

TUNGUM® ALLOY TUBING DATA TABLE



TYPE: TUNGUM ALLOY TUBING TCL100/B						
METRIC RANGE:						
TUBE O.D. (MM)	WALL THICKNESS (MM)	WORKING PRESSURE (PSI)	WORKING PRESSURE (BAR)	BURSTING PRESSURE (PSI)	BURSTING PRESSURE (BAR)	WEIGHT (KG/MTR)
38	4.0	3200	220	13,050	900	3.64

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Special Note: The above working pressures are for guidance purposes only. Your design pressure should include a suitable allowance over the working pressure to allow for possible fluctuations of pressure during operation. This allowance should be separately determined for each application by your design department.

Lloyd's approved batch testing available at extra cost.

®Tungum is a registered trademark.

OTHER SIZES ARE AVAILABLE ON REQUEST

SEE BELOW FOR
TUNGUM ALLOY TUBING
SPECIFICATIONS AND APPROVALS

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METRIC RANGE



OUTSIDE DIAMETER (mm)	WALL SECTION (mm)	MINIMUM THEORETICAL BURST PRESSURE (Bar)	BORE DIAMETER (mm)	CROSS SECTIONAL BORE AREA (sq. mm)	WEIGHT	
					Kg/M	Kg/ft
3.0	0.80	2715	1.40	1.5	.047	.014
	0.50	1515	2.00	3.1	.033	.010
3.5	0.80	2225	1.90	2.8	.058	.018
	0.50	1265	2.50	4.9	.040	.012
4.0	1.00	2500	2.00	3.1	.080	.024
	0.80	1890	2.40	4.5	.069	.021
	0.50	1090	3.00	7.1	.047	.014
6.0	1.25	1985	3.50	9.6	.159	.048
	1.00	1515	4.00	12.6	.134	.041
	0.80	1170	4.40	15.2	.111	.034
8.0	2.00	2500	4.00	12.6	.321	.098
	1.50	1745	5.00	19.6	.261	.080
	1.25	1405	5.50	23.8	.226	.069
	1.00	1090	6.00	28.3	.187	.057
	0.80	850	6.40	32.2	.154	.047
10.0	2.00	1890	6.00	28.3	.428	.131
	1.50	1340	7.00	38.5	.341	.104
	1.00	850	8.00	50.3	.241	.073
12.0	2.50	1985	7.00	38.5	.636	.194
	2.00	1515	8.00	50.3	.535	.163
	1.60	1170	8.80	60.8	.445	.136
	1.20	850	9.60	72.4	.347	.106
	1.00	695	10.00	78.5	.294	.090
15.0	1.60	910	11.80	109.4	.574	.175
16.0	4.00	2495	8.00	50.3	1.280	.390
	3.50	2105	9.00	63.6	1.162	.354
	3.00	1745	10.00	78.5	1.044	.318
	2.50	1405	11.00	95.0	.903	.275
	2.00	1090	12.00	113.1	.749	.228
	1.60	850	12.80	128.7	.617	.188
	1.00	510	14.00	153.9	.401	.122
20.0	4.00	1885	12.00	113.1	1.772	.540
	3.50	1605	13.00	132.7	1.546	.471
	3.00	1340	14.00	153.9	1.365	.416
	2.50	1090	15.00	176.7	1.171	.357
	2.00	850	16.00	201.1	.964	.294
	1.50	620	17.00	227.0	.743	.226
	1.00	405	18.00	254.5	.509	.155
22.0	1.60	600	18.80	277.6	.874	.266
	1.00	365	20.00	314.2	.562	.171

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METRIC RANGE



OUTSIDE DIAMETER (mm)	WALL SECTION (mm)	MINIMUM THEORETICAL BURST PRESSURE (Bar)	BORE DIAMETER (mm)	CROSS SECTIONAL BORE AREA (sq. mm)	WEIGHT	
					Kg/M	Kg/ft
25.0	5.00	1885	15.00	176.7	2.677	.814
	4.00	1445	17.00	227.0	2.248	.685
	3.50	1240	18.00	254.5	2.014	.614
	3.00	1040	19.00	283.5	1.767	.538
	2.50	850	20.00	314.2	1.506	.459
	2.00	665	21.00	346.4	1.231	.375
	1.50	490	22.00	380.1	.944	.288
	1.00	320	23.00	415.5	.642	.196
30.0	6.00	1885	18.00	254.5	3.850	1.174
	5.00	1515	20.00	314.2	3.346	1.020
	4.00	1170	22.00	380.1	2.784	.848
	3.50	1005	23.00	415.5	2.483	.757
	3.00	850	24.00	452.4	2.168	.661
	2.50	695	25.00	490.9	1.840	.561
	2.00	545	26.00	530.9	1.499	.457
	1.50	405	27.00	572.6	1.144	.349
	1.00	265	28.00	615.8	.776	.237
38.0	6.00	1420	26.00	530.9	5.139	1.566
	5.00	1155	28.00	615.8	4.416	1.346
	4.00	900	30.00	706.9	3.640	1.110
	3.50	775	31.00	754.8	3.233	.985
	3.00	655	32.00	804.2	2.810	.857
	2.50	540	33.00	855.3	2.376	.724
	2.00	425	34.00	908.0	1.928	.587
	1.50	315	35.00	962.1	1.465	.447
50.0	7.00	1240	36.00	1018.0	8.050	2.454
	6.00	1040	38.00	1134.2	7.076	2.152
	5.00	850	40.00	1256.6	6.022	1.836
	4.00	665	42.00	1385.4	4.925	1.501
	3.50	575	43.00	1452.2	4.356	1.328
	3.00	490	44.00	1520.5	3.774	1.150
	2.50	405	45.00	1590.6	3.179	.968
	2.00	320	46.00	1662.1	2.570	.782
57.0	7.00	1065	43.00	1452.3	9.370	2.853
	6.00	900	45.00	1590.4	8.191	2.496
	5.00	735	47.00	1734.9	6.959	2.121
	3.50	500	50.00	1963.5	5.012	1.528
	2.00	280	53.00	2206.4	2.945	.897
76.1	5.50	595	65.10	3328.5	10.393	3.168
	2.00	205	72.14	4086.9	3.967	1.209

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SPECIFICATIONS AND APPROVALS



SPECIFICATIONS:

All Tungum Alloy tubes have basically the same chemical composition, but are manufactured to a variety of Specifications according to the demands of the end use.

The following Standards refer to Tungum Alloy tubing:-

- House Specification TCL100 "Tungum tubing for general use".

The Specification is available in 3 ratings:

TCL100/A : Tested to 69 BAR (1000 psi)
or Eddy current tested - Standard specification

TCL100/B : Tested to 310 BAR (4500 psi)

TCL100/C : Tested to 465 BAR (6750 psi)

Note: 1) These are pre-delivery test pressure levels. They do not determine the working pressure capability of any given tube size.
2) Pre-delivery hydraulic tests to customer specific levels can be carried out on request.

N.B. When employed, Eddy Current Tests are conducted in accordance with the requirements of BS. 3889 and ASTM E.243-85.

- BRITISH STANDARD 1306
- BRITISH STANDARD 2871 Part 2 Metric
- FRENCH NAT. STANDARD UZ.15.NS
- AMERICAN STANDARD A.S.T.M B706-86

Identified as Alloy CZ.127

Identified as Copper Alloy UNS C.69100

- MINISTRY OF DEFENCE SPECIFICATIONS:-
AVIATION : DTD. 5019 (for H.P. SYSTEMS)
: DTD.253A (for L.P. SYSTEMS)

NAVY : NES.749 Part 3
ARMY : AFS.4000

Tungum Hydraulics Limited is totally dedicated to the concept of quality. The inspection facility is approved to:-

Tungum Alloy tubing and fittings have the approval of

- BS EN ISO 9002-1994.
- CIVIL AVIATION AUTHORITY STANDARD - AS A MATERIAL SUPPLIER.

- LLOYDS REGISTER OF SHIPPING.
- DET NORSKE VERITAS

CHEMICAL COMPOSITION

ELEMENT	PER CENT	
	MIN	MAX
Copper	81.00	86.00
Aluminium	0.70	1.20
Nickel	0.80	1.40
Silicon	0.80	1.30
Iron		0.25
Lead		0.05
Tin		0.10
Manganese		0.10
Total Other Impurities		0.50
Zinc	The Remainder	

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PHYSICAL PROPERTIES OF TUNGUM ALLOY



MECHANICAL PROPERTIES

SPECIFIC GRAVITY: WEIGHT:		Kg/mm ³ lb.per cu.in.	8.60 8.52 x 10 ⁻⁶ 0.308
ULTIMATE TENSILE STRENGTH:	Mean Value	N/mm ² Tons per sq.in.	480 31.07
	Min Value for NES.749 PT.3	N/mm ² Tons per sq.in.	450 29.13
	Min Value for TCL100	N/mm ² Tons per sq.in.	450 27.84
	Min Value for DTD5019	N/mm ² Tons per sq.in.	417 27.00
0.2% PROOF STRENGTH:	Mean Value	N/mm ² Tons per sq.in.	240 15.54
	Min Value for NES.749 PT.3	N/mm ² Tons per sq.in.	230 14.89
	Min Value for DTD5019	N/mm ² Tons per sq.in.	216 14.00
ELONGATION:	Mean Value	% on 5.65A	45
	Min Value for NES.749 PT.3 and DTD5019	% on 5.65A	40
HARDNESS:	Range for TCL100	HV5	120 - 140
	Range for NES.749 PT.3	HV5	125 - 140
MODULES OF ELASTICITY:	In Tension or	N/mm ²	116.5 X 10 ³
POISSON'S RATIO:			0.33
ULTIMATE SHEAR STRENGTH:		N/mm ²	253
		Tons per sq.in.	16.4
YIELD POINT IN SHEAR:		N/mm ²	143
		Tons per sq.in.	9.3
IZOD IMPACT VALUE:		J.	41.7

ELECTRICAL PROPERTIES

ELECTRICAL CONDUCTIVITY AT 20°C:	Referred to copper	15% ± 5%
SPECIFIC RESISTANCE AT 20°C:	Microhms per mm	1.13
ELECTROCHEMICAL EQUIVALENT:	Kg per coulomb	32.4
SOLUTION POTENTIAL:	m V Calomel scale	230
MAGNETIC PERMEABILITY	μ	1.0015

THERMAL PROPERTIES

MELTING TEMPERATURE:	°C	1008
STRESS RELIVING TEMPERATURE:	°C (for 15/20 mins)	300
SOLUTION TREATMENT TEMPERATURE:	°C (for 60 mins)	800
THERMAL CONDUCTIVITY:	W/m°C	77 at 100°C 103 at 300°C
COEFFICIENT OF THERMAL EXPANSION: per °C	19 x 10 ⁻⁶	

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COMPARATIVE & ELEVATED TEMPERATURE PERFORMANCE

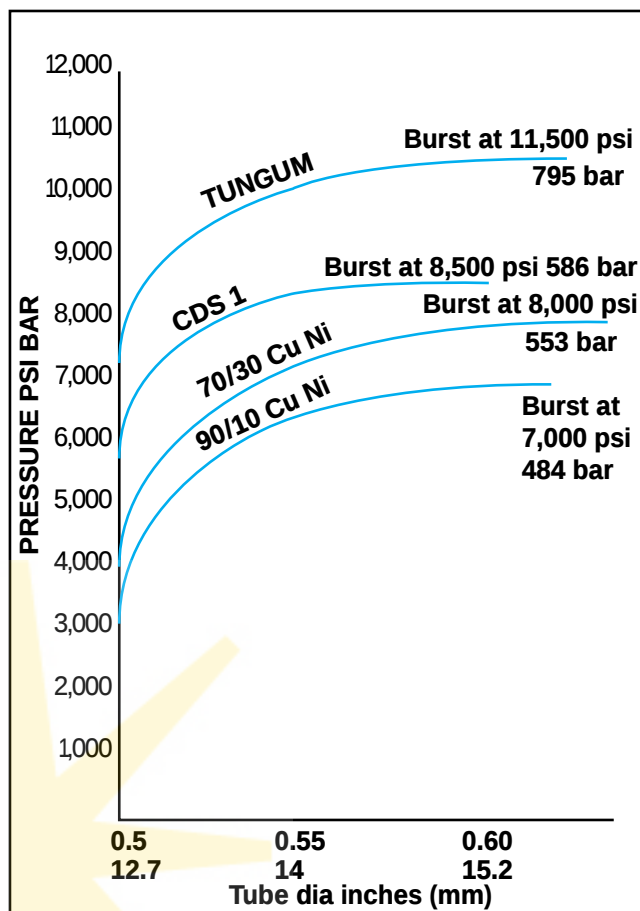


The strength to weight ratio of Tungum Alloy compares most favourably with other materials. In tubes, this often affords the opportunity to employ SMALLER, LIGHTER SECTIONS - easing handling during fabrication, reducing the size and cost of fittings and supports; **opening the way for more compact space saving systems.**

The graph shows the results of burst tests conducted on identical samples 1/2" O/D x 20 SWG tubing.

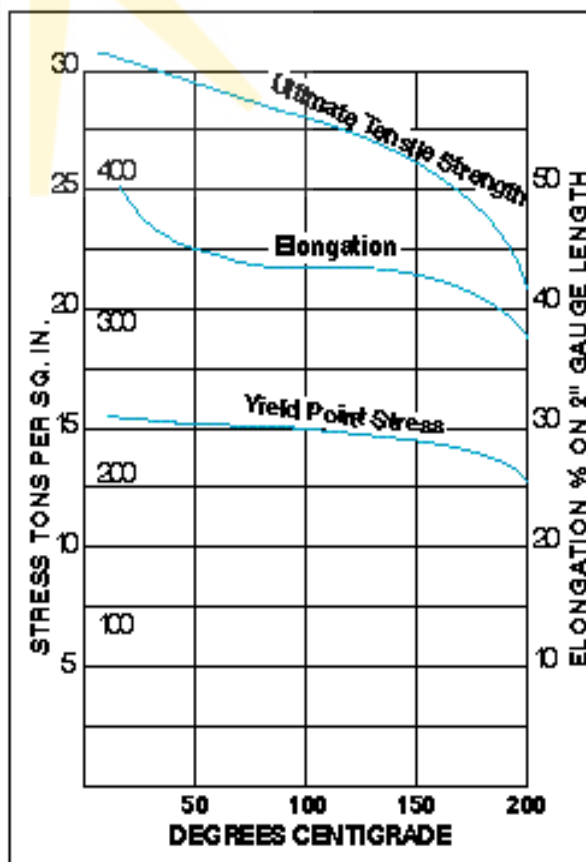
Room Temperature Design strengths taken from BS 1306 clearly confirm the outstanding performance of Tungum Alloy relative to other copper based materials.

COPPER	41 N/mm ²
90/10 CU.NI	68 N/mm ²
70/30 CU.NI	82 N/mm ²
TUNGUM ALLOY	105 N/mm ²



SHORT-TIME ELEVATED TEMPERATURE PROPERTIES

The graphs apply to Tungum Alloy tubing in the annealed condition with the test pieces maintained at the temperature for a period of 60 minutes.



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FATIGUE & LOW TEMPERATURE CHARACTERISTICS



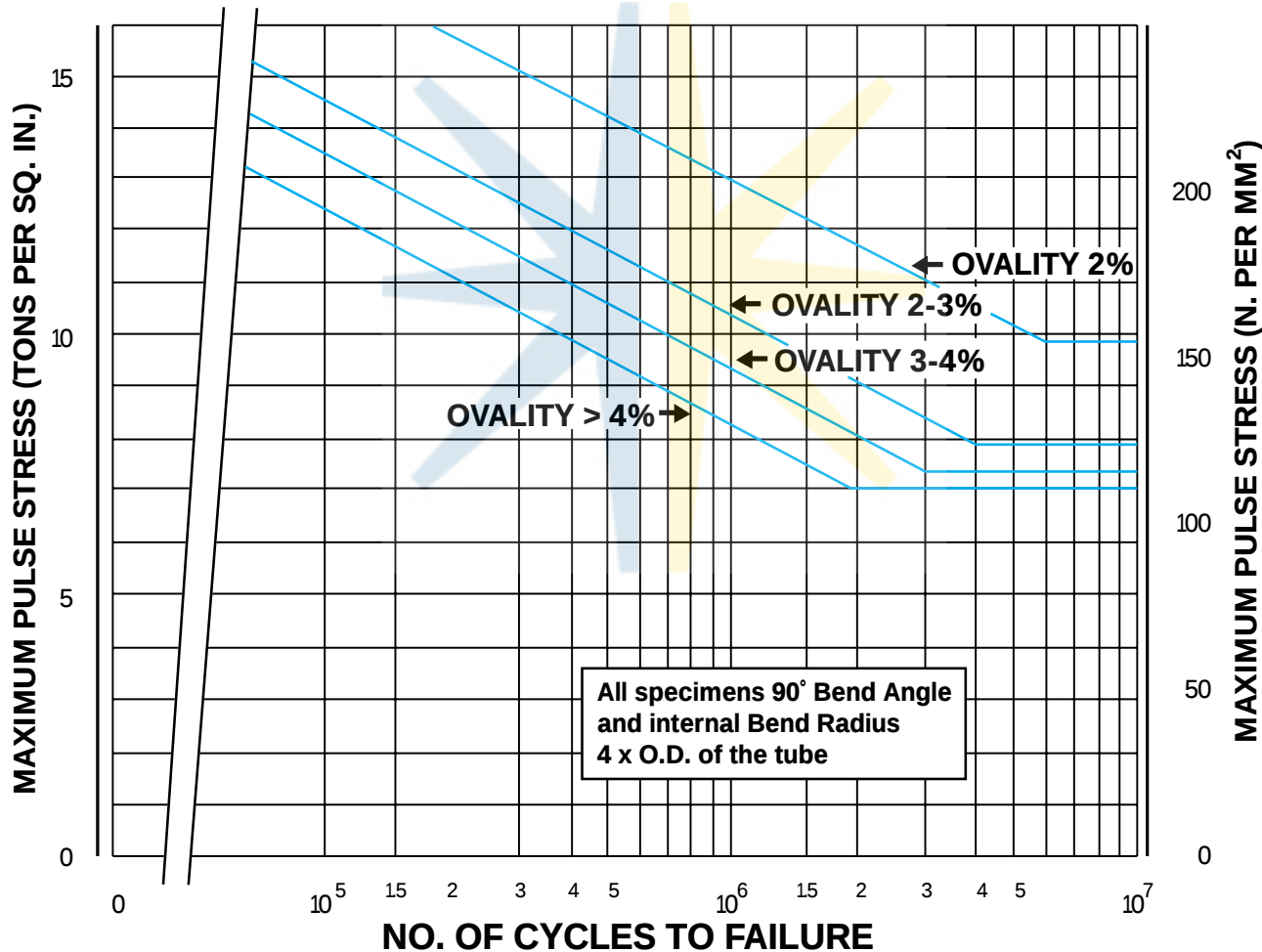
As would be expected of a material originally developed for use in the hydraulic control systems of aircraft, Tungum Alloy has excellent fatigue resisting properties.

Today, pulsing pressures and vibration are recognised as being a major factor influencing the integrity and performance of all hydraulic systems, irrespective of the application.

In practice, tubing is often used after bending. In this operation the outer wall of the tube becomes thinner and the inner wall thicker, and the severity of this effect depends on the radius of curvature, and the

angle encompassed by the bend. The tube also assumes ovality due to the forming operation.

The radius of the bend, the angle of the bend, the ovality of the tube and the properties of the tubing material, all influence its fatigue life. The relationship between the maximum stress, calculated for straight and circular Tungum Alloy tubing, and the number of stress repetitions to cause failure, is shown below. The graphs are based on the results of tests carried out in controlled conditions and are reproduced for guidance purposes only.



Tungum Alloy satisfies many low temperature and cryogenic applications. The mechanical properties of the alloy all improve with reducing temperatures down to as low as -196°C. The impact resistance also remains substantially unchanged over the same temperature range.

The table opposite compares the properties of solid, hard as drawn Tungum Alloy at 15°C and -196°C.

Temperature	15°C	-196°C
.2% Proof Stress (N/mm ²)	410	426
Ultimate Tensile Stress (N/mm ²)	617	793
Elongation % on 5.65 A	20	34
Izod V-Notch value of energy absorbed in joules	41	43

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GENERAL CORROSION RESISTANCE



Tungum Alloy has a high level of general corrosion resistance, allowing it to be specified for use in systems containing, or operating in the presence of, a variety of 'difficult' substances.

The ratings below are the result of laboratory tests conducted under the controlled conditions noted. They are published for guidance purposes only.

Where any doubt exists, samples of Tungum tubing are freely available for field trials in the precise conditions prevailing.

Rating: E. Excellent resistance
- minimal attack takes place.

G. Good resistance under the conditions of test.

SUBSTANCE	Max Concentration	Max Temp °C	Rating
Acetic Acid	All 0-30	20 20	E G
Acetic Anhydride	0-100	20	E
Alum	0-100	20	G
Aluminium Sulphate	0-40	20	G
Borax	All	20	E
Calcium Bi-Sulphate	All	70	G
Carbon Tetrachloride	-	Boiling	E
Citric Acid	All	20	G
Cotton Seed Oil	All	20	E
Creosote	All	20	G
Cresylic Acid	All	20	E
Formaldehyde	All	20	G
Formic Acid	0-50	20	E
Hydrochloric Acid	0-10	20	G
Hydrogen Sulphide	2500p.p.m.	-	G
Hydroquinone	0-100	20	E
Lactic Acid	All	20	E
Halic Acid	30grms./100c.c	20	G
Magnesium Chloride	0-10	50	E
Methylene Chloride	-	Boiling	E
Metol	S.S.	20	E
Oleic Acid	All	20	E

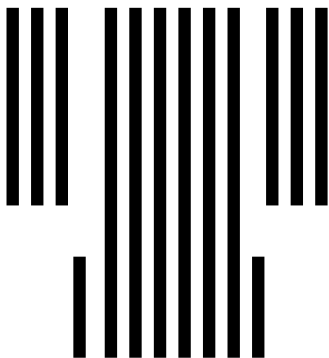
SUBSTANCE	Max Concentration	Max Temp °C	Rating
Oxalic Acid	25grms 100c.c.	20	E
Phosphoric Acid	0-10	100	G
Picric Acid	All	20	G
Potassium Bromide	S.S.	20	E
Potassium Nitrate	All	20	E
Salicylic Acid	S.S.	20	G
Sodium Bicarbonate	-	-	G
Sodium Chloride	S.S.	20	E
Sodium Hydroxide	S.S.	20	E
Sodium Hypochloride	S.S.	70	G
Sodium Hypochlorite	1% Av.Cl.	50	E
Sodium Metabisulphate	S.S.	20	E
Sodium Sulphate	S/S	20	E
Sodium Sulphite	0-10	50	E
Stearic Acid	All	20	E
Sulphur Dioxide	-	-	G
Tannic Acid	All	20	E
Tartaric Acid	All	20	E
Trichloroethylene	-	Boiling	E
Vinegar	All	20	G
Zinc Chloride	-	20	E
Zinc Sulphate	S.S.	20	E

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NOTE: Tungum Alloy should not be used in the presence of Acetylene, Ammonia or Mercury.

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TELEPHONE: 0242 245521
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IN AID OF
No.

25097

TEST CERTIFICATE

Customer

Hydrasun Limited
2 Pittodrie Lane
Aberdeen
AB2 1QW

Customers Order No.

100945

Our Order No.

33969

Contract No.

Despatched by

TO BE COLLECTED

Date Supplied

10RD JUNE, 1993

Item No.	Material Spec	o/d	SWG	No. of Lengths	Incoming Advice Note	Test No.	Test Pressure
	TCL100B	38mm	4mm	1	40/73130	31004	4500 psi
	TCL100B	38mm	4mm	1	40/25072	24821	4500 psi

Item No.	<u>Mechanical Testing</u>						Remarks
	Tensile	Proof	Elongation	Hardness	Flattening		
	472.7N/mm ²	-	-	131/134HV	Satisfactory		Drift Test Satisfactory
	30.8tsi	-	-	128/135HV	Satisfactory		" " "

Chemical Composition

Copper	81% - 89%	Lead	0.05% max
Aluminium	0.7% - 1.2%	Tin	0.10% max
Nickel	0.8% - 1.4%	Manganese	0.10% max
Silicon	0.8% - 1.3%	Impurities	0.50%
Iron	0.25% max	Zinc	Remainder

CERTIFIED THAT THE WHOLE OF THE MATERIALS AND/OR PARTS DETAILED HEREON HAVE BEEN
MANUFACTURED, TESTED AND INSPECTED AND, UNLESS OTHERWISE STATED ABOVE, CONFORM TO
THE REQUIREMENTS/OF THE APPROPRIATE DRAWINGS AND/OR SPECIFICATION RELATIVE THERETO.


For and on behalf of TUNGUM HYDRAULICS LTD.

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