

# **HIDUMINIUM**

## **TECHNICAL DATA**



**HIGH DUTY ALLOYS LTD**

**SLOUGH**

# Foreword

Extensive research carried out in recent years, combined with an increasing demand for "HIDUMINIUM" high tensile aluminium alloys, has necessitated the revision and increase of the series of data sheets previously issued by the Company.

As before, our aim is to place before designers and constructors the fullest possible particulars regarding the physical and mechanical properties of "HIDUMINIUM," which will enable them to select the materials most suitable for their requirements and to adapt their designs in accordance with the outstanding characteristics of this range of alloys.

"HIDUMINIUM" is produced under conditions of strict scientific control and progressive inspection and a staff of expert Metallurgists, Research Workers and Technicians is always ready to give advice on all problems connected with the use of these alloys.

Fresh data, as it is revealed by further research, will be issued on additional sheets. This will ensure that all information contained in this volume is up-to-date and may thus be referred to at all times with complete confidence.

HIGH DUTY ALLOYS LIMITED



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# HIDUMINIUM 15

Corrosion Resisting Low Strength Wrought Alloy

**AIR MINISTRY SPECIFICATION :**

**D.T.D. 213**

This wrought alloy possesses a degree of resistance to corrosion comparable with that of pure aluminium combined with strength and hardness superior to those of the pure metal.

It possesses excellent cold forming qualities in the softer tempers.

## **HEAT TREATMENT**

The alloy is not improved by heat treatment, the different combinations of mechanical properties being attained by varying amounts of cold working. To soften the alloy for purposes of cold forming, etc., it is annealed at 350° C.

## **CHEMICAL COMPOSITION**

MANGANESE	1.0-1.5 per cent.
ALUMINIUM	Remainder



# HIDUMINIUM 15

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.75		
Specific weight, lbs. per cu. in. ... ..	0.0985		
Co-efficient of thermal expansion 20–100° C. ... ..	$24.0 \times 10^{-6}$		
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$		
	<i>Soft</i>	<i>Half-Hard</i>	<i>Hard</i>
Thermal conductivity, 0–100° C. C.G.S. units ... ..	0.45	0.37	0.36
Thermal conductivity, compared with copper 100 ...	49.0	40.5	39.0
Specific resistance, microhms per cm. cube ...	3.4	4.2	4.3

## MECHANICAL PROPERTIES

	<i>Soft</i>	<i>Half-Hard</i>	<i>Hard</i>
ENDURANCE LIMIT at $10 \times 10^6$ complete cycles of stress, tons per sq. in. ... ..	$\pm 3.6$	$\pm 4.5$	$\pm 5.0$
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	6.5–7.5	8–11	12–16
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	3.0–4.5	5–10	11.5–14
ELONGATION % on 2 in. gauge length ... ..	25–40	5–20	3–6
BRINELL HARDNESS NUMBER ... ..	27–32	35–48	50–60

# HIDUMINIUM 23

## Corrosion Resisting Sand and Die Casting Alloy

“HIDUMINIUM” 23 is one of the Aluminium-Magnesium-Manganese range of alloys well known for their high resistance to corrosion. The alloy does not respond to hardening heat treatments and thus is used mostly in the “As Cast” condition.

### HEAT TREATMENT

None required.

### CHEMICAL COMPOSITION

MAGNESIUM	2.6–3.3 per cent.
MANGANESE	1.0–1.5 per cent.
TITANIUM	Not more than 0.2 per cent.
ALUMINIUM	Remainder

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.65
Specific weight, lbs. per cu. in. ... ..	0.095
Co-efficient of thermal expansion, 20–100° C. ... ..	$24.0 \times 10^{-6}$
Thermal conductivity at 20° C., in C.G.S. units ... ..	0.39
Thermal conductivity at 20° C., compared with copper 100	42.5
Pattern Makers' Scale for castings of moderate size and unrestricted shrinkage ... ..	1/75
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ... ..	4.0

## MECHANICAL PROPERTIES

of test bars cast in D.T.D. sand lined moulds.

	<i>Sand Cast</i>	<i>Die Cast</i>
ENDURANCE LIMIT at $10 \times 10^6$ complete cycles of stress, tons per sq. in. ... ..	$\pm 4.8$	$\pm 6.8$
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	9–11	10–12
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	4–6	5–7
ELONGATION % on 2 in. gauge length ... ..	3–5	5–7
BRINELL HARDNESS NUMBER... ..	40–60	50–70

# HIDUMINIUM 33

## Corrosion Resisting Wrought Alloy

### BRITISH STANDARD SPECIFICATION :

#### L. 46

" HIDUMINIUM " 33 is available in a variety of wrought forms, particularly in the form of extruded sections, sheet, strip and tubing. Although the alloy does not respond to heat treatment, except annealing, it can be produced with a variety of mechanical properties. Of the medium strength wrought alloys it possesses the highest resistance to corrosion.

#### HEAT TREATMENT

None required. To soften the alloy for purposes of cold forming, etc., it is annealed at 350° C.

#### CHEMICAL COMPOSITION

MAGNESIUM	2.6-3.3 per cent.
MANGANESE	1.0-1.5 per cent.
TITANIUM	Not more than 0.2 per cent.
ALUMINIUM	Remainder

# HIDUMINIUM 33

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.65
Specific weight, lbs. per cu. in. ... ..	0.095
Co-efficient of thermal expansion, 20–100° C. ... ..	$24.0 \times 10^{-6}$
Thermal conductivity, in C.G.S. units ... ..	0.39
Thermal conductivity, compared with copper 100 ... ..	42.5
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ... ..	4.0

## MECHANICAL PROPERTIES

	<i>Soft</i>	<i>Half-Hard</i>	<i>Hard</i>
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	15–17	20–22	22–26
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	6–8	16–19	19–23
ELONGATION % on 2 in. gauge length ... ..	15–25	5–8	3–5
BRINELL HARDNESS NUMBER ... ..	40–60	65–85	90–110

ENDURANCE LIMIT at  $10 \times 10^6$  complete cycles of stress (Extrusions)

tons per sq. in. ... ..  $\pm 8.25$

# HIDUMINIUM 35

## Corrosion Resisting Wrought Alloy

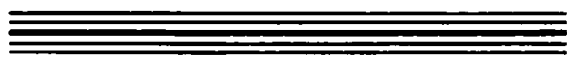
The alloy "HIDUMINIUM" 35 possesses a high degree of resistance to corrosion. It is harder and stronger than "HIDUMINIUM" 33, but these advantages are obtained at the expense of workability and it is thus more difficult to form than that alloy.

### HEAT TREATMENT

None required. To soften the alloy for purposes of cold forming, etc., it is annealed at 350° C.

### CHEMICAL COMPOSITION

MAGNESIUM	4.5-5.5 per cent.
MANGANESE	0.5-1.5 per cent.
TITANIUM	Not more than 0.2 per cent.
ALUMINIUM	Remainder



# HIDUMINIUM 35

## PHYSICAL PROPERTIES

Specific gravity	... ..	2.6
Specific weight, lbs. per cu. in.	... ..	0.0935
Co-efficient of thermal expansion, 20-100° C.	... ..	$24.0 \times 10^{-6}$
Thermal conductivity, in C.G.S. units	... ..	0.3
Thermal conductivity, compared with copper 100	... ..	32.0
Young's Modulus (E), lbs. per sq. in.	... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube	... ..	4.9

## MECHANICAL PROPERTIES

	<i>Soft</i>	<i>Half-Hard</i>	<i>Hard</i>
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	20-22	24-28	26-30
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	9-12	19-23	23-27
ELONGATION % on 2 in. gauge length ... ..	15-25	5-8	2-5
BRINELL HARDNESS NUMBER ... ..	45-65	70-90	100-120

ENDURANCE LIMIT at  $10 \times 10^6$  complete cycles of stress (Extrusions),  
 tons per sq. in. ... ..  $\pm 8.5$



# HIDUMINIUM 40 & 42

## Heat Treatable Corrosion Resisting Alloys for Sand and Die Casting

These alloys have a high resistance to corrosive attack, especially in respect of sea water and marine atmospheres, which is exceeded only by the casting alloy "HIDUMINIUM" 23. Unlike that alloy, however, they respond to heat treatment and are thus available with a wide range of excellent mechanical properties resulting from such treatment.

The alloys have excellent casting properties in both the sand and die cast forms. "HIDUMINIUM" 42 with its higher silicon content possesses greater fluidity than "HIDUMINIUM" 40 and is thus recommended for the more complicated castings. The other properties of the two alloys show little difference.

These alloys have been used very successfully for a large number of marine and architectural applications.

### HEAT TREATMENT

Solution Heat Treatment : 515–525° C. for 5 hours.

Quench in boiling water or in oil.

Ageing Treatment—Grade A : Natural ageing for 5 days at room temperature.

Grade B : 155–160° C. for 10–14 hours.

### CHEMICAL COMPOSITION

	"Hiduminium" 40	"Hiduminium" 42
SILICON ... ..	2.0–2.5 per cent.	4.5–5.5 per cent.
MAGNESIUM ... ..	0.6–0.8 per cent.	0.6–0.8 per cent.
MANGANESE ... ..	0.6–0.8 per cent.	0.6–0.8 per cent.
TITANIUM ... ..	0.1–0.2 per cent.	0.1–0.2 per cent.
ALUMINIUM ... ..	Remainder	Remainder



# HIDUMINIUM 40 & 42

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.7
Specific weight, lbs. per sq. in. ... ..	0.097
Co-efficient of thermal expansion, 20–100° C. ... ..	$23 \times 10^{-6}$
Thermal conductivity at 20° C., C.G.S. units ... ..	0.35–0.46
Thermal conductivity at 20° C., compared with copper 100	38–50
Pattern makers' scale for castings of moderate size and unrestricted shrinkage ... ..	1/96
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ... ..	4.6

## MECHANICAL PROPERTIES

of Test Bars cast in D.T.D. sand lined moulds.

	Annealed	Grade A	Grade B
ENDURANCE LIMIT at $10 \times 10^6$ complete cycles of stress, tons per sq. in.	±4.0–4.5	±4.5–5.0	±4.5–5.0
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	8–11	11–16	14–19
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	6–9	9–12	13–18
ELONGATION % on 2 in. gauge length ... ..	1.5–4.0	2.5–5.0	1–2
BRINELL HARDNESS NUMBER ... ..	60–70	70–80	85–100

# HIDUMINIUM 45

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## Heat Treatable Corrosion Resisting Wrought Alloy

### AIR MINISTRY SPECIFICATION :

D.T.D. 423A    D.T.D. 460

Alloys of the Al-Si-Mg-Mn type possess a very high degree of corrosion resistance, especially in respect of sea water and salt laden atmospheres, which is exceeded only by that of the Al-Mg-Mn alloys such as "HIDUMINIUM" 33. Unlike those alloys, however, they respond readily to heat treatment.

"HIDUMINIUM" 45 is a wrought alloy of this type and thus possesses the unique combination of high resistance to corrosion and availability with a wide range of mechanical properties, which properties can be accurately controlled by heat treatment.

The alloy is available in the form of extruded sections and bars, solid drawn tubes, sheet and strip, forgings and pressings, in which forms it has been used extensively in the shipbuilding, automobile and building industries and in the construction of equipment for the chemical and food industries.

### HEAT TREATMENT

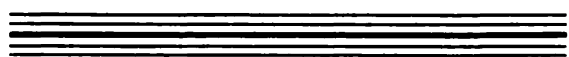
Solution Treatment :                      525–540° C. for 2–4 hours.  
  Quench in water.

Precipitation Treatment—Grade A : 140° C. for 2 hours.  
  Grade B : 155–160° C. for 10–20 hours.

Annealing :                                      360° C. for 4 hours.  
  Cool in air.

### CHEMICAL COMPOSITION

SILICON	0.5–1.5 per cent.
MAGNESIUM	0.5–1.0 per cent.
MANGANESE	0.5–1.0 per cent.
ALUMINIUM	Remainder



# HIDUMINIUM 45

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.7
Specific weight, lbs. per cu. in. ... ..	0.097
Co-efficient of thermal expansion, 20–100° C. ... ..	$24.0 \times 10^{-6}$
Thermal conductivity, at 20° C., C.G.S. units ... ..	0.50
Thermal conductivity, at 20° C., compared with copper 100	54.0
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ... ..	3.13–4.16

## MECHANICAL PROPERTIES

	Annealed	Grade A Solution Treated and Aged at 140° C.	Grade B Fully Heat Treated
ENDURANCE LIMIT at $10 \times 10^6$ complete cycles of stress, tons per sq. in.	—	$\pm 9.0$	$\pm 9.5$
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	7–8	16–18	20–23
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	4–5	10–13	17–19
ELONGATION % on 2 in. gauge length ... ..	27–20	22–18	14–10
BRINELL HARDNESS NUMBER ...	30–38	65–80	90–120



# HIDUMINIUM R.R. 50

## General Purpose Sand & Die Casting Alloy

### AIR MINISTRY SPECIFICATION :

#### D.T.D. 133B

"HIDUMINIUM" R.R. 50 is a general purpose casting alloy which combines excellent foundry properties with good ductility and mechanical strength.

Unlike most high strength light alloys, R.R. 50 requires only a low temperature precipitation treatment to develop the optimum properties. This quality is particularly valuable in large castings of varying sections as internal strains, which frequently follow severe quenching, are avoided. Castings in this alloy are not subject to age-hardening in service and the properties are well maintained at normal internal combustion engine working temperatures.

R.R. 50 is regularly employed for cylinder blocks, cylinder heads, crankcases and all parts in automobile and aircraft manufacture which demand a high standard of performance.

### HEAT TREATMENT

Precipitation treatment : 10-16 hours at 155-170° C. Quench in hot water or cool in air.

### CHEMICAL COMPOSITION

COPPER	0.8 -2.0 per cent.
NICKEL	0.8 -1.75 per cent.
MAGNESIUM	0.05-0.30 per cent.
IRON	0.8 -1.40 per cent.
TITANIUM	0.05-0.25 per cent.
SILICON	1.50-2.80 per cent.
ALUMINIUM	Remainder

# HIDUMINIUM R.R. 50

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.75
Specific weight, lbs. per cu. in. ... ..	0.0985
Co-efficient of thermal expansion, 20–100° C. ... ..	$22.0 \times 10^{-6}$
Co-efficient of thermal expansion, 20–200° C. ... ..	$23.1 \times 10^{-6}$
Co-efficient of thermal expansion, 20–300° C. ... ..	$24.0 \times 10^{-6}$
Thermal conductivity 0–100° C., in C.G.S. units ... ..	0.415
Thermal conductivity, compared with copper 100 ... ..	45
Linear Casting Contraction % ... ..	1.042
Pattern Makers' Scale for castings of moderate size and unrestricted shrinkage ... ..	1/96
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ... ..	4.25

## MECHANICAL PROPERTIES

of Test Bars cast in D.T.D. sand lined moulds and heat treated.

	Sand Cast	Die Cast
ENDURANCE LIMIT at $20 \times 10^6$ complete cycles of stress, tons per sq. in. ... ..	$\pm 4.5$	$\pm 5.8$
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	11–13	13–16
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	9–11	11–13
ELONGATION % on 2 in. gauge length ... ..	2–4	4–6
0.1% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	9–11	11–13
0.5% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	11–13	12–14
BRINELL HARDNESS NUMBER ... ..	65–75	70–80

# **HIDUMINIUM R.R. 53**

Sand and Die Casting Alloy for Parts Subject to Elevated Temperatures

## **AIR MINISTRY SPECIFICATIONS :**

**D.T.D. 238    D.T.D. 131A**

“ HIDUMINIUM ” R.R. 53 is a sand and die casting alloy possessing particularly good properties at elevated temperatures. This alloy also has excellent bearing properties and offers very low resistance to sliding friction. These qualities, combined with high thermal conductivity, make it eminently suitable for use in pistons, air cooled cylinder heads and similar parts. The use of the alloy for structural parts is not recommended.

Pistons for engines varying in size from the smallest motor cycle to the largest Diesel are regularly cast in this alloy. In aero engines its main applications are in air cooled cylinder heads and other parts operating at high temperatures. For aero engine pistons, however, the use of the forged alloy R.R. 59 is generally preferred.

## **HEAT TREATMENT**

Solution Treatment :            2-4 hours at 520-535° C.

  Quench in boiling water, oil or air blast.

Precipitation Treatment :    10-20 hours at 150-170° C. or 5-10 hours at 200° C.

  Quench in water or cool in air.

These treatments may be varied in practice to suit service requirements.

# HIDUMINIUM R.R. 53

## CHEMICAL COMPOSITION

COPPER	1.5-2.5 per cent.
NICKEL	0.5-2.0 per cent.
MAGNESIUM	1.4-1.8 per cent.
IRON	1.1-1.5 per cent.
TITANIUM	0.02-0.12 per cent.
SILICON	Not more than 2 per cent.
ALUMINIUM	Remainder

## PHYSICAL PROPERTIES

Specific gravity	...	2.75
Specific weight, lbs. per cu. in.	...	0.0985
Co-efficient of thermal expansion, 20-100° C.	...	$22.4 \times 10^{-6}$
Co-efficient of thermal expansion, 20-200° C.	...	$23.3 \times 10^{-6}$
Co-efficient of thermal expansion, 20-300° C.	...	$23.8 \times 10^{-6}$
Thermal conductivity, 0-100° C., in C.G.S. units	...	0.43
Thermal conductivity, compared with copper 100	...	47.0
Linear casting contraction %	...	1.163
Pattern makers' scale for castings of moderate size and unrestricted shrinkage	...	1/86
Young's Modulus (E), lbs. per sq. in.	...	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube	...	4.3

(See over)

# HIDUMINIUM R.R. 53 (Contd.)

## MECHANICAL PROPERTIES

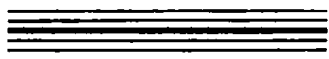
of Test Bars cast in D.T.D. sand lined moulds and heat treated to give maximum tensile properties at air temperature.

	<i>Sand Cast</i>	<i>Die Cast</i>
ENDURANCE LIMIT at $20 \times 10^6$ complete cycles of stress, tons per sq. in. ....	±5.5	±6.9
ULTIMATE STRESS IN TENSION tons per sq. in. ....	18-20	21-23
0.1% PROOF STRESS IN TENSION tons per sq. in. ....	—	19-22
ELONGATION % on 2 in. gauge length ....	0.5-1.0	0.5-1.5
0.1% PROOF STRESS IN COMPRESSION tons per sq. in. ....	19-21	23-25
0.5% PROOF STRESS IN COMPRESSION tons per sq. in. ....	21-23	25-27
BRINELL HARDNESS NUMBER....	124-148	124-148

## PROPERTIES AT ELEVATED TEMPERATURES

<i>Temperature</i>	<i>Ultimate Stress tons per sq. in.</i>		<i>Brinell at Temperature</i>		<i>Brinell after Cooling</i>	
	<i>Sand Cast</i>	<i>Die Cast</i>	<i>Sand Cast</i>	<i>Die Cast</i>	<i>Sand Cast</i>	<i>Die Cast</i>
20° C.	18.5	24.0	129	138	—	—
200° C.	16.0	22.0	101	115	129	138
250° C.	14.0	19.5	78	80	121	129
300° C.	13.0	15.5	50	55	101	105
350° C.	8.8	9.0	27	30	70	85





# **HIDUMINIUM R.R. 53. C**

High Strength Sand and Die Casting Alloy for Structural Components

## **AIR MINISTRY SPECIFICATIONS :**

**D.T.D. 313    D.T.D. 309**

This alloy meets a demand for a high strength casting alloy having a tensile strength between those of the medium strength casting alloys and of the high strength wrought alloys.

It is used in the form of both sand and die castings for a variety of moderately stressed machine and structural components including levers, brackets, etc.

## **HEAT TREATMENT**

Solution Treatment :    2-3 hours at 520-525° C.  
  Quench in boiling water, oil or air blast.

Precipitation Treatment : 16-20 hours at 165-175° C.  
  Quench in water or cool in air.

## **CHEMICAL COMPOSITION**

COPPER	0.8-2.0 per cent.
NICKEL	0.5-1.5 per cent.
MAGNESIUM	0.3-0.8 per cent.
IRON	0.8-1.4 per cent.
SILICON	2.0-3.0 per cent.
TITANIUM	Not more than 0.3 per cent.
ALUMINIUM	Remainder

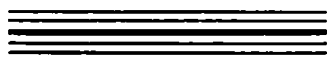
(See over)

# HIDUMINIUM R.R. 53. C

(Contd.)

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.75
Specific weight, lbs. per cu. in. ... ..	0.0985
Co-efficient of thermal expansion, 20-100° C. ... ..	$22.0 \times 10^{-6}$
Co-efficient of thermal expansion, 20-200° C. ... ..	$23.2 \times 10^{-6}$
Thermal conductivity 0-100° C. in C.G.S. units ... ..	0.413
Thermal conductivity, compared with copper 100 ... ..	45.0
Linear casting contraction % ... ..	1.042
Pattern makers' scale for castings of moderate size and unrestricted shrinkage ... ..	1/96
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ... ..	4.3



# HIDUMINIUM R.R. 53. C

## MECHANICAL PROPERTIES

of Test Bars cast in D.T.D. sand lined moulds.

	<i>Sand Cast</i>	<i>Die Cast</i>
<b>ENDURANCE LIMIT</b> at $20 \times 10^6$ complete cycles of stress, heat treated (full treatment), tons per sq. in. ... ..	$\pm 7.2$	$\pm 8.4$
<b>ULTIMATE STRESS IN TENSION</b> Heat treated (full treatment), tons per sq. in. ...	19-22	22-24
Solution treated only, tons per sq. in. ... ..	14-15	17-19
<b>0.1% PROOF STRESS IN TENSION</b> Heat treated (full treatment), tons per sq. in. ...	18-20	19-21
Solution treated only, tons per sq. in. ... ..	9-10	10-12
<b>ELONGATION % on 2 in. gauge length</b> Heat treated (full treatment) ... ..	1-2	1-2
Solution treated only ... ..	2-3	2-3
<b>0.1% PROOF STRESS IN COMPRESSION</b> Heat treated (full treatment), tons per sq. in. ...	20-23	20-24
Solution treated only, tons per sq. in. ... ..	10-12	11-14
<b>0.5% PROOF STRESS IN COMPRESSION</b> Heat treated (full treatment), tons per sq. in. ...	22-25	25-27
Solution treated only, tons per sq. in. ... ..	14-16	15-19
<b>BRINELL HARDNESS NUMBER</b> Heat treated (full treatment) ... ..	100-115	110-121
Solution treated only ... ..	70-75	75-85



# HIDUMINIUM R.R. 56

General Purpose Wrought Alloy

## BRITISH STANDARD SPECIFICATIONS :

2 L. 40      L. 45      L. 47

## AIR MINISTRY SPECIFICATIONS :

D.T.D. 130A      D.T.D. 179      D.T.D. 184  
D.T.D. 206      D.T.D. 220A      D.T.D. 246A  
D.T.D. 410

" HIDUMINIUM " R.R. 56 possesses a combination of high specific strength and excellent hot working properties which has established it as one of the most widely used high strength light alloys. Available in all wrought forms, including forgings, stampings, pressings, extrusions, tubes, sheet and strip, this alloy is suitable for use in a wide range of industries.

The homogeneity of this alloy and its freedom from ingot defects permits it to be manufactured in a wide variety of forms, the size of which is limited only by the capacity of the plant available.

Typical applications are :—

Forgings, stampings and pressings	Aero-engine crankcases, connecting rods, cylinder barrels, supercharger rotors, reduction gear-cases, undercarriage wheel forks, airscrew blades, etc.
Extrusions and tube      ...      ...	Air-frames, stiffeners, ribs, wing spars, etc.
Sheet and strip      ...      ...	Stressed skin covering, cowlings, covers, etc.

R.R. 56 also fulfils innumerable functions in the automobile and other industries. Applications range from cycle cranks to locomotive connecting rods.

## STANDARD HEAT TREATMENT

Solution Treatment :      2-6 hours at 525-535° C.  
Quench in hot water.

Precipitation Treatment :      10-20 hours at 165-180° C.  
Quench in water or cool in air.

# ===== ===== **HIDUMINIUM R.R. 56**

## **CHEMICAL COMPOSITION**

COPPER	1.8-2.5 per cent.
NICKEL	0.6-1.4 per cent.
MAGNESIUM	0.65-1.2 per cent.
IRON	0.6-1.2 per cent.
TITANIUM	0.05-0.15 per cent.
SILICON	0.55-1.25 per cent.
ALUMINIUM	Remainder

## **PHYSICAL PROPERTIES**

Specific gravity ... ..	...	...	...	...	2.75
Specific weight, lbs. per cu. in. ... ..	...	...	...	...	0.0985
Co-efficient of thermal expansion, 20-100° C. ... ..	...	...	...	...	22.0 × 10 <sup>-6</sup>
Co-efficient of thermal expansion, 20-200° C. ... ..	...	...	...	...	22.8 × 10 <sup>-6</sup>
	<i>Fully Heat Treated</i>	<i>Solution Treated</i>	<i>Annealed</i>	<i>Normalised Annealed</i>	
Thermal conductivity 30-70° C., in C.G.S. units ... ..	0.38	0.34	0.46	0.40	
Thermal conductivity, compared with copper 100 ... ..	41	37	50	43.5	
Specific resistance at 18° C., microhms per cm. cube ... ..	4.37	4.85	3.4	4.05	

(See over)

# HIDUMINIUM R.R. 56 (Contd.)

## ELASTIC PROPERTIES—Solution Treated and Aged Material

Young's Modulus (E), lbs. per sq. in. ... ..	10.0-10.8 × 10 <sup>6</sup>
Rigidity, lbs. per sq. in. ... ..	4 × 10 <sup>6</sup>
Volume Elasticity, lbs. per sq. in. ... ..	11.1-12.0 × 10 <sup>6</sup>
Poisson's ratio ... ..	0.35

## MECHANICAL PROPERTIES

of Test Bars machined from 1½ in. square forged bar.

	<i>Solution Treated and Aged</i>	<i>Solution Treated</i>	<i>Annealed</i>	<i>Normalised Annealed</i>
ENDURANCE LIMIT at 20 × 10 <sup>6</sup> complete cycles of stress, tons per sq. in. ...	±10.04	—	—	±8.73
ENDURANCE LIMIT at 50 × 10 <sup>6</sup> complete cycles of stress, tons per sq. in. ...	±9.1	—	—	—
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	27-30	22-26	12-15	16-19
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	21-23	10-13	6-8	7-11
ELONGATION % on 2 in. gauge length ...	10-15	15-22	20-25	16-22
BRINELL HARDNESS NUMBER	121-138	80-100	45-55	70-80
YOUNG'S MODULUS (E) lbs. per sq. in. ... ..	10.0-10.8 × 10 <sup>6</sup>	—	9.6 × 10 <sup>6</sup>	9.5 × 10 <sup>6</sup>
0.1% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	22-24	12-14	8-10	—
0.5% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	27-29	15-17	9-11	—

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# HIDUMINIUM R.R. 59

High Strength Wrought Alloy for use at Elevated Temperatures

## BRITISH STANDARD SPECIFICATION :

### 2 L. 42

“ HIDUMINIUM ” R.R. 59 is a wrought alloy which has been evolved for parts subjected in service to high stress at elevated temperatures. It possesses mechanical properties at normal working temperatures approaching those of R.R. 56 and has similar hot working properties. These qualities, combined with excellent mechanical properties at elevated temperatures, high thermal conductivity and low friction co-efficient, make the alloy an ideal material for use in the manufacture of all types of internal combustion engine pistons.

R.R. 59 is regularly employed for all classes of pistons ranging from the smallest motor cycle to the largest compression ignition engine and is the standardised material for this purpose in a large proportion of the aero engines manufactured in this country.

The properties at both normal and elevated temperatures are set out below in tabular form.

The excellent properties of this alloy at normal temperatures permit it to be used also as a general purpose structural material.

### HEAT TREATMENT

Solution Treatment :        2-3 hours at 520-530° C.  
  Quench in water, oil or air blast.

Precipitation Treatment : 15-20 hours at 150-170° C. or 5-10 hours at 200° C.  
  Quench in water or cool in air.

These treatments may be varied in practice to suit service requirements.

(See over)

# HIDUMINIUM R.R. 59

(Contd.)

## CHEMICAL COMPOSITION

COPPER	1.5-3.0 per cent.
NICKEL	0.5-1.5 per cent.
MAGNESIUM	1.2-1.8 per cent.
IRON	1.0-1.5 per cent.
TITANIUM	Not more than 0.2 per cent.
SILICON	Not more than 1.3 per cent.
ALUMINIUM	Remainder

## PHYSICAL PROPERTIES

Specific gravity	...	...	...	...	...	...	2.75
Specific weight, lbs. per cu. in.	...	...	...	...	...	...	0.0985
Co-efficient of thermal expansion, 20-100° C.	...	...	...	...	...	...	$22.0 \times 10^{-6}$
Co-efficient of thermal expansion, 20-200° C.	...	...	...	...	...	...	$23.1 \times 10^{-6}$
Co-efficient of thermal expansion, 20-300° C.	...	...	...	...	...	...	$24.0 \times 10^{-6}$
Co-efficient of thermal expansion, 20-400° C.	...	...	...	...	...	...	$24.8 \times 10^{-6}$
Young's Modulus (E), lbs. per sq. in.	...	...	...	...	...	...	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube	...	...	...	...	...	...	4.4
						<i>Annealed</i>	<i>Heat Treated</i>
Thermal conductivity, in C.G.S. units :							
at 0° C.	...	...	...	...	...	0.425	0.358
at 100° C.	...	...	...	...	...	0.441	0.381
at 200° C.	...	...	...	...	...	0.46	0.408
at 300° C.	...	...	...	...	...	0.48	0.431



# HIDUMINIUM R.R. 59

## MECHANICAL PROPERTIES

	<i>Of Test Bars forged to 1½ in. dia.</i>	<i>Of Specimens cut from Pistons</i>
ENDURANCE LIMIT at 20 × 10 <sup>6</sup> complete cycles of stress, tons per sq. in. ... ..	±10.3	—
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	27-30	25-30
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	20-22	18-21
ELONGATION % on 2 in. gauge length (forged bar) ...	10-15	6-12
0.1% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	21-23	—
0.5% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	25-27	—
BRINELL HARDNESS NUMBER ... ..	124-148	117-130

## RESULTS OF SHORT-TIME TESTS AT ELEVATED TEMPERATURES

<i>Temperature</i>	<i>Ultimate Stress tons per sq. in.</i>	<i>Brinell at Temperature</i>	<i>Brinell after Cooling</i>
20° C.	28.0	134	—
200° C.	21.5	110	134
250° C.	19.5	87	125
300° C.	13.0	52	90
350° C.	8.0	27	75
400° C.	—	12	70

# HIDUMINIUM 72

Natural-ageing Alloy for Sheet and Strip, Extruded and Rolled Bars and Sections, Solid Drawn Tubes

## AIR MINISTRY SPECIFICATIONS :

D.T.D. 270

D.T.D. 273

D.T.D. 275

D.T.D. 280

D.T.D. 290

" HIDUMINIUM " 72 has been developed to meet the demand for an aluminium alloy which, after only one heat treatment, will attain high tensile properties. The alloy is used chiefly in the form of extruded sections, sheet, strip, tubes and aluminium plated sheet and strip.

## HEAT TREATMENT

Solution Treatment : 2-6 hours at 495-505° C. followed by a water quench.

Ageing Treatment : Natural ageing for 3 or 4 days to obtain optimum mechanical properties.

## CHEMICAL COMPOSITION

COPPER	3.5-4.8 per cent.
MAGNESIUM	0.8-1.8 per cent.
MANGANESE	0.3-1.5 per cent.
IRON	Not more than 0.4 per cent.
SILICON	Not more than 0.5 per cent.
ALUMINIUM	Remainder

# HIDUMINIUM 72

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.76
Specific weight, lbs. per cu. in....	0.0985
Co-efficient of thermal expansion, 20–100° C.	$23.4 \times 10^{-6}$
Thermal conductivity, 0–100° C., in C.G.S. units	0.37
Thermal conductivity, compared with copper 100	40.0
Young's Modulus (E), lbs. per sq. in. ...	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ...	4.7

## MECHANICAL PROPERTIES

	Bar Sections Sheet	Tubes	Aluminium Plated Sheet and Strip
ENDURANCE LIMIT at $20 \times 10^6$ complete cycles of stress, tons per sq. in.	$\pm 11.5$	—	—
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	28–30	29–31	26–30
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	18–20	22–24	16–18
ELONGATION % on 2 in. gauge length ... ..	15–20	—	15–20
0.1% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	19–21	—	—
0.5% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	24–26	—	—
BRINELL HARDNESS NUMBER ...	129–148	129–148	—

# HIDUMINIUM R.R. 77

High Strength Wrought Alloy for Structural Purposes

## AIR MINISTRY SPECIFICATION :

D.T.D. 363

" HIDUMINIUM " R.R. 77, the composition of which is fundamentally different from that of other strong light alloys, possesses specific strength properties exceeding those of high tensile steel alloys. The alloy represents the result of prolonged research and, besides its high strength properties, it possesses excellent ductility, fatigue resistance and electrical and thermal conductivity. Available in various wrought forms it has been chiefly used as extrusions which enable full advantage to be taken of its high strength properties.

For the hot working and, to a lesser extent, for the heat treatment of this alloy, rather different conditions hold as compared with the better known alloys. However, a large amount of work has been carried out in this connection and a thorough knowledge has been acquired of the special characteristics of the alloy in these respects ; in fact, it has been found that parts fabricated from this alloy by special operations evolved for their production possess greater uniformity of properties in different sections and in different directions of flow than it has been possible to obtain in other wrought light alloys.

Cold forming may be carried out providing that special precautions are observed.

## HEAT TREATMENT

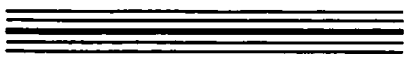
Solution Treatment : 2-3 hours at 455-465° C.  
Quench in water.

Precipitation Treatment : 15-20 hours at 130-140° C.  
Cool in air.

In certain circumstances special treatments are employed.

## CHEMICAL COMPOSITION

COPPER	1.5-3.0 per cent.
ZINC	4.0-6.0 per cent.
MAGNESIUM	2.0-4.0 per cent.
IRON	Not more than 0.6 per cent.
SILICON	Not more than 0.6 per cent.
MANGANESE	Not more than 1.0 per cent.
TITANIUM	Not more than 0.3 per cent.
ALUMINIUM	Remainder



# HIDUMINIUM R.R. 77

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.8
Specific weight, lbs. per cu. in. ... ..	0.101
Co-efficient of thermal expansion, 20–100° C. ... ..	$20.0 \times 10^{-6}$
Co-efficient of thermal expansion, 20–200° C. ... ..	$22.0 \times 10^{-6}$
Co-efficient of thermal expansion, 20–300° C. ... ..	$23.0 \times 10^{-6}$
Thermal conductivity, 0–100° C., in C.G.S. units ... ..	0.32–0.42
Thermal conductivity, compared with copper 100 ... ..	34.0–44.5
Young's Modulus (E), lbs. per sq. in. ... ..	$10.0-10.5 \times 10^6$
Specific resistance, microhms per cm. cube ... ..	3.7–5.0

## MECHANICAL PROPERTIES

of typical extrusions and pressings.

	Annealed	Solution Treated and Naturally Aged	Solution Treated and Artificially Aged
ENDURANCE LIMIT at $10 \times 10^6$ complete cycles of stress, tons per sq. in.	—	—	$\pm 12.5-13.0$
ULTIMATE STRESS IN TENSION tons per sq. in. ... ..	12–14	29–32	33–38
0.1% PROOF STRESS IN TENSION tons per sq. in. ... ..	4–8	18–21	28–33
ELONGATION % on 2 in. gauge length ... ..	20–14	21–16	16–10
0.1% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	4–8	17–21	27–30
0.5% PROOF STRESS IN COMPRESSION tons per sq. in. ... ..	7–9	22–25	32–36
BRINELL HARDNESS NUMBER ...	45–65	130–140	160–180



# HIDUMINIUM "Y" ALLOY

(WROUGHT)

Wrought Alloy for use at Elevated Temperatures

## BRITISH STANDARD SPECIFICATIONS :

4 L.25	414
478	533

This alloy has long been used for pistons and cylinder heads on account of its excellent properties at elevated temperatures.

Although it has been largely replaced by the more recently developed "HIDUMINIUM" R.R. 59, the alloy is still used to a considerable extent.

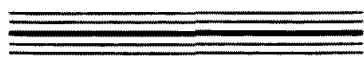
## HEAT TREATMENT

Solution Treatment : 2-6 hours at 490-525° C.  
Quench in boiling water or in oil.

Ageing at room temperature for 5 days or in boiling water for 2-4 hours.

## CHEMICAL COMPOSITION

COPPER	3.5-4.5 per cent.
NICKEL	1.8-2.3 per cent.
MAGNESIUM	1.2-1.7 per cent.
IRON	Not more than 0.6 per cent.
SILICON	Not more than 0.6 per cent.
SILICON plus IRON	Not more than 1.0 per cent.
OTHER IMPURITIES	Not more than 0.5 per cent.
ALUMINIUM	Remainder



# HIDUMINIUM "Y" ALLOY

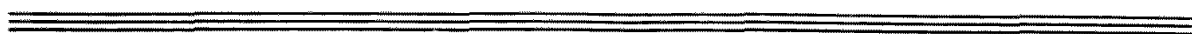
(WROUGHT)

## PHYSICAL PROPERTIES

Specific gravity	...	...	...	...	...	...	...	2.79
Specific weight, lbs. per cu. in.	...	...	...	...	...	...	...	0.101
Co-efficient of thermal expansion, 20–100° C.	...	...	...	...	...	...	...	$22.25 \times 10^{-6}$
Thermal conductivity, annealed, in C.G.S. units, at 0° C.	...	...	...	...	...	...	...	0.424
Thermal conductivity, annealed, in C.G.S. units, at 100° C.	...	...	...	...	...	...	...	0.435
Thermal conductivity, annealed, in C.G.S. units, at 200° C.	...	...	...	...	...	...	...	0.444
Thermal conductivity, annealed, in C.G.S. units, at 300° C.	...	...	...	...	...	...	...	0.455
Specific resistance, microhms per cm. cube	...	...	...	...	...	...	...	5.05

## MECHANICAL PROPERTIES

ENDURANCE LIMIT at $20 \times 10^6$ complete cycles of stress, tons per sq. in.	...	...	...	...	...	...	...	$\pm 9.3$
ULTIMATE STRESS IN TENSION tons per sq. in.	...	...	...	...	...	...	...	24–27
0.1% PROOF STRESS IN TENSION tons per sq. in.	...	...	...	...	...	...	...	14–17
ELONGATION % on 2 in. gauge length	...	...	...	...	...	...	...	15–20
BRINELL HARDNESS NUMBER	...	...	...	...	...	...	...	100–130



# HIDUMINIUM "Y" ALLOY


(CAST)

Sand and Die Casting Alloy for use at Elevated Temperatures

## BRITISH STANDARD SPECIFICATIONS :

2 L.24 L.35  
703 704

This alloy has long been used for pistons and cylinder heads on account of its excellent properties at elevated temperatures.

Although it has been largely replaced by the more recently developed "HIDUMINIUM" R.R.  with its improved casting qualities and mechanical properties, the alloy is still used to a considerable extent.

## HEAT TREATMENT

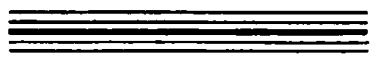
Solution Treatment : not less than 6 hours at 500° to 520° C.  
Quench in boiling water.

Ageing at room temperature for five days.

## CHEMICAL COMPOSITION

COPPER	3.5-4.5 per cent.
NICKEL	1.8-2.3 per cent.
MAGNESIUM	1.2-1.7 per cent.
IRON	Not more than 0.6 per cent.
SILICON	Not more than 0.6 per cent.
SILICON plus IRON	Not more than 1.0 per cent.
LEAD	Not more than 0.05 per cent.
TIN plus ZINC	Not more than 0.10 per cent.
TITANIUM	Not more than 0.02 per cent.
ALUMINIUM	Remainder





# HIDUMINIUM "Y" ALLOY

(CAST)

## PHYSICAL PROPERTIES

Specific gravity ... ..	2.79
Specific weight, lbs. per cu. in. ... ..	0.101
Co-efficient of thermal expansion, 20-100° C. ... ..	$22.5 \times 10^{-6}$
Thermal conductivity, annealed, in C.G.S. units ... ..	0.41
Thermal conductivity, annealed, compared with copper 100	44.5

## MECHANICAL PROPERTIES

	<i>Sand Cast</i>	<i>Die Cast</i>
ENDURANCE LIMIT at $20 \times 10^6$ complete cycles of stress, tons per sq. in. ... ..	$\pm 5.8$	$\pm 7.1$
ULTIMATE STRESS IN TENSION, tons per sq. in. (As Cast) ... ..	10-12	12-14
ULTIMATE STRESS IN TENSION, tons per sq. in. (Heat Treated) ... ..	14-17	18-20
0.1% PROOF STRESS IN TENSION, tons per sq. in. (As Cast) ... ..	8.5-9.5	8.5-10.5
0.1% PROOF STRESS IN TENSION, tons per sq. in. (Heat Treated) ... ..	13-14	14-16
ELONGATION % on 2 in. gauge length (As Cast)	0.5-1.0	1-2
ELONGATION % on 2 in. gauge length (Heat Treated)	—	2-3
BRINELL HARDNESS NUMBER (As Cast) ...	80-85	85-90
BRINELL HARDNESS NUMBER (Heat Treated) ...	100-125	105-130



# HIDUMINIUM DU BRAND

## General Purpose Wrought Alloy

### BRITISH STANDARD SPECIFICATIONS :

395 · 396 · 477 · 532 · 6 L.1 · 5 L.3  
2 L.38 · 2 L.39 · 4 T.4

### AIR MINISTRY SPECIFICATIONS :

D.T.D. 147    D.T.D. 150

This alloy, which is of the well-known duralumin type, has been established for many years as an aircraft material and although it has to some extent been superseded by the more recently developed high strength alloys it still finds considerable use in applications where its particular combination of strength and ductility and its natural ageing properties are of advantage.

### HEAT TREATMENT

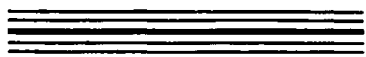
Solution Treatment : 2-6 hours at 485-505° C.  
Quench in water or oil.

Ageing at room temperature for 5 days.

### CHEMICAL COMPOSITION

(according to British Standard Specification)

COPPER	3.5-4.5 per cent.
MAGNESIUM	0.4-0.8 per cent.
MANGANESE	0.4-0.7 per cent.
SILICON	Not more than 0.7 per cent.
IRON	Not more than 0.7 per cent.
TITANIUM (if present)	Not more than 0.3 per cent.
ALUMINIUM	Remainder



# HIDUMINIUM DU BRAND

## PHYSICAL PROPERTIES

Specific gravity	... ..	2.79
Specific weight, lbs. per cu. in.	... ..	0.101
Co-efficient of thermal expansion, 20–100° C.	... ..	$23.7 \times 10^{-6}$
Co-efficient of thermal expansion, 20–200° C.	... ..	$25.0 \times 10^{-6}$
Thermal conductivity, in C.G.S. units	... ..	0.35–0.45
Thermal conductivity, compared with copper 100	... ..	37–47
Specific resistance, microhms per cm. cube	... ..	3.3–5.3

## MECHANICAL PROPERTIES

of Test Bars forged to  $1\frac{1}{8}$  in. diameter.

ENDURANCE LIMIT at $20 \times 10^6$ complete cycles of stress, tons per sq. in.	... ..	$\pm 9.5$
ULTIMATE STRESS IN TENSION tons per sq. in.	... ..	25–28
0.1% PROOF STRESS IN TENSION	... ..	15–17
ELONGATION % on 2 in. gauge length	... ..	15–20
BRINELL HARDNESS NUMBER	... ..	100–120



*Additional sheets should be inserted  
after this page in accordance with  
the instructions on the yellow slip.*