

rev.	by	description	checked	date	scanned
U	SRD	Added:BE.03 Updated all material designations		DEC '05	
V	SRD	Modif: BE.06	EYK	NOV '08	
W	SRD	Revised as indicated	EYK	JAN '09	Gescand

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prepared by SRD	date DEC '08	pertaining drawings	project GENERAL SPECIFICATION
checked by EYK	date FEB '09	SPECIFICATION FOR MATERIALS OF CONSTRUCTION	
seen by MEE	date FEB '09		
		size	18005
revision	W	A4	

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1 SCOPE

This specification details the requirements that are specified by means of material designations stated in Stamicarbon's P&I diagrams, data sheets and other documents.

The material designations stated in the P&I diagrams, data sheets and other documents are determined solely on the basis of process considerations, i.e. the corrosion and erosion properties of materials in relation to the process media handled. The mechanical requirements and properties of the materials are not taken into consideration in this specification; nor is this specification intended to be a substitute for any industrial standard, code or statutory regulations.

Where materials in Group A are intended to be used for low temperature service, they shall be checked for compliance with the relevant local rules or codes with respect to their low temperature performance.

This specification does not cover metallic gasket materials unless specifically indicated.

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2 GENERAL

2.1 This specification is based on the present state of the art and may be changed without notice due to developments in technology.

Also, supplements to this specification may be issued.

At the commencement of each project the user of this specification and Stamicarbon shall agree and lay down which issue of this specification and which supplements, if any, shall prevail for the project.

2.2 The MS (Material Specification) sheets shall be used in conjunction with the relevant Material Designation sheets.

2.2.1 All wrought and cast materials in Group B shall generally meet the requirements of the material specifications throughout the full material thickness after final heat treatment.



2.2.2 Overlay welds and clad materials in Group B shall have a thickness of 8 mm and shall meet the requirements of the material specifications over a thickness of at least 3 mm measured from the lowest point of the surface on the product side after final heat treatment and/or machining.

2.2.3 Overlay-welded flange facings of materials in Group B shall meet the requirements of the material specification over a thickness of at least 6 mm after final heat treatment and machining shall meet the requirements of the material specification. This is to enable re-machining.

2.2.4 The thickness of overlay welds on the tubesheet of the Pool Condenser / Pool Reactor of materials in Group B shall be 12 mm, measured from the lowest point of the surface after machining the weld preparation. At least the final 3 mm, measured from the lowest point of the surface (weld preparation) shall meet the requirements of the material specification.

2.3 Machining or grinding of final welded surfaces to improve the weld appearance is not allowed unless otherwise specified or after permission of client/contractor. Oxide layers from e.g. welding or annealing of stainless steels should be removed.

2.4 Where the ferrite content is specified for BC materials it shall be measured.

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Stamicarbon bv, P.O. Box 53, 6160 AB Geleen, The Netherlands

Up to a content of 30 %: by means of a calibrated 'Ferrite-scope' type MP3B-GAB 1.3.

From 30 % up to 70 %: by point counting in accordance with ASTM E 562.

A measuring tolerance up to 5 % (relative) can be allowed for point counting.

The 'Ferrite-scope' is manufactured by:

Messrs. Helmut Fischer GmbH & Co.

D7032 Sindelfingen 6 (Maichingen)

Germany

2.5 The materials mentioned in the Material Specification sheets shall comply with the European (EN) Standards or ASTM specifications, except that the chemical composition stated in the Stamicarbon material specification shall overrule. The allowable deviations from the product analysis stated in the Stamicarbon MS sheets shall be within the limits of the relevant European (EN) Standards or ASTM specifications except where otherwise specified.

2.6 Welding shall be carried out in accordance with the state of the art. The corrosion resistance of welds and heat-affected zones after the last heat input (e.g. final heat treatment, if necessary) shall meet that of the base material.

2.7 If quality tests are to be carried out, sampling shall take place in accordance with the Stamicarbon specifications or in consultation with Stamicarbon.

2.8 "Wrought materials" as used here shall be taken to include forged materials.

2.9 Cold deformation of materials in Group B shall not exceed 15 %. If more, quench annealing is mandatory.

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3 SYSTEM OF DESIGNATION

Carbon steels. Group A

This group consists of the following subgroups:

AA = Carbon steels.

This subgroup comprises the following material designations:

AA.01

Corrosion resistant metals and alloys. Group B

This group consists of the following subgroups:

BB = high FeCrNi austenitic alloys

BC = high FeCrNiMo austenitic alloys

BD = high FeCrNiMoCu austenitic alloys

BE = high FeCrNiMo(Cu) ferritic-austenitic alloys

BF = high Ni(Mo)Cr(Fe) austenitic alloys

BG = titanium

BK = aluminium

These subgroups comprise the following material designations:

BB.01 BC.01 BD.06 BE.01 BF.01 BG.01 BK.01

BB.03 BC.02 BE.02 BG.02

BB.04 BC.03 BE.03

BB.06 BC.05 BE.04

BB.08 BC.09 BE.05

BB.09 BC.10 BE.06

Corrosion resistant non-metals. Group C

Deleted

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Coating materials. Group D

This group consists of the following subgroups:

DA = coated carbon steels.

This subgroup comprises the following material designations:

DA.05

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4 MATERIAL DESIGNATIONS

Material designation AA.01

AA.01 designated material covers a large group of non-alloy and low-alloy carbon steels.

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

Note

Apart from a normal corrosion allowance by contractor, no special process, corrosion or erosion demands are made for this group of materials, unless otherwise specified.

For low temperature service see Scope.

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Material designation BB.01

For acceptable materials, see:



MS.16* MS.16 C*

MS.17 MS.17 C

MS.18

MS.19 MS.19 C

MS.25

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

Titanium bearing stainless steels as per MS.18 shall be welded using Niobium stabilized welding consumables.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

* Any materials in MS.16 and MS.16 C which are designated BB.01 shall only be used in quench-annealed condition, which means that they shall be quench-annealed after welding or hot forming.

For MS.18 materials it is particularly important to meet the requirements of general point 2.7.

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Material designation BB.03

For acceptable materials, see:

MS.16 MS.16 C

Also acceptable are all similar stainless steels.

For shafts, rods, etc., steel containing 17% Cr. Or over, such as precipitation hardening steels is acceptable too.

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

Note

BB.03 materials are intended for non-corrosive process areas where cleanliness of process fluids is essential.

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Material designation BB.04

For acceptable materials, see:

MS.17 MS.15 C

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

The materials shall be Huey-tested* in accordance with ISO 3651/I or ASTM A 262 practice C and shall meet the following requirements:

- The average value of the overall attack for 5 boiling periods of 48 hours each shall not exceed 0.32 gr/m² hr (2 μm/48 hr).
- The penetration of selective attack as determined by microscopic examination after the Huey test shall nowhere exceed 75 μm, in any direction

The materials as per MS.17 shall be sensitized before testing at 675 °C for 30 minutes.

* Performance of the Huey test with a multi-sample testing apparatus is not allowed.

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Material designation BB.06

For acceptable materials, see:

MS.17 MS.17 C

Weld filler metal shall be compatible, with the selected material and comply with the relevant AWS (American Welding Society) specifications.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

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Material designation BB.08

For acceptable materials, see:

MS.18

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

Titanium bearing stainless steel as per MS.18 shall be welded using Niobium stabilized welding consumables.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

For MS.18 materials it is particularly important to meet the requirements of general point 2.7.

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Material designation BB.09



For acceptable materials, see:

MS.25 MS.17C

Weld filler metal shall be compatible, with the selected material and comply with the relevant AWS (American Welding Society) specifications.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

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Material designation BC.01

For acceptable materials, see:
MS.26

1. Weld metals

1.1. Weld metal for overlay and connection welds.

All deposited weld metal shall after final heat treatment, if any, have a fully austenitic structure (max. ferrite content 0.6 %) with the following composition (% wt):

C max. 0.045 Cr min. 17.0 Ni min. 14.0 Mo 2.20-3.00 Mn min. 3.00.

1.2. Weld metal for connection welds only.

Deposited weld metal shall after final heat treatment, if any, have a fully austenitic structure (max. ferrite content 0.6 %) with the following composition (% wt):

C max. 0.030, Cr. min. 17.0, Ni min. 13.0, Mo 2.20-3.00

Deposits with a composition as mentioned under point 1 of designation BC.05 are also acceptable.

2. Huey test

The materials shall be Huey-tested in accordance with Stamicarbon specification 53961 and shall meet the following requirements:

The average value of the overall attack for 5 boiling periods of 48 hours each shall not exceed 0.54 gr/m² hr (3.3 μm/48 hr).

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3. Selective attack.

The penetration of selective attack as determined by microscopic examination after the Huey test shall not exceed

- for wrought materials, including heat affected zones: 70 µm perpendicularly to, and 200 µm in to the direction of, rolling or forging.
- for weld deposits: 200 µm

Note

Where material according to BC.01 is required, also material according to BC.05 or BE.06 may be allowed. Stamicarbon to be consulted.

Specification for materials of construction	GENERAL SPECIFICATION	
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Material designation BC.02

For acceptable materials, see:

MS.26 MS.29 C

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

1.0. Weld metals

1.1. Weld metal for overlay and connection welds.

All deposited weld metal shall after final heat treatment, if any, have a fully austenitic structure (max. ferrite content 1 %) with the following composition (% wt):

C max. 0.045, Cr min. 17.0, Ni min. 14.0, Mo 2.20-3.00, Mn min. 3.0

1.2. Weld metal for connection welds only.

Deposited weld metal shall after final heat treatment, if any, have a fully austenitic structure (max. ferrite content 2 %) with the following composition (% wt):

C max. 0.030, Cr. min. 17.0, Ni min. 13.0, Mo 2.20-3.00

For deposited weld metal also the materials designated BC.01 or BC.05 may be used.

Note

Where material according to BC.02 is required, also material according to BC.01, BC.05 or BE.06 may be allowed. Stamicarbon to be consulted.

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Material designation BC.03

For acceptable materials, see:

MS.29 MS.29 C

MS.30 MS.30 C

MS.32* MS.32 C*

MS.33

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

Titanium bearing stainless steels as per MS.33 shall be welded using Niobium stabilized welding consumables.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

* Any materials in MS.32 and MS.32 C which are designated BC.03 shall only be used in quench-annealed condition, which means that they shall be quench-annealed after welding or hot forming.

For MS.33 materials it is particularly important to meet the requirements of general point 2.7.

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Material designation BC.05

For acceptable materials, see:

MS.34

1. Weld metals

Weld metal for overlay and connection welds.

All deposited weld metal shall after final heat treatment, if any, have a fully austenitic structure (max. ferrite content 0.6 %) with the following composition (% wt):

C max. 0.040, Cr min. 24.0, Ni min. 21.0, Mo 1.90-2.70, Mn min. 3.00

2. Huey test

The materials shall be Huey-tested in accordance with Stamicarbon specification 53961 and shall meet the following requirements:

The average value of the overall attack for 5 boiling periods of 48 hours each, shall not exceed 0.16 gr/m² hr (1 µm/48 hr).

3. Selective attack

The penetration of selective attack as determined by microscopic examination after the Huey test shall nowhere exceed 70 µm, in any direction

Note 1.

Solidification defects in overlay welds are acceptable up to a depth of 100 µm.

Note 2.



Where material according to BC.05 is required, also material according to BE.06 may be allowed. Stamicarbon to be consulted.

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Material designation BC.09

For acceptable materials, see:

- MS.29 C
- MS.30 MS.30 C
- MS.32* S.32 C*
- MS.33
- MS.39

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

Titanium bearing stainless steels as per MS.33 shall be welded using Niobium stabilized welding consumables.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

* Any materials in MS.32 and MS.32 C which are designated BC.09 shall only be used in quench-annealed condition, which means that they shall be quench-annealed after welding or hot forming.

For MS.33 materials it is particularly important to meet the requirements of general point 2.7.

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Material designation BC.10

For acceptable materials, see:

MS.36

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

A forging ratio of at least 1:2.5 shall be applied for all sides.

The materials shall not contain slag inclusions larger than 0.2 mm.

Note

Where material according to BC.10 is required, also material according to BE.06 may be allowed.

Stamicarbon to be consulted.

Specification for materials of construction	GENERAL SPECIFICATION	
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Material designation BD.06

For acceptable materials, see:

MS.45

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

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Material designation BE.01

For acceptable materials, see:

MS.46

MS.47 MS.47 C

1. Weld metals

Weld filler metal shall be matching with the selected material.

To guarantee an appropriate ferrite-austenite balance (ferrite content 30-70 % vol.) in the deposited weld metal, the nickel content of the weld filler metal shall be higher than that of the base material.

The ferrite content in the heat affected zone of the weld shall be 30-70 %.

2. Streicher test

The material shall be Streicher-tested in accordance with ASTM Designation: A262 practice B "Ferric Sulfate-Sulfuric Acid Test". The specimen must be exposed for 120 hours (calculated from the moment of boiling) to a Ferric Sulfate-50% Sulphuric acid solution and the loss of weight of the specimen is determined.

The loss of weight shall not exceed:

- 1.6 gr/m² hr. (10 μm/48 hr)

3. Selective attack

After the test the corrosion resistant steels are microscopically examined for selective attack, while also the microstructure will be examined to check for a proper ferrite-austenite balance by the point count procedure as mentioned in ASTM Designation E-562 and a check on secondary phases.

The penetration of selective attack as determined by microscopic examination after the Streicher test shall nowhere exceed 100 μm, in any direction.

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Material designation BE.02

For acceptable materials, see:

MS.47 MS.47C

Weld filler metal shall be compatible with the selected material.

To guarantee an appropriate ferrite-austenite balance (ferrite content 30-70 % vol.) in the deposited weld metal, the nickel content of the weld filler metal shall be higher than that of the base material.

The ferrite content in the heat affected zone of the weld shall be 30-70 %.

The material shall be Streicher-tested in accordance with ASTM A 262 practice B and shall meet the following requirements:

- The value of the overall attack in as-delivered and in the final heat-treated condition (e.g. welding) shall not exceed 0.9 gr/m² hr (6 μm/48 hr).
- The penetration of selective attack as determined by microscopic examination after the Streicher test shall nowhere exceed 100 μm, in any direction.

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Material designation BE.03

For acceptable materials, see:

MS.46

MS.47 MS.47 C

Weld filler metal shall be matching with the selected material.

To guarantee an appropriate ferrite-austenite balance (ferrite content 30-70 % vol.) in the deposited weld metal, the nickel content of the weld filler metal shall be higher than that of the base material.

The ferrite content in the heat affected zone of the weld shall be 30-70 %.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

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Material designation BE.04

For acceptable materials, see:

MS.47 MS.47C

Weld filler metal shall be compatible with the selected material.

To guarantee an appropriate ferrite-austenite balance (ferrite content 30-70 % vol.) in the deposited weld metal, the nickel content of the weld filler metal shall be higher than that of the base material.

The ferrite content in the heat affected zone of the weld shall be 30-70 %.

The materials shall not be susceptible to intergranular attack, therefore a Strauss test according to ISO 3651/II or ASTM A 262 practice E may be requested in case of doubt about the material quality.

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Material designation BE.05

For acceptable materials, see:

MS.48

Weld filler metal shall be matching with the selected material.

To guarantee an appropriate ferrite-austenite balance (ferrite content 30 -70 % vol.) in the deposited weld metal, the nickel content of the weld filler metal shall be higher than that of the base material.

The ferrite content in the heat affected zone of the weld shall be 30 -70 %.

The materials shall be Huey-tested* in accordance with ISO 3651/I or ASTM A 262 practice C and shall meet the following requirements:

- The average value of the overall attack for 5 boiling periods of 48 hours each shall not exceed 0.36 gr/m² hr (2 μm/48 hr).
- The penetration of selective attack as determined by microscopic examination after the Huey test shall nowhere exceed 70 μm, in any direction.

The materials shall be tested in as delivered and in the final heat treated condition (e.g. welding)

*Performance of the Huey test with multi-sample testing apparatus is not allowed.

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Material designation BE.06 (Safurex[®])

For acceptable materials, see:

MS.50

1. Weld metals

The chemical composition of the deposited weld metal may differ from the base material but shall be of a similar material type.

The ferrite content in the deposited weld metal and heat affected zone of the weld shall be 30-70 %.

Note:

BE.06 cannot be welded directly to BC.01. Stamicarbon has to be consulted.

2. Streicher test

The materials shall be Streicher-tested in accordance with Stamicarbon specification 71112 and shall meet the following requirements:

The value of the overall attack shall not exceed 0.7 gr/m² hr. (4.3 μm/48 hr)

3. Selective attack



The penetration of selective attack as determined by microscopic examination after the Streicher test shall nowhere exceed 100 μm, in any direction.

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Material designation BF.01

For acceptable materials, see:

MS.56

Weld filler metal shall be compatible with the selected material and comply with the relevant AWS (American Welding Society) specifications.

The material shall be tested by the ferric sulfate-sulfuric acid test for one 24 hour period in accordance with ASTM G 28 method A and shall meet the following requirement:

- The value of the overall attack as determined by the gravimetric method shall not exceed 8.0 gr/m² hr (50 μm/48 hr).

The materials shall be tested in as welded condition.

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Material designation BG.01

For acceptable materials, see:

MS.64

MS.65

MS.66

MS.67

Weld filler metal and welding procedure shall be compatible with the selected material.

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Material designation BG.02

For acceptable materials, see:

MS.68

Weld filler metal and welding procedure shall be compatible with the selected material.

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Material designation BK.01

For acceptable materials, see:

MS.80

MS.81

MS.82

Weld filler metal and welding procedure shall be compatible with the selected material.

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Material designation DA.05

For acceptable materials, see:

MS.98

DA.05 designated material covers a group of coating materials that may be applied to non-alloy or low-alloy carbon steels according to material designation AA.01.

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5 MATERIAL SPECIFICATIONS

5.1. M.S. sheets are only valid when used in combination with the relevant designation sheet.

5.2. Contents

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MS.19	MS.56
MS.19 C	MS.64
MS.25	MS.65
MS.26	MS.66
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MS.29 C	MS.68
MS.30	MS.80
MS.30 C	MS.81
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MS.32 C	
MS.33	
MS.34	
MS.36	MS.98

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Material Specification MS.15 C

All cast material shall have an austenitic structure (max. ferrite content 2 %) after final heat treatment at the foundry, with the following composition (% wt):

C max. 0.03, Cr 17.0-21.0, Ni 8.00-12.0, Si max. 2.00, Mn max. 1.50,
 P max. 0.045, S max. 0.040

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	CF3	-	J92500
	CF-3 / CF-3A	-	J92700
EN	GX2CrNi19-11	1.4309	-

This sheet shall be read in conjunction with BB.04

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Material Specification MS.16

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.08, Cr 17.0-20.0, Ni 8.00-13.0, Si max. 1.00, Mn max. 2.00,
 P max. 0.045, S max. 0.030

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	304	-	S30400
EN	X5CrNi18-10	1.4301	-
	X4CrNi18-12	1.4303	-

This sheet shall be read in conjunction with BB.01 or BB.03

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Material Specification MS.16 C

All cast material shall have an austenitic structure, after final heat treatment at the foundry, with the following composition (% wt):

C max. 0.08, Cr 18.0-21.0., Ni 8.00-11.0, Si max. 2.00, Mn max. 1.50,
 P max. 0.045, S max. 0.040

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	CF8 / CF8A	-	J92600
EN	GX5CrNi19-10	1.4308	-

This sheet shall be read in conjunction with BB.01 or BB.03

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Material Specification MS.17

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.030, Cr 17.0-20.0, Ni 10.0-12.5*, Si max. 1.00, Mn max. 2.00,
 P max. 0.045, S max. 0.030, N max. 0.22

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	304L	-	S30403
	304LN	-	S30453*
EN	X2CrNi19-11	1.4306	-
	X2CrNi18-10	1.4311*	-

* The nickel content of nitrogen-containing materials (i.e. N min 0.14 %) may be min. 8.0 %.



This sheet shall be read in conjunction with BB.01, BB.04 or BB.06

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.17 C

All cast material shall have an austenitic structure, after final heat treatment at the foundry, with the following composition (% wt):

C max. 0.03, Cr 17.0-21.0, Ni 8.00-12.0, Si max. 2.00, Mn max. 1.50,
 P max. 0.045, S max. 0.040

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	CF-3	-	J92500
	CF-3 / CF-3A	-	J92700
EN	GX2CrNi19-11	1.4309	-

This sheet shall be read in conjunction with BB.01, BB.06 or BB.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.18

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.08, Cr 17.0-20.0, Ni 9.00-13.0, Si max. 1.00, Mn max. 2.00,
 P max. 0.045, S max. 0.030, Ti min. 5 x C max. 0.80

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	TP321 / 321	-	S32100
EN	X6CrNiTi18-10	1.4541	-

This sheet shall be read in conjunction with BB.01 or BB.08

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.19

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.08, Cr 17.0-19.0, Ni 9.00-13.0, Si max. 1.00, Mn max. 2.00,
 P max. 0.045, S max. 0.030, Nb+Ta min. 10 x C max. 1.10

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	TP347 / 347	-	S34700
EN	X6CrNiNb18-10	1.4550	-

This sheet shall be read in conjunction with BB.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.19 C

All cast material shall have an austenitic structure, after final heat treatment at the foundry, with the following composition (% wt):

C max. 0.08, Cr 17.5-21.0, Ni 9.00-12.0, Si max. 2.00, Mn max. 2.00,
 P max. 0.045, S max. 0.040, Nb+Ta min. 8xC max. 1.0

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	CF8C	-	J92710
EN	GX5CrNiNb19-11	1.4552	-

This sheet shall be read in conjunction with BB.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.25

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.030, Cr 17.0-20.0, Ni 8.0-12.0, Si max. 1.00, Mn max. 2.00,
 P max. 0.045, S max. 0.030, N max. 0.22

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	304L	-	S30403
	304LN	-	S30453
EN	X2CrNi19-11	1.4306	-
	X2CrNi18-10	1.4311	-



This sheet shall be read in conjunction with BB.01 or BB.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.26

All wrought material shall have a fully austenitic structure (max. ferrite content 0.6 %) after final heat treatment at the mill with the following composition (% wt):

C max. 0.030, Cr 17.0-18.5, Ni 13.0-15.0, Mo 2.20-3.00, Si max. 1.00,
 Mn max. 2.00, P max. 0.045, S max. 0.030, N max. 0.22.

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	316L	-	S31603
	316LN*	-	S31653*
EN	X2CrNiMo17-12-2	1.4404	-
	X2CrNiMo17-12-3	1.4432	-
	X2CrNiMo18-14-3	1.4435	-
	X2CrNiMoN17-11-2	1.4406**	-
	X2CrNiMoN17-13-3	1.4429***	-

The nickel content of nitrogen-containing materials may be min. 11.0 % for:

- * i.e. N min. 0.10 %
- ** i.e. N min. 0.12 %
- *** i.e. N min. 0.14 %

This sheet shall be read in conjunction with BC.01 or BC.02

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.29

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.030, Cr 16.5-18.5, Ni 11.5-15.0, Mo 2.00-3.00, Si max. 1.00,
 Mn max. 2.00, P max. 0.045, S max. 0.030, N max. 0.20

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	316L	-	S31603
	316LN*	-	S31653*
EN	X2CrNiMo17-12-2	1.4404	-
	X2CrNiMo17-12-3	1.4432	-
	X2CrNiMo18-14-3	1.4435	-
	X2CrNiMoN17-11-2	1.4406**	-
	X2CrNiMoN17-13-3	1.4429***	-

Nickel content of nitrogen-containing materials may be min. 10.5 % for:

- * i.e. N min. 0.10 %
- ** i.e. N min. 0.12 %
- *** i.e. N min. 0.14 %

This sheet shall be read in conjunction with BC.03

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.29 C

All cast material shall have an austenitic structure (max. ferrite content 2 %) after final heat treatment at the foundry, with the following composition (% wt):

C max. 0.030, Cr 17.0-21.0, Ni 11.5-16.0, Mo 2.00-3.00, Si max. 1.50,
 Mn max. 1.50, P max. 0.040, S max. 0.030

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	CF3M	-	J92800
EN	GX2CrNiMo19-11-2	1.4409	-

This sheet shall be read in conjunction with BC.02, BC.03 or BC.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.30

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.08, Cr 16.5-19.0, Ni 11.5-14.0, Mo 2.00-3.00, Si max. 1.00,
 Mn max. 2.00, P max. 0.045, S max. 0.030, Nb + Ta min. 10 x C max. 1.00

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	316Cb	-	S31640
EN	X6CrNiMoNb17-12-2	1.4580	-

This sheet shall be read in conjunction with BC.03 or BC.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.30 C

All cast material shall have an austenitic structure, after final heat treatment at the foundry, with the following composition (% wt):

C max. 0.06, Cr 18.0-21.0, Ni 10.5-14.0, Mo 2.00-3.00, Si max. 1.50,
 Mn max. 2.00, P max. 0.040, S max. 0.040, Nb+Ta min. 8 x C max. 1.00

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	-	-	
EN	GX5CrNiMoNb19-11-2	1.4581	-

This sheet shall be read in conjunction with BC.03 or BC.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.32

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.08, Cr 16.5-18.5, Ni 10.5-14.0, Mo 2.00-3.00, Si max. 1.00,
 Mn max. 2.00, P max. 0.045, S max. 0.030

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	316	-	S31600
EN	X5CrNiMo17-12-2	1.4401	-
	X3CrNiMo17-13-3	1.4436	-

This sheet shall be read in conjunction with BC.03 or BC.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.32 C

All cast material shall have an austenitic structure, after final heat treatment at the foundry, with the following composition (% wt):

C max. 0.08, Cr 17.0-21.0, Ni 9.0-14.0, Mo 2.00-3.00, Si max. 1.50,
 Mn max. 1.50, P max. 0.045, S max. 0.040

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	CF8M	-	J92900
EN	GX5CrNiMo19-11-2	1.4408	-

This sheet shall be read in conjunction with BC.03 or BC.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.33

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.08, Cr 16.5-19.0, Ni 10.0-14.0, Mo 2.00-3.00, Si max. 1.00,
 Mn max. 2.00, P max. 0.045, S max. 0.030, Ti min. 5 x C max. 0.80

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	316Ti	-	S31635
EN	X6CrNiMoTi17-12-2	1.4571	-

This sheet shall be read in conjunction with BC.03 or BC.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.34

All wrought material shall have a fully austenitic structure (max. ferrite content 0.6 %) after final heat treatment at the mill, with the following composition (% wt):

C max. 0.020, Cr 24.5-25.5, Ni 21.0-23.0, Mo 1.90-2.30, Si max. 0.40,
Mn max. 2.00, P max. 0.020, S max. 0.015, N 0.10-0.16

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	310MoLN	-	S31050
EN	X1CrNiMoN25-22-2	1.4466	-

This sheet shall be read in conjunction with BC.05

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.36

All wrought material shall have a fully austenitic structure (max. ferrite content 0.6%) after final heat treatment and shall have the following composition (% wt):

C max. 0.040, Cr 18.5-20.5, Ni 16.0-18.0, Mo 3.50-4.50, Si max. 0.70,
 Mn max. 2.50, P max. 0.030, S max. 0.020, N 0.10-0.25

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	316LN	-	S31653
EN	X2CrNiMoN17-13-3	1.4429	-

This sheet shall be read in conjunction with BC.10

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.39

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.030, Cr 16.0-18.5, Ni 10.0-15.0, Mo 2.00-3.00, Si max. 1.00,
 Mn max. 2.00, P max. 0.045, S max. 0.030, N max. 0.20

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	316L	-	S31603
	316LN	-	S31653
EN	X2CrNiMo17-12-2	1.4404	-
	X2CrNiMo17-12-3	1.4432	-
	X2CrNiMo18-14-3	1.4435	-
	X2CrNiMoN17-11-2	1.4406	-
	X2CrNiMoN17-13-3	1.4429	-

This sheet shall be read in conjunction with BC.09

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.45

All wrought material shall have a fully austenitic structure, after final heat treatment at the mill, with the following composition (% wt):

C max. 0.020, Cr 19.5-20.5, Ni 17.5-18.5, Mo 6.00-6.50, Si max. 0.80,
 Mn max. 1.00, P max. 0.030, S max. 0.010, Cu 0.50-1.00, N 0.18-0.22.

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	-	-	S31254
EN	X1CrNiMoCu20-18-7	1.4547	-

This sheet shall be read in conjunction with BD.06

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.46

All wrought material shall have a homogeneous ferritic-austenitic structure, after final heat treatment at the mill, with a ferrite content of 40-60 %.

The material shall have a uniform ferritic structure with austenite islands fully enclosed by ferrite.

The material shall have the following composition (% wt):

C max. 0.030, Cr 21.0-23.0, Ni 4.50-6.50, Mo 2.50-3.50, Si max. 1.00,
 Mn max. 2.00, P max. 0.030, S max. 0.020, N 0.12 - 0.20.

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	F51	-	S31803
	F60	-	S32205
EN	X2CrNiMoN22-5-3	1.4462	-

This sheet shall be read in conjunction with BE.01 or BE.03

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.47

All wrought material shall have a homogeneous ferritic-austenitic structure, after final heat treatment at the mill, with a ferrite content of 40-60 %.

The material shall have a uniform ferritic structure with austenite islands fully enclosed by ferrite.

The material shall have the following composition (% wt):

C max. 0.030, Cr 24.0-27.0, Ni 4.50-7.50, Mo 2.00-4.50 Si max. 1.00, Mn max. 2.00,
 P. max. 0.035, S max. 0.025, Cu max 2.50, N 0.12-0.28, W max. 0.50

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	F59	-	S32520
	-	-	S32550
	-	-	S31260
	F53	-	S32750
	-	-	S32760
EN	X2CrNiMoN25-7-4	1.4410	-
	X2CrNiMoCuN25-6-3	1.4507	-
	X2CrNiMoCuWN25-7-4	1.4501	-

This sheet shall be read in conjunction with BE.01, BE.02, BE.03 or BE.04

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.47 C

All cast material shall have a homogeneous ferritic-austenitic structure, after final heat treatment at the foundry, with a ferrite content of 40-60 %:

The material shall have a uniform ferritic structure with austenite islands fully enclosed by ferrite.

The material shall have the following composition (% wt):

C max. 0.07, Cr 24.0-27.0, Ni 4.50-7.50, Mo 2.00-4.00, Si max. 2.00, Mn max. 2.00,
 P max. 0.040, S max. 0.040, Cu max. 3.25, W max. 1.00, N max. 0.30.

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	CD-4MCu	-	J93370
	CE3MN	-	J93404
EN	GX2CrNiMoCuN25-6-3-3	1.4517	-

This sheet shall be read in conjunction with BE.01, BE.02, BE.03 or BE.04

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.48

All wrought material shall have a homogeneous ferritic-austenitic structure, after final heat treatment at the mill, with a ferrite content of 40-60 %.

The material shall have a uniform ferritic structure with austenite islands fully enclosed by ferrite.

The material shall have the following composition (% wt):

C max. 0.030, Cr 21.5-24.5, Ni 3.0-5.5, Si max. 1.00,
 Mn max. 2.50, P. max. 0.030, S max. 0.015, N 0.10-0.20,

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	2304	-	S32304
EN	X2CrNiN23-4	1.4362	-

This sheet shall be read in conjunction with BE.05

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.50

All wrought material shall have a homogeneous ferritic-austenitic structure, after final heat treatment at the mill, with a ferrite content of 40-60 %.

The material shall have a uniform ferritic structure with austenite islands fully enclosed by ferrite.

The material shall be Sandvik Safurex[®]

Safurex[®] corresponds with the following standard:

	Code	Grade	Steel number	UNS number
△ w	ASTM	-	-	S32906
	EN	-	-	-

This sheet shall be read in conjunction with BE.06

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.56

All wrought material shall be in solution heat-treated condition, and shall have the following composition (% wt):

C max. 0.010, Cr 14.5-16.5, Ni balance, Mo 15.0-17.0, Si max. 0.08,
 Mn max. 1.00, P max. 0.040, S max. 0.030, W 3.00-4.50, Fe 4.00-7.00,
 Co max. 2.50, V max. 0.35

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	Hastelloy C 276*	-	N10276
EN	-	2.4819	-

* Alternative alloys in consultation with Stamicarbon

This sheet shall be read in conjunction with BF.01 or BF.03

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.64

All wrought material shall have the following composition (% wt):

Ti balance, C max. 0.100, Fe max. 0.10, N max. 0.030, H max. 0.013, O max. 0.180

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	Grade 1	-	R50250
EN	-	3.7025	-

This sheet shall be read in conjunction with BG.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.65

All wrought material shall have the following composition (% wt):

Ti balance, C max. 0.100, Fe max. 0.10, N max. 0.030, H max. 0.013, O max. 0.250

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	Grade 2	-	R50400
EN	-	3.7035	-

This sheet shall be read in conjunction with BG.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.66

All wrought material shall have the following composition (% wt):

Ti balance, C max. 0.100, Fe max. 0.10, N max. 0.050, H max. 0.013, O max. 0.350

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	Grade 3	-	R50550
EN	-	3.7055	-

This sheet shall be read in conjunction with BG.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.67

All wrought material shall have the following composition (% wt):

Ti balance, C max. 0.100, Fe max. 0.10, Pd 0.15-0.25
 N max. 0.030, H max. 0.013, O max. 0.250

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	Grade 7	-	R52400
	Grade 11	-	R52250
EN	-	-	-

This sheet shall be read in conjunction with BG.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.68

All wrought material shall have the following composition (% wt):

Ti balance, C max. 0.10, Fe max. 0.10, N max. 0.050,
 H max. 0.013, O max. 0.20, Al 5.50 - 6.75, V 3.50 - 4.50

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	Grade 5	-	R56400 R56401 R56402
EN	-	3.1765	-

This sheet shall be read in conjunction with BG.02

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.80

All wrought material shall have the following composition (% wt):

Al min. 99.5, Mg max. 0.03, Zn max. 0.10 Cu max. 0.10 Ti max. 0.03
 Mn 0.03 - 0.05, Si + Fe max. 0.50,

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	alloy 1060	-	-
	alloy 1100	-	-
EN		3.0385	-
		3.0305	-
		3.0285	-
		3.0275	-
		3.0205	-

This sheet shall be read in conjunction with BK.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.81

All wrought material shall have the following composition (% wt):

Al balance, Cr max. 0.10, Mg max. 1.30, Si + Fe max. 0.70,
 Mn 1.00-1.50, Zn max. 0.25, Cu max. 0.10, Ti max. 0.10

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	alloy 3003 alloy 3004 alloy 3005	-	
EN	-	3.0515	-

This sheet shall be read in conjunction with BK.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.82

All wrought material shall have the following composition (% wt):

Al balance, Cr 0.15-0.35, Mg 2.2-2.8, Si+Fe max. 0.45,
 Mn max. 0.10, Zn max. 0.10, Cu max. 0.10

The following standard materials are acceptable provided that their composition corresponds with the above values.

Code	Grade	Steel number	UNS number
ASTM	alloy 5052	-	-
	alloy 5252		
EN	3.3523	-	-

This sheet shall be read in conjunction with BK.01

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.98

Coating materials

-Hard baked epoxy phenolic resin coating,	
- Standard	Tegon F 21
	Säkaphen Si 57 E
- Diffusion resistant	Tegon F 25
	Säkaphen Si 57 EG
	Zacosin 2025 / 2014

Thickness tolerance 50 µm;

Thickness shall nowhere be less than 200 µm

Flange facings shall be coated too.

Equipment design adaptations

- all parts to be coated shall be properly accessible;
- all edges shall be rounded off;
- welds shall be flush and pore-free on the side to be coated.
- for shape and design of metallic structures to be protected see VDI 2532.

Equipment surface treatment

All rust, grease, mill scale, weld spatter and other imperfections shall be removed from the surfaces to be coated by means of grinding, if necessary and shot blasting to SSPC-CP-5-63 or Sa3: 'White metal blast-cleaning'.

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W

Material Specification MS.98

Coating inspection

Film thickness:

For measurement of the dry film thickness a magnetic (e.g. Elcometer, Microtest) or an inductive gauge (e.g. Permascope or Minitest) shall be used.

Film continuity:

The continuity (i.e. the absence of pinholes, crevices, etc. shall be inspected with a high voltage spark tester (5000 V/mm, max. 3000 V) or a wet sponge tester. An example of a suitable spark tester is Porotest 3, while a suitable wet sponge tester is, for instance, the Elcometer Pinhole Detector.

This sheet shall be read in conjunction with DA.05

Specification for materials of construction	GENERAL SPECIFICATION	
	drawing nr	A4-18005
	revision	W