Chemical composition and deoxidation practice

Grade	A	B	D	E
Deoxidation Any method (for rimmed steel, see Note 1)	For t ≤ 50 mm: Any method except rimmed steel	For t < 50 mm: Killed	For t < 25 mm: grain treated with aluminium	Killed and fine
For t < 50 mm: Killed	For t < 50 mm: Killed	For t < 25 mm: Killed and fine gain treated with aluminium		
Chemical composition %				
Carbon	0,21 max. (see Note 3)	0,21 max.	0,21 max.	0,018 max.
Manganese	2,5 x C% min.	0,80 min (see Note 3)	0,60 min.	0,70 min.
Silicon	0,50 max.	0,35 max.	0,10 – 0,35	0,10 – 0,35
Sulphur	0,035 max.	0,035 max.	0,035 max.	0,035 max
Phosphorus	0,035 max.	0,035 max.	0,035 max.	0,035 max
Aluminium (acid soluble)	-	-	0,015 min. (see Note 4)	0,015 min. (see Note 4)
Carbon + ¼ of the manganese content is not to exceed 0,40%				

NOTES

(1) For Grade A, rimmed steel may be accepted up to 12,5mm thick inclusive, provided that it is stated on the test certificates or shipping statements to be rimmed steel and is not excluded by the purchaser's order.

(2) The maximum carbon content for Grade A steel may be increased to 0,23% for sections.

(3) Where Grade B is impact tested the minimum manganese content may be reduced to 0,60%.

(4) The total aluminium content may be determined instead of the acid soluble content. In such cases the total aluminium content is to be not less than 0,020%.

(5) Where additions of any other elements are made as part of the steelmaking practice, the content is to be recorded.

Mechanical properties for acceptance purposes (see Note 1)

Grade	Yield Stress N/mm² minimum	Tensile Strength N/mm²	Elongation on 5,65 $\sqrt{S_0}$ % minimum	Charpy V-notch impact test (longitudinal)		
				Thickness mm	Average energy J minimum	
					Longitudinal	Transverse (See Note 3)
A	235	400 – 520 (see Note 1) m	22 (see Note 2)	-	-	-
B				≤ 50	27	20
D				> 50 ≤ 70	34	24
E				> 70 ≤ 100	41	27

Impact tests are to be made on the various grades at the following temperatures:

A grade 20°C
B grade 0°C
C grade -20°C
D grade -40°C

NOTES

(1) Requirements for products over 50mm thick in Grades A, B and D and 100mm thick in Grade E are subject to agreement. See 2.1.1.

(2) For full thickness tensile test specimens with a width of 25mm and a gauge length of 200mm (see Fig. 2.2.4 in Chapter 2), the minimum elongation is to be:

Thickness mm		**>5**	**>10**	**>15**	**>20**	**>25**	**>30**	**>35**
	≤5	**≤10**	**≤15**	**≤20**	**≤25**	**≤30**	**≤35**	**≤50**
Elongation %	14	16	17	18	19	20	21	22

(3) Generally, tests need only be made in the longitudinal direction. For special applications, transverse test specimens may be required by the purchaser of LR. Transverse test results are to be guaranteed by the supplier.

(4) Impact tests are not required for Grade A material up to 50mm thick, nor for thicknesses above 50mm when the material is produced using a fine grained practice and is also normalized or thermomechanically controlled rolled.

(5) Impact tests are generally not required for Grade B steel of 25mm or less in thickness. However, the manufacturer should confirm, by way of regular in-house tests, and on occasional material selected by the Surveyor, that the material meets the above requirement. These results shall be reported to the Surveyor. The frequency of the in-house checks, should as a minimum, be every 250 tonnes.

Chemical composition

Strength Levels	32, 36, 40		42, 46, 50, 55, 62, 69	
Grades	**AH,DH, EH**	**FH**	**DH, EH**	**FH**
Carbon % max.	0,18	0,16	0,20	0,18
Manganese %	0,9 – 1,60 (see Note 1)	0,9 – 1,60	1,70 max.	1,60 max.
Silicon % max.	0,50	0,50	0,55	0,55
Phosphorous % max. (see Note 2)	0,035	0,025	0,035	0,025
Sulphur % max. (see Note 2)	0,030	0,025	0,030	0,025
Grain refining elements (see Note 3)				
Aluminium (acid soluble) %	0,015 min. (see Note 3)			
Niobium %	0,02 – 0,05			
Vanadium %				
Titanium %	0,02 max.			
Total (Nb + V + Ti) % (see Note 6)	0,12 max.			
Residual elements				
Nickel % max.	0,40	0,80	to comply with the	
Copper % max.	0,35	0,35	approved specification	
Chromium % max.	0,20	0,20		
Molybdenum % max.	0,08	0,08		

NOTES

(1) For AH grade steels in all strength levels and thicknesses up to 12,5mm, the specified minimum manganese content is 0,70%.

(2) The steel is to contain aluminium, niobium, vanadium or other suitable grain refining elements, either singly or in any combination.

When used singly, the steel is to contain the specified minimum content of the grain refining element. When used in combination, the specified minimum content of each element is not applicable.

(3) The total aluminium content may be determined instead of the acid soluble content. In such cases the total aluminium content is not to be less than 0,020%.

(4) Alloying elements other than those listed above are to be included in the approved manufacturing specification.

(5) The grain refining elements are to be in accordance with the approved composition.

Mechanical properties for acceptance purposes –
(See note 1)

Grade	Yield Stress N/mm² min.	Tensile Strength N/mm²	Elongation On 5,65 $\sqrt{S_o}$ % min. (see Note 2)	Charpy V-notch impact tests Average energy J minimum					
				t ≤50 mm		50 < t ≤70 mm		70 < t ≤100 mm	
				Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
AH 32 DH 32 EH 32 FH 32	315	440-590	22	31	22	38	26	46	31
AH 36 DH 36 EH 36 FH 36	355	490-620	21	34	24	41	27	50	34
AH 40 DH 40 EH 40 FH 40	390	510-650	20	41	27	-	-	-	-

Impact tests are to be made on the various grades at the following temperatures

AH grades 0°C
DH grades -20°C
EH grades -40°C
FH grades -60°C

NOTES

(1) The requirements for products thicker than those detailed in the Table are subject to agreement.
(2) For full thickness tensile test specimens with a width of 25mm and a gauge length of 200mm, the minimum elongation is to be:

Thickness mm		<5	>5 <10	>10 <15	>15 <20	>20 <25	>25 <30	>30 <40	>40 <50	>50
Elongation %	Strength level 32	14	16	17	18	19	20	21	22	to be specially agreed
	Strength level 36	13	15	16	17	18	19	20	21	
	Strength level 40	12	14	15	16	17	18	19	20	

(3) In the case of FH grades, the requirements of this Table apply only up to a maximum thickness of 50mm.