hydrasun

TUNGUM® ALLOY TUBING DATA TABLE

TYPE: TUNGUM ALLOY TUBING TCL100/B							
IMPERIAL RANGE:							
TUBE O.D. (INCHES)	WALL THICKNESS (INCHES)	WALL THICKNESS (SWG)	WORKING PRESSURE (PSI)	WORKING PRESSURE (BAR)	BURSTING PRESSURE (PSI)	BURSTING PRESSURE (BAR)	WEIGHT (KG/MTR)
1/4	0.036	20	4700	320	18,800	1295	0.133
3/8	0.048	18	4100	280	16,400	1130	0.271
3/8	0.080	14	7510	518	30,040	2071	0.408
1/2	0.064	16	4100	280	16,400	1130	0.484
5/8	0.080	14	4100	280	16,400	1130	0.753
3/4	0.080	14	3300	225	13,400	920	0.926
1	0.104	12	3200	220	13,000	895	1.609
1	0.128	10	4100	280	16,400	1130	1.927

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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.

OTHER SIZES ARE AVAILABLE ON REQUEST

PLEASE SEE FOLLOWING PAGES FOR FURTHER DETAILS

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TUNGUM ALLOY TUBING
IMPERIAL RANGE

NOTE: The figures shown in these tables are approximate, and are intended for estimating purposes only.

OUTSIDE DIAMETER (in)	WALL SECTION (S.W.G.)	MINIMUM THEORETICAL BURST PRESSURE (P.S.I.)	BORE DIAMETER (in)	CROSS SECTIONAL BORE AREA (sq. in)	WEIGHT	
					Kg/m	Kg/ft
1/8"	18	66830	.029	.001	.064	.019
	20	44210	.053	.002	.055	.017
	22	31910	.069	.004	.047	.014
	24	23800	.081	.005	.039	.012
3/16"	18	37875	.092	.007	.116	.035
	20	26395	.115	.010	.094	.029
	22	19620	.132	.014	.077	.024
	24	14930	.143	.016	.063	.019
1/4"	16	37825	.121	.012	.206	.063
	18	26425	.154	.019	.167	.051
	20	18810	.178	.025	.133	.041
	22	14165	.194	.030	.107	.033
	24	10875	.206	.033	.092	.028
5/16"	16	28550	.184	.027	.276	.084
	18	20295	.217	.037	.219	.067
	20	14615	.240	.045	.172	.052
	22	11085	.257	.052	.138	.042
	24	8555	.268	.057	.110	.034
3/8"	12	42035	.167	.022	.487	.148
	14	30040	.215	.036	.408	.124
	16	22930	.246	.048	.345	.105
	18	16470	.279	.061	.271	.083
	20	11945	.303	.072	.211	.064
	22	9105	.319	.080	.168	.051
	24	7050	.331	.086	.134	.041
1/2"	12	29105	.292	.067	.711	.217
	14	21265	.340	.091	.580	.177
	16	16450	.371	.108	.484	.147
	18	11965	.404	.128	.375	.114
	20	8755	.428	.144	.288	.088
	22	6705	.444	.155	.228	.070
	24	5215	.456	.163	.182	.055
5/8"	12	22260	.417	.137	.936	.285
	14	16460	.465	.170	.753	.229
	16	12825	.496	.194	.623	.190
	18	9390	.529	.220	.478	.146
	20	6905	.553	.240	.366	.112
	22	5305	.569	.254	.289	.088
	24	4135	.581	.265	.229	.070

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OUTSIDE DIAMETER (in)	WALL SECTION (S.W.G.)	MINIMUM THEORETICAL BURST PRESSURE (P.S.I.)	BORE DIAMETER (in)	CROSS SECTIONAL BORE AREA (sq. in)	WEIGHT	
					Kg/m	Kg/ft
3/4"	10	22940	.494	.192	1.375	.419
	12	18020	.542	.231	1.160	.354
	14	13425	.590	.273	.926	.282
	16	10510	.621	.303	.761	.232
	18	7730	.654	.336	.582	.177
	20	5705	.678	.361	.444	.135
	22	4395	.694	.378	.349	.106
	24	3425	.706	.391	.277	.084
1"	8	21265	.680	.363	2.321	.707
	10	16455	.744	.435	1.927	.587
	12	13050	.792	.493	1.609	.490
	14	9805	.840	.554	1.271	.387
	16	7720	.871	.596	1.039	.317
	18	5710	.904	.642	.789	.241
	20	4230	.928	.676	.599	.183
	22	3265	.944	.700	.470	.143
	24	2555	.956	.718	.372	.113
1 1/4"	8	16460	.930	.679	3.012	.918
	10	12830	.994	.776	2.480	.756
	12	10230	1.042	.853	2.058	.627
	14	7725	1.090	.933	1.616	.493
	16	6105	1.121	.988	1.317	.401
	18	4525	1.154	1.046	.996	.304
	20	3360	1.178	1.090	.755	.230
	22	2600	1.194	1.120	.591	.180
1 1/2"	6	16460	1.116	.978	4.337	1.322
	8	13425	1.180	1.094	3.702	1.128
	10	10515	1.244	1.215	3.033	.924
	12	8410	1.292	1.311	2.507	.764
	14	6370	1.340	1.410	1.962	.598
	16	5045	1.371	1.477	1.594	.486
	18	3750	1.404	1.548	1.204	.367
1 3/4"	6	13850	1.366	1.466	5.166	1.574
	18	3200	1.654	2.149	1.411	.430
2"	6	11955	1.616	2.051	5.995	1.827
	8	9805	1.680	2.217	5.084	1.550
	10	7725	1.744	2.389	4.138	1.261
	12	6205	1.792	2.522	3.405	1.038
	14	4720	1.840	2.659	2.652	.808
	16	3745	1.871	2.751	2.149	.655
2 1/2"	6	9385	2.116	3.517	7.652	2.332
	16	2980	2.371	4.417	2.705	.824
3"	6	7735	2.616	5.375	9.310	2.838
	14	3110	2.840	6.335	4.034	1.230

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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

] Identified as Alloy CZ.127

- FRENCH NAT. STANDARD UZ.15.NS
- AMERICAN STANDARD A.S.T.M B706-86

] 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:-

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

Tungum Alloy tubing and fittings have the approval of

- 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 5.65√A	45
	Min Value for NES.749 PT.3 and DTD5019	% on 5.65√A	40
HARDNESS:	Range for TCL100 Range for NES.749 PT.3	HV5 HV5	120 - 140 125 - 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 Tons per sq.in.	253 16.4
YIELD POINT IN SHEAR:		N/mm^2 Tons per sq.in.	143 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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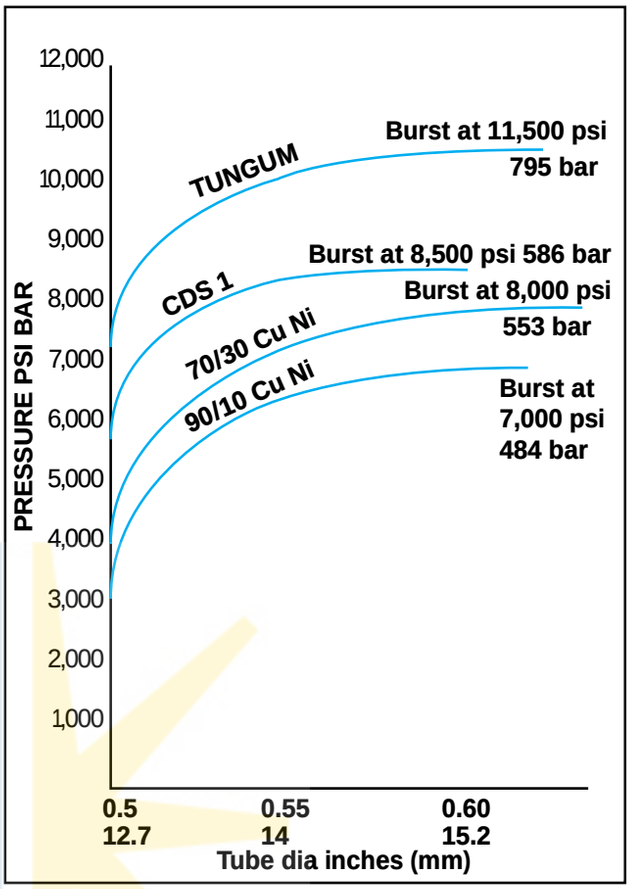
COMPARATIVE & ELEVATED TEMPERATURE PERFORMANCE

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/mm²
90/10 CU.NI	68 N/mm²
70/30 CU.NI	82 N/mm²
TUNGUM ALLOY	105 N/mm²



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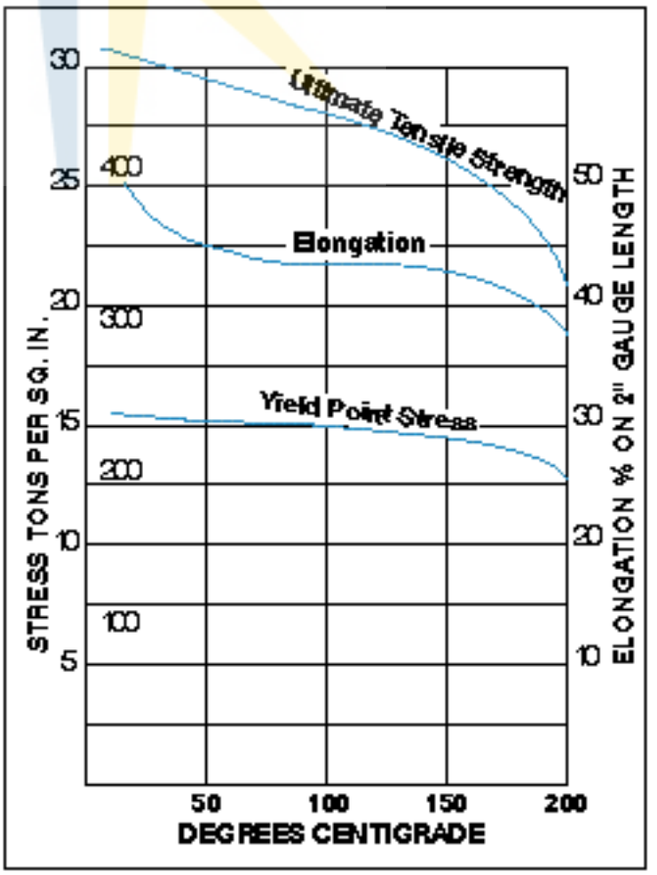
SHORT-TIME ELEVATED TEMPERATURE PROPERTIES

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.

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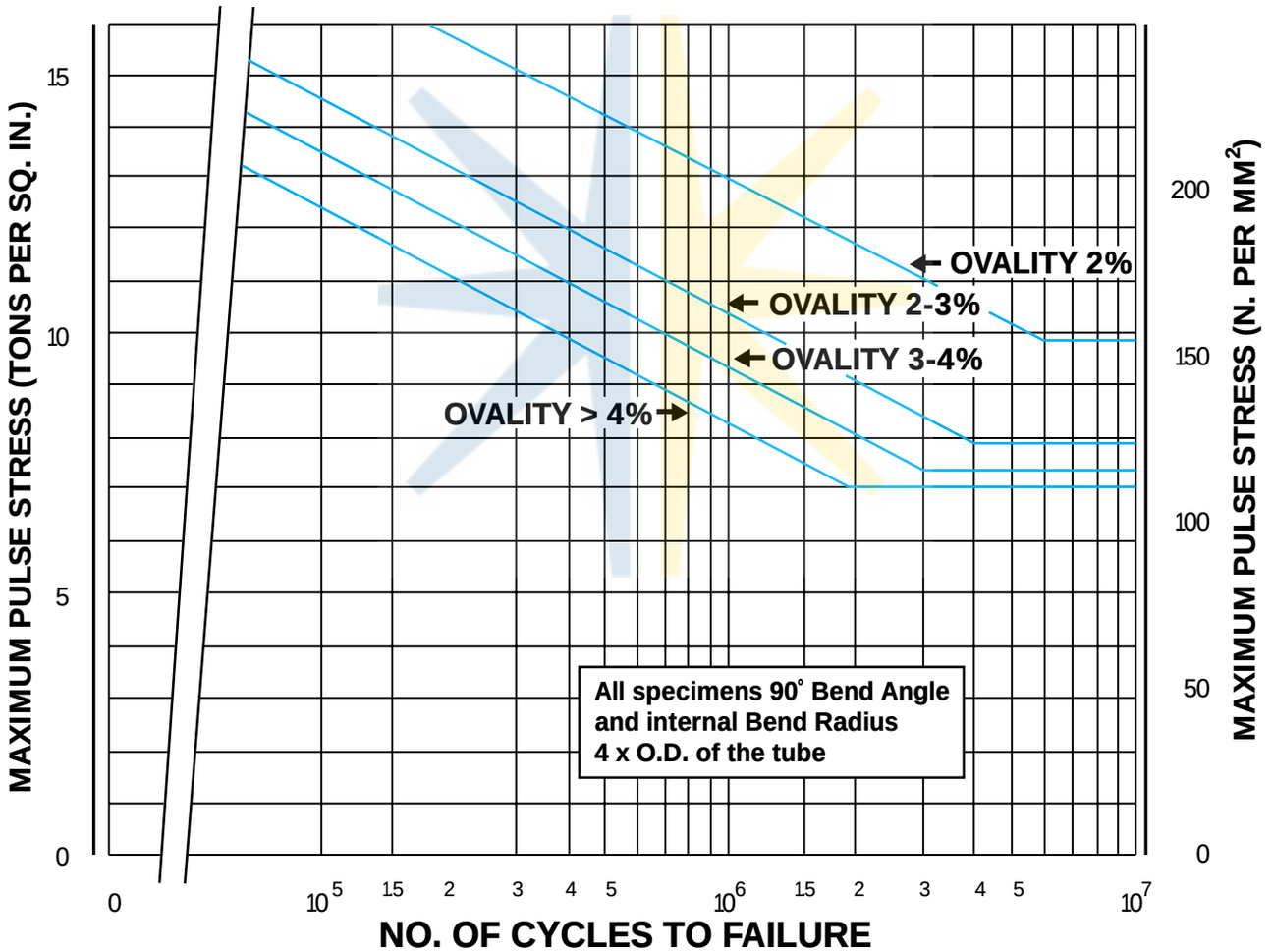

Tungum Alloy satisfies many low temperature and cryogenic applications. The mechanical properties of the alloy all improve with reducing temperatures down to as low as -196˚C. The impact resistance also remains substantially unchanged over the same temperature range.

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/mm²)	410	426
Ultimate Tensile Stress (N/mm²)	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 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
Creostum	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
Hydrokinone	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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1187

TEST CERTIFICATE

Customer: Hydrasun Limited 2 Pittodrie Lane Aberdeen AB24 5QW	Customer Order No: A182474 Our Ref: 4909 Contract No: Despatched By: JOSEPH RICE Date Supplied: 6TH DECEMBER, 1995

DESCRIPTION

Item No.	Material Spec'n.	O/D	SWG	No. of Lengths	Incoming A/Note	Test No.	Test Pressure
	TCL100/B	1/2"	16	84	40/89515	000968	4500 psi

MECHANICAL TESTING

Item No.	Tensile	Proof	Elongation	Hardness	Flattening	Drift
	445.9N/mm^2	246.8N/mm^2	47%	128.5Ave	Satisfactory	Satisfactory

REMARKS

Results Witnessed/Audited by Lloyds Register & Results Transferred

Special Testing S.W.Limited Report No: 000968

Selected Hydraulic Tests Witnessed by Surveyor

CHEMICAL COMPOSITION

Copper	81-86%	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%max.
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 full requirements of the appropriate drawings and/or specifications relative hereto."

for and on behalf of
TUNGUM HYDRAULICS LTD.

LLOYD'S REGISTER QUALITY COMPANY ISO9002

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