UDC 669.35'24'5'4

WROUGHT MATERIALS

COPPER-NICKEL-ZINC-LEAD ALLOYS
Leaded Nickel Silvers

Cu Ni10 Zn42 Pb2

Common names: Leaded 10% Nickel Brass
Leaded Nickel Silver, 10%

A copper-nickel-zinc-lead alloy with a duplex alpha-plus-beta phase structure containing a dispersion of fine lead particles. This silver-white material has excellent hot-working properties, very good machinability, and good tarnish resistance. The most commonly used wrought forms are rod, sections/shapes and forgings.

COMPOSITION (weight %)

Cu	44.0–48.0
Ni	9.0–11.0
Pb	1.0– 2.5
Mn	0– 0.5
Zn	rem.

1 SOME TYPICAL USES

Architectural and Decorative
Staircases and handrails; lighting fittings; screens; window frames; shop fronts; trim.

Mechanical
Wide variety of machined items; clock and watch parts.

Miscellaneous
Hinges for spectacle frames.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.5 g/cm³	0.305 lb/in³
2.2	Melting range	925–940 °C	1 695–1 725 °F
2.3	Coefficient of thermal expansion (linear) at: 20 to 200 °C *68 to 392 °F*	0.000 019 per °C	0.000 011 per °F
2.4	Specific heat (thermal capacity) at: 20 °C *68 °F*	0.10 cal/g °C	0.10 Btu/lb °F
2.5	Thermal conductivity at: 20 °C *68 °F*	0.08 cal cm/cm² s °C	19 Btu ft/ft² h °F
2.6	Electrical conductivity (volume) at: 20 °C *68 °F* (annealed or cold worked)	4.1 m/ohm mm²	7% IACS
2.7	Electrical resistivity (volume) at: 20 °C *68 °F* (annealed or cold worked)	0.25 ohm mm²/m 25 microhm cm	148 ohms (circ mil/ft) 9.7 microhm in
2.8	Temperature coefficient of electrical resistance at: 20 °C *68 °F* (annealed or cold worked) applicable over range from 0 to 100 °C *32 to 212 °F*	0.000 4 per °C (7% IACS)	0.000 2 per °F (7% IACS)
2.9	Modulus of elasticity (tension) at 20 °C *68 °F*: annealed or cold worked	13 000 kg/mm²	18 500 000 lb/in²
2.10	Modulus of rigidity (torsion) at 20 °C *68 °F*: annealed or cold worked	4 800 kg/mm²	6 800 000 lb/in²

N.B.: The values shown in Section 2, which have been appropriately rounded in view of the composition range involved, are based on selected literature references. The melting range covers the highest liquidus and lowest solidus temperatures over the composition range quoted.

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DATA SHEET No. M 1

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3 FABRICATION PROPERTIES

The information given in this table is for general guidance only, since many factors influence fabrication techniques.
The values shown are approximate only, since those used in practice are dependent upon form and size of metal, equipment available, techniques adopted and properties required in the material.

	Metric Units	English Units
3.1 Casting temperature range	1 025–1 100 °C	1 875–2 010 °F
3.2 Annealing temperature range	600– 700 °C	1 110–1 290 °F
Stress relieving temperature range	300– 400 °C	570– 750 °F
3.3 Hot working temperature range	725– 825 °C	1 335–1 515 °F
3.4 Hot formability	Excellent	
3.5 Cold formability	Fair	
3.6 Cold reduction between anneals	20% max.	
3.7 Machinability:	See General Data Sheet No. 2	
Machinability rating (free cutting brass = 100)	80	
3.8 Joining methods:	See General Data Sheet No. 3.10	
Soldering	Good	
Brazing	Fair	
Oxy-acetylene welding	Fair	
Carbon-arc welding	Not recommended	
Gas-shielded arc welding	Fair	
Coated metal-arc welding	Not recommended	
Resistance welding: spot and seam	Fair	
butt	Fair	

4 NATIONAL SPECIFICATIONS FOR MANUFACTURED FORMS

and ISO Recommendation

Country	Designation of Standards	Designation of Material in Standards	Specification for Chemical Composition [(a)]	Plate Sheet Strip	Rod	Wire	Tube	Sections / Shapes	Forgings
Australia	SAA	NS101	—	—	H90 H91	—	—	H91	H90
Belgium	NBN	—	—	—	—	—	—	—	—
Canada	CSA	—	—	—	—	—	—	—	—
Chile	NCh (INDITECNOR)	—	—	—	—	—	—	—	—
France	NF	U-Z45 N9	—	—	A53-305	—	—	A53-305	—
Germany	DIN	Cu Ni10 Zn42 Pb	17 663	—	17 672	—	—	—	—
India	IS	—	—	—	—	—	—	—	—
Italy	UNI	—	—	—	—	—	—	—	—
Japan	JIS	—	—	—	—	—	—	—	—
Netherlands	N or NEN [(b)]	Cu-Ni10 Zn42 Pb	NEN 6030	—	—	—	—	—	—
South Africa	SABS	—	—	—	—	—	—	—	—
Spain	UNE	—	—	—	—	—	—	—	—
Sweden	SIS	—	—	—	—	—	—	—	—
Switzerland	VSM	Cu Ni10 Zn42 Pb	10 804	—	10 804	—	—	—	—
United Kingdom	BS	NS101	—	—	2872 2874	—	—	2874	2872
United States	ASTM	—	—	—	—	—	—	—	—
International Organisation for Standardization	ISO	CuNi10Zn42Pb2	R430	—	—	—	—	—	—

(a) Applicable when the chemical composition is not given in the specification for wrought forms.
(b) Older specifications bear prefix N; for new specifications the NEN prefix is used.

5 MECHANICAL PROPERTIES

5.1 Mechanical properties at room temperature

Tensile properties	see tables 5.1.1/2/3
Hardness	,, ,, 5.1.1/2/3
Shear strength	,, ,, 5.1.1/2/3
Modulus of elasticity (tension)	see 2.9
Modulus of rigidity	,, 2.10

5.2 Mechanical properties at low temperature

Tensile properties	no data
Impact properties	,, ,,

5.3 Mechanical properties at elevated temperature

Short-time tensile properties	no data
Impact properties	,, ,,
Creep properties	,, ,,

5.4 Fatigue properties

Fatigue strength at room temperature	no data

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE (*)

5.1.1 Typical Tensile Properties and Hardness Values—Metric Units

This table is representative of practice in many European countries. For British and American practices, see tables 5.1.2 and 5.1.3, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.
For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength kg/mm²	Proof Stress 0.2% offset kg/mm²	Elongation % on $5.65\sqrt{S_o}$	Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown (a)
					Brinell	Vickers		
Rod (b)	Typical Cold Worked Tempers	54	40	27	135	140	37	5–30 mm diam. or equivalent area
		62	56	15	160	170	40	5–15 mm diam. or equivalent area
Sections (b) / Shapes	Hot Worked	49	—	—	115	120	34	—
	Typical Cold Drawn Temper	52	—	—	125	130	36	—
Forgings (b)	Hot Worked	47	—	—	115	120	33	—

(a) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

(b) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

5.1.2 Typical Tensile Properties and Hardness Values—SI and English Units

This table is based on British practice. For other European and American practices, see tables 5.1.1 and 5.1.3, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.
For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper (a)	Tensile Strength		Proof Stress 0.1% offset		Elongation		Vickers Hardness	Shear Strength		Typical Size Related to Properties Shown (b)
		hbar	ton/in²	hbar	ton/in²	%	gauge length		hbar	ton/in²	
Rod (c)	Hot Worked	54	35	28	18	22	$5.65\sqrt{S_o}$	150	40	26	12–50 mm (0.5–2 in.) diam. or equivalent area
	Cold Worked As—Manufactured	57	37	31	20	20	$5.65\sqrt{S_o}$	160	40	26	25–50 mm (1–2 in.) diam. or equivalent area
		60	39	34	22	18	$5.65\sqrt{S_o}$	170	42	27	12–25 mm (0.5–1 in.) diam. or equivalent area
		65	42	37	24	15	$5.65\sqrt{S_o}$	180	45	29	6–12 mm (0.25–0.5 in.) diam. or equivalent area
Sections (Extruded) (c)	Hot Worked	54	35	28	18	22	$5.65\sqrt{S_o}$	150	40	26	—
	Cold Drawn As—Manufactured	59	38	32	21	18	$5.65\sqrt{S_o}$	170	40	26	—
Forgings (c)	Hot Worked As—Manufactured	53	34	26	17	20	$5.65\sqrt{S_o}$	140	39	25	—

(a) The recognised temper designations used in the relevant British Standards are also given.

(b) It is possible to obtain sizes different from those given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

(c) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

(*) It will be noted that tables 5.1.1, 5.1.2 and 5.1.3, giving typical tensile properties and hardness values in Metric, SI and English, and American units respectively are not directly comparable. This is because the properties quoted reflect to some extent the metalworking techniques, specification practices and testing procedures in the countries concerned, and in view of the different sizes of products referred to in these tables. Individual manufacturers of semi-fabricated products can, however, normally meet the requirements of any national standard.

5.1.3 Typical Tensile Properties and Hardness Values—American Units

This table is based on American practice and the temper designations shown are those referred to in ASTM and other American Standards. For British and other European countries' practices, see tables 5.1.2 and 5.1.1, respectively.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.
For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength psi	Yield Strength 0.5% extension under load psi	Elongation		Rockwell Hardness			Shear Strength psi	Typical Size Related to Properties Shown [a]
				%	gauge length	F	B	30 T		
Rod [b]	Annealed	60 000	—	20	2 in.	—	—	—	45 000	1.0 in. diam.
	Cold Worked Half Hard	70 000	40 000	15	2 in.	—	70	—	49 000	1.0 in. diam.
Sections [b] / Shapes	As extruded	70 000	32 000	20	2 in.	—	72	—	49 000	—
	Cold Worked Hard	80 000	40 000	15	2 in.	—	85	—	56 000	—

(a) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.
(b) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.4 FATIGUE PROPERTIES

5.4.1 Fatigue Strength at Room Temperature

At the date of publication of this sheet, no data relating to this material have been traced.

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UDC 669.35'24'5'4

WROUGHT MATERIALS

COPPER-NICKEL-ZINC-LEAD ALLOYS
Leaded Nickel Silvers

Cu Ni18 Zn19 Pb1

Common name: Leaded 18% Nickel Silver

A copper-nickel-zinc-lead alloy with an alpha phase structure containing a dispersion of fine lead particles. This silver-white alloy has good corrosion resistance in various environments and good machinability. The most commonly used wrought forms are rod and sections/shapes.

COMPOSITION (weight %)

Cu	59.0–63.0
Ni	17.0–19.0
Pb	0.5–1.5
Mn	0–0.7
Zn	rem.

1 SOME TYPICAL USES

Mechanical
Wide variety of machined items; clock and watch parts; screws.
Miscellaneous
Hinges and screws for spectacle frames; cylinder locks; instrument and camera parts; model construction.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.8 g/cm³	0.320 lb/in³
2.2	Melting range	1 050–1 100 °C	1 920–2 010 °F
2.3	Coefficient of thermal expansion (linear) at: 20 to 200 °C *68 to 392 °F*	0.000 016 per °C	0.000 009 per °F
2.4	Specific heat (thermal capacity) at: 20 °C *68 °F*	0.10 cal/g °C	0.10 Btu/lb °F
2.5	Thermal conductivity at: 20 °C *68 °F*	0.06 cal cm/cm² s °C	15 Btu ft/ft² h °F
2.6	Electrical conductivity (volume) at: 20 °C *68 °F* (annealed or cold worked)	3.5 m/ohm mm²	6% IACS
2.7	Electrical resistivity (volume) at: 20° C *68 °F* (annealed or cold worked)	0.29 ohm mm²/m 29 microhm cm	173 ohms (circ mil/ft) 11 microhm in
2.8	Temperature coefficient of electrical resistance at: 20 °C *68 °F* (annealed or cold worked) applicable over range from 0 to 100 °C *32 to 212 °F*	0.000 3 per °C (6% IACS)	0.000 2 per °F (6% IACS)
2.9	Modulus of elasticity (tension) at 20 °C *68 °F*: annealed cold worked	 13 000 kg/mm² 13 400 kg/mm²	 18 500 000 lb/in² 19 100 000 lb/in²
2.10	Modulus of rigidity (torsion) at 20 °C *68 °F*: annealed cold worked	 4 800 kg/mm² 5 000 kg/mm²	 6 800 000 lb/in² 7 100 000 lb/in²

N.B.: The values shown in Section 2, which have been appropriately rounded in view of the composition range involved, are based on selected literature references. The melting range covers the highest liquidus and lowest solidus temperatures over the composition range quoted.

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 6); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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DATA SHEET No. M 2
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3 FABRICATION PROPERTIES

The information given in this table is for general guidance only, since many factors influence fabrication techniques. The values shown are approximate only, since those used in practice are dependent upon form and size of metal, equipment available, techniques adopted and properties required in the material.

		Metric Units	English Units
3.1	Casting temperature range	1 175–1 250 °C	2 145–2 280 °F
3.2	Annealing temperature range	625– 775 °C	1 155–1 425 °F
	Stress relieving temperature range	300– 400 °C	570– 750 °F
3.3	Hot working temperature range	900– 975 °C	1 650–1 785 °F
3.4	Hot formability	Very limited	
3.5	Cold formability	Fair	
3.6	Cold reduction between anneals	30% max.	
3.7	Machinability:	See General Data Sheet No. 2	
	Machinability rating (free cutting brass = 100)	70	
3.8	Joining methods:	See General Data Sheet No. 3.10	
	Soldering	Very Good	
	Brazing	Good	
	Oxy-acetylene welding	Fair	
	Carbon-arc welding	Not recommended	
	Gas-shielded arc welding	Fair	
	Coated metal-arc welding	Not recommended	
	Resistance welding: spot and seam	Fair	
	butt	Fair	

4 NATIONAL SPECIFICATIONS FOR MANUFACTURED FORMS

and ISO Recommendation

Country	Designation of Standards	Designation of Material in Standards	Specification for Chemical Composition [a]	Plate Sheet Strip	Rod	Wire	Tube	Sections / Shapes	Forgings
Australia . . .	SAA	NS113	—	—	H 91	—	—	H 91	—
Belgium . . .	NBN	—	—	—	—	—	—	—	—
Canada . . .	CSA	—	—	—	—	—	—	—	—
Chile	NCh (INDITECNOR)	—	NCh 251 of. 68	—	—	—	—	—	—
France. . . .	NF	—	—	—	—	—	—	—	—
Germany . . .	DIN	Cu Ni18 Zn19 Pb	17 663	—	17 672	—	—	—	—
India	IS	—	—	—	—	—	—	—	—
Italy	UNI	—	—	—	—	—	—	—	—
Japan	JIS	PbNSB	—	—	H 3712	—	—	—	—
Netherlands .	N or NEN [b]	Cu-Ni18 Zn19 Pb	NEN 6030	—	—	—	—	—	—
South Africa .	SABS	—	—	—	—	—	—	—	—
Spain	UNE	—	—	—	—	—	—	—	—
Sweden . . .	SIS	—	—	—	—	—	—	—	—
Switzerland . .	VSM	—	—	—	—	—	—	—	—
United Kingdom . .	BS	NS113	—	—	2874	—	—	2874	—
United States .	ASTM	No. 794	—	—	B 151	B 206	—	—	—
International Organisation for Standardization	ISO	Cu Ni18 Zn19 Pb1	R430	—	—	—	—	—	—

[a] Applicable when the chemical composition is not given in the specifications for wrought forms.
[b] Older specifications bear prefix N; for new specifications the NEN prefix is used.

5 MECHANICAL PROPERTIES

5.1 Mechanical properties at room temperature

Tensile properties	see tables 5.1.1/2/3
Hardness	,, ,, 5.1.1/2/3
Shear strength	,, ,, 5.1.1/2/3
Modulus of elasticity (tension)	see 2.9
Modulus of rigidity (torsion)	,, 2.10

5.2 Mechanical properties at low temperature

Tensile properties	no data
Impact properties	,, ,,

5.3 Mechanical properties at elevated temperature

Short-time tensile properties	see table 5.3.1
Impact properties	,, ,, 5.3.1
Creep properties	no data

5.4 Fatigue properties

Fatigue strength at room temperature	no data

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE [a]

5.1.1 Typical Tensile Properties and Hardness Values—Metric Units

This table is representative of practice in many European countries. For British practice, see table 5.1.2.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength kg/mm²	Proof Stress 0.2% offset kg/mm²	Elongation % on $5.65\sqrt{S_o}$	Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown [b]
					Brinell	Vickers		
Rod	Typical Cold Worked Tempers	53	40	15	150	155	37	2–10 mm diam. or equivalent area
		60	52	7	170	180	39	2–10 mm diam. or equivalent area
Sections / Shapes	Hot Worked	46	—	—	130	135	33	—
	Typical Cold Drawn Temper	50	—	—	145	150	35	—

(a) It will be noted that tables 5.1.1, 5.1.2 and 5.1.3, giving typical tensile properties and hardness values in Metric, SI and English, and American units respectively are not directly comparable. This is because the properties quoted reflect to some extent the metalworking techniques, specification practices and testing procedures in the countries concerned, and in view of the different sizes of products referred to in these tables. Individual manufacturers of semi-fabricated products can, however, normally meet the requirements of any national standard.

(b) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

5.1.2 Typical Tensile Properties and Hardness Values—SI and English Units

This table is based on British practice. For European practice, see table 5.1.1.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.
For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper [a]	Tensile Strength		Proof Stress 0.1% offset		Elongation		Vickers Hardness	Shear Strength		Typical Size Related to Properties Shown [b]
		hbar	ton/in²	hbar	ton/in²	%	gauge length		hbar	ton/in²	
Rod [c]	Cold Worked As Manufactured	51	33	37	24	7	$5.65\sqrt{S_o}$	150	36	23	6–12 mm (0.25–0.5 in.) diam. or equivalent area
		59	38	48	31	~5	$5.65\sqrt{S_o}$	180	40	26	2–6 mm (0.08–0.25 in.) diam. or equivalent area

(a) The recognised temper designation used in the relevant British Standard is also given.

(b) It is possible to obtain sizes outside the ranges given in the column, but information on their mechanical properties should be obtained from the metal manufacturers.

(c) The mechanical properties will be largely dependent upon the size and cross-sectional area or complexity of the product.

5.1.3 Typical Tensile Properties and Hardness Values—American Units

At the date of publication of this sheet, no data relating to this material have been traced.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

At the date of publication of this sheet, no data relating to this material have been traced.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties—Impact Properties

Form	Temper	Testing Temperature		Tensile Strength			Elongation		Reduction of Area %	Impact Strength [a]	
		°C	°F	kg/mm²	ton/in²	psi	%	gauge length		kg m/cm²	ft lb
Rod [1] **6 mm diam.** **0.24 in. diam.**	Annealed	20	68	**44.0**	28	62 500	**40**	30 mm	**65**	**4.0**	21.7
		250	482	**40.5**	25.5	57 500	**36**	30 mm	**52**	**2.7**	14.6
		300	572	**38.5**	24.5	55 000	**39**	30 mm	**48**	**2.1**	11.4
		330	626	—	—	—	—	—	—	**0.4**	2.2
		340	644	**37.0**	23.5	52 500	**30**	30 mm	**30**	—	—
		380	716	—	—	—	—	—	—	**0.6**	3.2
		450	842	**32.0**	20.5	45 500	**45**	30 mm	**54**	—	—

(a) Charpy test, V notch; cross sectional area at the notch 0.75 cm².

N.B.:— Original values are printed in **bold type**; other values are converted.
— All converted values for impact strength are to be taken as indicative only; the impact energy has been converted from kg m/cm² to ft lb by taking into account the cross-sectional area of the specimen at the notch.
— Data not available: Proof stress, 0.1 and 0.2% offset,
Yield strength, 0.5% extension under load.

5.4 FATIGUE PROPERTIES

5.4.1 Fatigue Strength at Room Temperature

At the date of publication of this sheet, no data relating to this material have been traced.

REFERENCE

MECHANICAL PROPERTIES (SECTION 5)

(1) Isler, P. and Form. W. The Mechanism of Fire-Cracking. J. Inst. Metals, Vol. 100 (1972), pp. 107-113.

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