

Quality	C60E	Quenching and Tempering Steel	<i>Technical card</i>
According to standards	ISO 683-1: 2018		Lucefin Group
Number	1.1221		rev. 2018

Chemical composition

C%	Si%	Mn%	P%	S%	Cr%	Mo%	Ni%	Cu%	
			max	max	max	max	max	max	
0,57-0,65	0,10-0,40	0,60-0,90	0,025	0,035	0,40	0,10	0,40	0,30	Product deviations are allowed
± 0.03	± 0.03	± 0.04	+ 0.005	± 0.005	+0.05	+0.03	+0.03	+0.05	
Cr+Mo+Ni max 0.63%									
For C60R n° 1.1223, S% 0.020-0.040 product deviations ± 0.005									

Temperature °C

Hot-forming	Normalizing +N	Quenching +Q	Quenching +Q	Tempering +T	Stress-relieving +SR		
1050-850	820-860 air	800 water	840 oil or polymer	550-660 air	50° under the temperature of tempering		
Soft annealing +A	Isothermal annealing +I	Natural state +U	End quench hardenability test	Pre-heating welding		Stress-relieving after welding	
700 air (HB max 241)	780 furnace cooling to 670, then air (HB 200-244)	(HB max 280)	830 water	250		600 furnace cooling	
				Ac1	Ac3	Ms	Mf
				730	760	290	70

Mechanical properties

C60E – C60R Hot-rolled mechanical properties in **normalized** condition ISO 683-1: 2018

size d / t		Testing at room temperature (longitudinal)					
mm		R	Re_H ^{a)}	A%	Z%	Kv₂	HB for information
from	to	N/mm ² min	N/mm ² min.	min.	min.	J min.	min
	16/16	710	380	10	-	-	218
16/16	100/100	670	340	11	-	-	203
100/100	250/250	650	310	11	-	-	200

^{a)} Re_H upper yield strength or, if no yield phenomenon occurs, Rp_{0.2} has to be considered
d = diameter t = thickness

Hot-rolled mechanical properties in **quenched and tempered** condition ISO 683-1: 2018

size d / t		Testing at room temperature (longitudinal)					
mm		R	Re_H ^{a)}	A%	Z%	Kv₂	HB
from	to	N/mm ²	N/mm ² min	min.	min.	J min	for information
	16/8	850-1000	580	11	25	-	253-298
16/8	40/20	800-950	520	13	30	-	240-290
40/20	100/60	750-900	450	14	35	-	225-271

^{a)} Re_H upper yield strength or, if no yield phenomenon occurs, Rp_{0.2} has to be considered
d = diameter t = thickness

Table of tempering values obtained at room temperature on rounds of Ø 10 mm after quenching at 830 °C in water

HB	697	688	634	560	468	371	264		
HRC	62.5	62	59	55	49	40	27		
R N/mm²			2420	2070	1700	1250	880		
Tempering at °C	50	100	200	300	400	500	600		
Thermal Expansion	10 ⁻⁶ · K ⁻¹	►	11.1	12.1		12.9	13.5	13.9	14.1
Mod. of Elasticity long.	GPa		210		197			178	
Mod. of Elasticity tang.	GPa		80		76			68	
Specific Heat Capacity	J/(Kg·K)		460	502	544				
Thermal Conductivity	W/(m·K)				46.8				
Density	Kg/dm ³		7.85						
Spec. Electric Resist.	Ohm·mm ² /m		0.13						
Elec. Conductivity	Siemens·m/mm ²		7.69						
°C		20	100	200	250	300	400	500	600

The symbol ► indicates temperature between 20 °C and 100 °C, 20 °C and 200 °C ...

Cold-drawn +C ^{c)}						Hot-rolled and Peeled +SH ^{d)}			
size		Testing at room temperature (longitudinal)				Testing at room temperature (longitudinal)			
mm		R ^{a)}	Rp ^{0.2 a)}	A%	HBW	R	Rp ^{0.2}	A%	HBW
from	to	N/mm ²	N/mm ² min	min	for inform.	N/mm ²	N/mm ² min	min	
5 ^{b)}	10	800-1150	630	5	240-347	-	-	-	-
10	16	780-1130	550	5	232-339	-	-	-	-
16	40	730-1100	480	6	224-331	670-940	-	-	198-278
40	63	-	-	-	-	670-940	-	-	198-278
63	100	-	-	-	-	670-940	-	-	198-278

^{a)} for flats and special sections, yield point can be – 10% and tensile strength can be ± 10%
^{b)} for thickness < 5 mm, mechanical properties should be agreed before order placement
^{c)} values valid also for +C+G
^{d)} values valid also for +SH+G

Hot-rolled, quenched and tempered, cold-drawn +QT+SH ^{c)}						Cold-drawn + quenching and tempering +QT+C			
size		Testing at room temperature (longitudinal)				Testing at room temperature (longitudinal)			
mm		R	Rp ^{0.2}	A%	Kv ₂	R	Rp ^{0.2}	A%	Kv ₂
from	to	N/mm ²	N/mm ² min	min	J min	N/mm ²	N/mm ² min	min	J min
5 ^{b)}	10	-	-	-	-	900-1100	630	6	-
10	16	-	-	-	-	880-1080	615	6	-
16	40	800-950	520	13	-	830-1030	580	7	-
40	63	750-900	450	14	-	780-980	545	8	-
63	100	750-900	450	14	-	750-950	525	8	-

^{b)} for thickness < 5 mm, mechanical properties should be agreed before order placement
^{c)} values valid also for +C+QT

Work-hardening by cold-drawing (Hot-rolled +N+C)						
R	N/mm ²	750	800	850	910	980
Rp ^{0.2}	N/mm ²	500	680	720	730	670
A%		18	10	9	8	7
Reduction	%	0	10	20	30	40

C60E 1.1221 Forged normalized UNI EN 10250-2: 2001								
size		Testing at room temperature (longitudinal)						
mm		R	Re ^{c)}	A%	A%	Kv	Kv	HB
from	to	N/mm ² min	N/mm ² min	min (L)	min (T)	J min (L)	J min (T)	min
	100	670	340	11				203
100	250	650	310	11	8			200
250	500	630	275	11	8			192
500	1000	620	260	10	7			190

C60E 1.1221 Forged quenched and tempered UNI EN 10250-2: 2001								
size d / t		Testing at room temperature (longitudinal)						
mm		R	Re ^{c)}	A%	A%	Kv	Kv	HB
from	to	N/mm ² min	N/mm ² min	min (L)	min (T)	J min (L)	J min (T)	min
	100/70	750	450	14				225
100/70	250/160	690	390	15	10			210
250/160	500/330	670	350	14	9			203

L = longitudinal T = tangential

^{c)} Re upper yield strength or, if no yield phenomenon occurs, Rp ^{0.2} has to be considered

d = diameter t = thickness

ISO 683-1: 2018 Jominy test HRC grain size 5 min.																	
mm distance from quenched end																	
	1	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30	H
min	60	57	50	39	35	33	32	31	30	29	28	27	26	25	23	21	normal
max	67	66	65	63	62	59	54	47	39	37	36	35	34	33	31	30	

EUROPE	ITALY	CHINA	GERMANY	FRANCE	U.K.	RUSSIA	USA
EN	UNI	GB	DIN	AFNOR	B.S.	GOST	AISI/SAE
C60E	C60	60	Ck60		070M60	60	1060