Specification of Anode/Cathode Steels and Anode Yokes/Extensions for primary Aluminium Smelters.

Technical specification:

1. Material

1.1 Steel produced by open-hearth furnace. Hot rolled bars of «Low Resistance Steel» (LRS) grade: S235JRG2 (235), HMR235, HMR10, S235JRG2mod (235), C37, SAE1015mod (1015), S275J2G3 (275). The name of steel indicated in brackets only for hot stamping.
1.2 Chemical analysis of the melt and allowed deviation of the piece analysis:
1.2.1 For quality S275J2G3 – accordingly to requirements of EN10025.
1.2.2 For qualities S235JRG2, HMR235, HMR10, S235JRG2mod, C37, SAE 1015mod – accordingly to the Tables No.1 & 2 (in the Appendix No.1, 2).
1.3 Macrostructure of rolled bars isn't controlled.
1.4 Mechanical properties:
The Producer has to determined mechanical properties as elongation (Re, Rm, A).
1.4.1 Mechanical properties should be determined on samples which taken from longitudinal thermally treated bars in diameter 25 mm.

Elongation test are to be made at normal temperature.

Remarks
For qualities S235JRG2, S235JRG2mod, S275J2G3 – the Producer has to determined impact value test (KV t˚C) on the sharply samples at the temperature :
for qualities S235JRG2, S235JRG2mod - +20˚C (KV +20˚C)
for quality S275J2G3 -20˚C (KV -20˚C).

1.4.2 Regime of thermal treatment of samples has to be determined by producer.
1.4.3 Mechanical properties aren't ordered.
1.4.4 Results of testing should be indicated in Mill's Certificate with regime of thermal treating and diameter of sample.

2. Anode Steel Bars:

2.1 Hot rolled round bars with tolerance as per DIN 1013.

Diameter, mm	Tolerance per size, mm	Cutting (length×number), mm
110	+/-2.0	L=(5530+50)×7
110	+/-2.0	L=(6000+50)×6+(3530+100)×1
120	+/-2.0	L=(5535+50)×6
120	+/-2.0	L=(6000+50)×5+(3170+100)×1
125	+/-2.0	L=(6000+50)×5
125	+/-2.0	L=(6050+50)×5
128	+/-2.0	L=(5800+50)×5
130	+/-2.0	L=(6000+50)×4+(4300+100)×1
140	+/-2.0	L=(6000+50)×4
145	+/-2.0	L=(5800+50)×3+(5300+100)×1
145	+/-2.0	L=(5690+50)×4
150	+/-2.0	L=(5900+100)×3+(3500+200)×1
160	+/-2.0	L=(6000+50)×3
170	+/-2.5	L=(5520+50)×3
170	+/-2.5	L=(5760+50)×2+(5040+100)×1
180	+/-2.5	L=(4900+50)×3

Difference between maximum and minimum size in one section has to be max 80% from sum of the allowed limiting deviations per diameter.
Concrete length must be indicated in customer's order.
Min and max length must be in range of length's tolerance.
Measuring of the dimensions is carried out on the distance min 150 mm from the end of the bars.
Deviations of straightness – max 2.5 mm per meter. For rounds 160, 170, 180 mm in diameter – max 5 per meter. Total deviation of straightness shall not exceed the multiply of allowed deviation per meter and full length of bar (in meter).

2.2 Cutting by the saw. Allowed burrs max 6 mm. Bevel from sawing are not controlled.
2.3 Quality of surface:
On surface are not allowed only rough breaks with visual non-metallic inclusions in overall dimensions more than 50 mm in any direction.

3. Cathode Steel Bars:

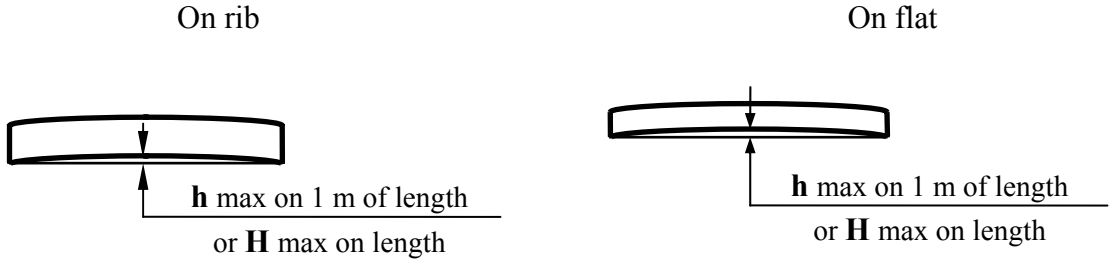
3. Size range

3.1. Hot rolled Flat bars.

Width, mm	Thickness, mm	Radius of corners, mm	Length , Tolerance, mm		Theoretical weight of 1 m, kg
160±2.5	70 +2.0/-3.0	15 +5	1854	-0/+20	85.7
165±2.5	70 ±2.0	max 15	2237	-2/+3	90.1
165±2.5	80±2.0	max 15	2015	-2/+3	103.0
170 –5/+2	60 -1/+2	9	2270	±10	79.5
170 –5/+2	60 -1/+2	9	2070	±10	79.5
170±3	60±2	9	2085	-0/+10	79.5
170±3	60±2	9	2195	-0/+10	79.5
170±3.5	60±2.5	9	2200	-0/+20	79.5
170±3	60±2	9	2250	-0/+10	79.5
180±3.5	65±2.5	9	4500	-0/+20	91.3
180±3.5	65±2.5	9	2380	-0/+10	91.3
180±3.5	65±2.5	9	3944	-0/+10	91.3
180±3.5	80±2.5	9	2200	-0/+10	112.5
180±3.5	80±2.5	9	2350	-0/+10	112.5
180±3.5	80±2.5	9	(4510+20)×5+(3620+20)×1		112.5
180±3.5	90±2.5	9	(4800+20)×4+(4050+100)×1		126.6
190±3.0	80±2.0	9	2000	-0/+20	118.8
220±4.0	90±2.0	10 -1/+5	1920	-0/+20	154.8
220±4.0	90±2.0	10 -1/+5	2050	-0/+20	154.8

Radius of curvature is provided with the tools and on hire is not controlled. The bevels in corners of section of profile are not allowed.
Rounding corners are allowed to make by abrasive cleaning.
Concrete length must be indicated in customer's order.
Min and max length must be in range of length's tolerance.
Measuring of the dimension carry out on the distance min 150 mm from the end of the bars.
Curvature of rectangular profiles hire - see Figure 1 and 2.
Method of measurement of curvature of rectangular hire - see Figure 1.

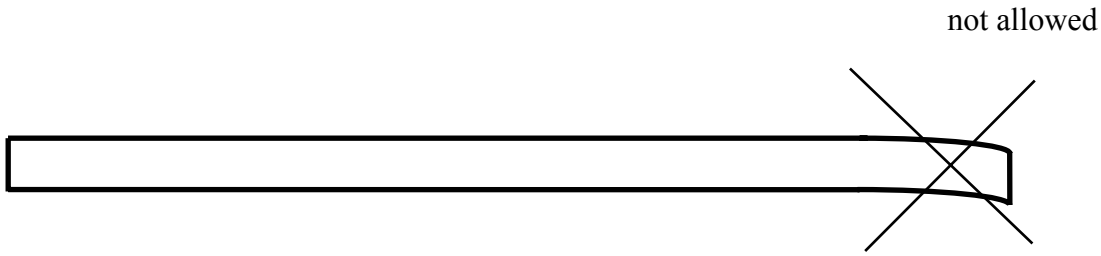
Figure 1.



Curvature on flat and rib: for 30% of flat bars – 5 mm per length of 1 meter; for 70% of flat bars – 5 mm on whole length and 2 mm on length of 1 m.

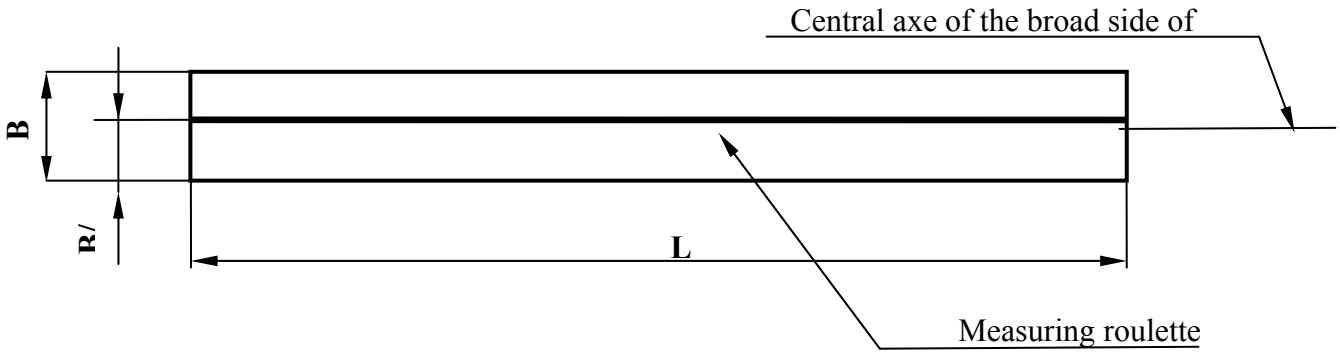
3.2. The sharp deviation from the form on the ends of bars is not allowed – see Figure 2.

Figure 2.



The visible torsion of flat bars is not allowed.
Determination of availability of torsion is visually
Method of measurement of length of flat bar – see Figure 3.

Figure 3.



The control of the length of flat bar is made on center of the broad side of flat bar. Accuracy of measurement +/-1 mm.
Length on all four surface should be within the limits of the tolerance.
L – controlled size of length of flat bar;
B – size of the broad side of flat bar.

3.3. Cutting by the saw. Allowed burrs max 6 mm. Bevel from sawing are not controlled.

3.4. Cutting of flats in cross-section 165x70x2237, 165x80x2015, 170x60x2085, 170x60x2195, 170x60x2250, 190x80x2000, 220x90x1920, 220x90x2050 mm are to be made in cold condition by mechanical way.

3.5. Quality of a surface:
On surface aren't allowed only rough breaks with visual non-metallic inclusions in overall dimensions more than 50 mm in any direction.

4. Anode Yokes/Extensions:

4.1. Type: welded 3-4-6 nipples constructions according to Customer's drawing.

4.2. Material: according to point №1 of this Specification.

5. Packing of Anode Bars:

5.1. Anode Steel Bars are supplied in bundles, strapped with strong wire at 3 different places over the whole bundle. Weight of the bundle is not more than 4 MT. Material is supplied with calculated weight, defined by multiply of theoretical weight of one meter on the length of bars in meter with the tolerance on a cutting. The form of the bundle is in mills option. Length of bars in each bundle must be the same. The difference between ends in bundle max 200 mm.

Remarks

1) Bundle weight can be changed in accordance with customer's order.
2) Spots from atmosphere corrosion, snow, and ice on the surface of HR bars and wire-rods can't be reason for rejection.
3) Sling of bundle can't be done for the strapped wire.

5.2. Cathode Steel Bars are supplied on wooden blocks are packed according to Customer's drawing.

6. Packing of Cathode Bars:

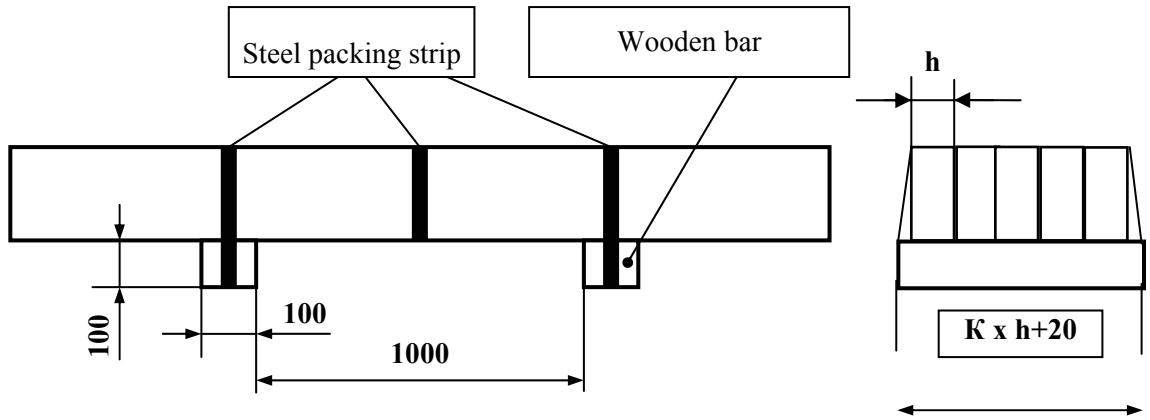
6.1. Material is supplied in bundles, strapped with strong wire at 3 different places over the whole bundle. Weight of the bundle not more than 3 mt. Material is supplied with calculated weight, defined by multiply of theoretical weight of one meter on the length of bars in meter with the tolerance on a cutting. The form of the bundle is in mills option. Length of bars in each bundle must be the same. The difference between ends in bundle max 200 mm.

***Remarks*.**

1) Bundle weight can be changed in accordance with customer's order.
2) Spots from atmosphere corrosion snow and ice on the surface of HR bars and wire-rods can't be reason for rejecting.
3) Sling of bundle can't be done for the strapped wire.

6.2. Flats in cross-section 165x70x2237, 165x80x2015, 170x60x2085, 170x60x2195, 170x60 x2250, 190x80x2000, 220x90x1920, 220x90x2050 mm are to be packed in accordance with attached drawings:

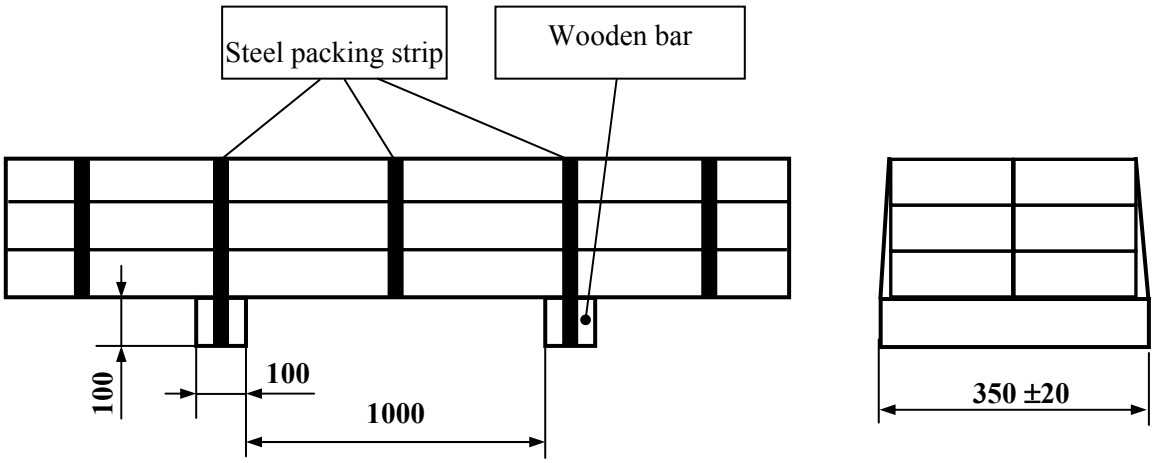
Packing of flats 220×90×1920, 220×90×2050 & 190×80×2000 mm



Number of bars packed in one bundle (K):
5 pieces – for flat 220×90×1920 mm
5 pieces – for flat 220×90×2050 mm
6 pieces – for flat 190×80×2000 mm.

Remark: Accepted to pack in bundle min 3 (three) pieces.

Packing of flats 165×70×2237, 165×80×2015 170×60×2085, 170×60×2195, 170×60×2250 mm



Remark: Accepted to pack in bundle min 2 (two) pieces.

7. Marking

7.1 Tags. Min 2 metal tags per bundle with following information:
- Mark
- Size: …mm
- Melt No.: ….
- No. of pieces …
- Bundle weight: …., kgs

Additional information for each lot, which must be indicated in tags, is shown in the customer's inquiry. Tags are fastened to the bundle by wire-rods.

7.1.1 The information in tags can be shown by self-sticking labels of size not less than 50*50 mm.

7.2 Color marking
Color marking of hot rolled bars by paint. Top ends free of hot stamping are to be marked by unwashed paint. Color of paint depends on diameter:

Round bar 128 mm – green
Round bar 130 mm – red
Round bar 140 mm – black
Round bar 180 mm – yellow
For other HR round bars material can be color marked on the top side of all bars (without hot stamping) with one of following color (in accordance with catalogue of "Tikkurila"):

RAL1018 Yellow	RAL2003 Orange	RAL3017 Pink
RAL3020 Red	RAL3027 Crimson	RAL4005 Lilac
RAL4008 Violet	RAL5012 Light Blue	RAL5017 Blue
RAL6024 Green	RAL7004 Grey	RAL8004 Brown
RAL9003 White	RAL9004 Black	RAL9006 Silver

Painted top ends are to be oriented in one side.

7.3 Hot stamping
Hot rolled round bars of diameter more than 110 mm should be hot stamped. Contents of hot stamp: steel grade, size, No. of melt. Location of parameters is not determined. Bars from the head end are marked by letter "A". Stamping in cold condition is accepted.
7.4 It's allowed to mark some bars (with information acc. to the item 6.3) by self-sticking labels. Information on the labels is to be written by unwashed paint. On the top after mechanical cutting one label in size 20*60 mm must be stuck instead of stamping by hit method. In the bundle top ends marked by labels are to be oriented in one side.

8. Mill's Certificate
Material has to be supplied with a mill's certificate per each steel grade and each melt, as per EN 10204-3.1.B and contents of:

- Steel grade
- Melt No.
- Size
- Results of chemical analysis
- Results of mechanical testing
- Weight per lot
- Number of pieces
- Manufacturer's name
- Customer's name

9. Delivery
At shipment of hire the deviation on weight from the ordered consignment: +10% is allowed; the shortage is not allowed. The deviation on weight from the ordered consignment can be changed in accordance with customer's order.

APPENDIX No.1
to the SPECIFICATION

Table No.1

Chemical composition by ladle sample:
(in % per weight):

		C37	SAE1015mod (1015)
Carbon	C	0,08 - 0,16	0.13 – 0.18
Silicon	Si	0.10 - 0.30	max 0.40
Manganese	Mn	0,25 – 0,70	0.30 – 0.60
Phosphorus	P	max 0,045	max 0.030
Sulfur	S	max 0,050	max 0.035
Chrome	Cr	max 0,35	max 0.30
Nickel	Ni	max 0,35	max 0.30
Copper	Cu	max 0,40	max 0.30
Molybdenum	Mo	-------	max 0.06
Wolframium	W	-------	max 0.06
Vanadium	V	-------	max 0.05
Titan	Ti	-------	max 0.03
Aluminium	Al	-------	0.020 – 0.070

Table No.2

Allowed deviation of the piece analysis:
(in % per weight)

		C37	SAE1015mod (1015)
Carbon	C	+0.01/-0.02	± 0.02
Silicon	Si	+ 0,05/-0.03	+ 0.05
Manganese	Mn	+0.03/-0.02	± 0.03
Phosphorus	P	+ 0,005	+ 0.005
Sulfur	S	+ 0,005	+ 0.005
Aluminium		-------	± 0.005

APPENDIX No.2
to the SPECIFICATION

Table No.1

Chemical composition by ladle sample:
(in % per weight):

		S235JRG2 (235)	Elstahl 10 (ES10)	S235JRG2 mod (235)	Elstahl 235 (ES235)
Carbon	C	max 0.20	max 0.15	max 0.20	0.14-0.20
Silicon	Si	max 0.40	max 0.30	max 0.40	Max 0.30
Manganese	Mn	max 1.40	0.25 – 0.50	max 0.60	0.25-0.50
Phosphorus	P	max 0.045	max 0.040	max 0.045	max 0.050
Sulfur	S	max 0.045	max 0.035	max 0.045	max 0.035
Chrome	Cr	max 0.30	max 0.30	max 0.30	Max 0.30
Nickel	Ni	max 0.30	max 0.30	max 0.30	Max 0.30
Copper	Cu	max 0.30	max 0.30	max 0.30	Max 0.30
Molybdenum	Mo	max 0.06	max 0.06	max 0.06	Max 0.06
Wolframium	W	max 0.06	max 0.06	max 0.06	Max 0.06
Vanadium	V	max 0.05	max 0.05	max 0.05	Max 0.05
Titan	Ti	max 0.05	max 0.03	max 0.03	Max 0.03
Nitrite	N	See table No.2 and Remarks No. 1 - 3			

Table No.2

Allowed contents of elements in the piece analysis:
(in % per weight)

		S235JRG2 (235)	Elstahl 10 (ES10)	S235JRG2 mod (235)	Elstahl 235 (ES235)
Carbon	C	max 0.22	max 0.17	max 0.22	0.12-0.22
Silicon	Si	max 0.45	max 0.35	max 0.45	Max 0.35
Manganese	Mn	max 1.50	0.21 – 0.54	max 0.64	0.21-0.54
Phosphorus	P	max 0.050	max 0.045	max 0.050	max 0.055
Sulfur	S	max 0.050	max 0.040	max 0.050	max 0.040
Nitrite	N	max 0.012	max 0.012	max 0.012	---

Remarks:

1. For chemical analysis in finished bars the contents of nitrogen doesn't order, if contents of aluminum is $Al_{total} \geq 0{,}020\%$. In this case contents of aluminum should be indicated in a Mill's Certificate.

2. In case of contents of aluminum $Al_{total} < 0{,}02\%$ contents of nitrogen in finished bars as per Table No.2 and remark No.3 guaranteed by producer's technology, don't order by analysis and don't include in a Mill's Certificate.

3. For chemical analysis in finished bars is accepted exceeding of ordered contents of nitrogen only in case when on each 0,001%N above ordered value, contents of phosphor should be decreasing on 0,005% from its limited value. However, contents of nitrogen couldn't be more than 0,014%.