R370 / H090 (70/30) are annealed conditions. 1 N/mm2 is equivalent to 1 MPa. BS EN 12449:2023 Table 10 gives closely similar conditions for general purpose duty with slightly different hardness windows (90/10 H075 max 110; 70/30 rows R370 / H085 / R480 / H135). The standard cited on the order governs. Source: BS EN 12451:2012 Table 2.

CuproNickel to ASTM B111 / ASME SB-111

UNS	Temper	Temper name	Tensile strength min MPa	Yield strength min MPa (0.5 % ext.)	Elongation in 50 mm min %
C70600	O61	Annealed	275	105	-
C70600	H55	Light-drawn	310	240	-
C71500	O61	Annealed	360	125	-
C71500	HR50 (wall up to and incl 1.2 mm)	Drawn and stress-relieved	495	345	12
C71500	HR50 (wall over 1.2 mm)	Drawn and stress-relieved	495	345	15

SI values shown (B111M); inch-pound values are a separate, equally valid system in the standard. Annealed (O61) grain size 0.010 mm - 0.045 mm to E112. Expansion (pin test, B153): O61 30 %, H55 20 %, HR50 20 % of original OD.

Every tube is eddy current tested to ASTM E243, with hydrostatic or pneumatic testing as the agreed alternative. Source: ASTM B111/B111M-18a Tables 3 and 4, Sections 9 and 13.

Aluminium brass: CZ110 (CuZn20Al2As CW702R / C68700)

Item	EN route: CuZn20Al2As CW702R	ASTM route: C68700
Composition Cu %	76.0 - 79.0	76.0 - 79.0
Composition Al %	1.8 - 2.3	1.8 - 2.5
Composition As %	0.02 - 0.06	0.02 - 0.06
Composition Fe max %	0.07	0.06
Composition Mn max %	0.1	-
Composition Ni max %	0.1	-
Composition P max %	0.01	-
Composition Pb max %	0.05	0.07
Composition Zn	Rem.	Rem. (Cu plus named elements 99.5 % min)
Others total max %	0.3	-
Mechanical, annealed	R340: Rm 340, Rp0.2 120, A 55 %, drift 30 %; or H070: HV 70 - 100, drift 30 %	O61: tensile 345 MPa min, yield 125 MPa min (0.5 % ext.), expansion 20 %
Mechanical, annealed (higher)	R390: Rm 390, Rp0.2 150, A 45 %, drift 30 %; or H085: HV 85 - 110, drift 30 %	-
Residual stress	Stress corrosion resistance test to EN ISO 196 / ISO 6957 when requested	Residual stress test (B154 / B858) when specified and not annealed

Sea water capable alloy (BS EN 12451 Table 1). Supplied 100 % eddy current tested with full certification. Source: BS EN 12451:2012 Tables 1 and 2; ASTM B111/B111M-18a Tables 1, 3 and 4; BS EN 12449:2023 Tables 8 and 15 carry the same alloy for general purpose duty.

Profile tube data

Shapes	Square, rectangular and oval; corners of square and rectangular tube may be rounded along their whole length
Square and rectangular	BS EN 13600:2021, across flats 5 mm - 150 mm, wall 0.5 mm - 10 mm; mechanical properties and composition as page 5. Non-electrical duty to agreed specification with material to the same composition tables
Across flats tolerances	EN 13600 Table 6: +/-0.10 mm (5 mm - 15 mm across flats) stepping to +/-0.35 mm (120 mm - 150 mm); not applicable to the annealed condition; doubled if all plus or all minus
Corner radii	EN 13600 Table 7: external max 1.8 mm (wall 0.5 mm - 1.5 mm), 2.2 mm (1.5 mm - 3 mm), 3.5 mm (3 mm - 6 mm), 6.0 mm (6 mm - 10 mm); internal max 0.8 mm throughout
Twist	EN 13600 Table 10: max 1.0 mm to 6.0 mm per 1 m length by across flats size (10 mm - 150 mm); applies at 10 mm across flats and over, all conditions except H035 / R200
Oval	Not covered by a European product standard. Supplied to drawing or agreed dimensions and tolerances, with material composition conforming to the ordered grade (pages 4 and 5) and mechanical condition by agreement
Works range	Cold drawn to the required shape and size, OD 3 mm - 80 mm, gauge 1 mm - 8 mm, lengths to 10 000 mm, random or exact cut; custom dies to order; small batch capability

Legacy grade cross reference

Legacy BS 2871 grade	Material	EN symbol	EN number	Nearest UNS
C101	Electrolytic tough pitch high conductivity copper	Cu-ETP	CW004A	C11000
C103	Oxygen-free high conductivity copper	Cu-OF	CW008A	C10200
C106	Phosphorus deoxidised copper, high residual phosphorus	Cu-DHP	CW024A	C12200
CN102	90/10 copper-nickel-iron	CuNi10Fe1Mn	CW352H	C70600
CN107	70/30 copper-nickel	CuNi30Mn1Fe	CW354H	C71500
CZ110	Aluminium brass	CuZn20Al2As	CW702R	C68700
BS 2871 was withdrawn and replaced by the EN series; the legacy grade names remain in everyday ordering use. UNS numbers are nearest equivalents: composition limits differ in detail between the systems, and the governing limits are those of the standard cited on the order.				

Test methods and certification

Requirement	EN route	ASTM route
Tensile test	EN ISO 6892-1	E8/E8M
Hardness	EN ISO 6507-1 (Vickers), EN ISO 6506-1 (Brinell)	-
Drift expanding / expansion	EN ISO 8493, 45 degree mandrel (EN 12451)	B153 pin test (B111)
Flattening	-	B968/B968M (B111)
Eddy current	EN 1971-1 / EN 1971-2 (EN 12451, when requested)	E243, every tube (B111)
Hydrostatic / pneumatic alternative	EN 12451 8.5.3 / 8.5.4	B111 13.1.2 / 13.1.3
Grain size	EN ISO 2624 / EN 16090	E112
Hydrogen embrittlement (Cu-OF)	EN ISO 2626 (EN 13600 6.4)	-
Residual stress / stress corrosion	EN ISO 196 / ISO 6957	B154 mercurous nitrate / B858 ammonia vapour
Electrical resistivity	EN 13600 8.4, at 20 °C or corrected to 20 °C	-
Certification	EN 10204 3.1 inspection certificate on request; declaration of conformity to EN ISO/IEC 17050-1	B111 Section 23 certification; mandatory for ASME BPVC applications
Cleanliness	Degreasing to BS EN 13348 carbon limits available on request	-

How to order

Example designation: Tube - EN 12449 - CuNi10Fe1Mn - H075 - OD22 x 2,0 - fixed length 3 000 mm

Element	Meaning
Tube	Denomination
EN 12449	Number of the governing document
CuNi10Fe1Mn	Material designation, symbol or CW number (CW352H)
H075	Material condition, from the alloy tables
OD22 x 2,0	Nominal outside diameter and wall thickness
3 000 mm	Length, or nominal coil weight for level wound coils
Designation format per BS EN 12449:2023 Clause 4.3; BS EN 13600:2021 mirrors it and adds the cross-sectional shape code (RND, SQR, RCT). State with the enquiry: quantity (pieces, length or mass), form (straight length, level wound coil, pancake coil or profile) and, for profile tube, the cross-section.	

Options to state on the order

- EN 10204 3.1 inspection certificate (all products)
 - Eddy current testing (standard on condenser tube)
 - Degreasing to EN 13348 carbon limits (all copper products)
 - Deburring, hand or machine (cut lengths)
 - Inner groove (level wound coils)
- Decoil direction and cardboard core (level wound coils)
 - Inkjet marking and individual bagging (pancake coils, cut lengths)
 - Sea water composition limits (90/10 CuNi10Fe1Mn)
 - Drift expanding test (EN 12451 and EN 12449 products)
 - Stress corrosion resistance test (stress relieved condition)

For more details, please refer to our website or contact us by e-mail at technical@lawtontubes.co.uk